CHAPTER III

ROADS AND STREETS

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ANNE ARUNDEL COUNTY DESIGN MANUAL

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ROADS AND STREETS

I. GENERAL

A. Introduction

This Chapter of the Manual outlines the Department of Public Works (DPW) policies, minimum design criteria, and other minimal essential design methodology for the design of trafficways. It is the intent that the criteria presented herein represents minimal requirements essential to the preparation of engineering reports, traffic studies, and construction documents. The requirements set forth herein shall apply to the design of new or proposed trafficways, as well as rehabilitative design of existing trafficways, whether they are to be constructed as capital projects, as part of a private subdivision or for a site development plan.

All engineering documents that require the approval of the DPW shall be prepared in strict accordance with the criteria presented herein, and shall not be deviated from without explicit approval, in writing, by the Director of the DPW.

The criteria contained in this manual are generally compatible with that of the American Association of State Highway and Transportation Officials (AASHTO), and the Maryland State Highway Administration (SHA). References are made to documents published by these and other agencies where appropriate.

Final determination concerning land division of a development project relative to road classification will be made by the Department of Planning and Code Enforcement (PACE), in accordance with the Zoning, and Subdivision Regulations.

B. Definitions

The DPW shall determine the functional classification of existing trafficways requiring rehabilitation and for any types not defined herein. For the purposes of this Manual, the below listed terms shall be defined as follows:

Trafficway: The term "Trafficway" identifies any highway, road, street, cul-de-sac, or alley. The term "State Road" identifies trafficways under the jurisdiction of the Maryland Department of Transportation, (SHA).

Highway: More heavily traveled trafficways (usually under the jurisdiction of the Maryland Department of Transportation, (SHA) with large daily rates of vehicular traffic, serving both local and through traffic.

Street or Road: Either term applies to less important trafficways (usually under the jurisdiction of the County DPW.)

Freeway: A divided road, four lanes or more, provides the highest level of mobility and speed, provides for efficient and uninterrupted travel over long distances serving interstate and commuter needs. Full control of access shall be utilized through the use of grade-separated interchanges. No access to adjacent properties is provided.

Expressway: A divided road, four lanes or more; provides a high level of mobility and speed for through traffic. Full or partial control of access with no direct access to adjacent properties. Some intersections may be at grade with traffic signal controls.

Principal Arterial: A multi-lane (divided or undivided) major artery of the County circulation network, serving the needs of through traffic for moderately long trips and serving inter/intra-area movements including travel between central business districts overlying residential areas, major inner city communities or major suburban centers. Provides full or partial control of access with direct access to adjacent properties allowed only under all but extreme circumstances.

Minor Arterial: This serves both functions of access and mobility with the emphasis on the movement of through traffic of trips of moderate length. Provides interconnection with principal arterial and to collector roads to provide access to or through communities of high density residential, commercial, retail or industrial land use. Provides at least partial control of access to adjacent properties at predetermined locations.

Collector: This serves both functions of access and mobility for traffic circulation within residential, commercial, and industrial areas, providing primary access to an arterial road, direct access to local roads and other collector roads. Provides direct access to all adjacent properties.

Local: This provides direct access to adjacent properties and residences. Lowest level of mobility and speed and discourages through traffic movement.

Cul-de-sac: A local street with one outlet, having a paved, circular turn-around area at the closed end. Collectors and Arterial may also terminate in a cul-de-sac in Commercial, Industrial, and Multi-family developments, or where topographic features make it necessary.

Alley: A trafficway, which provides secondary service access for vehicles and pedestrians to the side or rear of abutting properties.

Minimum Stopping Sight Distance: Sight distance is the length of roadway ahead visible to the driver. The minimum stopping sight distance available on a roadway should be sufficiently long to enable a vehicle traveling at or near the design speed to stop before reaching a stationary object in its path. Minimum stopping sight distance is the sum of two (2) distances: the distance traveled by the vehicle from the instant the driver sights an object necessitating a stop to the instant the brakes are applied, and the distance

required to stop the vehicle from the instant the brakes are applied. These are referred to as brake reaction distance and braking distance, respectively. The minimum stopping sight distance (SSD) is based on the longest distance at which a driver, whose eyes are three feet-six inches (3'- 6") above the pavement, can see the top of an object six (6") inches high on the trafficway along an over-vertical (crest) curve.

Minimum Headlight Sight Distance: The headlight sight distance conforms to the minimum stopping distance definition. The headlight sight distance is based on the length of roadway along an under vertical (sag) curve illuminated by headlights 2'-0" above the trafficway with a one-degree (1°) divergence of the light beam from the vehicle's longitudinal axis.

Intersection Sight Distance: The sight distance at a crossroad or street should be sufficient along the predominant highway to avoid the hazard of collision between a vehicle starting to cross the highway or turning into the intersecting highway from a stop position and a vehicle on the through road operating at design speed and appearing after the crossing or turning movement has begun.

C. Authorization, Permits

Where intersections occur with trafficways under the jurisdiction of Maryland State Highway Administration, or other political districts, a permit from the agency involved authorizing the proposed construction must be provided to the DPW before plans will be approved.

Depending on project location, funding program, and environmental, or other specific characteristics, projects may be required to be reviewed and approved by a combination of one or more of the following agencies:

- Anne Arundel County DPW (various divisions)
- Anne Arundel County Soil Conservation District
- Anne Arundel County Department of Planning and Code Enforcement (PACE)
- Maryland Department of Transportation (MDOT)
- State Highway Administration (SHA) (for construction within SHA right-of-way or State and Federally funded projects)
- Maryland Department of Natural Resources (DNR)
- Maryland Department of the Environment (MDE)
- Water Resources Administration (WRA)
- Federal Highway Administration (FHWA) for Federally funded projects
- Environmental Protection Agency (EPA) for Federally funded projects
- Maryland Forest Service, Department of Natural Resources
- U.S. Corps of Engineers (COE)
- Anne Arundel Soil Conservation District (AASCD)

D. Abbreviations

AASHTO:	American Association of State Highway and Transportation Officials
ADT:	Average Daily Traffic
CBR:	California Bearing Ratio
DPW:	Anne Arundel County Department of Public Works
SHA:	Maryland Department of Transportation, State Highway Administration
MUTCD:	Manual on Uniform Traffic Control Devices
PACE:	Anne Arundel County Department of Planning and Code Enforcement
P.C.:	Point of Curve
P.C.C.:	Point of Compound Curve
P.R.C.:	Point of Reverse Curve
P.T.:	Point of Tangent
P.V.C.:	Point of Vertical Curve
P.V.I.:	Point of Vertical Intersection
P.V.T.:	Point of Vertical Tangent
P.V.C.C.:	Point of Vertical Compound Curve
P.V.R.C.:	Point of Vertical Reverse Curve
P.S.D.:	Passing Sight Distance
S.S.D.:	Stopping Sight Distance
T.C.:	Top of Curb

II. DESIGN CRITERIA

A. Pre-Design Meeting

Prior to commencing any design work on Capital Projects, a pre-design meeting shall be held as provided in Chapter I, General Instructions. For Developer Projects, a pre-sketch meeting may be held at the request of the developer. These meetings will discuss, at a minimum, the need for traffic signals, in addition to items which pertain to any other Chapters, which will govern the design of the project:

B. Preliminary Considerations

1. Factors to be Considered in Trafficway Design

The design of trafficways include general layout, alignment, grades, subsurface conditions, grading, paving widths, paving thickness, paving material, and drainage facilities. Sufficient right-of-way shall be established in the early stages of planning and preliminary layout to allow for future phase increases in pavement widths, the addition of sidewalks, and other roadside improvements that may be in projected planning needs of the community. The road right of way widths shown in the Standard Details are only a guide for the normal roadway section for the classification shown. However, proposed right-of-way widths other than those shown on the Standard Details shall be determined by the design requirements (number and width of traffic lanes, median, turn lanes, by-pass lanes, shoulder width,

sidewalks, bike lanes, drainage ditches, etc.). When determining alignments and grades of trafficways the design professional must consider the requirements for future or existing utilities and any relocations required, including providing adequate storm drainage facilities. Any unusual aspects of the design such as railroad and commuter rail crossings, and similar rights-of-way shall be taken into account. The design professional must also endeavor to select alignments which fit the existing site topography to the greatest extent possible, provide public safety, and are aesthetically pleasing, as well as economically feasible, and will not have detrimental impacts on the environment. The environmental considerations shall meet the criteria of Local, State, and Federal agencies.

2. Survey Requirements

   a. Horizontal control shall be established by conventional "closed" traverse or Global Positioning System (GPS) surveys. All horizontal control shall be tied to the Maryland State Plane Coordinate System, utilizing the monumentation of the National Geodetic Survey (N.G.S.) and the Anne Arundel County Survey Control Stations. The State Plane Coordinate System Datum shall be specified, (i.e., N.A.D. 27; N.A.D. 83; N.A.D. 83/91).

      Conventional traverses shall have a minimum closure ratio of 1:15000. GPS control points shall be established in accordance with the specifications and requirements of the Federal Geodetic Control Committee (F.G.C.C) for using GPS relative positioning techniques as amended. All control points shall be referenced in detail on the Contract Drawings.

   b. Vertical control for all projects shall be based on the U.S.C.& G.S. Mean Sea Level Datum of 1929, (NAVD 1929) or NAVD 1988. The design professional shall clearly indicate on all drawings which datum was used. Benchmarks for the project shall be of a permanent nature, and spaced at a maximum distance of 1000 linear feet. Benchmarks shall be clearly shown and referenced in detail on the Contract Drawings. A minimum of one (1) benchmark shall be shown on each plan sheet.

   c. Survey baselines shall be extended for the full length of the project and extended a minimum of 400 linear feet beyond anticipated limits of work. Baseline stationing shall be shown at every 50 linear feet, at control points, and all intersecting points. Station equalities shall be shown for all common intersecting control points.

   d. Spur lines shall be run on all intersecting roads, railroads, streams, and natural drainage courses, and shall be tied into the main baseline.

   e. Topography (existing physical and/or natural features) to be shown on the Contract Drawings shall include but not be limited to all buildings and structures; utility poles, conduits, structures, overhead lines; manholes, water mains, valves, hydrants and meters; wells, springs, septic systems, fences, paving and curb,

trees, hedges, shrubs, flower beds, storm drain pipes; and all other topography necessary for the design and construction of the proposed project.

The method of locating topography shall be by field surveys using electronic data collection system or alternate method approved by DPW. If approved by DPW, aerial photogrammetry may be used and supplemented with field surveys as described above for topography only.

f. Topographic requirements (contour lines) may be provided by aerial photogrammetry for engineering studies and drainage area maps. All vertical survey requirements for preliminary and final design shall be acquired by actual, field surveys.

If approved by the County, developer projects such as subdivisions, and site developments located substantially within undeveloped areas, may be designed utilizing aerial photogrammetry.

g. Contour lines shall be shown on the Contract Drawings as required by the Soil Conservation Service. Traffic signalization plans do not require baseline contour lines.

h. Cross-sections shall be taken at fifty-foot stations, and at intersecting roads, driveways, entrances, rivers, streams, and railroads. Cross-sections shall be at right angles or radial to the proposed alignment, and extend a minimum of 100 feet beyond the proposed right-of-way line each side and a minimum of 200 feet beyond anticipated project limits. The minimum distances shown herein should be extended accordingly in order to provide sufficient information to establish profile grade lines beyond the actual project limits or to locate other topography or photographic relief, relative to the design or construction of the proposed improvements. Cross-sections shall be plotted on standard cross-section sheets of a quality that will provide acceptable prints.

i. Property corners shall be thoroughly referenced such that they may be reset after construction.

j. Anne Arundel County monuments that will be affected by the proposed construction shall be noted on the Contract Drawings as being protected or to be relocated accordingly.

3. Right-of-Way Requirements

The right-of-way width should be sufficient to accommodate the ultimate planned roadway, including as applicable, median, shoulder, grass strip, sidewalks, public utility facilities, flares at intersections, and width for necessary outer slopes, except where specific easements are provided. In all new subdivisions, the minimum right-of-way widths shown for the various classes of trafficways in the Standard Details must be provided.

4. General Development Plan

   All road or street planning shall be coordinated with the current General Development Plan of Anne Arundel County, which is available through PACE. If conditions change from those envisioned when the General Development Plan was prepared and the anticipated traffic on a given road consequently increases beyond the upper limit of its present classification, a new classification should be determined and submitted for review.

   The final determination of the roadway classification will be through a traffic study for the project based on the year of the project construction.

5. Preliminary Studies

   The first phase of a project shall be a preliminary study. The extent of a preliminary study will be as directed by DPW or by PACE, in the case of developer projects. Preliminary studies will require coordination with PACE in order to comply with the General Development Plan (GDP) and applicable Zoning and Environmental Regulations. Generally, the preliminary study will formulate multiple alternate alignments, and for each, evaluate all economic considerations, social or political impacts, safety, esthetics, environmental impacts, and any other relevant elements directed. The preliminary study shall arrive at a recommended alternate with justifications provided in detail through sound engineering principles.

6. Design Speed

   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. Running speed is the speed of a vehicle over a specified section of highway, being the distance traveled in the running time (the time the vehicle is in motion). Posted speed is usually based on the 85-percentile speed value determined by observation of a suitable sample of vehicles. For complete discussion on the relationship of design speed, running speed and posted speed see AASHTO "A Policy on Geometric Design of Highways and Streets." The chosen design speed must be a logical one with respect to the topography, the adjacent land use, and the type of highway. Once the design speed has been selected, all of the pertinent features of the highway must be related to it to obtain a balanced design.

   The design speed chosen should be consistent with the speed a driver is likely to expect. A highway or highway functional classification may justify a higher design speed than a less important facility in similar topography. A low design speed, however, should not be assumed for a secondary road where the topography is such that drivers are likely to travel at high speeds. Drivers do not adjust their speeds to the importance of the highway but to their perception of the physical limitations and traffic thereon.

After determining the functional classification of the trafficway under design, the design professional shall determine the appropriate minimum design speed based on the criteria presented herein.

Roads and streets in residential areas should not be designed to encourage speeds beyond the design speeds. For streets with posted speeds of 30 mph and less, the design speed should be the same as the posted speed. For posted speeds above 30 mph, the design speed should only be 5 to 10 mph above the posted speed. The design parameters (horizontal alignment, vertical alignment, etc.) should be in accordance with the design speed. See Appendix P for design features for development projects.

C. Traffic Studies

1. Necessity of Study

Level of service studies shall be performed for those proposed development projects, which are likely to generate sufficient traffic to have a significant impact on existing facilities. Level of service studies shall be conducted in accordance with the County's "Guidelines for Traffic Impact Studies" in the Appendix and the Adequate Facilities Ordinance.

Traffic studies will be a part of capital projects when included in the design professional's contract with DPW. Traffic impact studies will be performed for capital projects that generate 250 or more trips per day, such as parks, public buildings, landfills, etc. Traffic studies for capital projects may include level of service, accident, pedestrian, and parking studies. Studies shall adhere to the County's "Guidelines for Traffic Impact Studies" (see Appendix N).

2. Level of Service Study

a. General: A level of service study as discussed in this Manual begins with determining the level of service at which the existing facilities under study are presently operating, and the projected level of service operation at a specified future date or ultimate development year. The study is completed by determining the effect of the proposed construction on current and design year operating characteristics.

Capacity is the maximum number of vehicles that can pass over a given section of a lane or roadway in one direction (or in both directions on a two-lane or three-lane highway) during a given time period under prevailing roadway and traffic conditions. Unless otherwise specified, the time period is one hour. Although capacity is the maximum number of vehicles that can be accommodated by a roadway, operation at this level is not desirable because of the delay and discomfort experienced by the motorist.

Level of Service is a qualitative measure of the operating conditions occurring on a road or street and is dependent upon many factors, among which are speed, traffic freedom to maneuver, safety, driving comfort, convenience, and operating costs. Six Levels of Service, lettered A through F have been established. Level of Service A is characterized by high speeds and freedom to maneuver, while Level F is characterized by stop and go traffic and excessive delay.

Service volume is the maximum number of vehicles that can be expected to pass over a given section of a lane or roadway at the specified Level of Service.

The minimum level of service to be used in design shall be Level of Service D unless otherwise directed by DPW.

By specifying a level of service and the traffic desiring to use a given road, the geometries required to provide that level of service can be determined. There are 3 steps to be conducted in the study and are as follows: 1) collection of current data, 2) projection of traffic data, and 3) level of service analysis. When these studies are properly conducted and their results are taken into consideration in the design, the road should be capable of serving its intended purpose.

A detailed description of the methods of conducting a level of service study is beyond the scope of this manual and only some of the major points are discussed herein. Reference is made to the latest edition of the Transportation Research Board's Highway Capacity Manual and the County's "Guidelines for Traffic Impact Studies" for detailed methodologies on traffic studies.

b. Selection of Design Year: The design year for capital improvement projects shall be twenty years unless specified otherwise by DPW. Consideration should also be given to conditions expected to exist at various intervals between the expected completion of construction and those interim design years so that the possibility of staged construction can be evaluated. For APF traffic studies, existing traffic volumes plus projected traffic from development(s) shall be used.

c. Collection of Existing Data: When the project being studied involves an existing roadway, the first step in the level of service study is the determination of existing conditions. (See the County's "Guidelines for Traffic Impact Studies" in the Appendix). This includes not only volumes and peak factors, but also type of traffic (trucks, buses, cars), directional distribution, turning movements, and roadway data (width, etc.). This information is necessary to determine the existing level of service and the expected level of service in the future if no improvements are made.

Roadway data can be obtained from DPW and/or a field inspection. Roadway information required:

- Width
- Number of Lanes
- Presence of Parking
- Grades
- Distance to Lateral Obstructions
- Average Highway Speed
- Percent of passing sight distance greater than 1500 feet (On two lane highways only).
- Intersection Signal Timing and Plan
- Traffic Information Required:
  - ADT (Average Daily Traffic) - total number of vehicles passing a given point on an average day.
  - AWDT (Average Weekday Traffic) - total number of vehicles passing a given point on an average weekday (used in industrial areas with little weekend traffic). Note: Both ADT and AWDT vary throughout the year and shall be adjusted for seasonal variations.
  - DHV (Design Hourly Volume) - the number of vehicles passing a given point during the peak hour of an average day (or weekday in industrial areas). On two-lane roads the DHV is the total number of vehicles, bi-directional, whereas on other highways, it is divided into directional flows.
  - PHF (Peak Hour Factor) - the ratio of the design hourly volume to the peak rate of flow expanded to one hour. For intersections, the peak rate of flow is measured in fifteen-minute periods, while on roadways it is measured in five-minute periods.
  - D (Directional Distribution) - the percentage of the DHV oriented in the predominant direction.
  - K - DHV/ADT (or DHV/AWDT) - peak hour percentage of ADT
  - T (Truck Percentage) – percentage of trucks in the DHV.
  - Turning Movements

Sources of traffic information include DPW and SHA. If traffic data are not available from these sources, counts will have to be made and converted to an ADT (or AWDT) and DHV. The directional distribution is needed on all roads and shall be determined by actual counts.

In residential and other areas not strictly influenced by commercial or industrial land use, the truck percentage may be assumed to be 5 percent. In commercial and industrial areas or in any location with a large number of trucks, the truck percentage shall be determined by actual counts.

Though DPW will furnish any current data available in its files, the assembly of the data for analysis is the responsibility of the developer or design professional.

d. Projection Of Traffic Volumes: To ensure that a road will be capable of accommodating the demand imposed on it at an acceptable level of service for a

number of years beyond its construction, it is necessary to predict future traffic. Changes in the trends of development, population and income are but a few of the factors that can alter traffic patterns and consequently change projected volumes. It is, therefore, necessary to carefully consider the anticipated requirements of the future in determining traffic volumes for the design year. The three primary components of the design year traffic are existing, normal growth, and developed. When considering future volumes, each of these categories must be analyzed individually and then combined for their total impact on the facility. The basic volume used in traffic projections is the ADT or AWDT.

Existing traffic volumes can be determined by methods set forth in the previous section. In the case of a proposed development, there is no existing traffic and the only traffic to be considered is the future volume.

Normal growth traffic projections for capital projects shall be based on land use assumptions and historic growth patterns. When engineering studies indicate a growth rate other than those projected by the County to be appropriate, the alternate rate may be used if approved by the County.

Developed traffic is determined by relating traffic volume and land use. Studies of existing land uses have shown a fairly consistent relationship between the number of average daily trips and such factors as dwelling units, employees, acreage, floor area, etc.

The average daily trips are said to be generated by the associated land use. Appropriate trip generation rates shall be developed from the latest edition of the Institute of Transportation Engineers (ITE) "Trip Generation" or from an actual study of a similar existing land use.

Caution and judgment must be exercised in applying the generation rates. The availability of mass transit, extensive car-pooling, schools within walking distance of homes, and multiple shift industries may warrant their modification. In addition, the orientation of trips must be considered. The use of trip generation rates other than those in the ITE's "Trip Generation", is subject to review and approval by the County.

e. Level of Service Analysis: The level of service analysis can be used in several ways. The existing level of service, the level of service at some future date if no improvements are made, and the geometries required providing a desired level of service for a specific volume of traffic can be determined.

A complete level of service analysis may require the study of more than one time period. The peak flow normally occurs twice per day: once in the morning and once in the evening. The predominant movement during the A.M. peak is away from residences and toward employment areas, whereas the opposite occurs during the P.M. peak. Consequently, both of the peak periods should be considered. For commercial subdivisions, level of service analysis should also

consider Saturday peak traffic periods (typically midday). Normally the hours of peak traffic to and from a development will coincide with the hours of peak highway traffic.

A level of service analysis is required at locations per the Adequate Facilities Ordinance.

The level of service analysis is the responsibility of the developer or design professional.

1) Roadway (uninterrupted flow): All existing County and State roads per the County's Adequate Facility Ordinance in all directions from each point of entrance to and exit from the proposed subdivision, through the intersection with the first arterial or major highway, and along the arterial or major highway in both directions, to the next intersecting arterial or major highway shall have a roadway analysis performed in accordance with the County's road rating system. In some specific cases, roadway level of service analysis may also be required (per County) to be performed using procedures from the latest edition of Transportation Research Board's Highway Capacity Manual.

2) At-Grade Intersection (interrupted flow): At-grade intersections can be controlled by several means, such as basic right-of-way rule, yield, two-way stop, four-way stop, roundabouts and signalization. The level of service analysis assumes signalization, but is also applicable to intersections controlled by other means.

   If an intersection analysis is required, a simple critical lane analysis shall be performed in accordance with the County's Traffic Impact Study Guidelines. When the critical lane volume exceeds 1,300 vph, supplemental analysis using the TRB's Highway Capacity Manual is required.

   Two factors used in the level of service analysis are the Peak Hour Factor for volume adjustment and the area type. The Peak Hour Factor and area type categories shall be established by DPW.

   The "critical lane analysis" also may be used for assessing intersection level of service. If the Critical Lane Volume is less than 1300 vph, the intersection can be assumed to be operating satisfactorily. If, however, the critical lane volume exceeds 1300 vph, the intersection shall be further analyzed using the Transportation Research Board's Highway Capacity Manual procedures. The critical lane analysis procedures and an example are included in the Appendix.

   Level of Service analysis shall also include an Anne Arundel County Road Rating System Analysis as described in the County's "Road Rating System User Manual."

f. Street Lighting: Street lighting shall be studied when so directed by the DPW. Additional information is provided in paragraph II. F. 11, herein.

g. Maintenance of Traffic: When designing either an improvement of an existing road or a completely new road, consideration must be given to maintaining traffic during construction. Maintenance of traffic plans are to be part of the construction contract documents. Traffic volumes often found in areas of construction, coupled with a construction period, can result in a complex problem, which can make an otherwise acceptable design infeasible. The maintenance of traffic, therefore, must be carefully studied during the design process. Three methods of maintaining traffic are available:

   1) Stage construction so that the existing facility can be used to accommodate traffic during construction.

   2) Construct temporary detour routes to accommodate existing traffic.

   3) When traffic cannot be satisfactorily accommodated by the previous two methods, divert existing traffic to adjacent streets for detour routes. Diversion of traffic onto existing residential roadways is extremely undesirable because the increase in traffic volume will be unacceptable to the residents and disrupt pedestrian movement, residents' travel pattern, emergency vehicles, school busses, local deliveries, and mail routes. The County allows detour routes only if it is impossible to maintain traffic on the impacted roadway.

      A traffic control plan shall be developed utilizing some combination of the above methods. Traffic volumes and speeds, capabilities of existing roads, the existing street pattern, availability of land for detour routes, and scheduling of construction activities are among the factors that must also be considered.

      Traffic control typicals are contained in the Standard Details. These typicals and general notes will be required on traffic control plans.

      The roadway, whether in a construction area or a detour, shall be satisfactory to accommodate traffic at a reasonable speed, which is dependent upon speed approaching the roadway and length of project, but normally not less than 30 mph.

      Where rail traffic is interrupted, the railroad affected shall be contacted and a maintenance of traffic plan developed which is acceptable to both the railroad and DPW.

      The signing and marking of all roadways associated with the maintenance of traffic shall be in accordance with the Manual of Uniform Traffic Control Devices for Streets and Highways.

The complete maintenance of traffic plan including but not limited to the schedule of construction operations as related to traffic maintenance, the number and widths of lanes to be open during various periods of the day, and the alignment, grade, typical section, and construction details of temporary detour roads, work restrictions as to working hours, such as working on Saturdays, Sundays and holidays shall be included in the Contract Documents.

Special attention will be required when projects are located in residential communities. Access to local residences, maintenance of pedestrian traffic, maintenance of bicycle traffic, working hours, restrictions in work activities shall be included in the Contract Documents.

The maintenance of traffic plan is subject to review and approval by the DPW.

3. Presentation and Use of Results of Study

Though the extent and content of traffic reports will vary with the needs of the project being studied, traffic reports shall be in the general format presented herein.

D. Horizontal Alignment

1. Selection of General Alignment

Horizontal and vertical alignments cannot be designed independently as they complement each other. Horizontal alignment and vertical profile are the most important of the permanent design elements of the highway, for which thorough study is warranted. Curvature and grades must be in proper balance. Vertical curvature superimposed on horizontal curvature, or vice versa, generally results in a more pleasing facility, but it should be analyzed for effect on traffic. Horizontal curvature should not be introduced at or near the top of a vertical curve. This condition is hazardous in that the driver cannot perceive the horizontal change in alignment, especially at night when the headlight beams go straight ahead into space. The hazard of this arrangement is avoided if the horizontal curvature leads the vertical curvature, i.e., the horizontal curve is made longer than the vertical curve. Suitable design can also be made by using design values well above the minimum requirements for the design speed. However, roads and streets in residential areas should not be over designed to encourage speeds beyond the intended design speeds. Sharp horizontal curvature should not be introduced at or near the low point of sag vertical curve. Because the road ahead is foreshortened, any curve but flat horizontal curvature assumes an undesirably distorted appearance. Further, vehicular speeds, particularly of trucks, often are high at the bottom of grades, and erratic operation may result, especially at night.

On two-lane roads and streets the need for safe passing sections at frequent intervals and for an appreciable percentage of the length of the roadway often supersedes the

general desirability for combination of horizontal and vertical alignment. In these cases it is necessary to work toward long tangent sections to secure sufficient passing sight distance in design, however the designing for sufficient passing sight distance in residential communities is not required, since passing in residential communities is undesirable.

Horizontal curvature and profile should be made as flat as feasible at intersections where sight distance along both roads or streets is important and vehicles may have to slow or stop. On divided highways and streets, variation in width of median and the use of separate profiles and horizontal alignments should be considered to derive design and operational advantages of one-way roadways. Where traffic justifies provision of four lanes, a superior design without additional cost generally results from the concept and logical design basis of one-way roadways.

The alignment should be designed with considerations given to aesthetics to enhance attractive scenic views of the natural and manmade environment.

2. Horizontal Curves

Horizontal curves are used to change direction at a safe rate of speed and shall be used wherever the roadway centerline changes direction. The relationship of design speed, curvature and superelevation shall be established to provide a balanced design. The relationship between design speed, curvature and superelevation is:

$$e + f = \frac{V^2}{15R} = \frac{DV^2}{85{,}660}$$

Where: e = rate of superelevation, foot per foot
f = side friction factor
V = vehicle speed, mph (design speed)
R = radius of curve, feet
D = degree of curve

The vehicle speed shall be the minimum design speed, as established for the specific road classification.

The side friction factor is a measure of the comfort experienced by the motorist while negotiating a curve. Values vary indirectly with the design speed of the highway, decreasing from 0.17 at 20 mph, 0.16 at 30 mph, 0.15 at 40 mph, 0.14 at 50 mph, 0.13 at 55 mph, 0.12 at 60 mph.

Maximum superelevation rates are dependent upon the type of roadway, the effect of the superelevation upon vehicles operating at less than the design speed and drainage considerations. Vehicles operating at low speeds may have to steer against the curve to overcome the effect of superelevation, and erratic operation can result. On ice and snow, slow moving vehicles may slide to the inside of the curve if the superelevation rate is too great. In urban areas, the close spacing of intersections and driveways

limit the superelevation. On curves flatter than the maximum, values of superelevation and side friction must be distributed to produce a balanced design. The method used is to increase both superelevation and the side friction factor to maximum values at the sharpest allowable curvature, maximum degree of curvature is shown in the Appendix.

The means of transitioning from a normal crown section to a fully superelevated section and then back to normal crown section is the tangent and superelevation runoff. The runoff must be sufficiently long to provide a smooth transition and not appear distorted to the driver. The length of tangent run out shall be such that the outside edge of pavement has the same slope relative to the centerline as that through the superelevation runoff. For appearance and comfort, the rate of superelevation runoff should not exceed a longitudinal slope (edge compared to centerline of a two-lane highway) of 1:200. In other words, when considering a two-lane pavement with plane sections, the difference in longitudinal gradient between the edge of pavement profile and its centerline profile should not exceed 0.5 percent. Two-thirds of the superelevation runoff shall be placed on the tangent and one-third on the curve.

Methods of obtaining superelevation are shown in the Appendix. Though the means of changing cross slopes are presented in terms of straight lines, the angular breaks shall be rounded in final design to produce smooth pavement edge profiles.

3. Superelevation and Warping

   Horizontal curves of residential streets shall not be superelevated or warped. Horizontal curves of arterial joining or within major developments may warrant superelevation. Horizontal curves of arterial, commercial and industrial trafficways shall normally be superelevated or warped, in accordance with AASHTO "A Policy on Geometric Design of Highways and Streets" criteria and the material presented in Paragraph 2 above. Superelevation of rural collector highways shall not exceed 0.06 ft./ft.

4. Sight Distance

   a. Passing: Passing sight distance (PSD) is the distance required for a vehicle to pass another before meeting an opposing vehicle which might appear after the pass began. It is applicable only to two-lane, two-way rural major collectors and minor arterial.

      Passing sight distance is measured between an eye height of 3.5 feet and an object height of 4.25 feet.

      The minimum passing sight distance should be provided at least once per mile.

      See Table III-2 for minimum passing sight distance.

b. Stopping: Stopping sight distance (SSD) is the distance required for a vehicle to stop before reaching an object in its path. It is the sum of the distance traveled from the moment the object is first visible to the driver to the moment the brakes are applied, plus the distance required to stop after the brakes are applied. The equation for stopping sight distance is:

$$SSD = \text{Reaction time } x\ (V) + \frac{V^2}{30(f \pm G)}$$

Where: V = initial speed (mph)
f = coefficient of friction for wet pavement
G = percent of algebraic grade divided by 100 (G is positive for upgrade and negative for downgrade)

Stopping sight distance is measured between an eye height of 3.5 feet and an object height of 6 inches.

Stopping sight distance for various combinations of design speeds and grades are shown Table III-3 and Table III-4.

E. Vertical Alignment

1. Allowable Grades of Trafficways

The minimum grade for all roads and streets shall be 1.0 percent unless otherwise approved by the County. Where a curbed section is used, the spacing of inlets must be carefully studied when utilizing the minimum grade to avoid the excessive spreading of storm water across the pavement. Criteria limiting drainage encroachment upon the roadway are given in Chapter V, Storm Drains.

The maximum allowable grade varies with both the road classification and design speed. The maximum road grades shall be in accordance with the Table III-1:

TABLE III-1

Maximum Allowable Road Grade for Collector, Local Cul-de-Sac Streets

Zoning District	Local Streets/Road and Collector Streets/Roads	Cul-de-Sac Streets
RA, R-1, R-2,	10%	10%*
R-5, R-15, R-22	10%	10%*
R-44	8%	10%*
Commercial & Industrial Districts, Parks & Recreational Areas	8%	10%*

*12% maximum on short cul-de-sac streets will be allowed with DPW approval.

Maximum Allowable Road Grade for Principal Arterial and Minor Arterial

Design Speed MPH	Maximum Grade Desirable	Absolute
40	6%	8%
50	5%	7%
60	4%	6%

It is necessary to consider, in addition to maximum grade, the effect of length of grade upon vehicle operation. Though most passenger cars can climb fairly steep long grades with little difficulty, trucks generally undergo a substantial reduction in speed, which can result in a reduced level of service and increased accident potential. The maximum length of designated upgrade that a loaded truck can travel without an unreasonable reduction in speed is termed the "critical length of grade". Major collectors in commercial or industrial areas and all arterial shall be checked for critical length of grade.

The maximum permissible speed reduction shall normally be 15 mph. Where the upgrade is preceded by a substantial downgrade, vehicle speeds are likely to be higher at the bottom of the upgrade, and the maximum permissible speed reduction may then be as great as 20 mph. Whenever a design exceeds the critical length of grade, the grade shall be reduced, the length reduced, or a climbing lane added. In no case shall the climbing lane be ended prior to a point at which the truck can attain a speed of at least 30 mph.

The design criteria presented herein regarding vertical curve lengths shall be carefully evaluated for the various conditions to ensure minimum requirements are designed for. An example of this is that intersection site distance may govern crest vertical curve length.

2. Vertical Curves

The vertical curve, which is a parabola, is the means by which transitions are made between vertical tangents. A typical curve with the major elements identified is shown in the Appendix.

The elevation of any point on the curve may be computed by using the following formula:

$$Y = ax^2 + bx + c$$

Where: Y = Elevation of desired point on curve
a = (G2 - G1)/2L
b = G1
c = Elevation of PVC
x = Distance from PVC to point on curve (in stations)

G1 and G2 = Tangent grades, in percent with upgrades in the direction of the stationing being positive and downgrades negative.

L = total length of vertical curve in stations.

The vertical offset between the tangent and any point on the curve can be determined by the following formulas:

a. Between PVC and PVI: $y = ax^2$
b. Between PVI and PVT: $y = a (L - x)^2$

The high or low point of a vertical curve can be found by the following formula:

$$x = \frac{(L)(G1)}{G_1 - G_2}$$

The grade, Y^1, at any point on the vertical curve can be determined by the following formula:

$$Y^1 = \frac{(G2 - G1)(x)}{L} + G1$$

Whenever vertical tangents change grade, they shall be connected by a vertical curve.

3. Sight Distance

a. Passing Sight Distance (PSD): Appreciable grades increase the sight distance required for safe passing. Passing is easier for the vehicle traveling downgrade because the overtaking vehicle can accelerate more rapidly than on the level and thus can reduce the time of passing, but the over taken vehicle can also accelerate easily and increase the passing distance.

The passing sight distance required to permit vehicles traveling upgrade to pass with safety is greater than those required on level roads because of reduced acceleration of the passing vehicle, which increases the time and distance of passing, and the likelihood of opposing traffic speeding up.

Design values for crest vertical curves to provide sufficient length for passing sight distance differ from those for stopping sight distance because of the different height criterion. The general formulas apply, but the 4.25 feet height of object results in the following specific formulas:

When S is less than L

$$L = \frac{AS^2}{3093}$$

When S is greater than L

$$L = 2S - \frac{3093}{A}$$

L = Length of Vertical Curve, ft.
S = Stopping Sight Distance, ft.
A = Algebraic difference in grades (G), percent (%)

(Height of eye and object are 3.5 ft. and 4.25 ft. respectively.)

The passing sight distance on upgrades shall be greater than the derived minimum.

Table III-2

Minimum Passing Sight Distance

Design Speed (mph)	Passed Vehicle (mph)	Passing Vehicle (mph)	Computed Distance (ft.)	Rounded for Design (ft.)
20	20	30	810	800
30	26	36	1,090	1,100
40	34	44	1,480	1,500
50	41	51	1,840	1,800
60	47	57	2,140	2,100
65	50	60	2,310	2,300
70	54	64	2,490	2,500

b. Stopping Sight Distance (SSD): When a highway is on a grade, the standard formula for braking distance is the following:

$$D = \frac{V^2}{30(f \pm G)}$$

$$\text{Stopping sight and distance} = \text{Reaction time } x\ (V) + \frac{V^2}{30(f \pm G)}$$

$$= 3.675(V) + \frac{V^2}{30(f \pm G)}$$

The terms are as previously stated. The safe stopping sight distances on upgrades are shorter; those on downgrades are longer. The effect of grade on stopping sight distance is shown in Table III-3. These corrections are computed for wet conditions and the assumed design criteria is the same as that presented in the Stopping Sight Distance Table (Table III-4).

Crest vertical curves must be sufficiently long to provide the required stopping sight distance. The formulas for minimum length of crest vertical curves are:

When S is less than L

$$L = \frac{AS^2}{1{,}329}$$

When S is greater than L

$$L = 2S - \frac{1{,}329}{A}$$

L = Length of Vertical Curve, ft.
S = Stopping Sight Distance, ft.
A = Algebraic difference in grades (G), in Percent (%)

(Height of eye and objects are 3.5 ft. and 6 inch, respectively.)

Minimum lengths of sag vertical curves shall be based upon headlight sight distance, which shall be equal to the stopping sight distance.

Table III-3

Effect of Grade on Stopping Sight Distance
(Wet Conditions)

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

Reference: AASHTO, A Policy on Geometric Design of Highways and Streets, 1990

Table III-4

Stopping Sight Distance
(Wet Pavements)

Distance Design Speed (mph)	Brake Time (sec)	Braking Reaction Distance (ft.)	Coefficient of Friction, f	Distance on Level (ft.)	Computed Distance (ft.)	Rounded for Design Distance (ft.)
20	2.5	73.3	0.40	33.3	106.7	125
25	2.5	91.7	0.38	54.8	146.5	150
30	2.5	110.3	0.35	85.7	195.7	200
35	2.5	128.3	0.34	120.1	248.4	250
40	2.5	146.7	0.32	166.7	313.3	325
45	2.5	165.0	0.31	217.7	382.7	400
50	2.5	183.3	0.30	277.8	461.1	475
55	2.5	201.7	0.30	336.1	537.8	550
60	2.5	220.0	0.29	413.8	633.8	650
65	2.5	238.3	0.29	485.6	724.0	725
70	2.5	256.7	0.28	583.3	840.0	850

Reference: AASHTO, A Policy on Geometric Design of Highway and Streets, 1990

c. Headlight Sight Distance: For the purpose of this Manual, the headlight sight distance shall not exceed the stopping sight distance. When a vehicle traverses a sag vertical curve at night, the portion of highway lighted ahead is dependent on the position of headlights and the direction of the light beam. It is to be assumed that the headlight has a height of 2.0 feet above the road surface, and a 1-degree upward divergence of the light beam from the longitudinal axis of the vehicle. The upward spread of the light beam provides some additional visible length but this is to be ignored. The following formulas show the S, L, and A relation, using S as the distance between the vehicle and point where the 1 degree angle of light ray intersects the surface of the roadway:

When S is less than L:

$$L = \frac{AS^2}{400 + 3.5S}$$

When S is greater than L:

$$L = 2S - \frac{400 + 3.5S}{A}$$

Where L = length of sag vertical curve, ft. (minimum)
S = light beam distance, ft. (Stopping Sight Distance)
A = algebraic difference in grades, percent (%)

For overall safety on highways, a sag vertical curve length should be long enough so that the light beam distance is nearly the same as the stopping sight distance. Accordingly, it is pertinent to use stopping sight distances for different

design speeds as the S value in the above formulas. Table III-5 lists the design controls for sag vertical curves based on stopping sight distance.

Table III-5

Design Controls for Sag Vertical Curves Based on Stopping Sight Distance

			Rate of Vertical Curvature, k	
Design Speed (mph)	Coefficient of Friction, f	Stopping Sight Distance, Rounded for Design (ft.)	Computed	Rounded for Design
20	0.40	125	14.7	20
25	0.38	150	23.5	30
30	0.35	200	35.3	40
35	0.34	250	48.6	50
40	0.32	325	65.6	70
45	0.31	400	84.2	90
50	0.30	475	105.6	110
55	0.30	550	126.7	130
60	0.29	650	163.4	160
65	0.29	725	178.6	180
70	0.28	850	211.3	220

Minimum length of sag vertical curve is the rate of vertical curvature, k, multiplied by the algebraic difference in grades, A.

F. Cross-Section Elements

1. Use of Typical Sections in Standard Details

   Unless otherwise approved by the County, typical sections for the various functional classifications shall be as shown in the Standard Details.

2. Pavement Criteria

   a. Typical Sections: Typical sections of each type of proposed trafficway to be constructed shall conform with the typical sections shown in the Standard Road and Street Details when it has been proven through soil boring tests (as described below) that existing sub grade soil is California Bearing Ratio (CBR) of 5 or greater. The pavement structures for these typical sections require a minimum sub grade CBR of 5. The design professional shall perform soil borings as described in General Instructions, Chapter I of this Manual or perform laboratory CBR tests (AASHTO T193) to determine if the roadway sub base material will satisfy a minimum CBR of 5. If the soils on the project site do not satisfy the minimum CBR value, the design professional shall create a design that corrects the deficient sub base conditions.

An exception to the pavement width criteria may be permitted by the Director, PACE in the case of "Planned Unit Developments".

b. CBR Improvement: Sufficient testing of sub grade soils must be performed to assure the necessary data is provided for design of the pavement structure.

Should the existing soils on site not have the required minimum CBR value of 5, the design professional may require the soil to be scarified and recompacted or removed to an appropriate depth and replaced with suitable material to increase CBR values to meet the minimum specified.

c. Geotextiles: In cases where poor load bearing soils are encountered after three feet of unsuitable material have been undercut and removed below pavement subgrade, a geotextile may be used to separate the poor load bearing soils from the suitable backfill material. In no case will the use of the geotextile be allowed in lieu of undercutting unsuitable material and replacing it with compacted suitable material.

3. Shoulders

Where shoulders and open drainage sections are applicable, the shoulder typical section shall be the same as the adjacent trafficway typical section material as shown in the Standard Details. Where there is a prior approval by DPW, other shoulder materials may be specified in large lot residential subdivisions (one-acre lots or larger with 150-foot minimum frontage).

4. Valley Gutters

Valley gutters, as shown in the Standard Details, shall be used only where approved by DPW but will normally be permitted where the approach road is a cul-de-sac or local street, providing that no more than 2 cfs are carried across an intersection.

5. Sidewalks

Those areas normally requiring sidewalks are so indicated on the typical sections contained in the Standard Details. The minimum sidewalk width shall be 4 feet. Sidewalks shall be five (5) feet wide if constructed contiguous to the curb. Where there will be a large number of pedestrians, such as near schools and in some commercial areas, the sidewalks shall be made sufficiently wide to accommodate the anticipated pedestrian demand. The selection of a sidewalk width in such areas is subject to review and approval by DPW. Sidewalks shall be constructed in accordance with the Standard Details. Sidewalks at intersections shall be provided for handicap access in accordance with ADA requirements.

6. Bikeways

   Bikeways shall be constructed where directed by PACE. Residential areas, school and open space areas and short routes connecting residential and employment centers typically warrant provisions for bicyclists.

   Bikeways may be located within the roadway pavement, separated from the roadway but within the street right-of-way or within their own right-of-way such as through open areas.

   Cul-de-Sac streets and local streets will not normally have designated bikeways because of the low traffic volumes and speeds. Designation of Bikeways within the roadway is the responsibility of the Director of Public Works; as a guide to developers and design professionals, such bikeways will not normally be permitted within the roadway when the design speed exceeds 40 mph.

   Unless otherwise approved by the County, bikeways shall conform to typical sections as shown in the Standard Details.

7. Guardrail

   Guardrail is needed at certain roadside obstacles and along some embankments to reduce the severity of run-off-the-road type accidents. It should only be installed where the severity of a collision with the guardrail will be less than that which would occur were the guardrail not present.

   Combinations of embankment slope and height warranting guardrail for open sections are shown in the Appendix. Wherever feasible, the embankment should be adjusted to eliminate the need for guardrail. Where guardrail is warranted, it shall be placed as shown on the typical sections and Standard Details.

   Factors to be considered when determining the need for guardrail at fixed roadside objects include design speed, roadway functional classification, type of obstacle and distance from pavement edge to the obstacle. The determination of need for guardrail is subject to review and approval by DPW.

   Guardrail shall conform to the standard details, except that along cul-de-sac streets, local streets and minor collectors in residential areas, wooden guardrail may be used if approved by DPW.

   Guardrail shall normally be extended from the fill into the cut. Where a long low fill not requiring guardrail is adjacent to a fill that does warrant guardrail, the guardrail may be started or ended on the low fill.

8. Underdrains

   To drain free water from sub grades, under drains shall be incorporated into the design of trafficways (See Standard Details). The design professional shall evaluate

acquired soils data relative to excessive ground water conditions and provide recommendation to DPW for locations and design of under drains.

9. Gutters and Ditches

   The minimum and maximum grades for gutters and ditches shall be designed in accordance with Chapter V, Storm Drains, and incorporated into the road design accordingly.

10. Bus Stop Widening

    The deceleration lane, standing, or loading area, and acceleration lanes for buses shall be designed to be separated from the through traffic lanes. The design of bus turnouts shall include, but not be limited to, passenger platforms, ramps, stairs, railings, signs, and markings. Speed-change lanes shall be long enough to enable the bus to leave and enter the through traffic lanes at approximately the average running speed of normal traffic without undue inertial discomfort to passengers. The length of acceleration lanes from bus turnouts shall be well above the normal minimum values for passenger cars, to allow a loaded bus to attain acceptable speed prior to reentering the through travel lane. The bus standing or loading area and transition lanes, which include the shoulders, shall be a minimum of 20 feet wide to permit passing a stalled bus. The pavement areas of turnouts should contrast in color and texture with the through traffic lanes to discourage through traffic from encroaching on, or entering the bus stop.

    The dividing area between the outer edge of trafficway shoulder and the edge of the bus turnout lane should be as wide as feasible, but in no instance shall it be less than 20 feet wide. A barrier is required in the dividing area, and fencing shall be designed to keep pedestrians from entering the trafficway unless otherwise directed by DPW. Pedestrian loading platforms shall be designed a minimum of 10 feet wide unless otherwise approved by DPW and conform to ADA requirements.

    The deceleration lane shall be tapered at a 5:1 transition.

    The loading area shall provide a minimum of 50 feet of length for each bus. The width shall be a minimum of 12 feet wide unless otherwise approved by DPW.

    The re-entry acceleration lane taper shall be a maximum of 3:1 transition.

    The minimum length of turnout for a two-bus loading area shall be a minimum of 195 feet for a mid-block location, 165 feet for a nearside location, and 145 feet for a far-side location. These dimensions are based on a loading area width of 12 feet. Greater lengths of bus turnouts expedite bus maneuvers, encourage full compliance on the part of bus drivers, and lessen interference with through traffic.

11. Street Lighting

When directed by DPW to provide street lighting as part of a capital improvement project or a developer project, the following minimal criteria shall be met:

a. The average maintained horizontal illumination for roadway and walkway shall conform to the requirements of Table III-6

b. The ratio of average-to-minimum uniformity ratio of 3:1 to 4:1 shall be applied wherever an average illumination of 0.6-foot candle or more is required. Where the average illumination of less than 0.6 foot-candle is required, a 6:1 ratio shall apply.

c. Breakaway light pole bases shall be used along all roadways if pole is within the clear zone and not protected. At all other locations, outside the clear zone, or within the clear zone and protected, light bases shall be the non-breakaway type. Clear zone requirements shall conform to AASHTO's "Roadside Design Guide".

d. The lighting pole and foundation shall be designed to withstand a 100 mph wind.

e. For arterials and above, the light pole should be located outside of the roadway clear zone.

f. The lighting system should be designed in conjunction with the roadway so that the result will be a coordinated facility in which each element complements the other. The relation between lighting and signs and potential obstacles must be carefully considered. Roadside obstacles can often be reduced by the utilization of "joint use" poles, which can for example, support both a luminaire and a traffic signal.

g. The determination of need for lighting, as well as the design of a lighting system, shall be subject to review and approval by DPW.

h. The illumination of intersections shall be the summation of the levels of the intersecting roadways.

i. For street lighting in development projects, refer to Appendix P for additional County criteria.

Table III-6

Average Maintained Horizontal Illumination for Roadways and Walkways

Roadway and Walkway Classification	Footcandles for Areas Indicated*		
	Commercial	Intermediate	Residential

Vehicular Roadways			
Principal and Minor Arterial	2.0	1.4	1.0
Collector	1.2	0.9	0.6
Local	0.9	0.6	0.4
Alleys	0.6	0.4	0.2
Pedestrian Walkways			
Sidewalks	1.0	0.6	0.4
Pedestrian Walkways	2.0	1.0	0.5

*Area Classification

Commercial - That portion of a municipality in a business development where ordinarily there are large numbers of pedestrians and a heavy demand for parking space during periods of peak traffic or a sustained high pedestrian volume and a continuously heavy demand for off-street parking space during business hours. This definition applies to densely developed business areas outside of, as well as those that are within, the central part of municipality.

Intermediate - That portion of a municipality which is outside of a downtown area but generally within the zone of influence of a business or industrial development, characterized often by moderately heavy nighttime pedestrian traffic and a somewhat lower parking turnover than is found in a commercial area. This definition includes densely developed apartment areas, hospitals, public libraries and neighborhood recreational centers.

Residential - A residential development, or mixture of residential and commercial establishments, characterized by few pedestrians and a low parking demand or turnover at night. This definition includes areas with single family homes, townhouses and/or small apartments. Regional parks, cemeteries, and vacant lands are also included.

Reference:AASHTO "An Informational Guide for Roadway Lighting", March, 1976.

G. Intersection Design

1. Horizontal Alignment and Spacing:

Trafficways shall be so designed by functional classification that sufficient length is provided between intersections for the maneuvering of traffic volume, storage and support of adjacent land uses. The minimum intersection spacing, as measured along the through roadway between centerlines of intersecting roadways, shall be as indicated in the Table III-7. Centerlines of trafficways shall continue through intersections without breaks or offsets, and shall intersect as nearly as possible at

right angles. The layout of intersections with State Highways shall be subject to final approval by the State Highway Administration. County trafficways shall not intersect State Highways at intervals less than 750 ft. between centerlines unless otherwise approved by DPW and SHA. This requirement supersedes the Minimum Intersection Spacing Table III-7 when the functioning classification of a State Road requires less than 750 feet.

Table III-7

Minimum Intersection Spacing

Functional Classification of Through Road	Minimum Intersection Spacing (Centerline to Centerline)
Freeway	1 mile (interchange)
Expressway	Median Crossover: 1,500'
Divided	Tee Intersections: 750'
Divided	750'
Undivided	500'
Principal Arterial	750'
Minor Arterial	500'
Collector	250'
Local Street/Road	150'
Cul-de-Sac	NA

2. Layout of Curbs, Pavement Edges and Property Lines at Intersections.

   The design radii of traffic curbs and pavement edges at intersections shall be in accordance with the Minimum Curb Fillet Radius Table III-8.

Table III-8

Minimum Curb Fillet Radius

Functional Classification of Intersection Streets	Residential Area (ft.)	Industrial or Commercial Area (ft.)
Cul-de-Sac Streets	20	30
Any Classification		
Local-Local	20	30
Local-Collector	20	30
Local - Minor Arterial	20	30
Collector-Collector	25	40
Collector - Minor Arterial	25	40

Minor Arterial- Minor Arterial	30	50
Minor Arterial- Expressway	30	50
Major Highway- Arterial	30	60
Principal Arterial-Minor Arterial	30	60
Freeway	Consult DPW	
Principal Arterial-Principal Arterial	30	60
Expressway	Consult DPW	

The above radii are based on a 90-degree turning angle. Reference is made to "AASHTO Policy on Geometric Design of Highways and Streets".

At an intersection of trafficways (excluding alleys), the cutback of the property line shall be a line connecting two points on intersecting right-of-way lines and a minimum of 25 feet from their point of intersection. At an intersection of alleys, the property line shall conform with the pavement fillet.

All curbs, sidewalks, and paving configurations at intersections shall be designed for handicap access in strict accordance with the Americans with Disabilities Act and all applicable State and County Codes and regulations.

3. Intersections With State Highway

   Criteria and permits related to intersections of private or County roads with State Highways shall be designed in accordance with SHA standards and subject to its approval.

4. Vertical Alignment

   a. Pavement slopes of through streets or streets with the higher functional classification shall be carried through the intersection without deviation. The pavement slopes of the street with the lower classification shall be warped to meet the pavement edge of the through street. Where two roads of the same classification intersect, they shall be connected by considering one the more important and transitioning the other or by transitioning both roadways. Proposed paving elevations at all points of intersection of curb line shall be clearly shown and identified on the plan and profile, as well as other points required to adequately construct the proposed facility. A top of curb or edge of pavement profile shall be shown on the contract drawings for radii 50' or greater.

   b. Curb or Edge of Pavement Grades at Intersections: As discussed above, one of the intersecting roads shall be determined to be the more important and its grade carried through the intersection without interruption. Gutter or edge of pavement grades around fillets shall be intersected with a smooth transition that promotes complete positive drainage. Other grades at the intersection shall be such that complete runoff of drainage will occur and water will not pond across or in any portion of the two intersecting trafficways. Proposed top of curb grades shall be

clearly shown and identified at each fillet on the P.C., P.T., and mid-point. The grade of the minor intersecting road shall not exceed that indicated in Table III-9.

Table III-9

Pavement Grades at Intersections

Functional Classification	Maximum Grade Through Intersection	Distance from Intersection[1]
Expressway	3.0%	200'
Principal Arterial	3.0%	200'
Minor Arterial/Collectors	3.0%	175'
Local/Cul-de-sacs	4.0%	40'

[1] Distance measured from pavement edge of intersecting road to the P.V.C. of the vertical curve. Intersections with State Highways shall be designed in accordance with SHA criteria, and subject to its approval.

5. Sight Distance

The maneuvers occurring at an intersection are different from those occurring at other points along a highway and the sight distance needed to ensure safety at intersections is consequently different. There are conditions where the intersection sight distance will prevail over other data to establish minimum crest vertical curve lengths, and this must be thoroughly investigated by the design professional. At signalized intersections, the movements are controlled and provisions for the stopping sight distance as given in the Appendix shall be utilized for design. However, at unsignalized intersections, the driver on the cross street must be able to see enough of the highway to enable him to turn left, right, or proceed straight through the intersection without causing undue delay to traffic on the major road.

The following criteria have been established for the determination of unsignalized intersection sight distance:

a. Cross Movement: Sufficient distance, both left and right, to enable a stopped vehicle to cross the intersection before a vehicle on the major highway reaches the intersection, even though this vehicle appears just as the crossing maneuver begins, without the through vehicle having to decelerate.

b. Left Turn Movement: Sufficient distance on the left to enable a stopped vehicle to turn left onto the major road before a vehicle approaching from the left reaches the intersection even though this vehicle appears just as the left turn begins, without the through vehicle having to decelerate. Also, sufficient distance on the right to enable a stopped vehicle to turn left onto the major road without a vehicle on the major road approaching from the right, having to decelerate more than 10 mph, even though the approaching vehicle appears just as the turn begins.

c. Right Turn Movement: Sufficient distance on the left to enable a stopped vehicle to turn right onto the major road without a vehicle on the major road, approaching from the left, having to decelerate more than 10 mph, even though the approaching vehicle appears just as the turn begins.

Reference is made to Appendices G, H and J regarding sight distances .

6. Turning/Storage and Merge Lane Design

The design professional shall investigate the necessity of providing auxiliary lanes to at grade intersections preceding and following right turning movements and to other purposes supplementary to through traffic movements.

Auxiliary lanes shall be a maximum of 12 feet wide and a minimum of 10 feet wide. The length of the auxiliary lanes for turning vehicles consists of three components: (1) deceleration length, (2) storage length, and (3) entering transition taper. The total length of the auxiliary lane shall be the sum of the length for these three components. Where intersections occur as frequently as four per mile, the auxiliary lane length shall be the sum of the storage length plus transition taper.

The deceleration length required is that needed for a comfortable stop from a speed that is typical of the average running speed on the main facility. On the basis of design speeds of 30, 40, and 50 mph, deceleration lengths are 235, 315, and 435 feet respectively according to AASHTO "A Policy on Geometric Design of Highways and Streets", criteria.

In urban areas where the design professional determines that it would not be feasible to provide the full length for deceleration the design professional shall present the recommendations to DPW with justification. In such cases it shall be demonstrated that a partial deceleration must be accomplished before entering the auxiliary lane. Deceleration lengths shown are applicable to both left and right turning lanes. The auxiliary lane shall be sufficiently long to store the number of vehicles during a critical period. The storage length shall be liberal to avoid the possibility of left turning vehicles stopping in the through lanes. The storage length shall be sufficiently long so that the entrance to the auxiliary lane is not blocked by vehicles standing in the through lanes waiting for a signal change or for a gap in the opposing traffic flow.

At unsignalized intersections the storage length, exclusive of taper, shall be based on the number of turning vehicles in an average 2-minute period during the peak hour. As a minimum requirement, space for at least three passenger cars shall be provided. Where truck traffic exceeds 10 percent of total traffic volume, provision shall be made for at least two cars and one truck. The design professional shall evaluate traffic patterns of opposing traffic volumes and provide recommendations on whether another appropriate time interval should be used, or confirm that the 2 minute interval is satisfactory.

At signalized intersections the required storage length depends on the signal cycle length, the signal phasing arrangement, and the rate of arrivals and departures of left-turning vehicles. The storage length is a function of the probability of occurrence of events and shall be based on one and one-half to two times the average number of vehicles that would be stored per cycle, which is predicated on the design volume. This length will be sufficient to serve heavy surges that occur from time to time. As in the case of unsignalized intersections, provision shall be made for storing at least three vehicles.

The longitudinal location along the highway, where a vehicle will move from the through lane to a full width deceleration lane, will vary depending on several factors. These factors include the type of vehicle, the driving characteristics of the vehicle operator, the speed of the vehicle, weather conditions, and lighting conditions. Straight line tapers are frequently used. The taper rate shall be between 8:1 for operating speeds of 30 mph and less and 15:1 for operating speeds greater than 30 mph. The tapered section of deceleration auxiliary lanes shall be designed to be constructed in a "squared-off" section at full paving width and depth. This design requires a painted delineation of the taper and is only applicable to noncurbed sections. The design also requires transition of the outer or median shoulders around the squared-off beginning of the deceleration lane. A squared-off design principle can be applied to median deceleration lanes, and it may also be used at the beginning of deceleration right-turn exit terminals when there is a single exit lane.

7. Signalization Warrants

Based on the results of the traffic study recommendations, DPW will determine whether signalization is required at a particular intersection.

It is essential that intersection design be accomplished simultaneously with the development of traffic control plans to ensure that sufficient space is provided for proper installation of traffic control devices. Geometric design should not be considered complete nor should it be implemented until it has been determined that needed traffic control devices will have the desired effect in controlling traffic.

Most intersections are adaptable to either signing control, signal control, or a combination of both. At intersections not requiring signal control, the normal pavement widths of the approach highways shall be carried through the intersection with the possible addition of speed change lanes, median lanes, auxiliary lanes, or pavement transition tapers. Where traffic is sufficient to require signal control, the number of lanes for through movements may require analysis to consider the need for additional lanes at the intersection. Where the traffic volume approaches the uninterrupted flow capacity of the intersection leg, the number of lanes in each direction may have to be increased (based on the design professional's recommendations to the County) at the intersection to accommodate the traffic volume under stop and go traffic control. Other geometric features that shall be investigated by the design professional that may be affected by signalization are, length and width of storage areas, location and position of turning roadways, spacing

of other subsidiary intersections, access connections, and the possible location and size of islands to accommodate signal posts or standards.

8. Traffic Signal Design

   The design of traffic signals and associated traffic control devices shall be conducted basically in accordance with Maryland State Highway Administration's "Traffic Signal Design Guidelines for State/Local Agencies and Private Developers". However, Anne Arundel County Signalization Standards differ slightly from the State's, both in the way the drawings are laid out and in some of the design details. For development projects refer to Paragraph E. in Appendix P. For specifics, contact the Traffic Engineering Division, DPW.

9. Speed Control Devices

   Speed control devices such as traffic circles, islands, nubs, and speed humps shall be used only where approved by DPW. Details of speed control devices are shown in the Appendix.

H. Private Entrances

1. Location of Driveways - General

   Driveways shall be designed and located in accordance with all County Codes, ordinances, and regulations. Driveways shall be designed such that they will not interfere with, or be a hazard to the free movement of normal highway traffic and traffic congestion will not be created due to the entrance. In accordance with this principle, driveways shall be located where the roadway alignment and profile are favorable; i.e., where there are no sharp curves, or steep grades, and where driveway sight distance will be in accordance with criteria established herein for safe traffic operation. Driveways at locations that would interfere with the placement and proper functioning of highway signs, signals, lighting, or other devices that affect traffic operation shall be avoided. No driveway shall be located within 50 feet from the P.C. of the intersection curb radius.

   Driveway location and design is essential in assuring that a road will be capable of performing its intended role through and even beyond the design year. Driveways shall be located to minimize impact on traffic flow, and provide access consistent with the road's classification. Driveway design must be such that vehicles can safely and quickly enter and leave the roadway without excessively impeding through traffic.

   The control of access shall be in accordance with the functional classification of the street.

   There are two types of driveways: residential and commercial/industrial. Residential driveways are those serving single-family houses or apartment buildings with no

more than five dwelling units. Commercial/industrial driveways serve employment and shopping areas, multifamily residential, and apartment buildings with more than five dwelling units, and are consequently used by more trucks and a larger number of vehicles than residential driveways. High volume driveways are those with anticipated volumes exceeding 100 vehicles per hour.

All driveways (commercial/industrial and residential) shall be shown on the Contract Drawings in plan view including spot elevations. Spur line profiles shall be shown for all commercial/industrial entrances clearly indicating intersection of proposed and existing grades as applicable. A section of all entrances shall be shown on the cross-sections indicating centerline road station and tie-in to existing grades.

Driveways shall have a minimum grade of 2% and a maximum grade of 14% except for high volume driveways shall have a maximum grade of 6%.

Entranceways which will have gatehouses, walls, fences and/or signs shall be designed in accordance with the "Anne Arundel County Standards for Gatehouses, Fences and Community Signs Within County Right-of-Way, June 2, 1997."

2. Commercial/Industrial Entrances

   a. Channelization: All commercial/industrial entrances shall be channelized with concrete curb and gutter unless otherwise approved by DPW. The front curb shall be constructed on a line parallel to the existing or proposed edge of trafficway and the trafficway pavement shall be widened to meet ultimate section as required.

      Where the existing right-of-way width meets the ultimate roadway design criteria, the rear edge of the back of curb shall be constructed on the existing right-of-way line. Where existing right-of-way width does not meet ultimate improvement requirements, the back of curb shall be placed on the alignment of the proposed right-of-way line. The area between the curbs shall be properly graded and paved, sodded or seeded as required. No signs, structures, etc., shall be placed within the existing or proposed right-of-way.

   b. Entrance Location: The number and location of entrances that may be permitted will be based on other criteria presented herein, the usage, interior and exterior traffic patterns and the requirements of PACE and DPW. A maximum of two entrances will be allowed in the first 200 feet of frontage. For each additional 100 feet of frontage a maximum of one entrance may be permitted, subject to the County's approval. All entrance drives shall be shown on the plan and profile of trafficway construction drawings. Profile of the entrance spur shall be shown clearly to the intersection of grades where necessary, together with spot elevation on the plan view.

      The minimum frontages for two-way driveways are as follows:

1) Urban - Interior location - 75 feet
2) Urban - Corner location - 110 feet
3) Rural - Interior location - 90 feet (desirable 110 feet)
4) Rural - Corner Location - 125 feet (desirable 145 feet)

c. Entrance Width: The maximum width for two-way entrances at 60 to 90 degrees shall be 40 foot unless otherwise approved by DPW. The 40 feet width shall be divided into two 12-foot outbound lanes and one 16-foot inbound lane. If the design professional recommends a wider entrance width, the design professional shall submit justification to DPW for review. The maximum width for a one-way entrance shall be 35 feet.

Minimum allowable width for one-way access is 16 feet, minimum width for a two-way entrance is 24 feet.

d. Curbing: All islands must be curbed with standard concrete curb or concrete curb and gutter, as shown in the Standard Details. Depressed curb, and handicap ramps shall be designed to allow full handicap access and usage, in accordance with all Federal, State and County handicap codes and regulations.

e. Curb Length: Minimum curb island length on tangent shall be as shown on the Standard Details. Minimum curb tangent length between entrances and property lines shall be 5 feet.

f. Median Openings: No new openings shall be permitted in existing County divided highway medians for commercial entrances, unless approved by DPW. Median openings designed for new construction shall also be subject to the approval of DPW.

g. Drive-In Island Location: Drive-in islands shall include but not be limited to, gasoline pump islands, self-service banks, drive-in banks, drive-in restaurant, and drive-in photo service. Drive-in islands shall conform to the set-back requirements of PACE unless stopping sight distance or zoning ordinance dictate a greater distance for a particular usage. In all cases drive-in islands shall be located to provide sufficient queuing space so as to prevent vehicles from standing in driveways or public trafficways.

h. Building Setback: Minimum building setback shall be as specified in the Zoning Ordinance. However, intersection sight distance shall prevail as a minimum if building setback meets the zoning requirements but interferes with proper sight distance at an intersection. Therefore, the more stringent requirement will control building setbacks at intersections. The design professional will investigate and provide the appropriate recommendations regarding building setbacks at each intersection. Recommendations shall address existing structures or buildings, as well as establish requirements for future structures or buildings.

i. Angular Entrances: Angular entrances shall not extend beyond property line when paving driveway to highway, or beyond access control limits. The point of control will be the extension of the property line from its intersection County right-of-way line normal or radial to the edge of pavement.

j. Parking Lot Design: Commercial/Industrial establishments shall provide sufficient parking or storage space off the right-of-way to prevent the storage of vehicles on driveway areas or backing up of traffic on the public trafficway. Where there are one or more driveways to a corner establishment at a roadway intersection, parking will be restricted on each roadway between the intersection and the nearest driveway. Parking shall be in strict accordance with the requirements of PACE.

k. Sight Distance: To the extent feasible within frontage limits, all driveways shall be located at the point of optimum sight distance along trafficways.

Where a driveway is provided to a commercial establishment, the buffer area and adjacent border area shall be reasonably cleared so that either the establishment itself or any appropriate sign located outside the right-of-way can be seen at sufficient distance to enable proper and safe maneuvers on the part of drivers desiring to enter the establishment.

The profile of a driveway and the grading of the buffer area shall be such that the driver of a vehicle that is standing on the driveway outside the edge of the trafficway has proper sight distance in both directions along the trafficway to enable the vehicle to enter without creating a hazardous situation. Driveway sight distance shall be the same as intersection sight distance or as approved by DPW. Attention is also directed to the A.A. County Zoning Ordinance regarding permissible height of objects adjacent to driveway areas, including slopes.

l. Signing: All commercial signs in conjunction with roadside establishments shall be placed outside the roadway right-of-way, and in accordance with the A.A. County Zoning Ordinance. Necessary official and standard signs located within the right-of-way shall be so positioned and mounted as not to obstruct the view along the trafficway on the part of driveway users. Traffic control devices, and regulatory and warning signs located on private property shall conform to MUTCD and the State's supplement thereto. For development projects, refer to the criteria in Appendix P.

3. Residential Entrances

a. Single-Family: All entrances for single-family residences shall be located to allow safe stopping distance for the design speed of vehicles traveling on the public trafficway and allow minimum intersection sight distance for vehicle exiting the driveway.

Entrance of single-family residences on a corner lot shall be located off of the road with the lower ADT.

b. Multi-Family: For multi-family residences the driveway(s) shall be located as to not affect the flow of traffic. A turning lane shall be provided at the discretion of the DPW. Entrance shall be located to allow minimum stopping distance for vehicles traveling along the road and minimum intersection sight distance for vehicles exiting the driveways.

c. Median Openings: Median openings will not be permitted for residential driveway entrances. Median openings for multi-family residential areas will be permitted if approved by DPW. Where approval is given for median openings, turning lanes shall be provided unless waived by DPW.

I. Special Trafficways

1. Alleys

The maximum permissible grade on alleys shall be the same as private entrances and stipulated in Paragraph II.H. herein. Minimum vertical sight distance allowable for alleys shall be 100 feet. Alleys shall follow the general pattern of the adjoining streets. Tangents may be used up to a deflection angle of 20 degrees, curves shall be used with a minimum radius of 100 feet, or the curve can be made with a series of short chords. At the intersection of an alley and a street, the angle shall be 90 degrees. The elevation of the outside edges of the alley shall be two inches lower than that of the finished grade of the adjoining property.

Drainage design for alleys shall conform with, Chapter V, Storm Drains, of this Manual.

2. Cul-de-Sac, Alley Entrances, Driveways

Permanent dead-end streets or roads with a circular turnaround at the closed end shall be no longer than 600 feet. However, if approved by the County, lengths up to 1000 feet are permitted where the topography or shape of the parcel make longer extensions necessary. The minimum radius of paving and right-of-way shall be in accordance with the Standard Details. Positive drainage shall be provided in cul-de-sacs and the gutter line shall be shown in a linear profile. Spot elevations shall be shown on the plan view of the contract drawings at a minimum every 45-degree interval indicating proposed top of curb or edge of paving elevations. Vertical profiles of the top of curb or edge of pavement will be required for radii 40 feet and greater.

Off street parking must be provided in all cul-de-sacs. In the case of multi-family developments, the design professional must design off street parking areas. Traffic circulation provisions in parking area designs shall be reviewed and approved by

PACE. The Bureau of Highways, DPW, shall review and approve entrances onto County roadways.

3. Tee Turn-Arounds

If a street or road designed as a temporary dead-end street is to be extended into a through street at a future date, a tee turnaround shall be used in place of a cul-de-sac. The length of the turn around, of "T" portion, shall equal the width of the right-of-way. See the Standard Details for other pertinent dimensions.

J. Construction Affecting Existing Roadways

1. Utility Location and Trench Repair

The normal locations for the placement of utilities within an existing road right-of-way are shown in the Standard Details. Where conditions are such that the use of normal location arrangement would be impractical an alternate arrangement shall be developed by the design professional and appropriate recommendations submitted to DPW for review and approval. All utility owners shall have their utility installation plans approved by DPW before any construction work is commenced. Utilities installed in existing roadways shall be permanently patched in strict accordance with the trench repair detail shown in the Standard Details See Section 2 below (Restoration of Roadways Affected by Excavations.

Utilities within existing or proposed trafficways shall be clearly shown and identified on the Contract Drawings in plan and profile. The design professional shall thoroughly investigate the relationship between the existing utility locations and the proposed design improvements. Utilities to be relocated, protected, etc. shall be so indicated on the Contract Drawings. These relocations shall be coordinated with the Utility Owner by the design professional and appropriate schedules and construction cost provided to the County.

2. Restoration of Roadways Affected by Excavations

(a) If any individual, company, government agency or property owner within a two-year period makes three excavations within a 500 foot length of right-of-way pavement with a condition rating of 90 or above, they, at the time specified in subsection (e) of this section, shall mill to a depth of 1.5 inches and resurface the travel lane or lanes for a minimum length of 100 feet and a maximum length of 500 feet.

(b) If any individual, company, government agency, or property owner makes a longitudinal excavation of 20 feet or more in right-of-way pavement with a condition rating of 90 or above, they, at the time specified in subsection (e) of this section, shall mill to a depth of 1.5 inches and resurface the travel lane or lanes for a minimum length of 100 feet and a maximum length equal to the length of the excavation.

(c) If any individual, company, government agency, or property owner within a two-

year period makes three excavations within a 100 foot length of right-of-way pavement with a condition rating of greater than 70 but less than 90, they,at the time specified in subsection (e) of this section, shall mill to a depth of 1.5 inches and resurface the travel lane or lanes for the 100 foot area.

(d) If any individual, company, government agency, or property owner makes a longitudinal excavation of 100 feet or more in right-of-way pavement with a condition rating of greater than 70 but less than 90, they, at the time specified in subsection (e) of this section, shall mill to a depth of 1.5 inches and resurface the travel lane or lanes for a minimum length of 100 feet and a maximum length equal to the length of the excavation.

(e) All milling and resurfacing required by this section shall be accomplished within 90 days following completion of the permanent patches, unless this time is extended by the department.

This section does not apply to an excavation for a manhole or valve adjustment if the excavation is less than five feet by five feet or to any excavation that is less than two feet by two feet.

3. Maintenance of Traffic in Construction Areas

   a. DPW Consultation: The design professional shall consult with DPW to insure compliance with the existing requirements on the location; type and size of traffic control devices in place or to be installed, work restrictions including working hours and lane or shoulder closures.

   b. Manual of Uniform Traffic Control Devices (MUTCD): Reference shall be made to the MUTCD for the location and type of device best suited to aid in the safe and efficient flow and control of traffic. Traffic shall include both motorized and nonmotorized traffic.

   c. Traffic Control Plan: A traffic control plan shall be prepared by the design professional and included as part of the Contract Documents for each Capital improvement road project, unless otherwise directed by DPW. The traffic control plans shall designate traffic controls required during the various phases of construction indicating signage, detours, temporary trafficways, and other such devices to ensure existing traffic (vehicular and pedestrian) is maintained and is carefully and safely directed and controlled during construction. The traffic control plan shall designate work restrictions and working hours. For developer projects, traffic control plans will be required where the proposed construction of new facilities are tied into existing trafficways.

III. CONTRACT DRAWINGS AND DOCUMENTS

A. Reports

When required by DPW, the design professional shall prepare a report which shall address the need for a new or improved trafficway. This report shall include impacts,

both social and economical, for a built and non-built improvement and provide recommendations with justifications of the action that should be implemented.

B. Design Calculations

The design professional shall submit all design calculations prepared in connection with the project to DPW for review and approval. The calculations shall be submitted along with the Contract Drawings and shall be as specified in the General Instructions, Chapter I of this Manual. Any deviation from the criteria of this manual shall be so noted at the time of submittal. The design professional shall also submit survey control cards containing information on the permanent control marker, which were required to be established.

C. Contract Drawings

Contract Drawings shall be submitted to DPW for review and approval at each required design phase.

1. Street Names

The names of all trafficways shall be clearly identified and lettered in bold heavy letters along the right-of-way such that it does not interfere with other pertinent information on the drawing.

All road or trafficway names on each drawing shall be placed in the same relative position and be of the same size lettering.

2. Widths of Rights-of-Way, Pavement and Easements

Widths of existing and proposed rights-of-way and pavements for each trafficway shall be shown by dimensioning. Slope easements, utility easements, and rights-of-way which intersect proposed or improved trafficway rights-of-way shall be clearly identified, and dimensioned accordingly.

3. Topography

The location of all structures and topographic features shall be accurately shown, including poles, wells, septic systems, shrubs, trees, hedges, utilities, property markers, walls, buildings and other structures. This topography shall be obtained and shown on the drawings a minimum of 100 feet beyond right-of-way lines, 200 feet beyond the ends of trafficways or beyond approved limits of work, and 200 feet in each direction from an intersection. Standard symbols are shown in General Instructions, Chapter I. These indicated distances are minimal requirements. Actual site conditions will determine if additional topography is warranted beyond the above minimum distances, however, the design professional is responsible to ensure adequate design information is shown on the drawings.

4. Coordinates, Bearing and Ties

   All horizontal survey control (traverse) shall be identified at each control point by station and coordinates. Traverse lines between the control points shall be stationed and bearings shall be shown on each traverse line. All traverse control points shall be referenced to permanent objects not affected by the proposed construction, and shall be shown by reference diagrams on the Contract Drawings.

   Bearings of trafficway centerlines and coordinates of centerline P.C.'s, and P.T.'s and of intersecting trafficway centerline P.I.'s shall be shown along the respective centerlines.

   In addition to the above requirements, all P.I.'s, P.C.'s, P.T.'s and other points that are needed to re-establish the centerline of the trafficway shall be referenced to permanent features or guarded hub stakes that will not be disturbed by construction prior to the completion of all work.

   The location and description of all reference points and the distance or angles to the centerline control points shall be shown on the Contract Drawings.

5. Horizontal Curve Information

   Centerline curve information for each horizontal curve shall be tabulated on the plan sheet and the curve data is shown in the following order:

   Δ =_____°_____'_____" (External Angle)
   DC =_____°_____'_____" (Degree of Curve)
   CR = _____ ft. (Centerline Radius)
   T = _____ ft. (Tangent Length)
   L = _____ ft. (Length of Curve)
   E = _____ ft. (External)

   Should a spiral curve be incorporated into the proposed facilities the same relative data shall be shown on the drawings, and shall be labeled and identified as shown in AASHTO's "A Policy on Geometric Design of Highways and Streets".

6. Stationing

   Stationing along the surveyed horizontal control traverse and trafficway centerlines shall be in even 50-foot stations, indicated by a small circle and the station number. Stationing along horizontal curves shall be indicated in like manner.

   P.C.'s and P.T.'s of horizontal curves shall be indicated by a small double circle on the centerline, and their stations shown to the nearest hundredth of a foot. Drainage structures and pipes with pipe diameters and direction of flow shall be shown. Flood plain and wetland areas shall be shown and identified.

D. Contract Specifications

Proposed work not covered by Anne Arundel County Standard Specifications for Construction of Water Mains, Sanitary Sewers, Storm Drains, Streets and Roads, dated 1988 or latest edition, and subsequent revisions thereof, shall be covered by Special Provisions in the contract specifications.

E. Estimates of Quantities and Costs

The design professional shall furnish detail construction cost estimates including all quantities and costs to complete all proposed work shown on Contract Drawings including fixed price contingent items. Estimates shall indicate current Engineering News Record Index and date. Estimates for the proposed work shall accompany each required submittal. The design professional shall throughout the duration of the capital project, notify the County of any significant additions that would require additional funds for construction so that adequate funding may be appropriated prior to the bidding process, or the project scope revised accordingly.

F. Cross-Sections

The design professional shall prepare cross-sections for all proposed road construction or widening of County owned roads. Cross-sections shall be plotted at a natural scale of not greater than 1 inch = 5 feet. Cross-section sheets shall be kept neat and legible, and shall be made a part of the Contract Documents when bid for construction. Cross-sections shall be plotted at 50-foot station intervals and at intersecting roads, drives, or entrances.

IV. APPENDIX

A. References

B. Road and Street Contract Drawing Check List

C. Maximum Degree of Curvature

D. Superelevation Transitions

E. Minimum Length of Speed - Change Lanes

F. Ratio of Speed Change Lane Length to Grade

G. Sight Distance on Horizontal Curves

H. Critical Length of Grade

I. Design Controls For Vertical Curves

J. Sight Distance at Intersections

K. Horizontal Circular Curve

L. Widening Computations

M. Guardrail Required For Embankment

N. Guidelines for Traffic Impact Studies

O. Anne Arundel County Standards for Gatehouses, Fences and Community Signs within County Right-of-Way, June 2, 1997.

P. Anne Arundel County Traffic Control Devices and Street Trees for New Development Projects.

APPENDIX A

REFERENCES

(1) Highway Capacity Manual Special Report No. 209, Transportation Research Board.

(2) "A Policy on Geometric Design of Highway and Streets", AASHTO.

(3) "Manual on Uniform Traffic Control Devices for Streets and Highways", Federal Highway Administration.

(4) "Transportation Planning Handbook", Traffic Engineering Handbook, Institute of Transportation Engineers.

(5) "Manual of Traffic Engineering Studies", Institute of Transportation Engineers.

(6) "Traffic Trends," Bureau of Traffic Engineering, State Highway Administration, Maryland Department of Transportation.

(7) "Trip Generation" Informational Report, Institute of Transportation Engineers.

(8) "Guidelines for Driveway Design and Location," Institute of Traffic Engineers.

(9) Anne Arundel County Zoning Ordinance.

(10) Anne Arundel County Code.

(11) "Americans With Disabilities Act, Accessibility Guidelines Checklist for Buildings and Facilities," U.S. Architectural and Transportation Barriers Compliance Board.

(12) "Roadside Design Guide", AASHTO

(13) "Road Rating System User Manual", Anne Arundel County Department of Planning and Code Enforcement.

(14) "Traffic Signal Design Guidelines for State/Local Agencies and Private Developers", Maryland State Highway Administration.

CHECK LIST
ROADS AND STREETS CONTRACT DRAWINGS

LOCATION: _____

DATE: _____

CHECKED BY: _____

– PLAN –

A. SUPPLEMENTARY INFORMATION.

1. PROPERTY -- ALL LINES ABUTTING TRAFFIC WAY RIGHT-OF-WAY SHOWN IN PROPER SYMBOLS.
2. PROPERTY -- EXISTING RIGHT-OF-WAY SHOWN AND DIMENSIONED.
3. PROPERTY -- SUBDIVISION PLAT BOOK AND FOLIO NUMBERS WHEN AVAILABLE.
4. PROPERTY -- SUBDIVISION LAYOUT CHECKED WITH FINAL SUBDIVISION PLAT.
5. PROPERTY -- SUBDIVISION NAME, SECTION, BLOCK LETTER WHEN AVAILABLE.
6. TOPOGRAPHY -- FIELD RUN CHECKED FOR POLES, FENCES, BUILDINGS, DRIVEWAYS. HYDRANTS. SHRUBS. TREES. PAVEMENT WALKS, SYMBOLS. ETC.
7. TOPOGRAPHY -- CARRIED 100' BEYOND RIGHT-OF-WAY LINES AND 200' BEYOND ENDS OF TRAFFIC WAYS OR BEYOND APPROVAL LIMITS.
8. TOPOGRAPHY -- SHOW EXISTING PAVEMENT AND LABEL TYPE OF SURFACE.
9. UTILITIES -- SHOW STORM DRAIN FACILITIES BEING PREPARED: WITH PROPER SYMBOL.
10. UTILITIES -- EXISTING UTILITIES SHOWN AND LABELED.
11. SCALES -- SHOWN IN PROPER LOCATION.

B. PROPOSED ROAD AND STREETS (TRAFFICWAYS)

12. TRAFFIC WAYS -- NAMES OF ALL TRAFFICWAYS IN PROPER POSITIONS.
13. TRAFFIC WAYS -- LIMITS OF CONTRACT CLEARLY DEFINED.
14. TRAFFICWAYS -- LIMITS OF NEW RIGHT-OF-WAY SHOWN AND DIMENSIONED.
15. TRAFFICWAYS -- LIMITS OF NECESSARY EASEMENT SHOWN AND DIMENSIONED.
16. TRAFFICWAYS -- WIDTHS OF PROPOSED PAVEMENT PROPERLY SHOWN AND DIMENSIONED.
17. TRAFFICWAYS -- CENTERLINES CORRECTLY SHOWN AND STATIONED.
18. TRAFFICWAYS -- COMPLETE BEARING INFORMATION.
19. TRAFFICWAYS -- CURVE DATA IN PROPER ORDER; CHECK COMPUTATIONS.
20. TRAFFICWAYS -- PROPER RADII RETURNS TO FACE OF CURB OR EDGE OF PAVEMENT.
21. TRAFFICWAYS -- P.I.s OF CURB LINES LOCATED AND LABELED.
22. TRAFFICWAYS -- DIRECTION OF FLOW ARROWS AT CURB RETURNS AND CRITICAL DRAINAGE POINTS.
23. TRAFFICWAYS -- SLOPES OF NON-STANDARD GUTTERS NOTED ON PLAN.
24. TRAFFICWAYS -- LOCATIONS OF CURB, GUTTER. INLETS, SIDE DITCHES, OUTLET DITCHES, SWALES OR MOUNTABLE CURB AND GUTTER SHOWN AND LABELED WHERE NECESSARY.
25. TRAFFICWAYS -- TYPICAL SECTIONS PROPERLY DRAWN AND LABELED.
26. TRAFFICWAYS -- GUARD FENCE OR BARRICADE POST LOCATIONS NOTED.
27. TRAFFICWAYS -- CUL-DE-SACS OR TEE STREETS CORRECTLY DRAWN: DIMENSIONED.
28. TRAFFICWAYS -- HORIZONTAL CURVES MEET REQUIREMENTS FOR DESIGN SPEED.

– PROFILE –

A. SUPPLEMENTARY INFORMATION

1. **PROPERTY -- EXISTING GROUND ALONG PROPERTY LINES SHOWN WITH PROPER SYMBOL AND LABELED WITH SURVEY DATE.**
2. **TOPOGRAPHY -- EXISTING GROUND ALONG PROPOSED CENTERLINE SHOWN WITH PROPER SYMBOL AND LABELED WITH SURVEY DATE.**
3. **TOPOGRAPHY -- PREVIOUSLY ESTABLISHED GRADES LABELED WITH DATE OF ESTABLISHMENT AND ORIGINAL DRAWING NUMBER WHEN AVAILABLE.**
4. **TRAFFICWAYS -- EXISTING TRAFFICWAYS SHOWN AND LABELED.**
5. **TOPOGRAPHY -- EXISTING GROUND LINES OR TOP CURB LINES EXTENDED 200' AT TIE-INS OR BREAKS. HEIGHT OF EXISTING CURB FACES NOTED.**

B. PROPOSED ROAD AND STREETS (TRAFFICWAYS)

6. **TRAFFICWAYS -- NAMES OF ALL TRAFFICWAYS IN PROPER POSITION.**
7. **TRAFFICWAYS -- CENTERLINES OF INTERSECTING TRAFFICWAYS SHOWN AND LABELED.**
8. **TRAFFICWAYS -- TOP CURB GRADE OR CENTERLINE GRADE PROPERLY SHOWN AND LABELED.**
9. **TRAFFICWAYS -- PROFILES OF WARPED CURBS SHOWN WITH PROPER SYMBOL (ONE SOLID LINE: THE OTHER A DASHED LINE).**
10. **TRAFFICWAYS -- P.V.C.s, P.V.T.s INDICATED, AND P.I.s OF INTERSECTING CURB LINES INDICATED AND LABELED.**
11. **TRAFFICWAYS -- GRADE MEET MINIMUM AND MAXIMUM GRADIENT REQUIREMENTS.**
12. **TRAFFICWAYS -- TANGENT PERCENTS OF GRADE SHOWN TO TWO DECIMAL PLACES.**
13. **TRAFFICWAYS -- VERTICAL CURVES MEET SIGHT DISTANCE AND MINIMUM LENGTH REQUIREMENTS.**
14. **TRAFFICWAYS -- COMPLETE STATIONING AT 50' MINIMUM INTERVALS AND WHEREVER ELSE REQUIRED.**
15. **TRAFFICWAYS -- ELEVATIONS SHOWN AT 50' MINIMUM INTERVALS AND WHEREVER ELSE REQUIRED.**
16. **TRAFFICWAYS -- LINEAR PROFILE AROUND CUL-DE-SACS.**
17. **TRAFFICWAYS -- PROFILES CARRIED 200' BEYOND PROFILE LIMITS.**
18. **TRAFFICWAYS -- 200' MINIMUM OF PROFILE REPEATED AT BREAKS.**
19. **TRAFFICWAYS -- FINISHED CENTERLINE GRADE PROFILES SHOWN FOR ALLEYS AND ENTRANCES TO PARKING AREAS AS REQUIRED.**
20. **TRAFFICWAYS -- CHECK ALL COMPUTATIONS.**

– GENERAL –

1. **CHECK RECOMMENDATI0NS OF PRELIMINARY SUBDIVISION SUBMISSION.**
2. **TITLE BLOCK --DRAFTER'S INITIALS, DESIGNER'S INITIALS, CHECKER'S INITIALS**
3. **GENERAL NOTES**
4. **TITLE OF DRAWING -- SUBDIVISION NAME AND SECTION, ELECTION DISTRICT, TRAFFICWAY NAME.**
5. **ENGINEER'S SEAL. OR ENGINEER'S SIGNATURE AND LICENSE NUMBER.**
6. **BENCH MARK REFERENCE AND DESCRIPTION. -**
7. **LOCATION PLAIT -- SCALE I" = 1,000' PLUS SMALL SCALE WHEN REQUIRED; SITE OF PROPOSED WORK SHADED.**
8. **LOCATION PLAN -- NAMES OF PROPOSED AND ADJACENT TRAFFICWAYS.**
9. **LOCATION PLAN -- ARTERIAL STREETS LEADING TO SITES SHOWN.**
10. **PERMITS -- SERIAL NUMBERS OF PERMITS AS REQUIRED FROM STATE HIGHWAY ADMINISTRATION, MDE OR OTHERS.**
11. **NORTH ARROW PROPERLY ORIENTED.**
12. **THREE COORDINATE "TICS" LABELED AT MULTIPLES OF 250'.**
13. **ADDITIONAL REVISIONS AS NOTED ON CHECK PRINT.**

APPENDIX "C"

TABLE
MAXIUM DEGREE OF CURVATURE

FUNCTIONAL CLASSIFICATION	RURAL (R-DISTRICT)				URBAN (ALL ZONING DISTRICTS OTHER THEN R)			
	MINIMUM DESIGN SPEED	MAXIMUM E	MAXIMUM D	MINIMUM R	MINIMUM DESIGN SPEED	MAX. E	MAX. D	MIN. R
FREEWAY HIGHWAY	60	0.06	4.5	1273'	60	0.06	4.5	1273'
EXPRESSWAY HIGHWAY	50	0.06	7.0	819'	50	0.06	7.0	819'
PRINCIPAL ARTERIAL	50	0.06	7.0	819'	40	RC	9.0	637'
MINOR ARTERIAL	50	0.06	7.0	819'	40	RC	9.0	637'
COLLECTOR	35	RC	9.5	603'	35	NC	9.5	603'(1)
LOCAL STREET (ROAD)	30	RC(5)	20.0	286'	30	NC	14.5	395'(2)
CUL-DE-SAC STREET (4)	30(3)	RC(5)	45.8	125'	30(3)	NC	-	125'

E - SUPERELEVATION RATE (FT./FT.)
D - DEGREE OF CURVATURE
R - RADIUS (FT.)

NC - NORMAL CROWN SLOPE
RC - REMOVE ADVERSE CROWN, SUPERELEVATE AT NORMAL CROWN SLOPE.

(1) WHERE Δ EXCEEDS 30°, THE MIN. RADIUS MAY BE DECREASED TO 300' UPON APPROVAL OF DPW.
(2) WHERE Δ EXCEEDS 30°, THE MIN. RADIUS MAY BE DECREASED TO 200' UPON APPROVAL OF DPW.
(3) WHEN CUL-DE-SAC IS 600' OR LESS IN LENGTH, THE MIN.DESIGN SPEED MAY BE REDUCED TO 25 MPH.
(4) RESIDENTIAL SINGLE FAMILY DEVELOPMENT ONLY.
(5) RESIDENTIAL STREETS SHALL NOT BE SUPERELEVATED.

Published: 01/01 Revised:

APPENDIX "D"

TABLE D-1

SUPERELEVATION RATE AND TRANSITION LENGTH

DESIGN SPEED: 60 MPH

DEGREE OF CURVE	E	MINIMUM SUPERELEVATION RUNOFF			MINIMUM TANGENT RUNOUT ★		
		CASE 1	CASE 2 & 4	CASE 3 & 5	CASE 1	CASE 2 & 4	CASE 3 & 5
0° - 15'	NC	0	0	0	0	0	0
0° - 30'	RC	175.00	175.00	175.00	175.00	175.00	175.00
0° - 45'	RC	175.00	175.00	175.00	175.00	175.00	175.00
1° - 00'	0.027	175.00	175.00	175.00	129.63	129.63	129.63
1° - 30'	0.036	175.00	175.00	189.47	97.22	97.22	105.26
2° - 00'	0.044	175.00	176.00	231.58	75.55	80.00	105.26
2° - 30'	0.050	175.00	200.00	263.16	70.00	80.00	105.26
3° - 00'	0.054	175.00	216.00	284.21	64.81	80.00	105.26
3° - 30'	0.057	175.00	228.00	300.00	61.40	80.00	105.26
4° - 00'	0.059	175.00	236.00	310.53	59.32	80.00	105.26
4° - 30'	0.060	175.00	240.00	315.79	58.33	80.00	105.26

★ MINIMUM TANGENT RUNOUT BASED ON NORMAL CROWN OF 2%.

E - RATE OF SUPERELEVATION

NC - NORMAL CROWN SECTION

RC - REMOVE ADVERSE CROWN, SUPERELEVATE AT NORMAL CROWN SLOPE.

FOR METHOD OF SUPERELEVATION, SEE:

CASE 1 PAGE D-5

CASE 2 PAGE D-5

CASE 3 PAGE D-5

CASE 4 PAGE D-6

CASE 5 PAGE D-6

Published: 01/01 Revised:

APPENDIX "D"
TABLE D-2
SUPERELEVATION RATE AND TRANSITION LENGTH
DESIGN SPEED: 50 MPH

DEGREE OF CURVE	E	MINIMUM SUPERELEVATION RUNOFF			MINIMUM TANGENT RUNOUT ★		
		CASE 1	CASE 2&4	CASE 3&5	CASE 1	CASE 2&4	CASE 3&5
0°-15'	NC	0	0	0	0	0	0
0°-30'	NC	0	0	0	0	0	0
0°-45'	RC	150.00	150.00	150.00	150.00	150.00	150.00
1°-00'	RC	150.00	150.00	150.00	150.00	150.00	150.00
1°-30'	0.028	150.00	150.00	150.00	107.14	107.14	107.14
2°-00'	0.035	150.00	150.00	166.67	85.71	85.71	95.24
2°-30'	0.040	150.00	150.00	190.48	75.00	75.00	95.24
3°-00'	0.044	150.00	157.14	209.52	68.18	71.43	95.24
3°-30'	0.048	150.00	171.43	228.57	62.50	71.43	95.24
4°-00'	0.051	150.00	182.14	242.86	58.82	71.43	95.24
4°-30'	0.054	150.00	192.86	257.14	55.56	71.43	95.24
5°-00'	0.056	150.00	200.00	266.67	53.57	71.43	95.24
5°-30'	0.058	150.00	207.14	276.19	51.72	71.43	95.24
6°-00'	0.059	150.00	210.71	280.95	50.85	71.43	95.24
6°-30'	0.060	150.00	214.29	285.71	50.00	71.43	95.24
7°-00'	0.060	150.00	214.29	285.71	50.00	71.43	95.24

★ MINIMUM TANGENT REUNOUT BASED ON NORMAL CROWN OF 2%

E - RATE OF SUPERELEVATION
NC - NORMAL CROWN SECTION
RC - REMOVE ADVERSE CROWN, SUPERELEVATE AT NORMAL CROWN SLOPE

FOR METHOD OF SUPERELEVATION, SEE:

CASE 1 PAGE D-5
CASE 2 PAGE D-5
CASE 3 PAGE D-5
CASE 4 PAGE D-6
CASE 5 PAGE D-6

Published: 01/01 Revised:

APPENDIX "D"

TABLE D-3

SUPERELEVATION RATE AND TRANSITION LENGTH

DESIGN SPEED: 40 MPH

DEGREE OF CURVE	E	MINIMUM SUPERELEVATION RUNOFF			MINIMUM TANGENT RUNOUT		
		CASE 1	CASE 2	CASE 3	CASE 1	CASE 2	CASE 3
0° - 15'	NC	0	0	0	0	0	0
0° - 30'	NC	0	0	0	0	0	0
0° - 45'	NC	0	0	0	0	0	0
1° - 00'	NC	0	0	0	0	0	0
1° - 30'	RC	125.00	125.00	125.00	125.00	125.00	125.00
9° - 30'	RC	125.00	125.00	125.00	125.00	125.00	125.00

E - RATE OF SUPERELEVATION

NC - NORMAL CROWN SECTION

RC - REMOVE ADVERSE CROWN, SUPERELEVATE AT NORMAL CROWN SLOPE.

FOR METHOD OF SUPERELEVATION, SEE:

CASE 1 PAGE D-5

CASE 2 PAGE D-5

CASE 3 PAGE D-5

Published: 01/01 Revised:

APPENDIX "D"

TABLE D-4

SUPERELEVATION RATE AND TRANSITION LENGTH

DESIGN SPEED: 30 MPH (RURAL LOCAL ROADS ONLY)

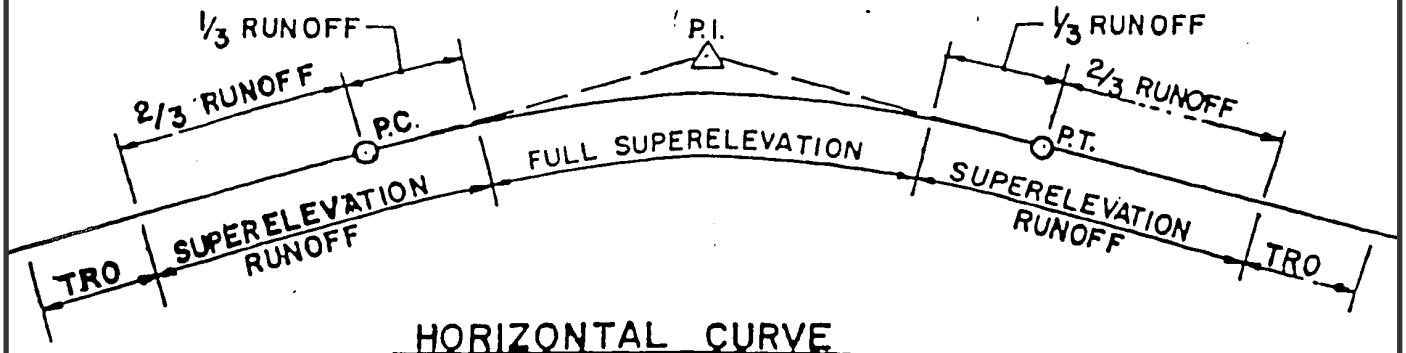
DEGREE OF CURVE	E	MINIMUM SUPERELEVATION RUNOFF CASE 1	MINIMUM TANGENT RUNOUT CASE 1
0° - 15'	NC	0	0
1° - 00'	NC	0	0
2° - 00'	NC	0	0
3° - 00'	NC	100.00	100.00
20° - 00'	RC	100.00	100.00

E - RATE OF SUPERELEVATION
NC - NORMAL CROWN SECTION
RC - REMOVE ADVERSE CROWN, SUPERELEVATE AT NORMAL CROWN SLOPE

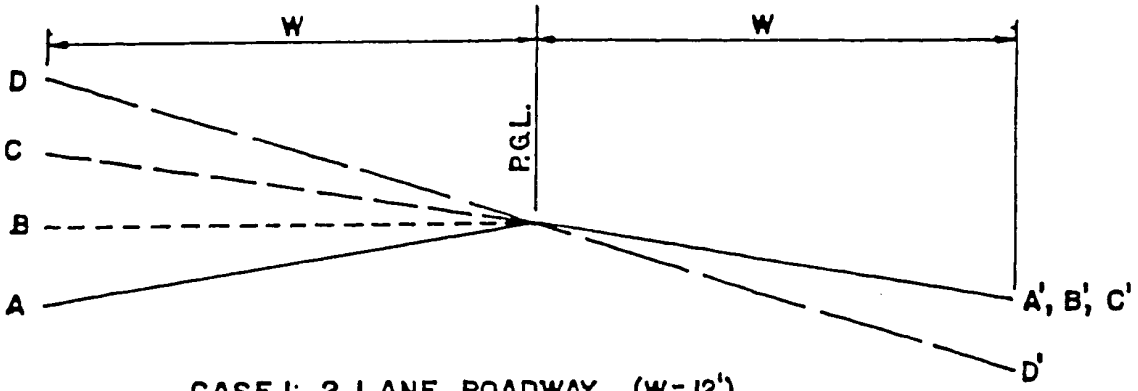
FOR METHOD OF SUPERELEVATION, SEE:
CASE 1 PAGE D-5

Published: 01/01 Revised:

METHOD OF ATTAINING SUPERELEVATION
(CLASES 1,2 & 3)

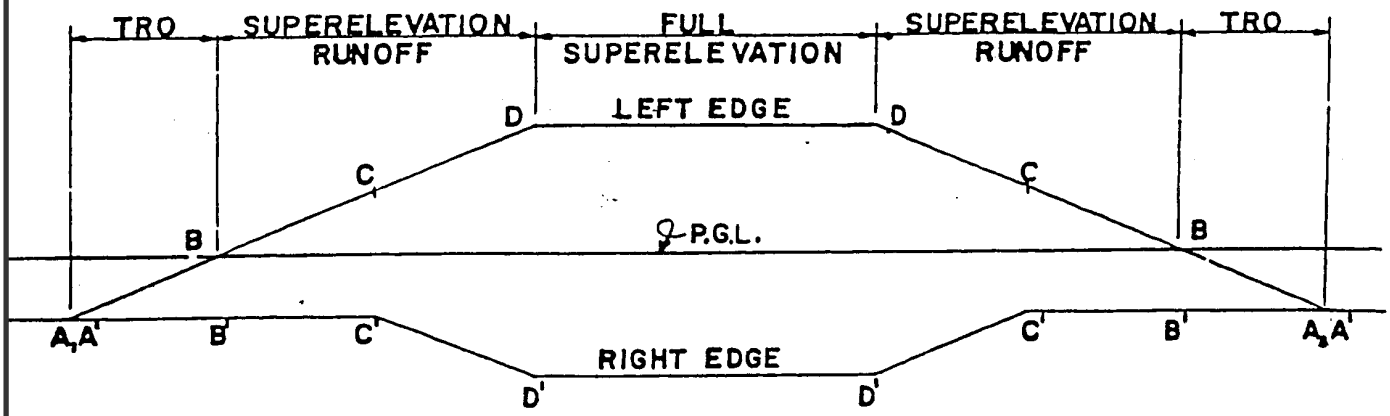


HORIZONTAL CURVE



CASE 1: 2 LANE ROADWAY (W=12')
CASE 2: 4 LANE ROADWAY (W=24')
CASE 3: 6 LANE ROADWAY (W=36')

CROSS SECTION



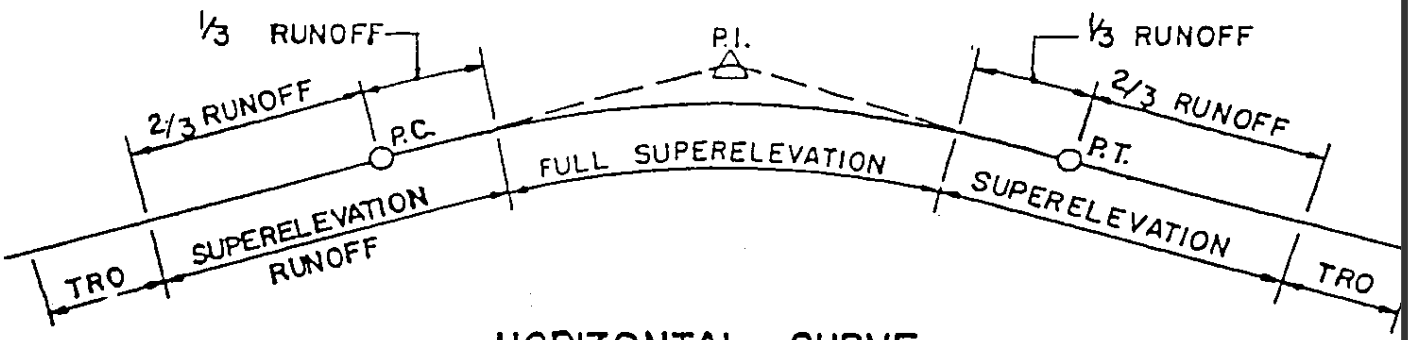
EDGE PROFILES

LEGEND

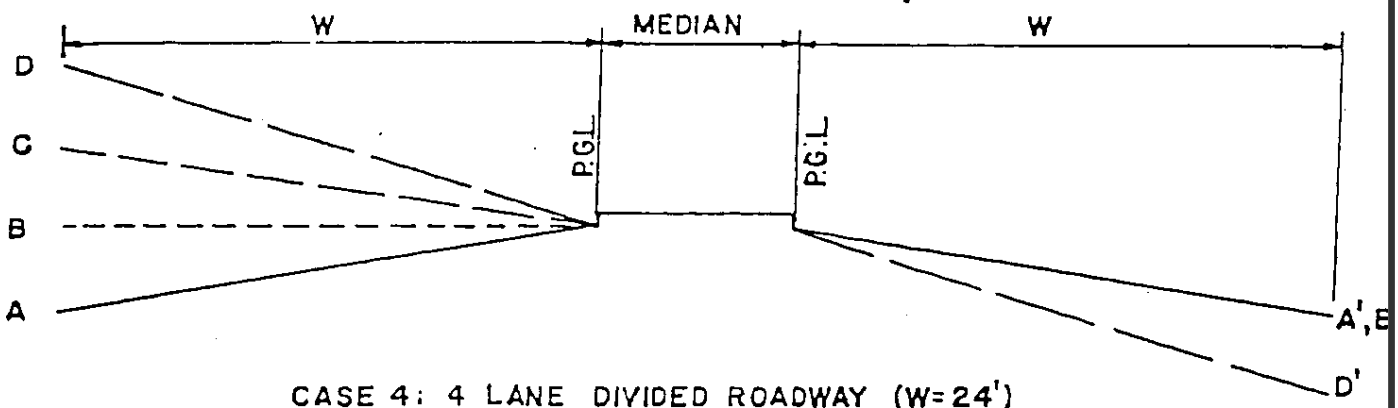
P.C.– POINT OF CURVATURE
P.T.– POINT OF TANGENCY
TRO– TANGENT RUNOUT
P.G.L.– PROFILE GRADE LINE

D-5

METHOD OF ATTAINING SUPERELEVATION
(CASE 4 & 5)

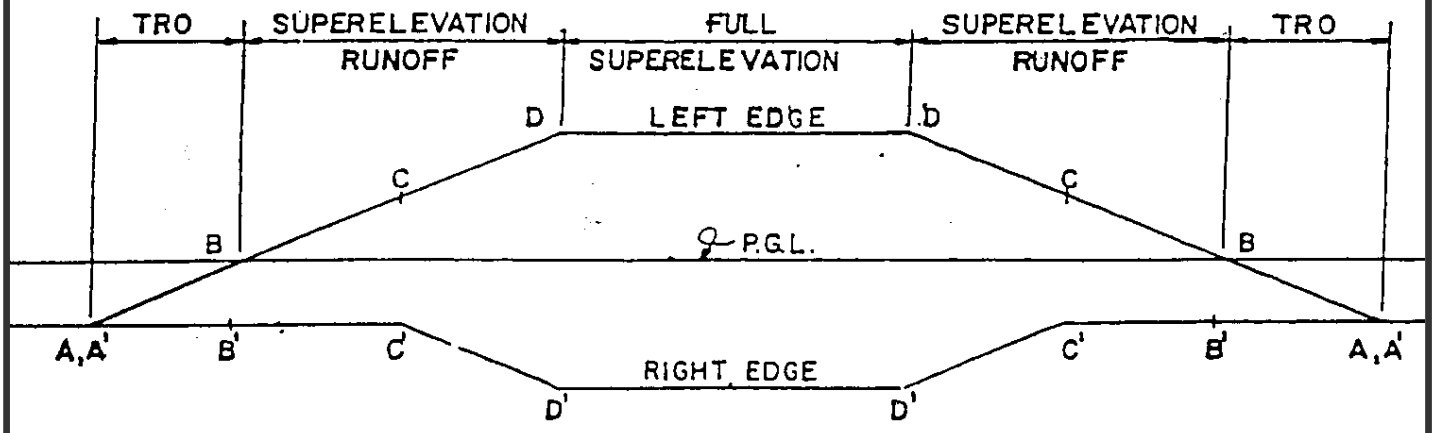


HORIZONTAL CURVE



CASE 4: 4 LANE DIVIDED ROADWAY (W=24')
CASE 5: 6 LANE DIVIDED ROADWAY (W=36')

CROSS SECTION



EDGE PROFILE

LEGEND

P.C.— POINT OF CURVATURE
P.T.— POINT OF TANGENCY
TRO- TANGENT RUNOUT
P.G.L.- PROFILE GRADE LINE

D-6

APPENDIX E

MINIMUM LENGTHS OF SPEED-CHANGE LANES
(FOR ARTERIALS AND COLLECTORS)
FLAT GRADES-2 PERCENT OR LESS

Design speed of turning roadway curve, mph		Stop condition	15	20	25	30
Minimum curve radius, feet			50	90	150	230
Design speed of highway, mph	Length of taper, feet	Minimum length of auxiliary lane required for DECELERATION, excluding taper, feet:				
30	100	225	200	175	150	--
35	125	275	250	225	200	175
40	150	325	300	275	250	200
50	200	425	400	375	350	325
60	250	500	500	475	450	425
Design speed of highway, mph	Length of taper, feet	Minimum length of auxiliary lane required for ACCELERATION, excluding taper, feet:				
30	100	200	-	-	-	-
35	125	275	200	-	-	-
40	150	375	325	250	225	-
50	200	775	700	625	600	500
60	250	1175	1125	1075	1000	900

APPENDIX "F"

RATIO OF LENGTH OF SPEED CHANGE LANES ON GRADE TO LENGTH ON LEVEL

DECELERATION LANES

Design speed of highway, mph	Ratio of length on grade to length on level for: *	
All	3 to 4 % upgrade 0.9	3 to 4 % downgrade 1.2
All	5 to 6 % upgrade 0.8	5 to 6 % downgrade 1.35

Acceleration Lanes

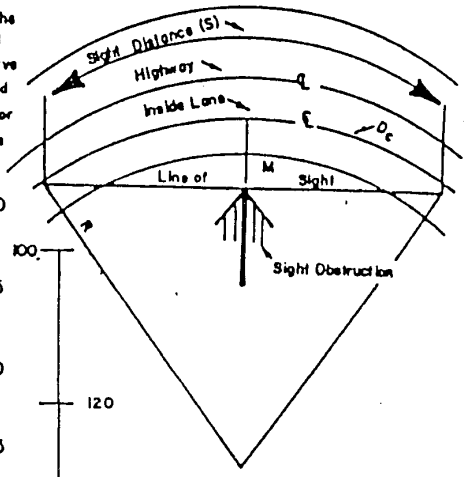
Design speed of highway, mph	Ratio of length on grade to length on level for: Design speed of turning roadway curve, mph *			
	20	30	40	All Speeds
	3 to 4 % upgrade			3 to 4 % downgrade
40	1.3	1.3	-	0.7
50	1.3	1.4	1.4	0.65
60	1.4	1.5	1.5	0.6
	5 to 6 % upgrade			5 to 6 % downgrade
40	1.5	1.5	-	0.6
50	1.5	1.7	1.9	0.55
60	1.7	1.9	2.2	0.5

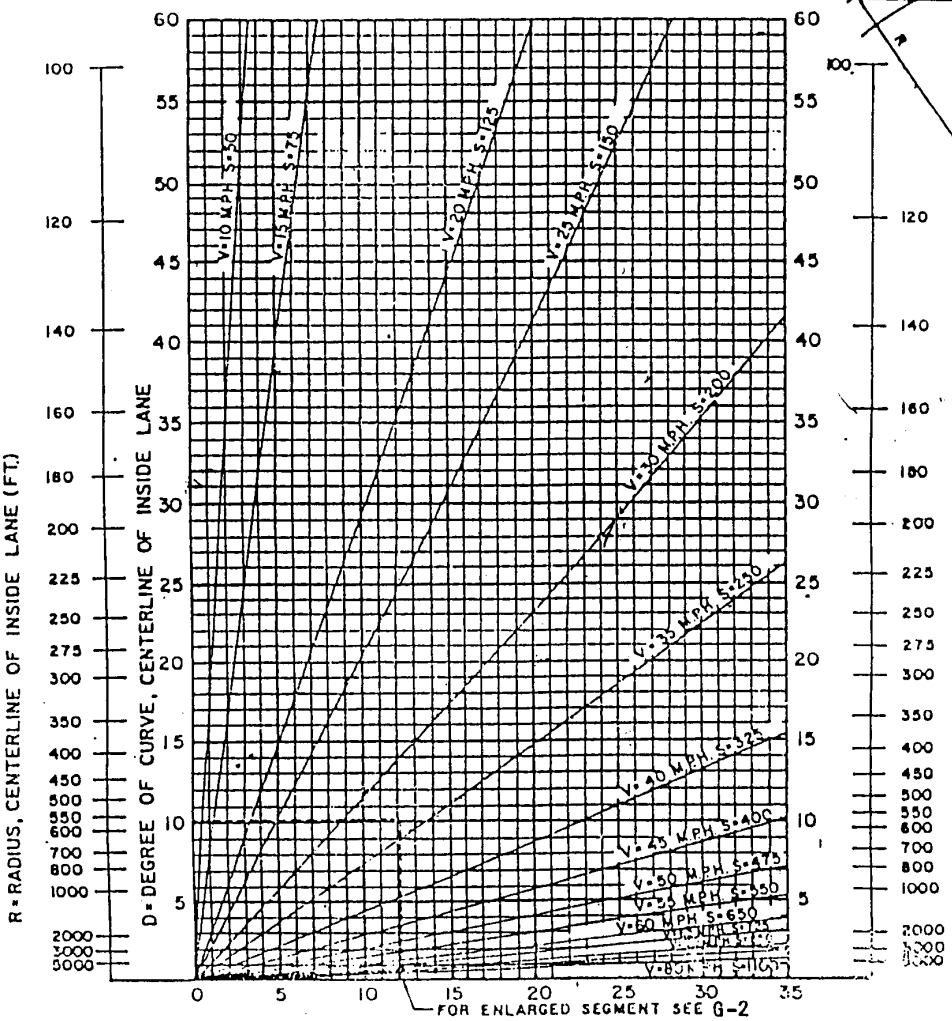
* RATIO FROM THIS TABLE MULTIPLIED BY LENGTH IN PAGE G-1 GIVES LENGTH OF AUXILIARY LANE NEEDED FOR DECELERATION OR ACCELERATION ON THE SPECIFIED GRADE. IT IS NOT TO BE APPLIED TO THE LENGTH REQUIRED FOR TAPER OR STORAGE.

SOURCE: A POLICY ON GEOMETRIC DESIGN OF HIGHWAYS AND STREETS 1990.

STOPPING SIGHT DISTANCE ON HORIZONTAL CURVE
ENTIRE CHART

This Chart and Formulas apply only where the sight obstruction falls within the length (L) of Horizontal Curve, on a straight grade and/or on a Sag Vertical curve. Where Sight Distance (S) is greater than Length (L) of Horizontal Curve or that of a Crest Vertical curve or where the horizontal curve is followed by a compound and/or reverse curve, the stopping sight distance (S) and/or the Middle ordinate (M) shall be checked by graphic methods. When on a constant down grade, check S.S.D.





$R = \frac{3730}{D}$, AND $\theta = \frac{SD}{200}$

$M = R(1-\cos\theta)$

$M = R\left(1-\cos\frac{28.65(S)}{R}\right)$, WHERE:

$M = \frac{3730}{D}\left(1-\cos\frac{SD}{200}\right)$.

D_c = DEGREE OF CURVE

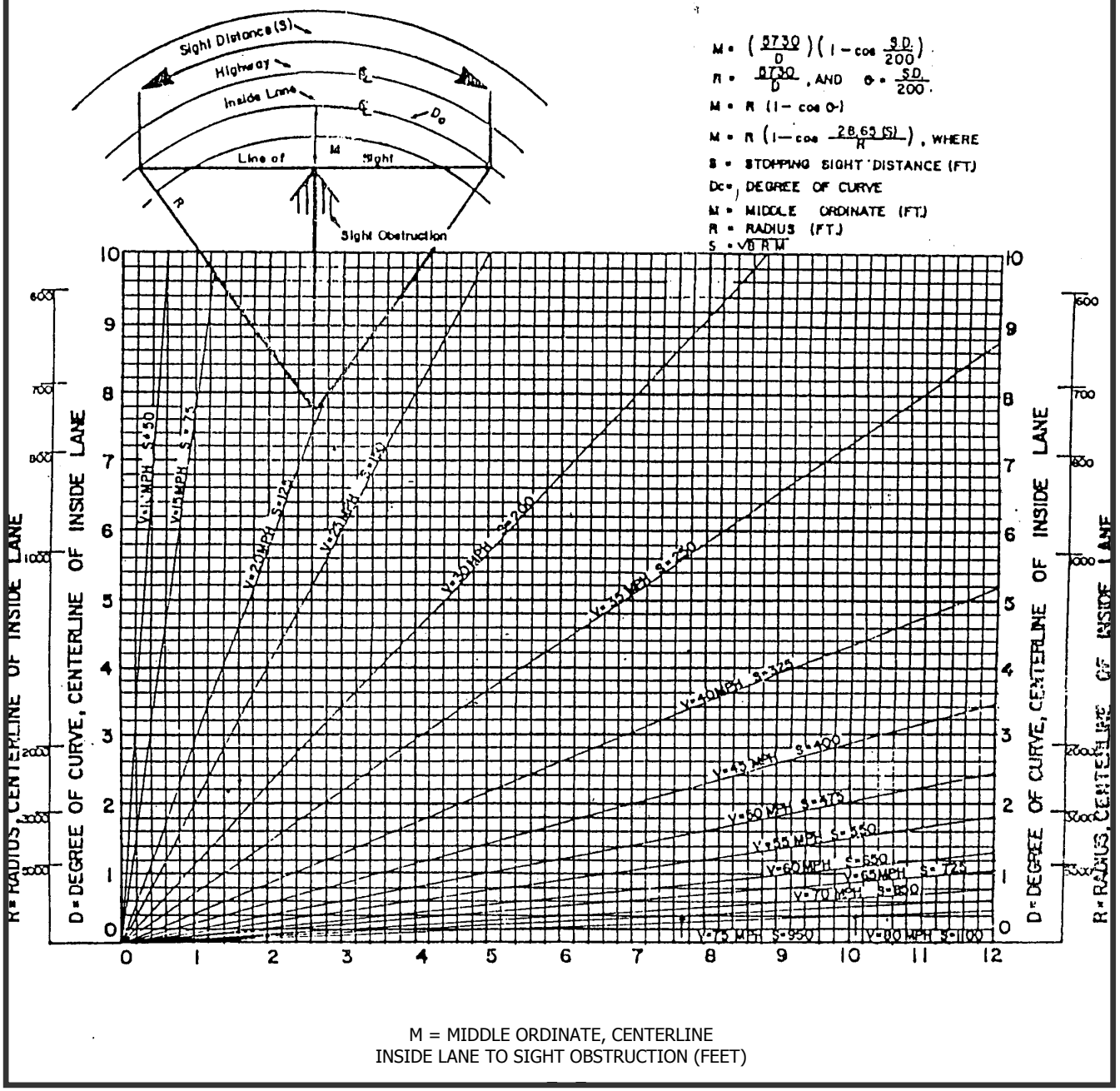
M = MIDDLE ORDINATE (FT.)

R = RADIUS (FT.)

SHORT FORMULA = $S = \sqrt{8RM}$

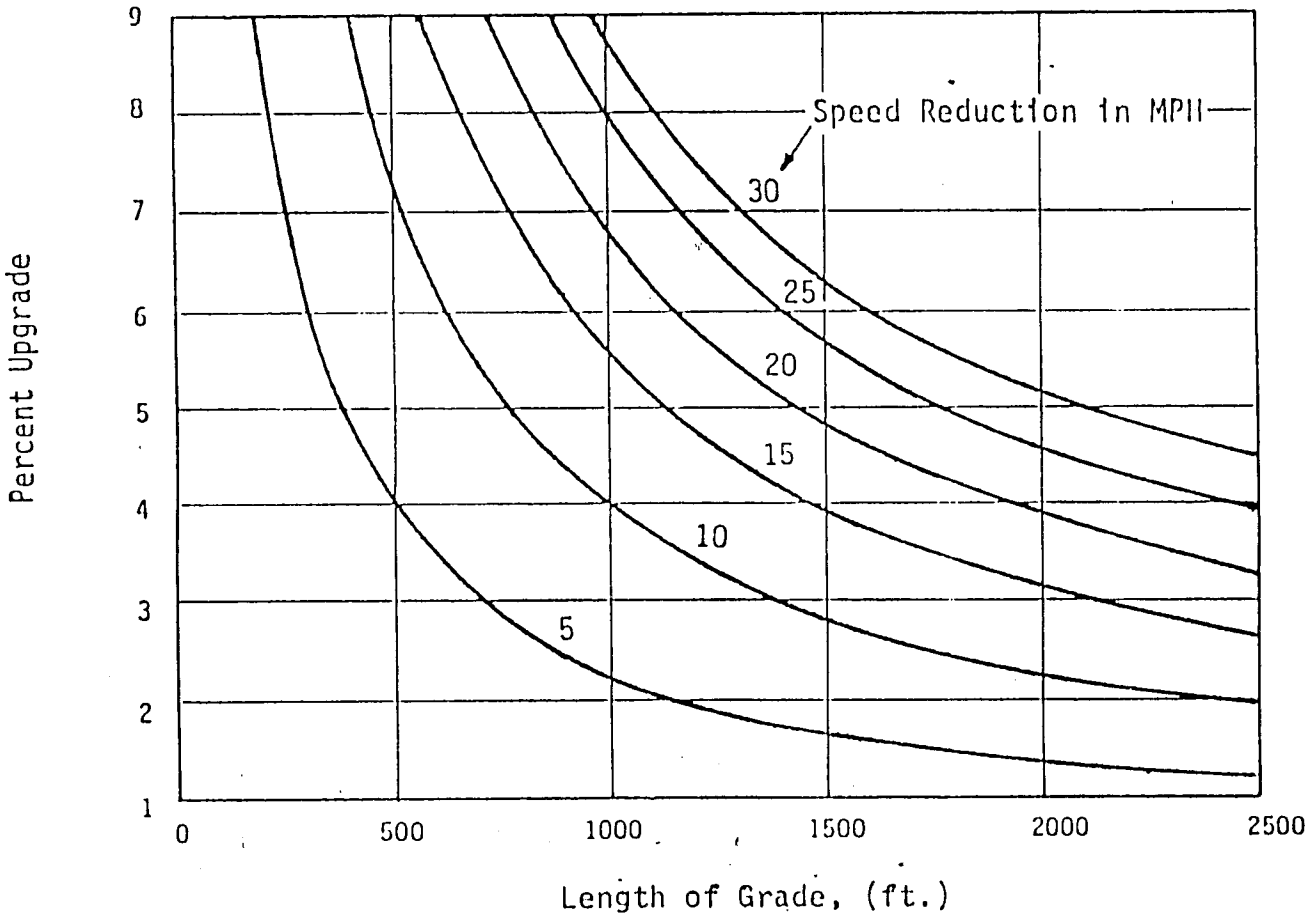
S = STOPPING SIGHT DISTANCE

STOPPING SIGHT DISTANCE ON HORIZONTAL CURVE
ENLARGED SEGMENT



M = MIDDLE ORDINATE, CENTERLINE
INSIDE LANE TO SIGHT OBSTRUCTION (FEET)

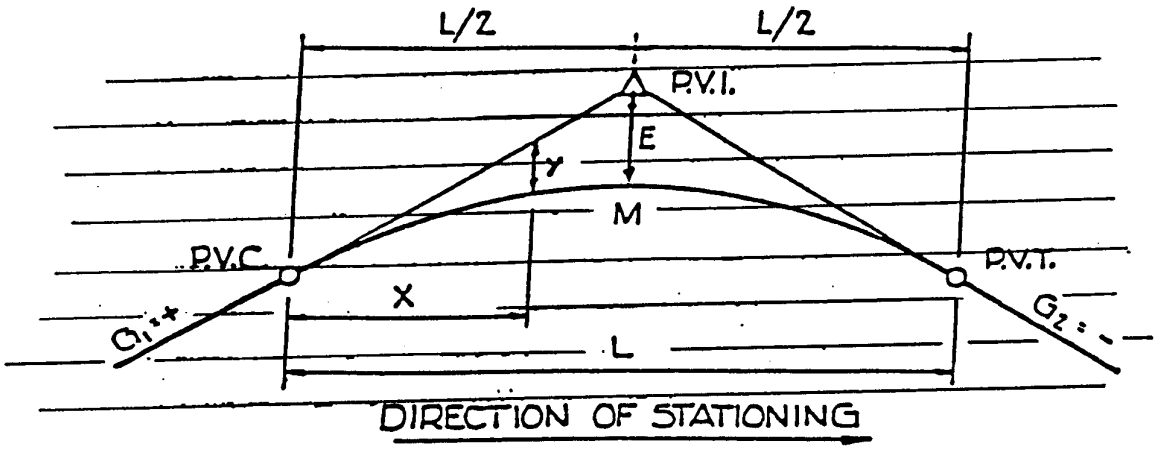
CRITICAL LENGTHS OF GRADE



CRITICAL LENGTHS OF GRADE FOR DESIGN, ASSUMED TYPICAL HEAVY TRUCK OF 300/LB/HP, ENTERING SPEED = 55 MPH.

SOURCE: AASHTO, A POLICY ON GEOMETRIC DESIGN OF HIGHWAYS AND STRUCTURES.

APPENDIX "I"



DEFINITIONS

P.V.I. POINT OF VERTICAL INTERSECTION.

P.V.C. POINT OF VERTICAL CURVATURE.

P.V.T. POINT OF VERTICAL TANGENCY.

M MIDPOINT OF VERTICAL CURVE.

G_1 & G_2 GRADE OF TANGENTS, IN PERCENT, WITH UPGRADES IN DIRECTION OF STATIONING BEING POSITIVE AND DOWNGRADES NEGATIVE.

L TOTAL LENGTH OF VERTICAL CURVE, IN STATIONS.

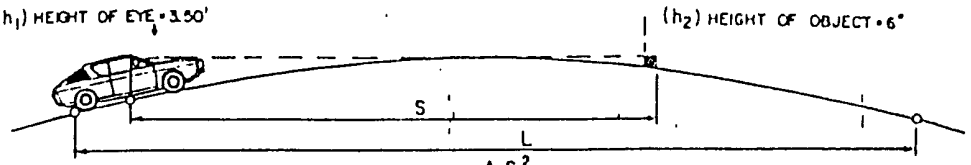
E VERTICAL OFFSET FROM P.V.I. TO MIDDLE OF CURVE, IN FEET.

y VERTICAL OFFSET IN FEET FROM A POINT ON THE TANGENT TO AN INTERMEDIATE POINT ON THE CURVE.

X HORIZONTAL DISTANCE FROM THE P.V.C. TO ANY POINT ON THE CURVE, IN STATIONS.

VERTICAL CURVE

STOPPING SIGHT DISTANCE
ON CREST VERTICAL CURVES
ENTIRE CHART

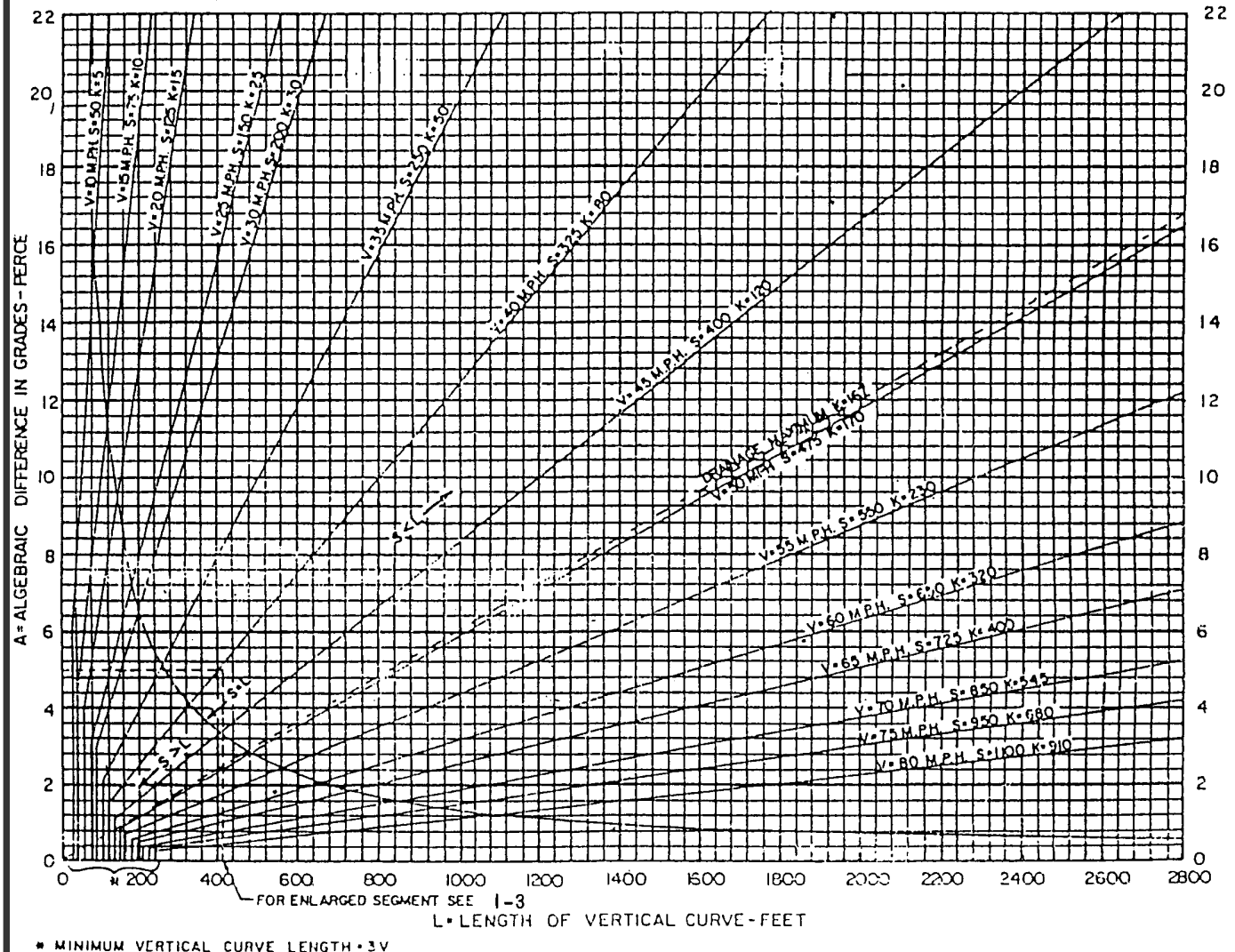


L • LENGTH OF VERTICAL CURVE, FT.
A • ALGEBRAIC DIFFERENCE IN GRADES, PERCENT.
$K = \frac{L}{A}$
S • SIGHT DISTANCE
V • DESIGN SPEED

WHEN S IS LESS THAN L, $L = \frac{A S^2}{100(\sqrt{2h_1}+\sqrt{2h_2})^2}$ (S<L)

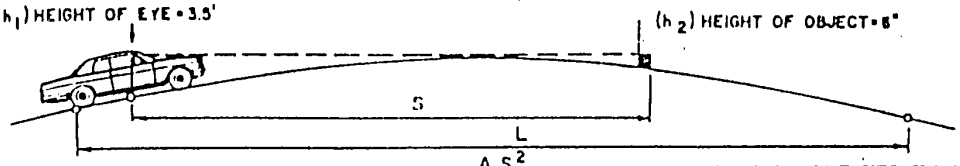
WHEN S IS GREATER THAN L, $L = 2S - \frac{200(\sqrt{h_1}+\sqrt{h_2})^2}{A}$ (S>L)

WHEN THE REQUIRED SIGHT DISTANCE (S) IS GREATER THAN THE LENGTH OF CURVE (L) OR THE CURVE IS FOLLOWED BY A COMPOUND AND/OR A REVERSE CURVE, THE STOPPING SIGHT DISTANCE SHALL BE CHECKED BY GRAPHIC METHOD.



* MINIMUM VERTICAL CURVE LENGTH = 3V

STOPPING SIGHT DISTANCE
ON CREST VERTICAL CURVES
ENLARGED SEGMENT

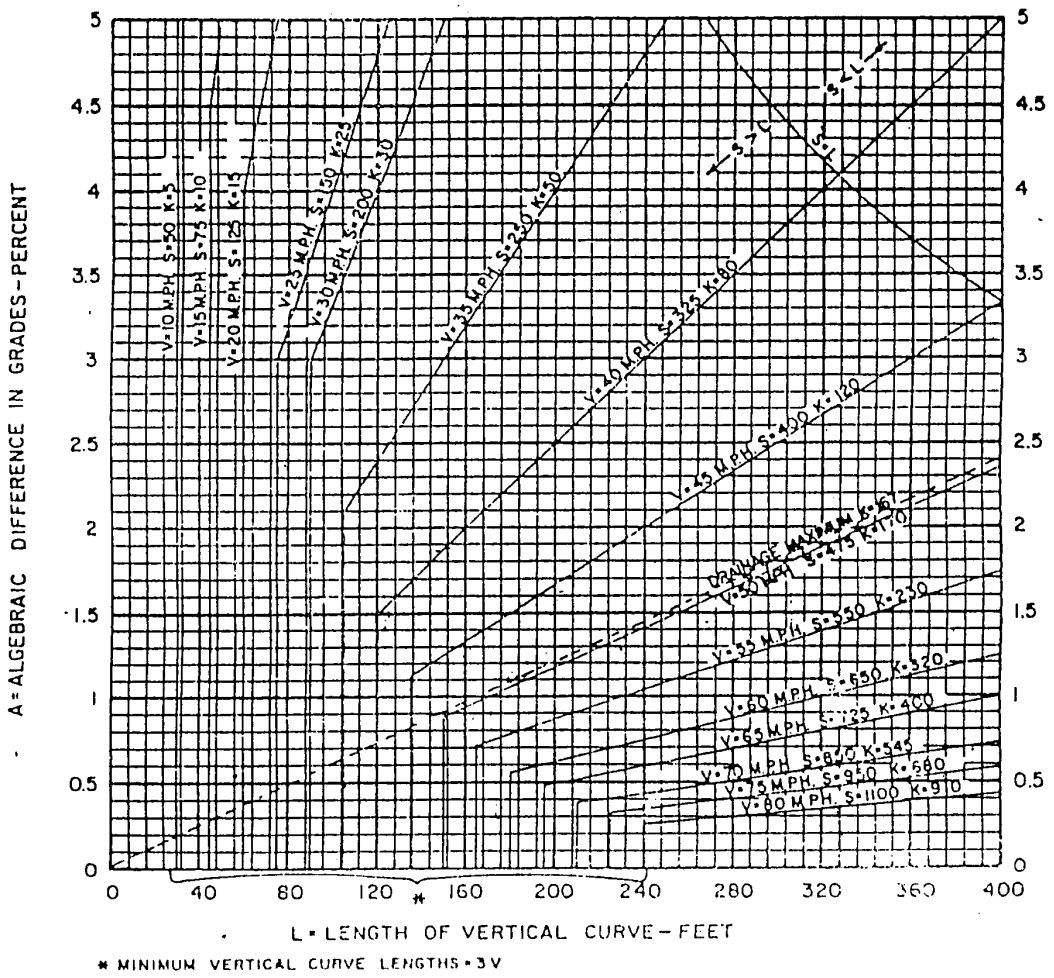


L = LENGTH OF VERTICAL CURVE, FT.
A = ALGEBRAIC DIFFERENCE IN GRADES, PERCENT.
$K = \frac{L}{A}$
S = SIGHT DISTANCE
V = DESIGN SPEED

WHEN S IS LESS THAN L, $L = \frac{A S^2}{100(\sqrt{2h_1} + \sqrt{2h_2})^2}$ $(S < L)$

WHEN S IS GREATER THAN L, $L = 2S - \frac{200(\sqrt{h_1} + \sqrt{h_2})^2}{A}$ $(S > L)$

WHEN THE REQUIRED SIGHT DISTANCE (S) IS GREATER THAN THE LENGTH OF CURVE (L) OR THE CURVE IS FOLLOWED BY A COMPOUND AND/OR A REVERSE CURVE, THE STOPPING SIGHT DISTANCE SHALL BE CHECKED BY GRAPHIC METHOD.

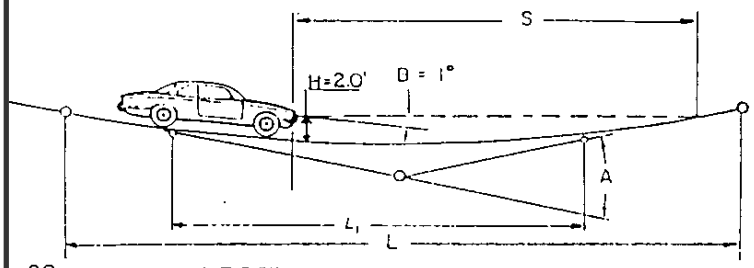


Published: 01/01 Revised:

STOPPING SIGHT DISTANCE ON SAG VERTICAL CURVE

(HLSD)**-ENTIRE CHART

** HEADLIGHT SIGHT DISTANCE



WHEN $S < L$, $L = \frac{S^2 A}{400 + 3.5S}$

WHEN $S > L$, $L = 2S - \frac{400 + 3.5S}{A}$, WHERE

S = STOPPING SIGHT DISTANCE, FT.

L OR L_1 = LENGTH OF VERTICAL CURVE, FT.

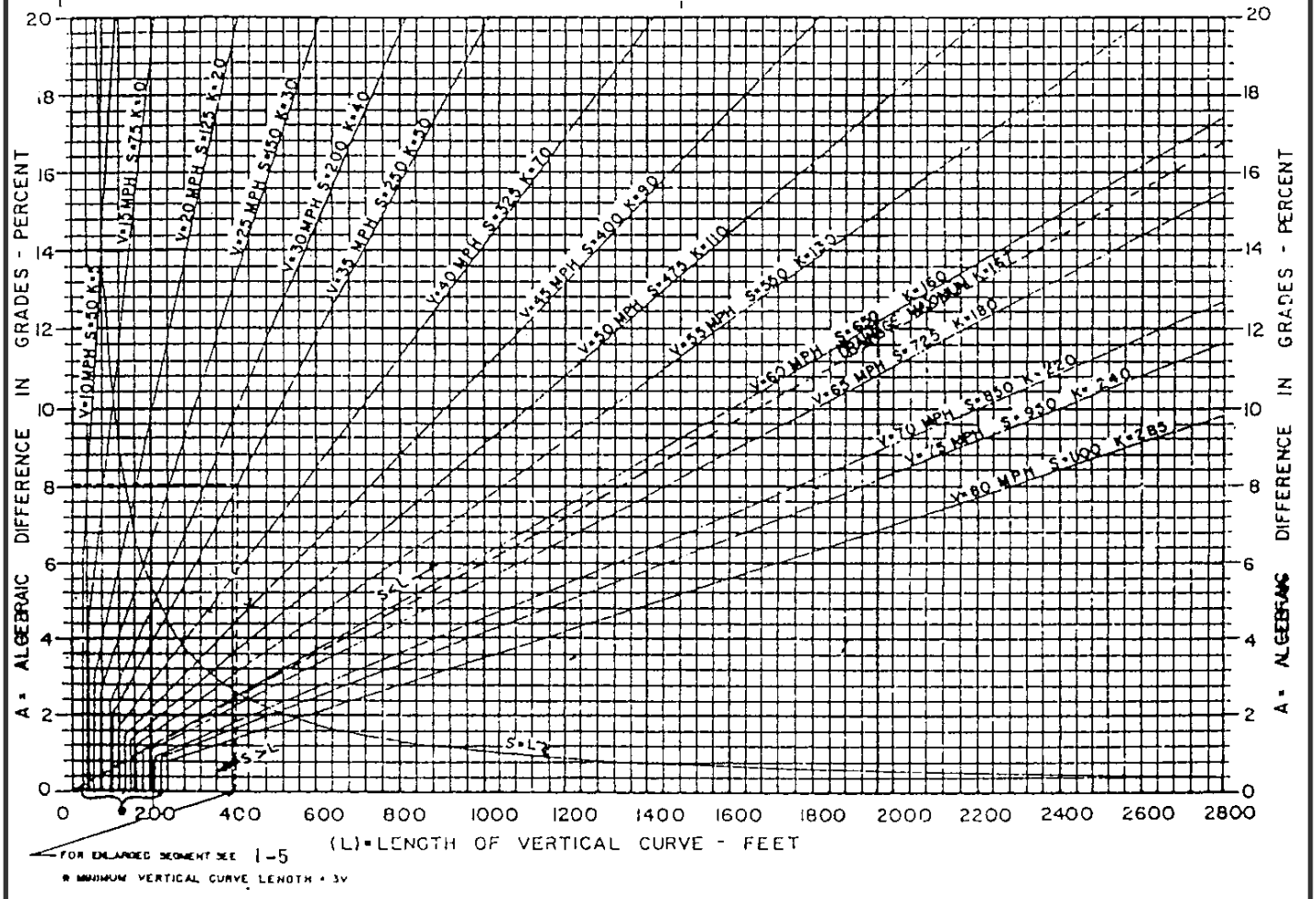
A = ALGEBRAIC DIFFERENCE IN GRADE

B = UPWARD ANGLE OF THE LIGHT BEAM WITH THE HORIZONTAL

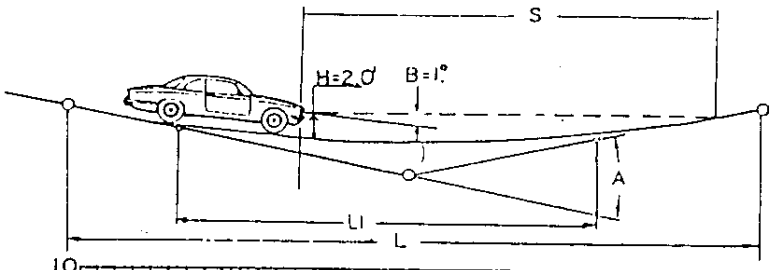
WHEN THE REQUIRED S.D. IS GREATER THAN THE LENGTH OF CURVE (L & L_1) AND THE CURVE IS FOLLOWED BY A COMPOUND AND/OR A REVERSE CURVE, THE STOPPING SIGHT DISTANCE SHALL BE CHECKED BY GRAPHIC METHOD

H = HEIGHT OF HEADLIGHTS

$K = \frac{L}{A}$



STOPPING SIGHT DISTANCE ON SAG VERTICAL CURVE (HLSD)★★-ENLARGED SEGMENT



WHEN $S < L$, $L = \frac{S^2 A}{400 + 3.5S}$

WHEN $S > L$, $L = 2S - \frac{400 + 3.5S}{A}$, WHERE

S = STOPPING SIGHT DISTANCE, FT.

L OR L_1 = LENGTH OF VERTICAL CURVE, FT.

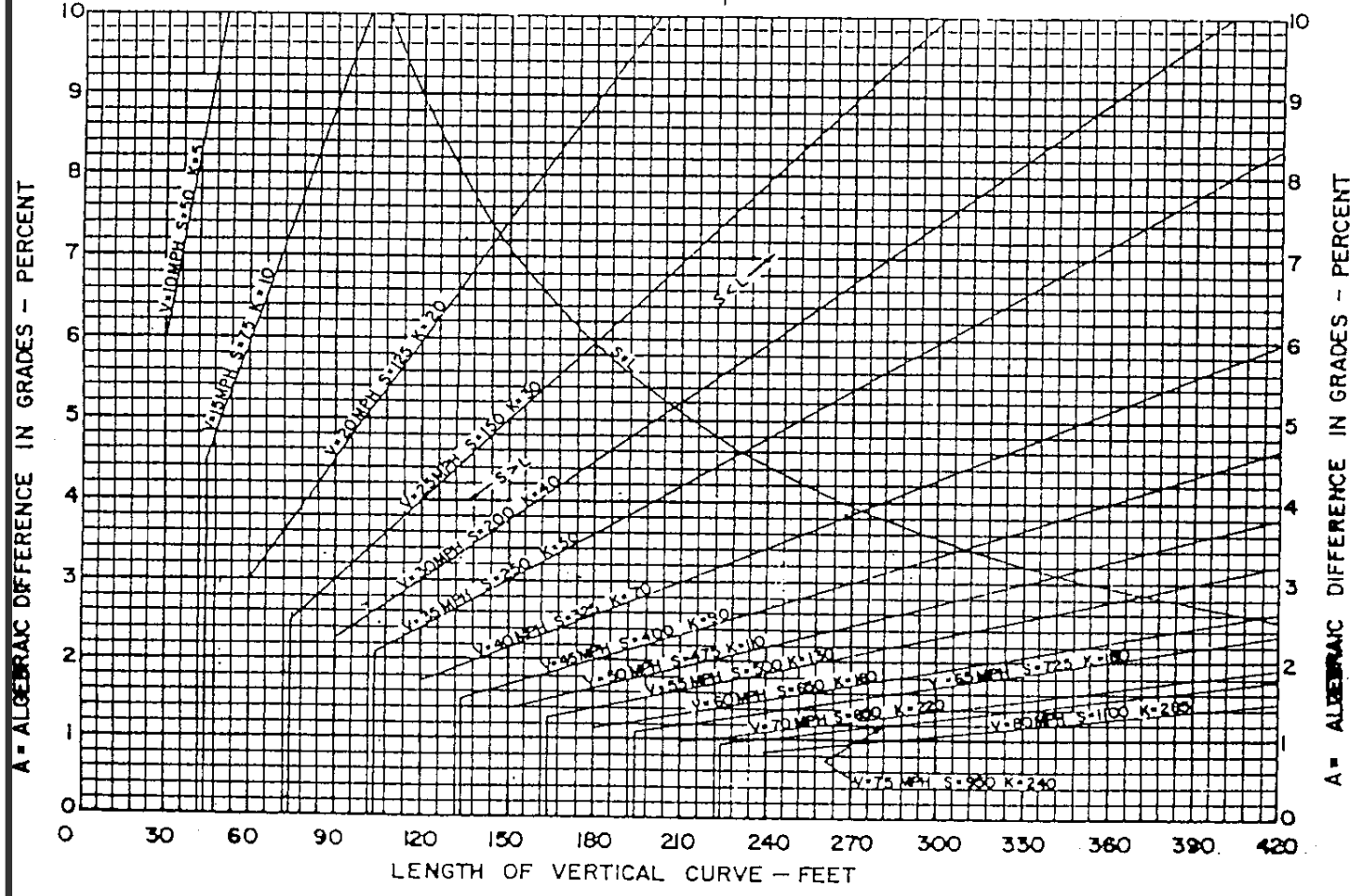
A = ALGEBRAIC DIFFERENCE IN GRADE

B = UPWARD ANGLE OF THE LIGHT BEAM WITH THE HORIZONTAL

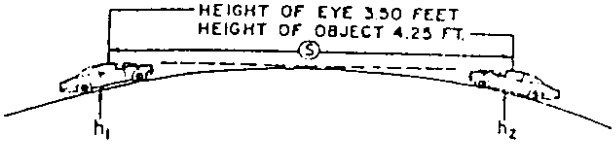
WHEN THE REQUIRED S.D. IS GREATER THAN THE LENGTH OF CURVE (L & L1) AND THE CURVE IS FOLLOWED BY A COMPOUND AND/OR A REVERSE CURVE, THE STOPPING SIGHT DISTANCE SHALL BE CHECKED BY GRAPHIC METHOD

H = HEIGHT OF HEADLIGHTS

$K = \frac{L}{A}$



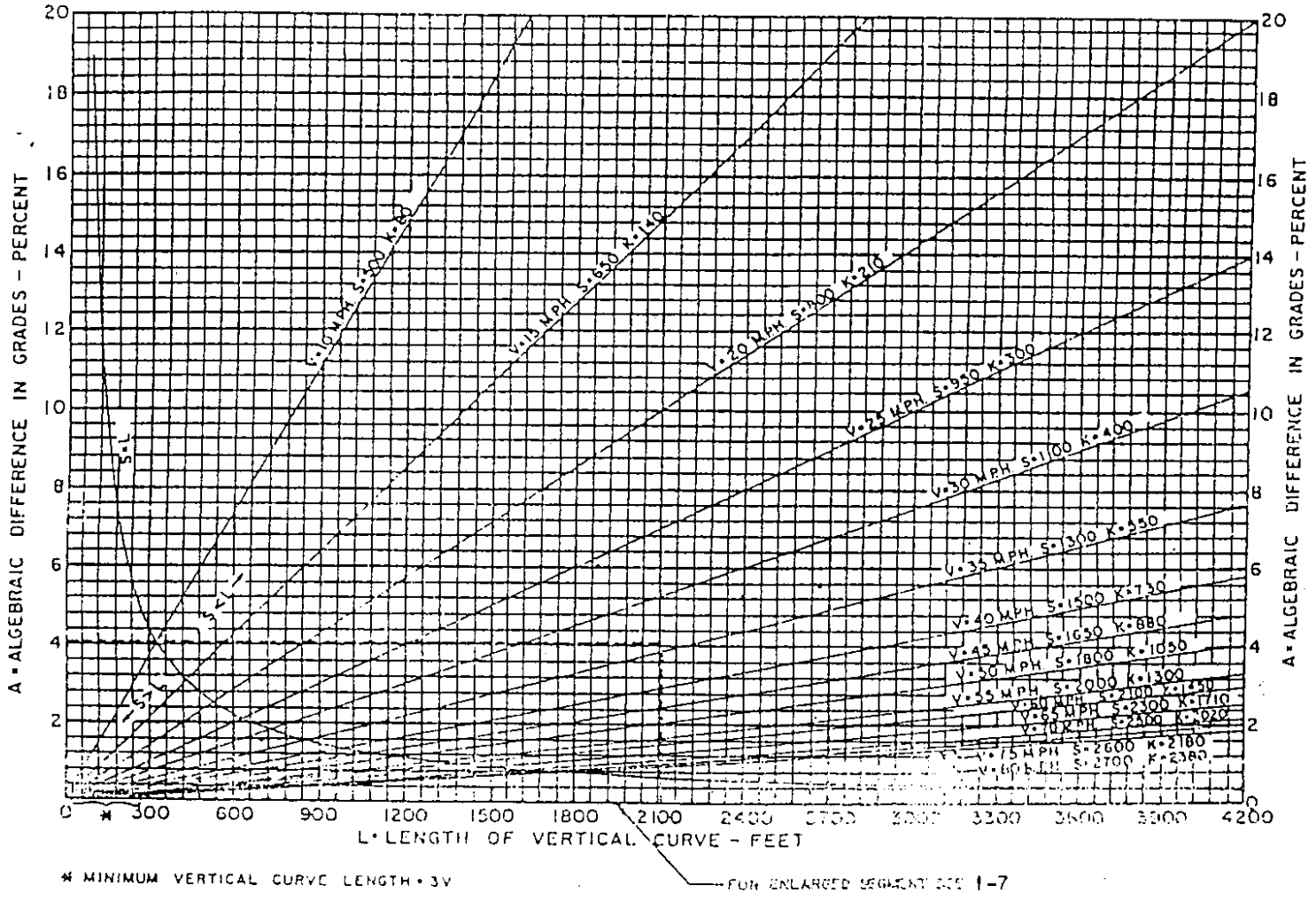
PASSING SIGHT DISTANCE
ON CREST VERTICAL CURVES
ENTIRE CHART



L = LENGTH OF VERTICAL CURVE, FT.
A = ALGEBRAIC DIFFERENCE IN GRADES, PERCENT.
V = DESIGN SPEED
S = SIGHT DISTANCE
$K = \frac{L}{A}$

WHEN S IS LESS THAN L, $L = \frac{A S^2}{100(\sqrt{2h_1} + \sqrt{2h_2})^2}$ (S < L)

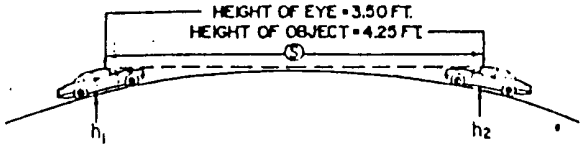
WHEN S IS GREATER THAN L, $L = 2S - \frac{200(\sqrt{h_1} + \sqrt{h_2})^2}{A}$ (S > L)



* MINIMUM VERTICAL CURVE LENGTH = 3V

FOR ENLARGED SEGMENT SEE I-7

PASSING SIGHT DISTANCE ON CREST VERTICAL CURVES ENLARGED SEGMENT



V = DESIGN SPEED

S = SIGHT DISTANCE

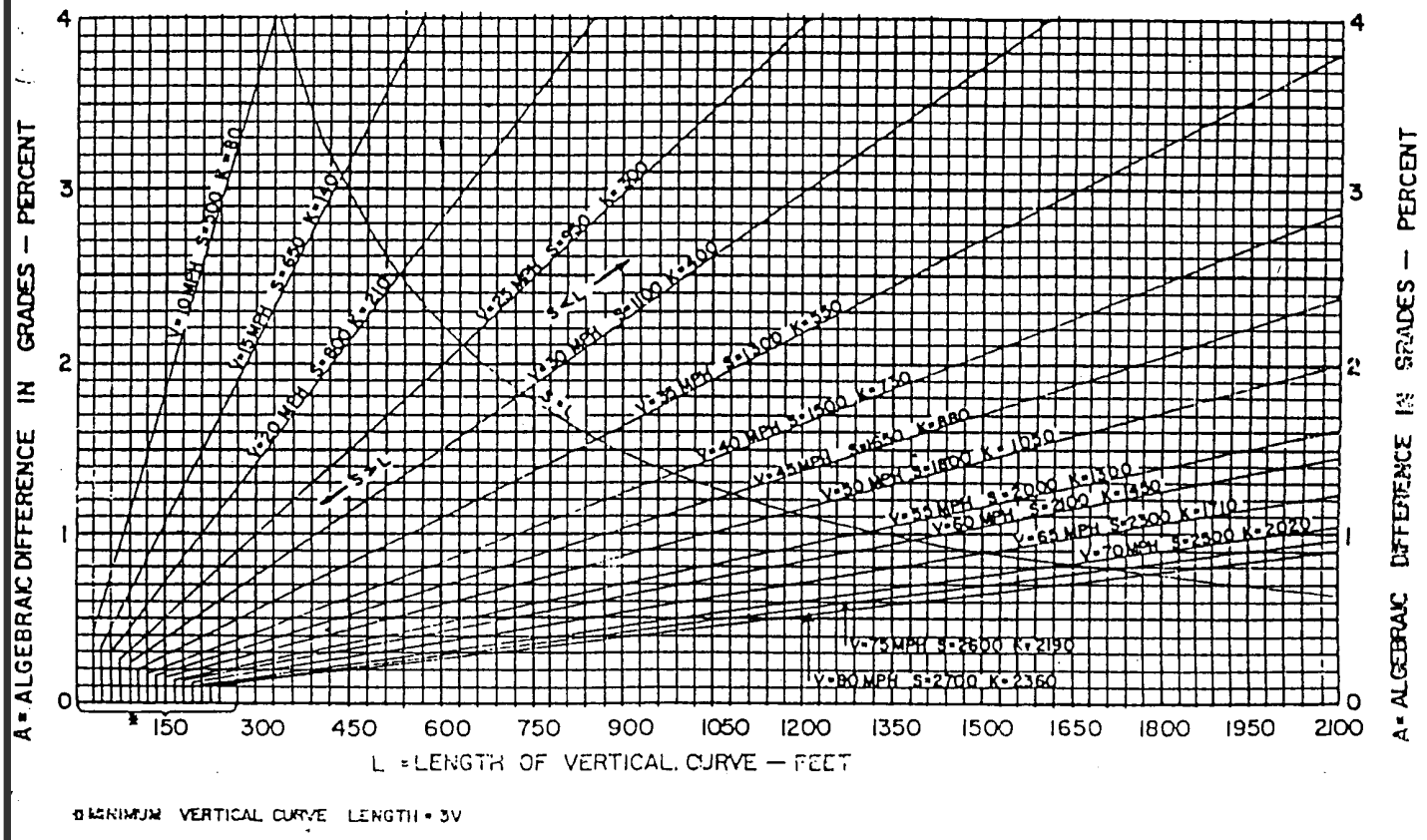
$K = \frac{L}{A}$

L = LENGTH OF VERTICAL CURVE, FT.

A = ALGEBRAIC DIFFERENCE IN GRADES, PERCENT.

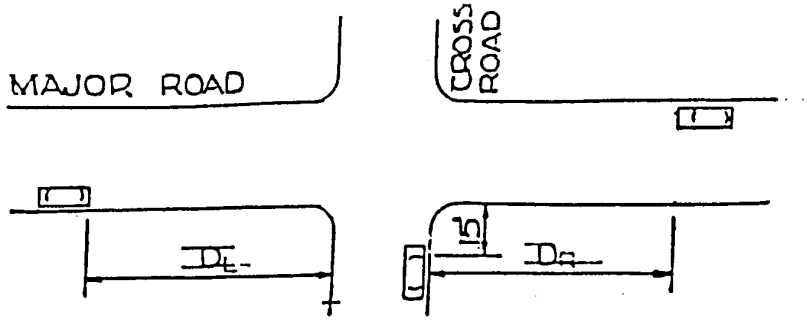
WHEN S IS LESS THAN L, $L = \frac{A S^2}{100(\sqrt{h_1}+\sqrt{h_2})^2}$ (S < L)

WHEN S IS GREATER THAN L, $L = 2S - \frac{200(\sqrt{h_1}+\sqrt{h_2})^2}{A}$ (S > L)



* MINIMUM VERTICAL CURVE LENGTH = 3V

APPENDIX "J"



MAJOR ROAD (2 LANES)

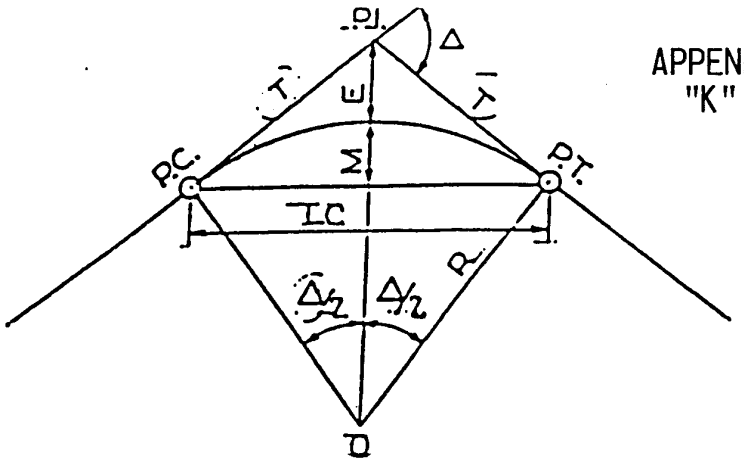
OPERATING SPEED	D_L									D_R					
	CROSS			LEFT TURN			RIGHT TURN			CROSS			LEFT TURN		
	P	SU	WB-50	P	SU	WB-50	P	SU	WB-50	P	SU	WB-50	P	SU	WB-50
30	270	370	500	330	470	620	300	420	560	310	410	550	330	470	620
40	370	490	670	440	630	830	510	740	1000	420	550	730	540	790	1050
50	460	620	840	540	780	1030	770	1140	1560	520	680	910	800	1200	1620
60	560	740	1010	650	940	1240	1090	1640	2250	620	820	1090	1110	1700	2310
* MAJOR ROAD (4 LANES)															
30	300	400	530	550	490	640	300	420	560	360	470	600	340	480	630
40	400	540	720	460	650	860	510	740	1000	480	620	800	550	800	1060
50	510	670	900	580	820	1070	770	1140	1560	600	780	1000	810	1200	1620
60	610	810	1080	690	980	1280	1090	1640	2250	720	930	1200	1120	1700	2320
* MAJOR ROAD (6 LANES)															
30	330	430	570	370	520	670	300	420	560	430	550	700	360	500	640
40	440	580	770	500	690	900	510	740	1000	570	740	930	560	820	1050
50	560	730	960	620	870	1120	770	1140	1560	720	920	1170	820	1220	1640
60	670	880	1150	750	1040	1350	1090	1640	2250	860	1110	1400	1140	1720	2330

* INCLUDES MEDIANS LESS THAN 20 FEET WIDE. FOR WIDER MEDIAN ANALYZE LEFT TURNS AND CROSSINGS AS 2-STEP MANEUVERS.

NOTES:
1. HEIGHT OF EYE: P = 3.50 SU BUS AND WB=6.00'
2. HEIGHT OF OBJECT: 3.50'.
3. OPERATING SPEED IS THE 85TH PERCENTILE SPEED ON EXISTING ROADS AND 85% OF THE DESIGN SPEED ON PROPOSED ROADS.
4. ASSUMPTIONS: REACTION TIME – 2 SECONDS; ACCELERATION RATE – P = 4.1 FPS^2; SU = 2.4 FPS^2 ; W-50=1.65 FPS^2
5. WHEN TRAFFIC TURNS ONTO AN UPGRADE OR DOWNGRADE, MULTIPLY THE SIGHT DISTANCES BY THE FOLLOWING:

GRADE	MULTIPLY BY
-6% TO -5%	0.5
-4% TO -3%	0.6
-2% TO +2%	1.0
+3% TO +4%	1.4
+5% TO +6%	1.7

SIGHT DISTANCE AT INTERSECTION



APPENDIX
"K"

DEFINITIONS AND FORMULAS

P.I. - POINT OF INTERSECTION
THE POINT AT WHICH THE TWO TANGENTS TO THE CURVE INTERSECT.

P.C. - POINT OF CURVATURE
THE POINT AT WHICH THE TANGENT ENDS AND CURVE BEGINS.

P.T. - POINT OF TANGENCY
THE POINT AT WHICH THE CURVE ENDS AND THE TANGENT BEGINS

Δ - DELTA OR INTERSECTION ANGLE ..... $(\Delta = \frac{D \times L}{100})$
THE DEFLECTION ANGLE BETWEEN THE TANGENTS AT THE P.I. THIS IS EQUAL TO THE CENTRAL ANGLE SUBTENDED BY THE CURVE.

D - DEGREE OF CURVE $(D = 100\frac{\Delta}{L})$
THE CENTRAL ANGLE SUBTENDED BY AN ARC OF 100 FEET. THIS IS THE ARC DEFINITION OF A CURVE AND SHALL BE USED FOR ALL ROAD AND STREET PROJECTS.

R - RADIUS $(R = \frac{5729.578}{D})$
THE DISTANCE BETWEEN THE CENTER AND ANY POINT ON THE CURVE

T - TANGENT DISTANCE $(T = R \text{ TAN.} \frac{\Delta}{2})$
THE DISTANCE BETWEEN THE P.C. AND P.I. OR BETWEEN THE P.I. AND P.T.

L - LENGTH OF CURVE $(L = 100\frac{\Delta}{D})$
THE ARC DISTANCE BETWEEN THE P.C. AND THE P.T.

LC - LONG CHORD $(LC = 2R \text{ SIN.} \frac{\Delta}{2})$
THE STRAIGHT LINE DISTANCE BETWEEN THE P.C. AND THE P.T

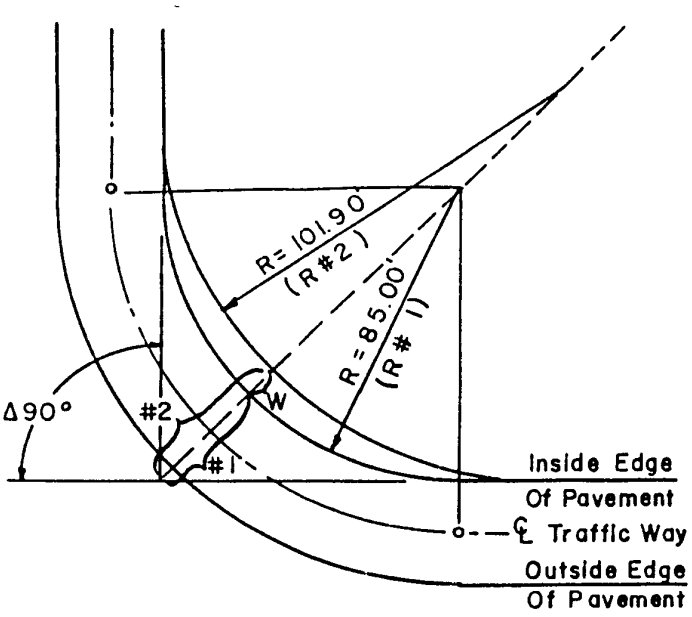
E - EXTERNAL DISTANCE $(E = T \text{ TAN.} \frac{\Delta}{4})$
THE DISTANCE BETWEEN THE P.I. AND THE MIDDLE OF THE CURVE.

M - MIDDLE ORDINATE $M = R(1 - \text{COS.} \frac{\Delta}{2})$
THE DISTANCE BETWEEN THE MIDDLE OF THE CURVE AND THE MIDDLE OF THE LONG CHORD.

O - CENTER POINT OF CURVE

HORIZONTAL CIRCULAR CURVE

APPENDIX "L"



1. Find External #1, using the following formula:
   External #1 = R #1 · Exsec 1/2 Δ
2. Add Widening W to External #1 This will be External #2.
3. Find Radius #2, using the following formula:

$$R\#2 = \frac{\text{External } \#2}{\text{Exsec } 1/2\ \Delta}$$

CENTER LINE RADIUS OF CURVE	MIN. LENGTH OF CURVE*	WIDENING AT MIDPOINT
500' - 451'	400'	3'
450' - 351'	350'	4'
350' - 251'	300'	5'
250' - 151'	200'	6'
150' - 100'	150'	7'

* CURVES LESS THAN THIS LENGTH WILL NOT REQUIRE WIDENING.

Example:

Given:

℄ Radius = 100'

Δ = 90°-00'

Normal pavement width = 30' (Right of Way = 50')

Required Widening for ℄ R of 100' = 7' (to be applied at midpoint of inside edge pavement.)

Required:

Radius (R #2) of widening.

Solution:

Radius of inside edge of pavement (R#1) = 100'- 15' = 85'

External #1 = 85 x Exsec 1/2 Δ =
85 x .41421 = 35.21

External #2 = 35.21 + 7 = 42.21

$$\text{Radius (R\#2)} = \frac{\text{External \#2}}{\text{Exsec } 1/2\ \Delta} = \frac{42.21}{.41421} = 101.90'$$

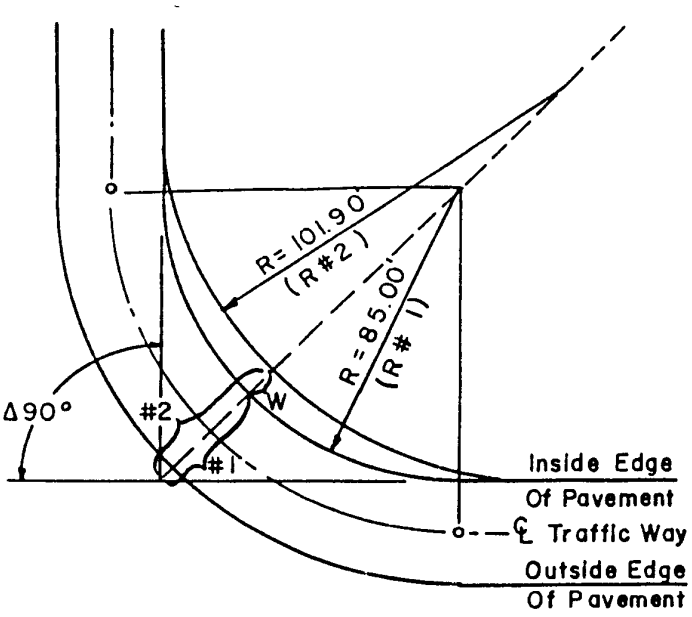
Note:

The Radius of the inside Property Line in this example will be 91.90'. (101.90'- 10.00')

STANDARD PAVING DETAILS

WIDENING COMPUTATION

APPENDIX "L"



1. Find External #1, using the following formula:
   External #1 = R #1 · Exsec 1/2 Δ
2. Add Widening W to External #1 This will be External #2.
3. Find Radius #2, using the following formula:

$$R\#2 = \frac{\text{External } \#2}{\text{Exsec } 1/2\ \Delta}$$

CENTER LINE RADIUS OF CURVE	MIN. LENGTH OF CURVE*	WIDENING AT MIDPOINT
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Example:

Given:

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Normal pavement width = 30' (Right of Way = 50')

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Required:

Radius (R #2) of widening.

Solution:

Radius of inside edge of pavement (R#1) = 100'- 15' = 85'

External #1 = 85 x Exsec 1/2 Δ =
85 x .41421 = 35.21

External #2 = 35.21 + 7 = 42.21

$$\text{Radius (R\#2)} = \frac{\text{External \#2}}{\text{Exsec } 1/2\ \Delta} = \frac{42.21}{.41421} = 101.90'$$

Note:

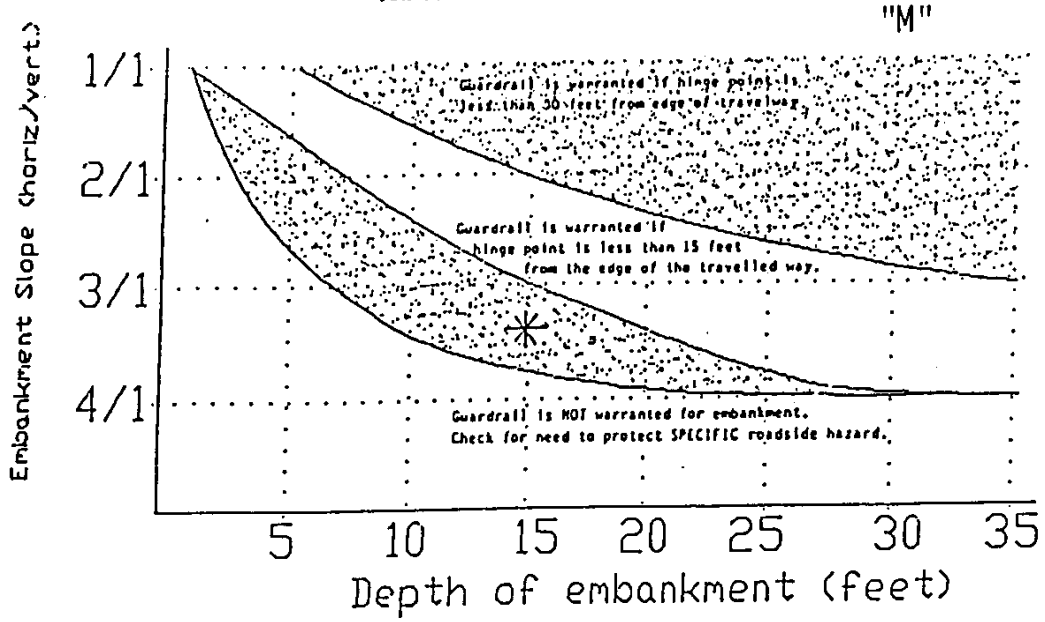
The Radius of the inside Property Line in this example will be 91.90'. (101.90'- 10.00')

STANDARD PAVING DETAILS

WIDENING COMPUTATION

FOR NEW ROADWAYS IN FILL SECTIONS

APPENDIX
"M"



* Guardrail is warranted if hinge point is less than 4 feet from edge of travelled way.

NOTES:

- The hinge point is defined as the break between a shoulder slope of 6/1 or less and the embankment slope. If the slope adjacent to the travelled way is steeper than 6/1, assume the hinge point is at the edge of the travelled way.
- Guardrail may be deleted under conditions of superior alignment only with the approval of the chief engineer.
- Chart to be used for all open section roadways at any speed and closed section roadways with posted speed limits of 35 MPH or more. Guardrail may be required on lower speed closed section roadways to protect unusually steep or deep embankments.
- On closed section roadways, face of guardrail must be within 9 inches of face of curb.
- Approach flares will be required as follows:

Posted Speed Limit	Approach flare required for shoulder width
≤ 30 MPH	≤ 4 feet
≤ 40 MPH	≤ 6 feet
> 40 MPH	≤ 8 feet

- Determination of need for guardrail to protect roadside obstructions to be based on 1989 AASHTO Roadside Design Guide.
- Wooden guardrail not allowed on County roadways except as a temporary barricade at the end of the road (if road is to be extended at a later date).

GUARD RAIL
REQUIREMENTS FOR EMBANKMENT

APPENDIX N

ANNE ARUNDEL COUNTY

GUIDELINES FOR TRAFFIC IMPACT STUDIES

1. When is a traffic impact study required?

    - At sketch stage for any major subdivision.
    - At site development plan review stage for building permits.

    Note: A scoping meeting with the County and State may be required for major projects.

2. What roads and intersections must be studied?

    - In Town Center Growth Management Areas:

        - Each intersection from site access point to and including the first intersection with an arterial or higher classification road in each direction.

        - Key intersections as identified by the County during the information concept plan review.

    - Elsewhere in the County:

        - Each intersection from site access point to and including the first intersection with an arterial or higher classification road in each direction to and including the second intersection with an arterial road in each direction.

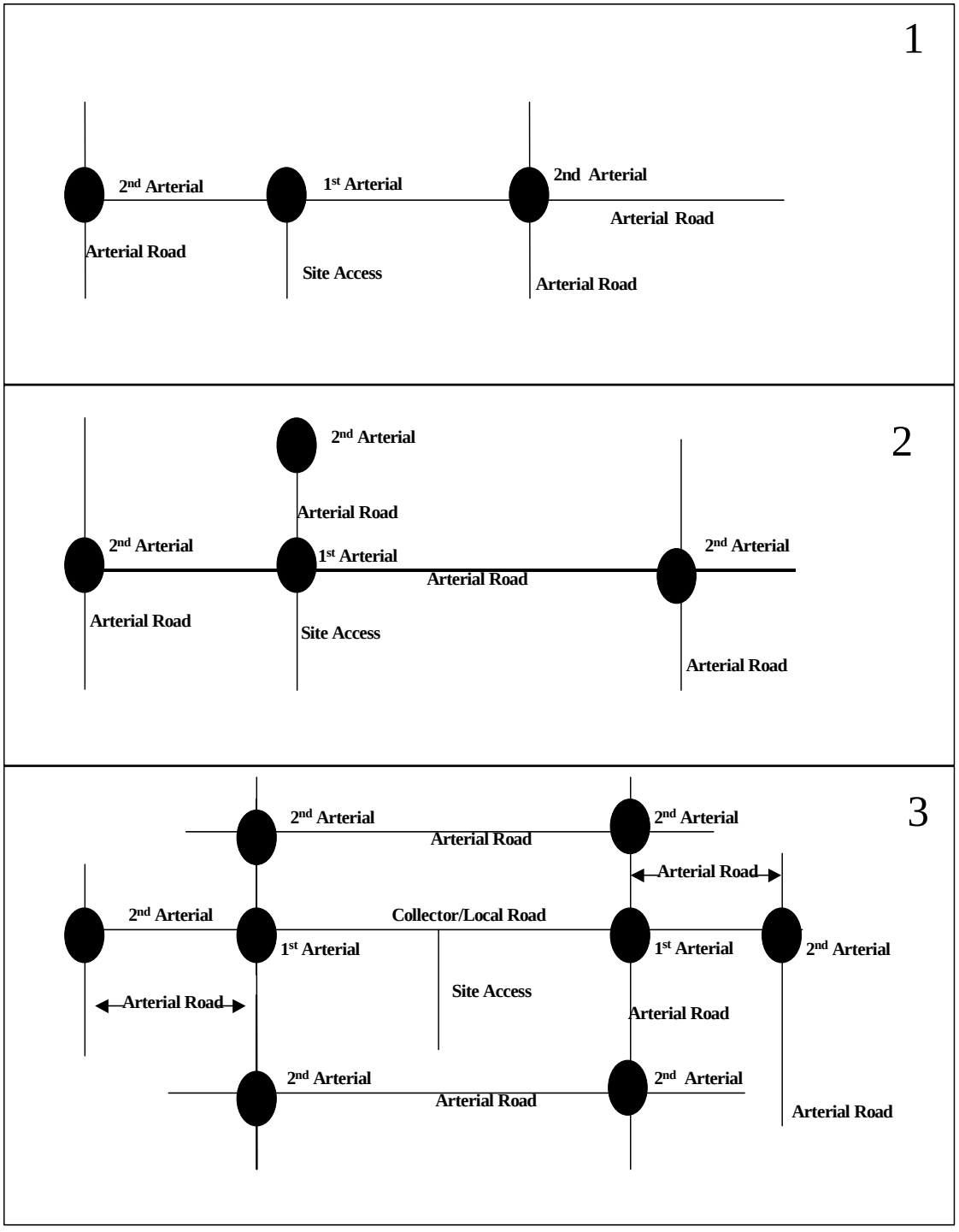
        - The study shall analyze any intervening intersections designated by the County or State.

    - Special Requirements Along Certain Peninsulas

        - The impact area shall be extended through the second intersecting arterial road and along that arterial road to the third arterial intersection in all direction if the development is located along MD 173 (east of MD 607), MD 177 (east of Woods Road), Bay Ridge Avenue (east of Bay Ridge Road) or MD 214 (east of MD 468).

        - The study shall analyze any intervening intersections designated by the County or State.

TRAFFIC STUDY IMPACT LIMITS



- Notes:

  - If a site enters directly on an arterial, this is considered as the first arterial intersection.

  - Analyses need not be carried past the County's exterior boundary, into the City of Annapolis (except on County maintained roadways, such as Forest Drive) or outside of town center limits.

  - Arterial roadways built within a subdivision will be considered as internal subdivision streets, not as the first arterial to be studied.

  - A continuous arterial route consisting of more than one road name (New Cut Road to Gambrills Road, for example) shall be considered as one arterial if so shown on the County's road network and classification plan.

3. What traffic must be included in the study?

   - For all developments:

     - Existing Traffic;

     - Traffic to be generated by:

       a. Building Permits that have been issued and are expected to generate more than 50 vehicle trips per day;
       b. Pending Building Permits expected to generate more than 50 vehicle trips per day; and
       c. Subdivisions that have sketch plan approval.

     - Traffic projected to be generated from the proposed development.

   - Traffic from other proposed developments must be considered if it can reasonably be expected to impact the roads and intersections under study. At a minimum, this will include all other developments whose traffic impact study area would overlap or abut the proposed development's traffic impact study area. It may also include other development further away.

4. How should the study be organized and presented?

   - In an organized, logical, and neat fashion.

   - With the project name and number clearly identified on the cover.

   - With all assumptions clearly stated and documented.

   - With all backup material provided.

- Required form:

  - Description of existing conditions along with a condition diagram of all intersections under review, roads, and traffic volumes
  - Location map
  - Description of proposed developments: scope, size, type of development, schematic map
  - Other nearby developments
  - Traffic generated by other development (amount, distribution, splits)
  - Traffic generated by the proposed development (amount, distribution, splits)
  - Total traffic volumes (Note: It is necessary to provide a series of maps/ diagrams showing (a) existing traffic, (b) other development traffic, (c) total background (a+b) traffic, (d) site traffic (if the development under review is for a mixed use project, then the total site traffic generation should be included), (e) total (c+d) traffic for both am, pm and other peaks as identified by the County).

  - Required analyses:

    a. Critical lane volume analysis.
    b. Latest version of the Highway Capacity Manual (HCM) intersection analysis for any intersection with a total critical volume (see paragraph a above) of 1300 or more.
    c. Signalization studies for intersections designated by the County. Such studies shall compare projected traffic volumes to signalization warrants contained in the Manual on Uniform Traffic Control Devices.
    d. Synchro system analysis if required by the County or State.

    For developments not within a Town Center Growth Management Area, the following analyses will also be undertaken.

    e. HCM capacity analysis for all roadway segments (must use HCM worksheets or FHWA software) for State roads.
    f. A County Road Rating analysis for all roadway segments.

  - Analyses will normally be required for morning and evening peak hours (based on the adjacent roadway peak). Where the development's peak occurs at significantly different times than the adjacent roadways', other analysis may be required (mid-day, weekend, etc.).

- Acceptable assumptions

- The County will generally accept trip generation rates found in the latest edition of the Institute of Transportation Engineers Trip Generation Report. This report provides three methods to determine average trip generation for proposed developments: a weighted trip generation rate, a plot of actual trip ends versus an independent variable, and a regression equation. Consultants will be required to use whichever method provides the best fit for the data. For example, if the regression equation for a particular use has a high correlation factor and the averaged trip rate for that use has a large standard deviation, the regression equation should be used. This will require a careful analysis of data for each use. Again, the Consultant should determine which method provides the best fit for the type and size of the proposed development. Questions of interpretation should be directed to the Development Division, which will make the final determination of what method will be used.

- Other sources for trip generation rates may be considered if sufficient documentation is provided. This will generally apply only to uses not covered by the ITE report.

- Trip distributions for new traffic should be based on the proximity of trip generators and attractions and on existing travel patterns.

- Existing traffic volumes should be based on current count information. Three to seven day machine counts should be used to determine daily and peak volumes along roadway segments, and peak hour turning movement counts should be used to determine peak intersection volumes. Counts from one to three years old must be increased by 4% per year unless historical data is available. Counts older than three years may not be used. (See also Question 7, “What information is available to assist in the preparation of a traffic impact study?”).

- The County will allow the consideration of intercepted pass-by trips based on information in the ITE Trip Generation Handbook. If intercepted pass-by trips are assumed, care must be taken to properly route all trips through all affected intersections and roadways. Please note that the County will allow consideration only of intercepted pass-by trips, that is, trips that would already be on the adjacent roadway(s). Trips that would be diverted from other roadways must be considered as new trips.

- Calculations for multi-use trip reductions may be considered by the County for multi-use developments when the ITE Trip Generation Handbook calculations are included in the study.

- These guidelines may be altered (by the County) for specific sites.

5. What standards will apply?

- Intersections must operate at LOS D or better as determined by the critical lane method (critical lane volume of 1450 or less). Intersections with a total critical lane volume of more than 1300 must also be analyzed using the latest version of the Highway Capacity Manual. This analysis is to determine if any approaches have individual unacceptable levels of service (E or F). If an approach does fail, the study must address what the development's impact is and what actions are required to improve the service level to D or mitigate the impact of the traffic generated by the development. The County will review these analyses regarding what improvements, if any, should be required of the developer.

  With the approval of the Planning and Zoning Officer, intersections in the core of the Town Center Growth Management area may operate with a critical lane volume of less than 1600 at the discretion of the Planning and Zoning Officer.

- For developments not within a Town Center Growth Management area, the following standards will also apply:

  - Maryland State Highway Administration roadway segments must operate at a V/C ratio of .90 or better as determined by the latest version of the Highway Capacity Manual.
  - Roadway segments must have a County road rating system score of 70 or greater.

6. When should the traffic impact study be submitted?

- The traffic study must be submitted with the sketch or site development plan submittal, whichever is submitted first.

7. What information is available to assist in the preparation of a traffic impact study?

- Developers should contact the Office of Planning and Zoning to review the subdivision activity map. This will identify other nearby subdivisions that may need to be included in the study. It is up to the traffic engineer to determine the distribution of traffic included in the study based on traffic patterns in the area. The Development Division traffic reviewer may be contacted to determine if the background traffic information is available from recently reviewed studies.

- Developers may request information from the Development Division which will provide copies of available turning movement and volume counts, as well as information from other <u>approved</u> traffic studies. Every effort will be made to respond within two weeks. Developers and consultants should not expect that they will be able to pick up information from the Development Division without advance notice.

ANNE ARUNDEL COUNTY
STANDARDS FOR GATEHOUSES, FENCES AND COMMUNITY SIGNS WITHIN COUNTY RIGHT-OF-WAY
June 2, 1997

- In these standards, the term gatehouse includes any covered structure proposed as an entryway feature of a subdivision or development. The term community sign includes signs, fences, sculptures, and structures designed to identify the community.

- Gatehouses, fences and community signs are to be decorative only. They are not to be used to control access or for mail delivery. The only exception which will be considered is an open-sided bus shelter located outside of the roadway (not in the median).

- Gatehouses, fences and community signs are to be constructed and maintained by developer and/or community. Any gatehouse, fence or community sign within a County owned right-of-way will require an agreement with County which is to be recorded prior to plat approval and liability insurance in the amount of $500,000. The agreement shall specify:
  a) The County's right to approve the design, construction and location of the gatehouse, fence or community sign.
  b) The developer's/community's responsibility to maintain the structure in a manner acceptable to the County.
  c) A hold harmless agreement whereby the developer/community accepts full responsibility and liability for any claims arising from the construction, maintenance and/or presence of the structure.
  d) The County's right to require maintenance or removal of the structure.
  e) The County's right to maintain or remove the structure and to bill the developer/community to recover the cost of such action.
  f) That proof of insurance shall be submitted to the County yearly. If insurance is not maintained, the structure will be removed by the County at the developer's/community's expense.

- Preferred Location and Design
  a) Gatehouses - The preferred structure is open-sided and located outside the roadway (not in a median). Close-sided structures will be allowed outside the roadway or within a median subject to the conditions noted below under Construction Standards. No open-sided structures will be allowed within a median.

b) Fences - The preferred location is on private or community property, not within the public right-of-way. Fences will be allowed in the right-of-way only if they are within three feet of the right-of-way line and meet the conditions noted below under Construction Standards. Fences will not be allowed within medians.

c) Community signs - The preferred location is outside of the roadway near the edge of the County owned right-of-way. In addition, community signs must meet the requirements of Article 28, Section 8-115(b)(2 & 3) of the County Code, which notes that:

(2) "One sign giving the name of the subdivision or multifamily development may be placed at each roadway entry point. The sign may not exceed 36 square feet in area or a height of five feet above grade." Double sided signs with less than 18 inches of separation will be considered as a single sign.

(3) "Instead of the sign provided for in paragraph (2), one sign may be located at each side of the roadway entry point. Each sign may not exceed 20 square feet in area, the total area shall be 40 square feet or less and the height of each sign may not exceed five feet above grade".

The square footage of the actual sign and not the structure is considered in the measurement. Sculptures, statuary and other structures intended to identify the community will be reviewed on a case-by-case basis, but must at least meet the requirements for gatehouses as contained in these standards. No changeable messages will be permitted

Construction Standards - In this section, the term structure refers to any gatehouse, fence or community sign.

a) Structures are to be subject to all applicable building codes.

b) Structures are to be at least 25 feet behind the edge (curb or shoulder) of the cross road.

c) Structures are to be at least 2 feet behind curb or 6 feet behind the edge of the shoulder on roads with posted speed limit of 30 MPH or less. Distances are to be 6 and 8 feet respectively on roads with posted speed limit in excess of 30 MPH (except that no gatehouses or community signs shall be allowed in the median of a road with posted speed limit in excess of 30 MPH). These distances apply to structures located in medians. Structures in other locations shall not interfere with sidewalks or obstruct sight distance. The Department of Public Works will specify the appropriate speed limit. Speed limits will not be lowered to allow relaxation of these setbacks.

d) No utilities (except electricity when approved) will be allowed to serve the structure. Electricity shall be allowed only to provide lighting as approved by the Department of Public Works. Where electricity is allowed, the developer/community shall be responsible for all hook-up and on-going energy charges. All electrical work will require a County permit and shall be subject to all applicable codes. All circuits shall be protected by ground fault interrupters. Lighting shall illuminate only the intended gatehouse or community sign and shall not shine directly into motorists' lines of sight or beyond the right-of-way.

e) Closed-sided gatehouses will only be allowed if all windows are permanently closed (incapable of being opened) and the door is hinged to open into the structure and provided with a one inch throw deadbolt lock. The lock shall be keyed with a standard County specified key. The County shall be provided with a list of those developer/community officers (maximum of 4) holding keys. This list shall be updated and resubmitted to the County at least annually.

f) Maximum gatehouse footprint area is 100 square feet.

g) Maximum gatehouse height is 15 feet.

h) Plantings in the median are to be no higher than 24 inches above road surface.

I) All standards are subject to revision by the County on a case by case basis as needed to protect the health, safety and welfare of the general public.

Approved:

Steven R. Cover
Director of Planning and
Code Enforcement

John Brusnighan
Director of Public Works

Appendix P
Anne Arundel County, Maryland
TRAFFIC CONTROL DEVICES AND STREET TREES FOR NEW DEVELOPMENT PROJECTS

Traffic control devices (TCDs) include all signs, signals, lighting, and pavement markings placed on, over, or adjacent to a County roadway by the authority of the Director of Public Works to regulate, warn, and guide vehicular and pedestrian activity. The purpose of this policy is to provide guidance for the layout of signs, markings, signals, lighting, street trees, and pavement markings for inclusion in the Final Plan package.

Developers will prepare plans for traffic control devices, street lights, and street trees and submit them for approval once the roadway layout has been approved by the Department of Planning and Code Enforcement (PACE). Developers will be responsible for the costs of signs and street lights, but they will be installed by the County or its contractor. Signals and pavement markings will generally be installed by the Developer's contractor under the supervision of Traffic Engineering, DPW.

A. General

1. Traffic signs, street lights, and street trees shall be shown on a separate plan sheet included in the Final Plan package for all new development projects. This plan will include clear descriptions and locations of all required traffic control devices. The sheets will also include locations of all driveways, intersections, required street trees and street lights so that conflicts can be avoided.

2. All costs associated with required TCDs for any new development will be bonded under the Public Works Agreement for that project. A current TCD cost sheet can be obtained from PACE.

3. The developer will be required to submit the traffic sign/street light/street tree sheet(s) and cost estimate to PACE for review and approval. PACE will supply the Traffic Engineering Division, DPW with a copy of the plan for review of signs and street light placement. Traffic Engineering will send their recommendations back to PACE within five working days of receipt of the plan. PACE will not approve any placement of signs or street lights unless they receive Traffic Engineering’s agreement. Once the original is signed, one copy will be returned to the Traffic Engineering Division for the preparation of necessary Notices of Traffic Control and work orders for the installation of signs and street lights.

4. All TCDs shall be in conformance with the Manual

OnUniform Traffic Control Devices (MUTCD) and applicable State and County regulations. If there is a discrepancy between requirements, the Traffic Engineering Division, DPW shall be consulted for direction on what standards are to be followed. Developers are especially reminded that a State law adopted in 1998 requires all TCDs on private property to conform to the MUTCD.

B. Traffic Signs

1. The signing plan must be designed to provide the motorist with clear and concise regulatory, warning, and guidance information regarding the roadways within or adjacent to the development.

2. Traffic signs shall be located as close to property lines as possible in all new developments. Care must be taken to avoid placing signs at mid-lot locations.

3. Generally, only one traffic sign will be placed on a channel. The major exception to this is the acceptable practice of placing STREET NAME sign(s) and a STOP sign on the same channel. At times, a NO OUTLET or a DEAD END sign may also be added to this channel.

4. The Traffic Engineering Division may be consulted prior to TCD plan submittal to determine if additional signs are required due to unusual circumstances. Examples of this included the presence of schools, playgrounds, or sharp curves along a roadway. During the TCD plan review, it may be determined that additional signs will be required.

5. Traffic signs shall be banded to streetlight posts whenever practical.

6. Refer to Figure 1 for a list of standard symbols that are to be used when developing TCD plans.

7. All traffic signs should be placed to provide adequate sight distances. Care must be taken to not obstruct the visibility of any traffic sign with street trees. Figure 2 illustrates the minimum clearances between street trees and signs/street lights. Warning signs for specific hazards should be placed as noted below:

Traffic Control Device/Roadway Feature		Symbol
9" Street Name Sign (2 Blades)	SNS	
STOP Sign	R1-1	
YIELD Sign	R1-2	
Speed Limit Sign	R2-1	SL
Crossroad Warning Sign	W2-1	
T Intersection Warning Sign	W2-2	
Street Name Panel (Used with W2-1 or 2)	D3-2	SNP
KEEP RIGHT Sign	R4-7	
DEAD END Sign (For SNS Assembly)	W14-1s	DE
NO OUTLET Sign (For SNS Assembly)	W14-2s	NO
Other Warning Signs	Wx-y	
Street Light		L
Street Tree		T

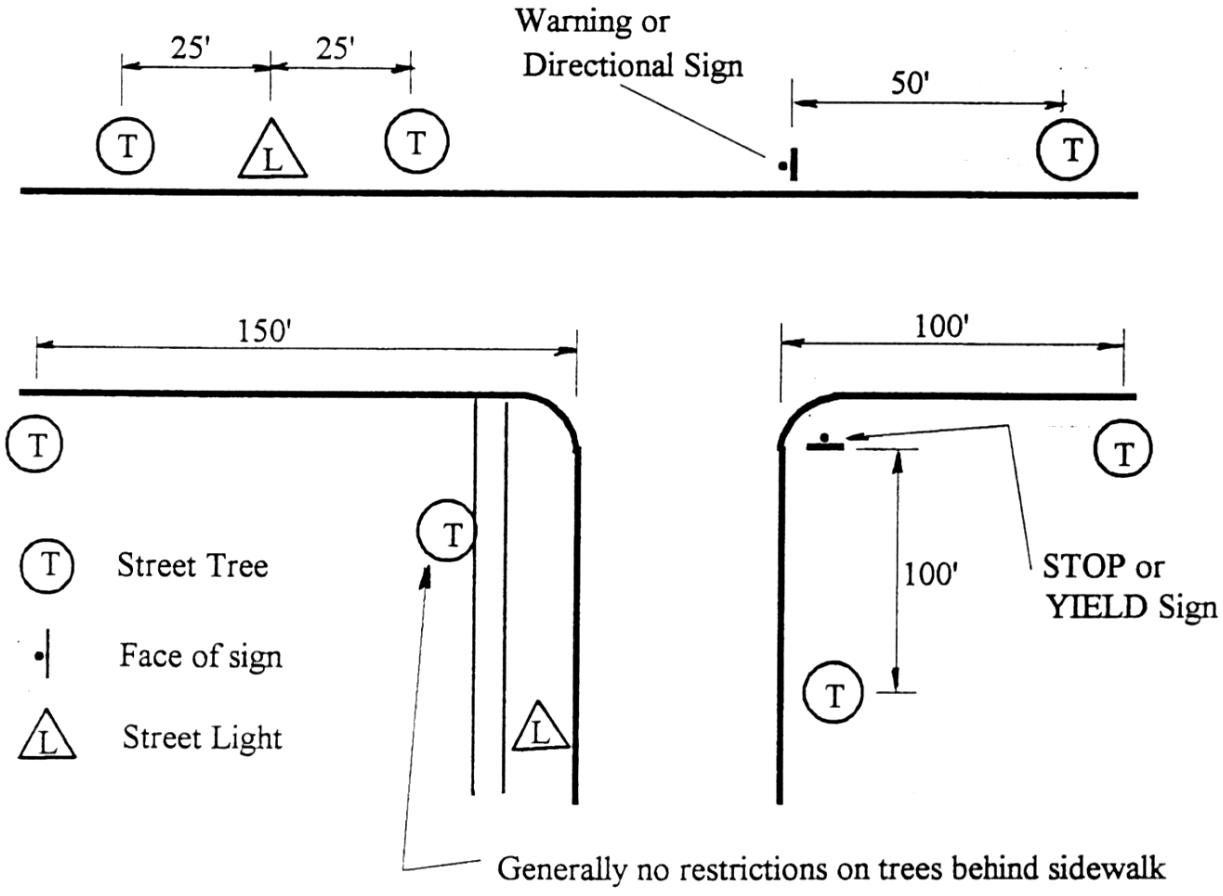
Figure 1 - Standard Symbols

Figure 2 - Street Tree Placement
General Guidelines

Street trees which are placed behind sidewalk on closed section roads or at least eight feet from the edge of paving on open section roads usually do not obstruct sight distance and are generally not subject to these restrictions. However, a case by case review may be necessary depending on the species of tree used.

In order to assure adequate visibility of signs and vehicles, and to prevent the blocking of street lights, street trees shall not be placed:

- Within 100 feet of the face of a STOP or YIELD sign;
- Within 50 feet of the face of any other street sign;
- Within 25 feet of a street light; or
- Within 150 feet of the intersection to the left or within 100 feet of the intersection to the right along a cross street at an intersection controlled by a STOP or YIELD sign.



Posted Speed Limit of Roadway (MPH)	Minimum Clear Sight Distance to Sign (FT)	Warning Sign Minimum Distance To Hazard (FT)	Minimum Spacing Between Signs (FT)
25	300	250	175
30	350	300	185
35	400	350	200
40	500	400	240
45	600	450	275
50	700	500	300

8. STREET NAME Signs

   a. The standard designation for a STREET NAME sign is SNS.

   b. All SNS blades will be double-sided and nine inches in height with six inch lettering.

   c. One SNS installation will generally be required at new intersections. Two SNS installations will be required at each intersection along roadways that have medians or at those intersections where the street name changes from one side of the road to the other.

   d. If only one SNS is used at an intersection, it shall be installed on the higher volume cross-street leg.

   e. Refer to Figure 3 for additional information regarding SNS installations at the intersection of two County roadways.

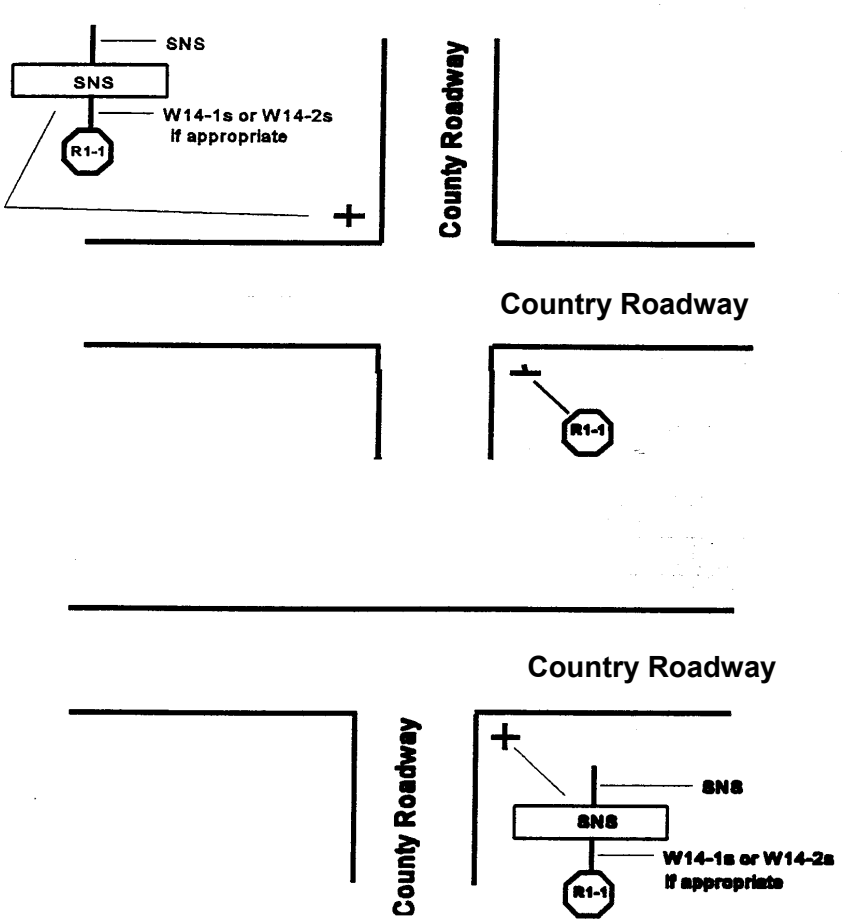
   f. Refer to Figure 4 for additional information regarding SNS installations at the intersection of a County roadway and a State highway.

9. STOP Signs

   a. The standard designation for a STOP sign is R1-1.

   b. In general, the minor roadway(s) will be provided with a STOP sign at all County intersections. Refer to Figure 3 for additional information.

Figure 3 - Signing for State/County Intersections



c. When two residential roadways meet in a four-legged fashion, the road that intersects or is nearest to a collector or arterial roadway will typically be considered the major movement and the traffic on the other road will be required to stop. At a tee-intersection, the traffic on the base of the tee shall generally be required to stop.

d. The State Highway Administration is responsible for the installation and maintenance of STOP signs at the intersection of County roadways with State highways. The cost of a State maintained STOP sign will be included in the State's access permit, not the County's Public Works Agreement. Refer to Figure 4 for additional information.

10. DEAD END signs are required for roads that end without intersecting another road.

a. The standard designation for a street name sign assembly DEAD END sign is W14-1s.

b. The standard designation for a diamond shaped DEAD END sign is W14-1.

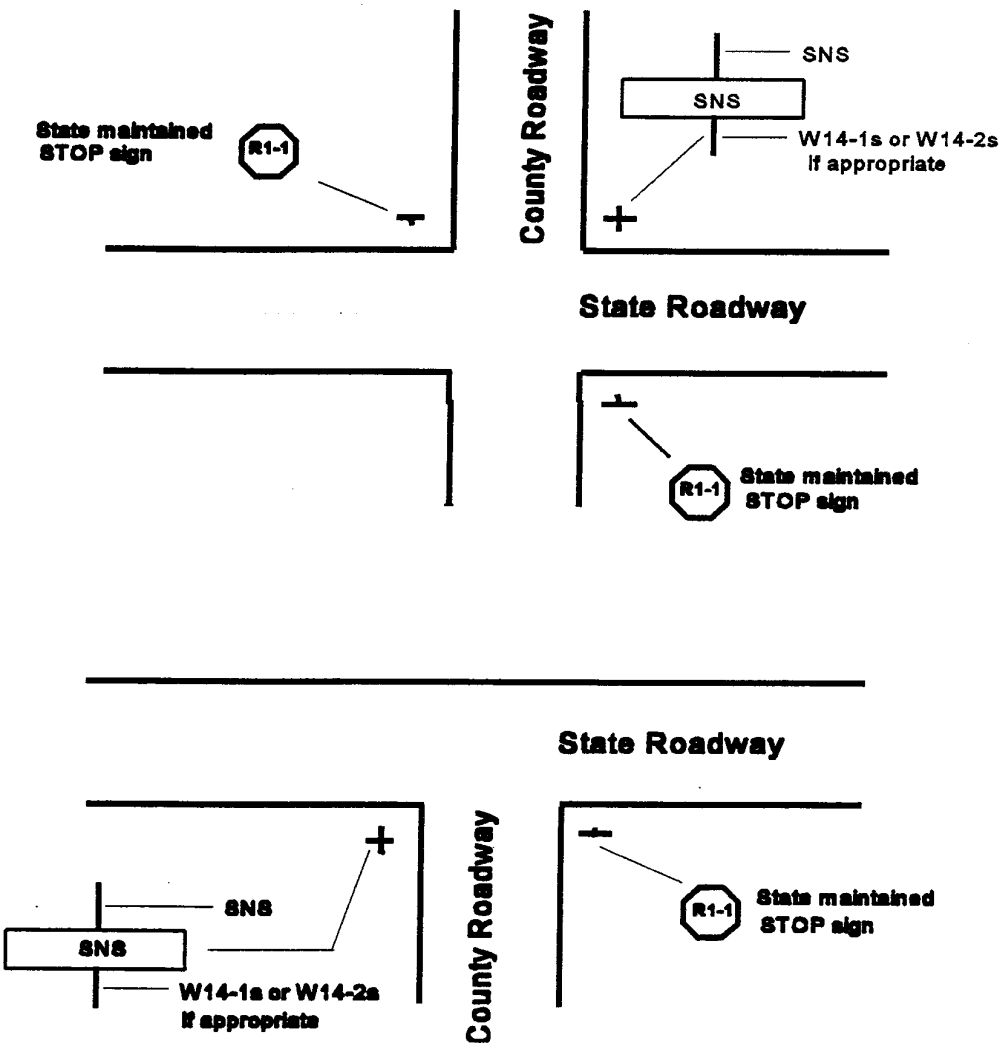


Figure 4 Signing for State/County Intersections

c. It is anticipated that the STREET NAME sign type DEAD END sign (W14-1s) will be used much more frequently than the diamond shaped DEAD END sign (W14-1). It shall be mounted between the STOP sign and the bottom STREET NAME sign. The diamond shaped variety shall only be used when the majority of the approach traffic is directly oncoming. No sign shall be required if the end of the roadway can be seen from the cross street.

11. NO OUTLET signs are required for roads that serve as the

only access to a community.

a. The standard designation for a STREET NAME sign assembly NO OUTLET sign is W14-2s.

b. The standard designation for a diamond shaped NO OUTLET sign is W14-2.

c. It is anticipated that the STREET NAME sign type NO OUTLET sign (W14-2s) will be used much more frequently than the diamond shaped NO OUTLET sign (W14-2). It shall be mounted between the STOP sign and the bottom STREET NAME sign. The diamond shaped variety shall only be used when the majority of the approach traffic is directly oncoming. No sign shall be required if the end of the roadway can be seen from the cross street.

12. KEEP RIGHT Signs

a. The standard designation for a KEEP RIGHT sign is R4-7.

b. KEEP RIGHT signs will be required at both ends of the median for monumental type entrances.

c. For those roadways with continuous medians that have breaks for driveways and roadway intersections, KEEP RIGHT signs will generally only be required at the beginning and end of the median.

13. SPEED LIMIT Signs

a. The standard designation for a SPEED LIMIT sign is R2-1(XX), where XX is the numeric value of the assigned speed limit.

b. A SPEED LIMIT sign will be installed along the inbound lane of all new residential roads within three hundred fifty feet of the beginning of the roadway and then beyond major intersections and/or at other locations where it is necessary to remind motorists of the posted speed limit. If the roadway is longer than five hundred feet, an outbound SPEED LIMIT sign will be installed approximately three hundred feet from the end of the roadway and then beyond major intersections and/or at other locations where it is necessary to remind motorists of the posted speed limit.

c. Collector and arterial roadways will have an inbound SPEED LIMIT sign placed within five hundred feet of the beginning of the roadway as well as an outbound SPEED LIMIT sign placed within five

hundred feet of the end of the roadway. Additional SPEED LIMIT signs will then be placed in pairs at one-half mile intervals or after intersecting side roads at close to the same intervals.

d. The Final Development Plan will show only the location of the SPEED LIMIT signs, not the actual speed limit(s). Speed limits will be established by the Traffic Engineering Division. In residential areas, the following guidelines will be used for setting speed limits:

- Local and collector roadways with R-2 or greater density zoning: 25 miles per hour.
- Local and collector roadways with less than R-2 density zoning: 30 miles per hour.
- Collector roadway with direct driveway access and R-2 or greater density zoning: 30 miles per hour.
- Collector roadway without direct driveway access but with less than R-2 density zoning: 35 miles per hour.

14. INTERSECTION WARNING Signs

a. Arterial roadways will have INTERSECTION WARNING signs placed in advance of intersecting roadways, which are not controlled by a signal.

b. The INTERSECTION WARNING signs will include supplementary STREET NAME panels.

c. The standard designation for a four-legged INTERSECTION WARNING sign is W2-1.

d. The standard designation for a three-legged INTERSECTION WARNING sign is W2-2.

e. The standard designation for a STREET NAME panel is D3-2.

C. Street Lighting Design

1. The Final Development Plan will show the locations for the street lights. The actual luminaires and poles will be ordered by Traffic Engineering using only those devices approved by Baltimore Gas and Electric for use under the Public Street Light rate schedule. 175-watt mercury vapor luminaires will typically be used. In residential areas, the luminaires will be mounted on fourteen-foot black fiberglass poles. Thirty-foot steel poles will be used on divided roadways, on major collector and arterial roadways in residential areas, and in commercial areas.

2. Refer to Figure 1 for a list of standard symbols that are to be used when developing TCD plans.

3. Other similar poles may be used if approved by the Baltimore Gas and Electric Company.

4. Generally, street lights are to be placed as close to intersections as possible and then spaced as follows (see Figure 5):

   a. Roadways with medians: Street lights are to be installed on both sides of the road at one hundred eight to two hundred foot spacings, as close to property lines as possible.

   b. Roadways without medians: Street lights are to be installed on alternate sides of the road at one hundred eighty to two hundred foot spacings, as close to property lines as possible.

5. On closed section roadways, the street lights are to be placed in the grass area between the curb and the sidewalk.

6. On open section roadways, the street lights are to be placed adjacent to the shoulder, approximately eighteen inches from the edge of shoulder. Where no paved shoulder exists, street lights will be placed at least six feet from the edge of roadway. Street lights shall not be placed as to impede the flow of water in storm drain ditches.

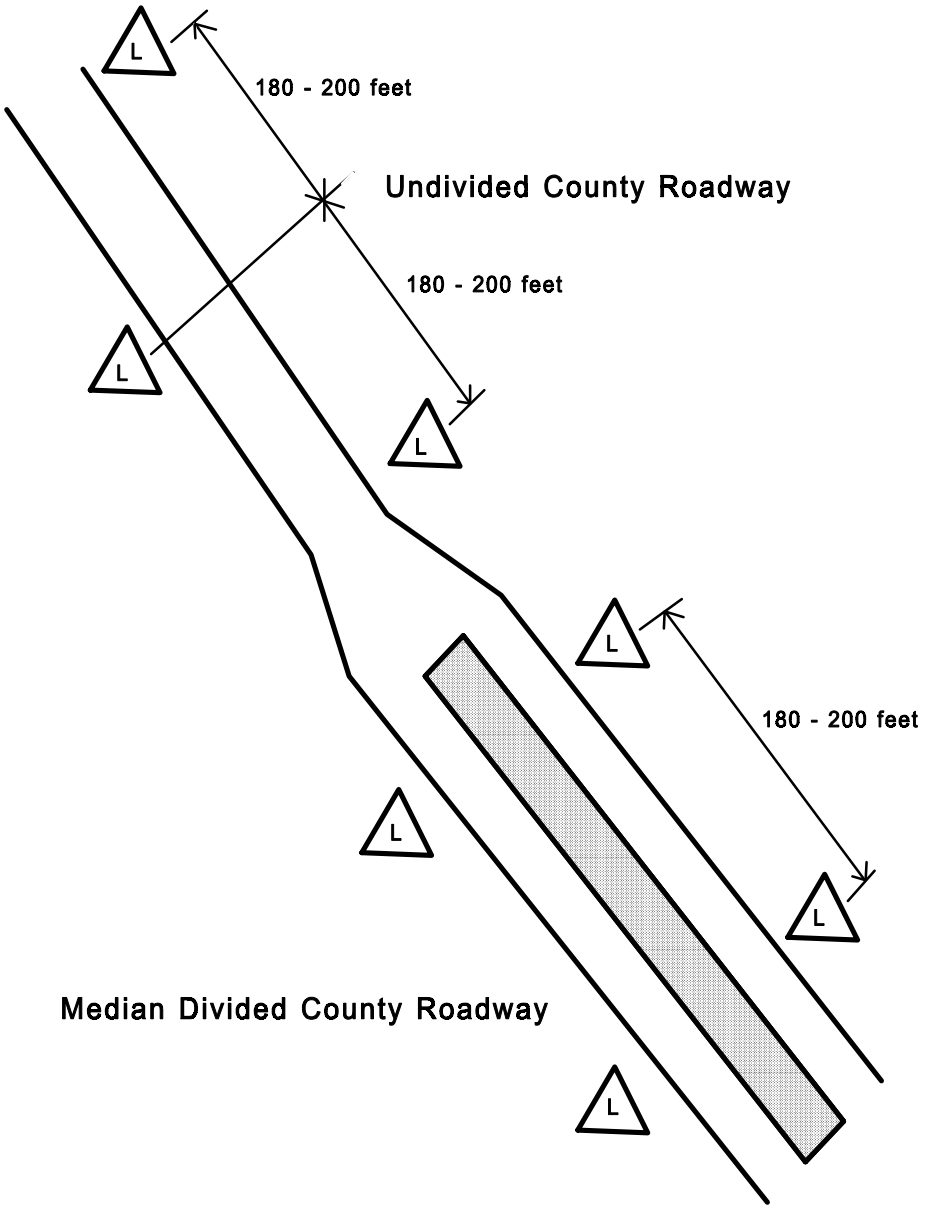
7. Street trees shall be placed a minimum of twenty-five feet from street lights, except in those cases where a traffic sign is attached to a street light post. In these instances, street trees must be positioned such that the minimum clear sight distance to the sign, as described in Section B.4, is achieved.

D. Street Trees

Street Trees shall be placed in accordance with the Landscaping Manual and to provide the minimum clearances from signs and street lights as noted below and as shown on Figure 2.

Street trees, which are placed, at least eight feet behind the curb (or edge of paving on open section roads) are <u>not</u> subject to the following restrictions. These restrictions apply only along the roadway frontage.

Figure 5 - Street Light Placement



In order to assure adequate visibility of signs and vehicles, and to prevent the blocking of street lights, street trees shall not be placed:

- Within 100 feet of the face of a STOP or YIELD sign;
- Within 50 feet of the face of any other street sign;
- Within 25 feet of a street light; or
- Within 150 feet of the intersection to the left or within 100 feet of the intersection to the right along a cross-street at an intersection controlled by a STOP or YIELD sign.

Further restrictions may be applied on a case-by-case basis as necessary.

Care should be taken to avoid placing street trees directly under overhead utility lines.

E. Signal Design

Refer to the Traffic Engineering Division's Policy and Procedure Manual for signal design standards and plan requirements.

F. Pavement Marking Design

1. The pavement marking plan is to be included in the public roads plans submitted to PACE for approval. PACE will supply the Traffic Engineering Division with a copy of the plan for review of pavement markings. Traffic Engineering will send their recommendations back to PACE within five working days of receipt of the plan. PACE will not approve the placement of any pavement markings unless they receive Traffic Engineering’s agreement.

2. The pavement marking plan must be designed to provide the motorist with clear driving guidance along County roadways.

3. The developer will be responsible for all pavement striping necessary for both roadway widening improvements as well as newly constructed subdivision roadways. The following are the most common types of roadway improvements:

   a. Collector and arterial roadway widening improvements. The pavement marking improvements will generally consist of the reconfiguration of the centerline, laneline, and edgeline markings so that the full pavement width can be utilized by

motorists.

b. Intersection improvements (new construction or widening). The pavement marking improvements will generally consist of striping bypass or turning lanes around or into the minor legs of the intersection, or the reconfiguration of the lane assignments of the major legs of the intersection. Pavement markings may also be required in the form of crosswalks, lane assignment arrows, and stop bars.

c. Residential roadway construction. Pavement markings are usually not required for these roadways.

4. It is recommended that the developer review the following sections of the Traffic Engineering Division's Policy and Procedure Manual for further information regarding pavement markings:

E.2.3 Pavement Markings

E.2.3.1 Arrow Placement in Turn Lanes, Lane Drops, and Two-Way Left Turn Lanes

E.2.3.2 Auxiliary Lane Lines

E.2.3.3 Stop Line Placement

E.2.3.4 Crosswalk Markings

All pavement marking plans must be consistent with Traffic Engineering Division Policies and the Manual on Uniform Traffic Control Devices. Contact Traffic

Engineering for up-to-date specifications for pavement marking materials.

5. The minimum transition rate of centerline and edgeline striping is as per the following table:

SPEED LIMIT (MPH)	TAPER RATIO (FT TO FT)
30	15 : 1
35	20 : 1
40	25 : 1
45	35 : 1
50	45 : 1

6. The minimum lane width for pavement striping purposes is ten feet.

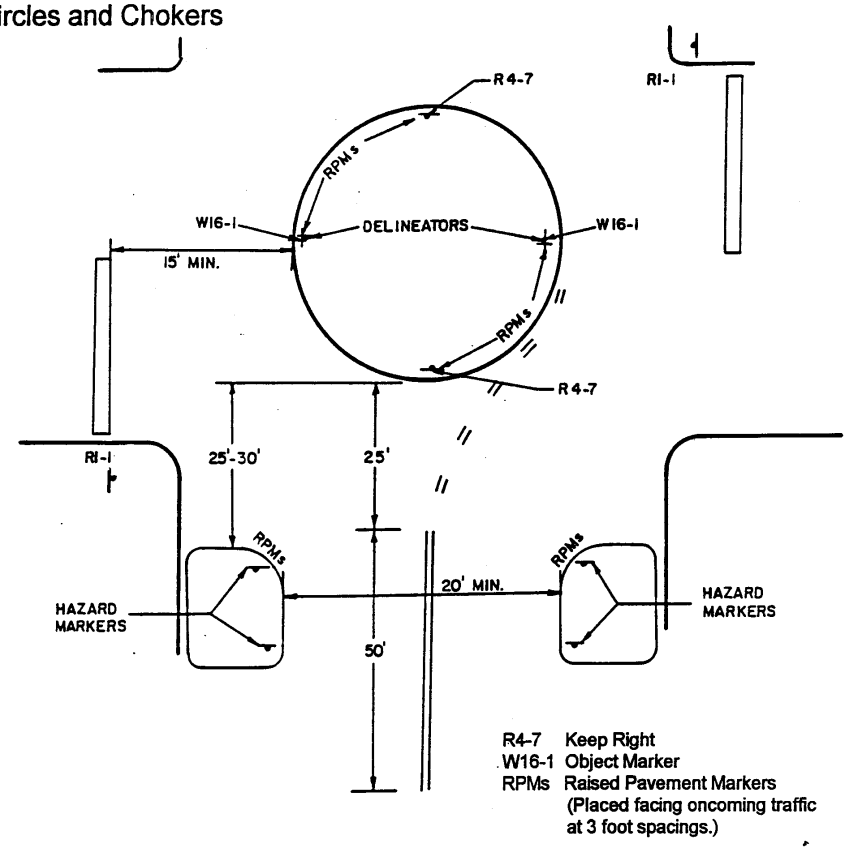
7. Twenty-five feet of storage space is required per vehicle for the design of turning lanes.

8. Traffic count data may be required at intersections where it is not clear whether a bypass lane arrangement or an exclusive left turn lane would be more appropriate.

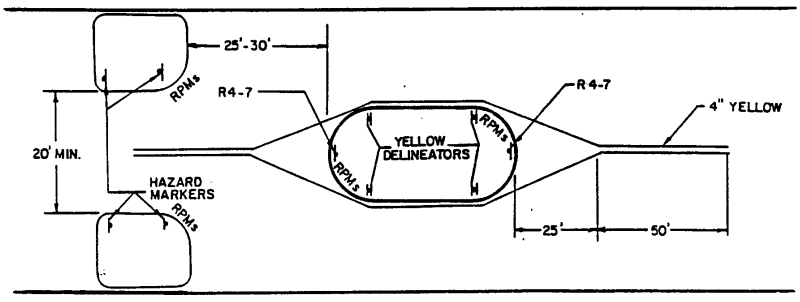
9. Any existing pavement markings that conflict with required new markings must be removed to the satisfaction of the Traffic Engineering Division, DPW. Either an asphalt overlay or grinding is appropriate. Painting the existing striping with black paint is not acceptable. The costs associated for this work must be bonded under the

Figure 6 - Signing and Marking for Speed Control Circles, Islands, and Chokers

Circles and Chokers



Islands and Chokers



subdivision's Public Works Agreement.

10. All pavement-marking plans must include a note requiring the Contractor to notify the Traffic Engineering Division (410-222-7331) and arrange a field review before installing any pavement markings.

G. Traffic Calming Device Signing and Pavement Marking

Roadways should be designed to discourage speeds in excess of the posted speed limit. Speed humps should generally not be installed on new residential roadways. The design and layout of other speed control devices (such as islands, circles, chokers, edge lines, etc.) should be reviewed with the Traffic Engineering Division to assure appropriate designs for school buses, emergency vehicles, snowplows, and trash trucks. Plans for traffic calming devices will be included in the public roads plans. (See Traffic Engineering Policy E-4.) Signing and striping for islands, circles, and chokers shall be as shown on Figure 6.

H. Sight Distance at Intersections

At intersections controlled by STOP or YIELD signs, care must be taken to provide adequate sight distance for vehicles exiting the minor road. In addition, vehicles turning left into the minor road must have adequate sight distance and must be visible to other vehicles approaching from the rear.

Figure 7 illustrates the minimum acceptable sight distance for vehicles entering local and collector roadways. For higher speed roadways, AASHTO Green Book guidelines should be followed.

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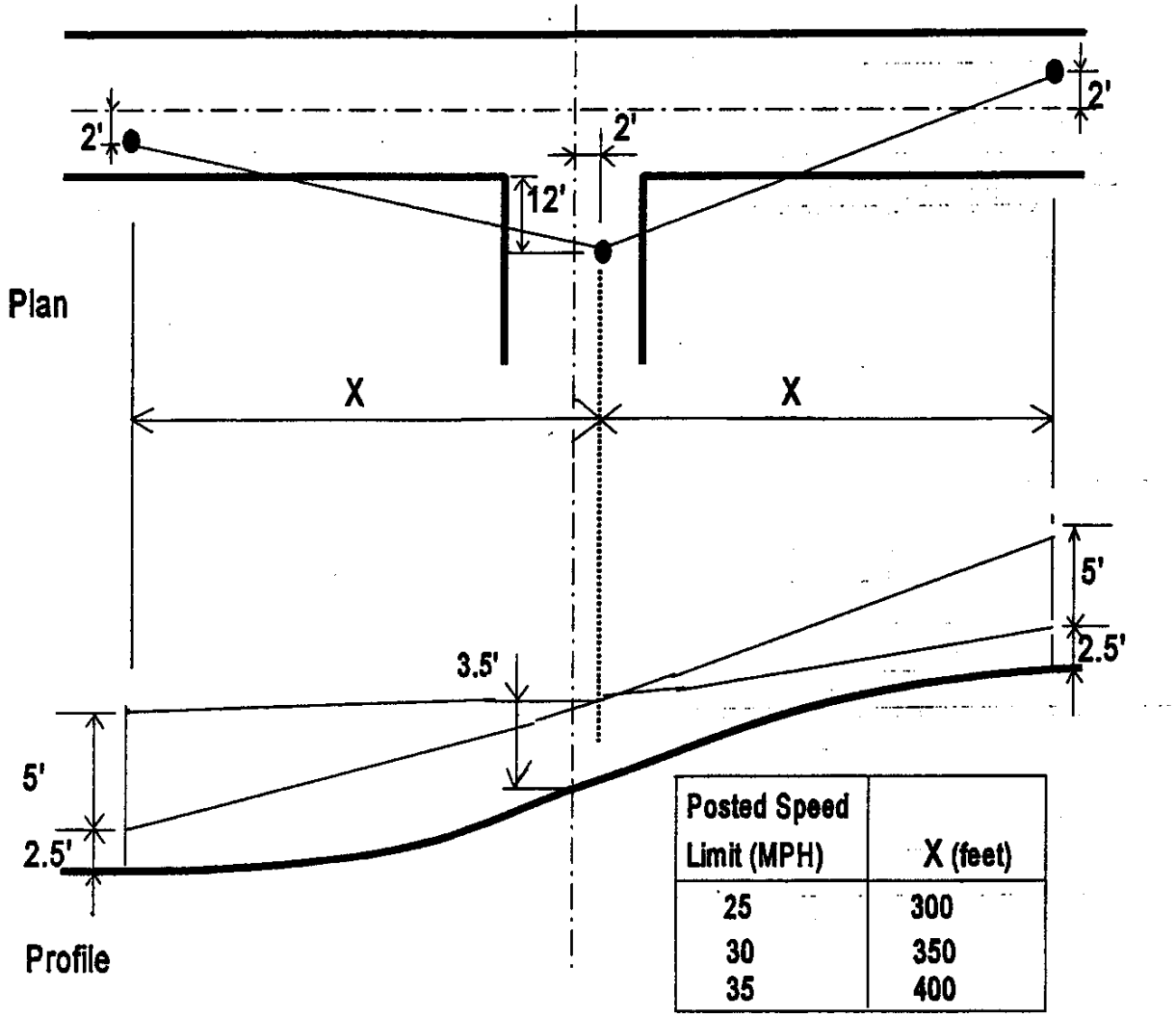
Traffic Engineering
E.2.2

Figure 7 - Sight Distance Requirements for Local and Collector Roads

(See AASHTO for intersections with Arterial or higher roadways)



Posted Speed Limit (MPH)	X (feet)
25	300
30	350
35	400

The sight triangle must be free of obstructions in both the horizontal and vertical planes as defined above.