CHAPTER 4

GRADE SEPARATIONS AND INTERCHANGES

4.0 INTRODUCTION

The ability to accommodate high volumes of intersecting traffic safely and efficiently through the arrangement of one or more interconnecting roadways can be achieved by utilizing a grade separation or an interchange system to provide for the movement of traffic between the roadways. By definition, a grade separation represents a crossing of two highways (or a highway and a railroad) at different levels while an interchange represents a system of interconnecting roadways, in conjunction with one or more grade separations, to provide for the movement of traffic between two or more roadways on different levels.

For Interstate highways, interchanges shall be provided between all intersecting Interstate routes, between other selected access controlled highways and at other selected public highways to facilitate distribution of traffic. Each interchange shall provide for all traffic movements.

The type and design of grade separations and interchanges are influenced by many factors such as highway classification, character and composition of traffic, design speed and degree of access control. These controls plus signing needs, economics, terrain and right-of-way are of great importance in designing facilities with adequate capacity to safely accommodate traffic demands. Although each interchange presents an individual problem, its design shall be considered in conjunction with adjacent interchanges or grade separations on the project as a whole to provide uniformity and route continuity to avoid confusion in driver expectancy.

The design elements, capacity analysis and traffic control concepts presented in this Chapter apply to grade separations and interchanges and their appurtenant features. Additional sources of information and criteria to supplement the concepts presented in this Chapter are contained in the 2004 AASHTO Green Book, Chapter 10 and the MUTCD.

4.1 TYPES OF INTERCHANGES

Interchanges vary in type from single ramps connecting local streets to complex and comprehensive design layouts involving the intersection of multiple highways. The basic interchange configurations are indicated in the 2004 AASHTO Green Book, Chapter 10, Exhibit 10-1. Their application at a particular location is reflected by surrounding topography and culture, the degree of flexibility in the traffic operations desired and the practical aspects of costs. Any one configuration can vary extensively in shape and scope since numerous combinations of interchange types can evolve through the assembly of one or more of the basic types. An important element of interchange design which influences the efficiency, safety and capacity attained is the size and arrangement of ramps that connect two or more legs at an interchange.

For additional information concerning the types of interchanges and their application at a particular site, refer to the section "Introduction and General Types of Interchanges" in the 2004 AASHTO Green Book, Chapter 10.

4.2 WARRANTS FOR GRADE SEPARATIONS AND INTERCHANGES

The justification of an interchange at a given location is difficult due to the wide variety of site conditions, traffic volume, highway types and interchange layouts. Six warrants should be considered when determining if an interchange is justified at a particular site: (1) design designation; (2) reduction of bottlenecks or spot congestion; (3) safety improvement; (4) site topography; (5) road-user benefits; and (6) traffic volumes. For more information concerning these six warrants, refer to the section "Warrants for Interchanges and Grade Separations" in the 2004 AASHTO Green Book, Chapter 10.

Not all warrants for grade separations are included in the warrants for interchanges. For these additional warrants for grade separations, refer to the section "Warrants for Interchanges and Grade Separations" in the 2004 AASHTO Green Book, Chapter 10.

4.3 ADAPTABILITY OF HIGHWAY GRADE SEPARATIONS AND INTERCHANGES

Intersections are comprised of three general types: intersections, highway grade separations and interchanges. Each type has a practical range of situations but the limits of that range are not sharply defined. Therefore, there is considerable overlapping and the final selection usually represents a compromise after joint consideration of design traffic volume and pattern, cost, topography, and availability of right-of-way. Each type is based on the following considerations: (1) traffic and operation; (2) site conditions; (3) type of highway and intersecting facility; (4) access separations and control on the crossroad; (5) safety; (6) stage development; and (7) economic factors.

For additional presentations on the above considerations, refer to the section "Adaptability of Highway Grade Separations and Interchanges" in the 2004 AASHTO Green Book, Chapter 10.

4.4 GRADE SEPARATION STRUCTURES

The section "Grade Separation Structures", found in the 2004 AASHTO Green Book, Chapter 10, discusses various types of structures that are employed to separate the grades of two intersecting roadways or a highway and a railroad. Although many phases of structural design should also be considered, AASHTO's discussion is confined to the geometric features of grade separation structures. The discussion focuses on the following topics:

A. Types of Separation Structures. There are three general types of grade separation structures: through, partial through and deck type. Every effort should be made to design a grade separation structure that fits the environment in a pleasing and functional manner without drawing unnecessary or distracting attention.

B. Overpass Versus Underpass Roadways. A detailed study should be made at each proposed highway grade separation site to determine whether the main road should be carried over or under the crossroad. The issues governing whether a road should be carried over or under usually fall into one of three general groups:

1. The influence of topography predominates and the design should be closely fitted to it.

2. The topography does not favor any one arrangement.

3. The alignment and gradeline controls of one highway predominate and the design should accommodate that highway's alignment instead of the site topography.

Where topography does not govern, as in the case of flat topography, the section "Overpass versus Underpass Roadways", found in the 2004 AASHTO Green Book, Chapter 10, identifies additional secondary factors and general guidelines that should be examined.

When determining the appropriate width of the roadway over or under a grade separation, in determining the dimensions, location, and design of the structure as a whole, and in detailing features adjacent to the road, the designer should aim to provide a facility on which driver reaction and vehicle placement will be essentially the same as elsewhere on the intersecting roads. However, the width should not be so great as to result in the high cost of structure without proportionate value in usefulness and safety.

C. Underpass Roadways. For each underpass, the type of structure used should be determined by the dimensional, load, foundation and general site needs for that particular location. It is desirable that the entire roadway cross section, including the median, traveled way, shoulders and clear roadside areas be carried through the structure without change.

Several possible limitations may require some reduction in basic roadway cross section: structural design limitations; vertical clearance limitations; controls on grades and vertical clearance; limitations due to skewed crossings, appearance, or aesthetic dimension relations; and cost factors such as lengthy depressed sections of roadway.

The lateral clearances for major roadway underpasses are illustrated in the 2004 AASHTO Green Book, Chapter 10, Exhibit 10-6. For a two-lane roadway or an undivided multilane roadway, the minimum lateral clearance from the edge of the traveled way to the face of the protective barrier should be the normal shoulder width. On divided highways, the clearances on the left side of each roadway are usually governed by the median width. A minimum median width of 3.0 m (10 ft) may be used on a four-lane roadway to provide 1.2 m (4 ft) shoulders and rigid median barrier. For a roadway with six or more lanes, the minimum median width should be 6.6 m (22 ft) to provide 3.0 m (10 ft) shoulders and a rigid median barrier. Where structural design makes it necessary to reduce their horizontal clearance through an underpass, the change in lateral width should be accomplished through gradual adjustments in the cross section of the approach roadway rather than abruptly at the structure. Such transitions in width may have a longitudinal/lateral ratio of 0.6 × design speed to 1 for a design speed in kilometers per hour (design speed to 1 for a design speed in miles per hour). For lateral width "flare" transitions, refer to Chapter 12, Table 12.7 (Flare Rates for Barrier Design).

For new or reconstruction projects, the minimum lateral clearance from the edge of the pavement to the face of the protective barrier in front of retaining walls and bridge substructures including piers, columns, and abutments shall be 4300 mm (14 ft) unless supporting documentation is provided. A design exception for lateral clearance will not be required if 4300 mm (14 ft) of lateral clearance is not provided; however, other geometric criteria such as required shoulder width and sight distance must still be met unless properly justified through the design exception process.

Sound barrier walls shall be located as far away as possible from the edge of traveled way while still providing the maximum benefit for insertion loss. Positive protection is required as per Publication 218M, *Standards for Bridge Design*, for sound barrier walls located within the clear zone. When a sound barrier wall protected by a concrete barrier is constructed along a highway or when a concrete barrier alone is constructed along a highway, the barrier shall be located no closer than the outer edge of shoulder and preferably should be located 0.6 m (2 ft) beyond the outer edge of shoulder.

Positive protection shall be provided when substructure units, retaining walls, or sound barrier walls must be placed within the clear zone width identified in Chapter 12, Table 12.1.

For the vertical clearance requirements of all structures, refer to Chapter 2, Section 2.20.

D. Overpass Roadways. The roadway dimensional design of an overpass or other bridge should be the same as that of the basic roadway in cross section dimensions unless the cost becomes prohibitive. The use of bridge railings, lateral clearances and median treatment should be as specified in Publication 15M, Design Manual, Part 4, *Structures*, and Publication 218M, *Standards for Bridge Design*.

E. Longitudinal Distance to Attain Grade Separation. The longitudinal distance needed for adequate design of a grade separation depends on the design speed, the roadway gradient and the amount of rise or fall needed to achieve the separation. To determine whether or not a grade separation is practical for given conditions, Exhibit 10-8 from Chapter 10 of the 2004 AASHTO Green Book should be used as a guide for preliminary design to determine horizontal distance in flat terrain. The figure also may serve as a general guide in other than flat terrain and adjustments can be made in the length of the terminal vertical curves.

F. Grade Separations Without Ramps. There are many situations where grade separations are constructed without the provision of ramps. In other situations, despite sufficient traffic demand, ramps may be omitted: (1) to avoid having interchanges so close to each other that signing and operation would be difficult, (2) to eliminate interference with large highway traffic volumes and (3) to increase safety and mobility by concentrating turning traffic where it is practical to provide adequate ramp systems.

For additional guidelines and criteria for the procedures, considerations and geometric design features for grade separation structures, refer to the section "Grade Separations without Ramps" in the 2004 AASHTO Green Book, Chapter 10.

4.5 INTERCHANGES

The basic types of interchanges can be classified in general terms to include: (1) three-leg designs, (2) four-leg designs and (3) other special interchange designs involving two or more structures. The type of configuration used at a particular site is determined by the number of intersection legs, expected volumes of through and turning movements, type of truck traffic, topography, culture, design controls, proper signing and the designer's initiative.

Signing and operations are major considerations in the design of the interchanges. The signing of each design should be tested to determine if it can provide for the smooth, safe flow of traffic. The need to simplify interchange design from the standpoint of signing and driver understanding cannot be overstated.

Three-leg designs represent an interchange with three intersecting legs consisting of one or more highway grade separations and one-way roadways for all traffic movements. When two of the three intersection legs form a through road and the angle of intersection is not acute, the interchange is classified as a T interchange. When all three intersection legs have a through character or the intersection angle with the third intersection leg is small, the interchange is classified as a Y interchange. The 2004 AASHTO Green Book, Chapter 10, Exhibits 10-9 and 10-10 illustrate various patterns of three-leg interchanges.

Four-leg designs represent interchanges with four intersection legs which may be grouped under six general configurations:

1. Ramps in one quadrant.
2. Diamond interchanges.
3. Single-point urban interchanges (SPUIs).
4. Partial cloverleafs.
5. Full cloverleafs.
6. Interchange with direct and semidirect connections.

The section "Four-Leg Designs", found in the 2004 AASHTO Green Book, Chapter 10, provides additional discussion about the operational characteristics and adaptations of each configuration. The 2004 AASHTO Green Book, Chapter 10, Exhibits 10-15 through 10-37 presents actual examples of existing or planned interchanges for each configuration.

Additional interchange configurations may include special interchange arrangements that would include an offset interchange or a combination of two or more of the previously discussed interchanges. An offset interchange may be applicable where there are major buildings or other developments near the crossing of the freeways. The need for a combination interchange design may be predicated on an analysis that requires the accommodation of one or two turning movements that have high volumes with respect to the other turning movements.

For overpass lengths exceeding 24 m (80 ft), consider providing supplemental lighting during daylight hours beneath the underpass structures. This consideration should include design and construction costs, as well as long-term energy and maintenance requirements.

The following concepts should be used to govern the general design considerations for interchanges:

A. Determination of Interchange Configuration. For detailed discussion, refer to the section "Determination of Interchange Configuration" in the 2004 AASHTO Green Book, Chapter 10.

B. Approaches to the Structure. For detailed discussion, refer to the section "Approaches to the Structure" in the 2004 AASHTO Green Book, Chapter 10.

C. Interchange Spacing. Since interchange spacing has a pronounced effect on freeway operations, proper spacing can be difficult to attain due to traffic demand for frequent access. As a rule, the 2005 AASHTO publication, *A Policy on Design Standards - Interstate System*, notes that minimum spacing should be 1.5 km (1 mi) in urban areas and 5 km (3 mi) in rural areas. In urban areas, spacing of less than 1.5 km (1 mi) may be developed by grade-separated ramps or by collector-distributor roads.

D. Uniformity of Interchange Patterns. For detailed discussion, refer to the section "Uniformity of Interchange Patterns" in the 2004 AASHTO Green Book, Chapter 10.

E. Route Continuity. For detailed discussion, refer to the section "Route Continuity" in the 2004 AASHTO Green Book, Chapter 10.

F. Overlapping Routes. For detailed discussion, refer to the section "Overlapping Routes" in the 2004 AASHTO Green Book, Chapter 10.

G. Signing and Marking. Signing and marking are important elements of driver communication at interchanges and should conform to the sources of reference listed in Chapter 2, Section 2.18.A. For additional information, refer to the section "Signing and Marking" in the 2004 AASHTO Green Book, Chapter 10.

H. Basic Number of Lanes. For detailed discussion, refer to the section "Basic Number of Lanes" in the 2004 AASHTO Green Book, Chapter 10.

I. Coordination of Lane Balance and Basic Number of Lanes. For detailed discussion, refer to the section "Coordination of Lane Balance and Basic Number of Lanes" in the 2004 AASHTO Green Book, Chapter 10.

J. Auxiliary Lanes. For detailed discussion, refer to the section "Auxiliary Lanes" in the 2004 AASHTO Green Book, Chapter 10.

K. Lane Reduction. For detailed discussion, refer to the section "Lane Reduction" in the 2004 AASHTO Green Book, Chapter 10.

L. Collector-Distributor Roads Within an Interchange. For detailed discussion, refer to the section "Collector-Distributor Roads" in the 2004 AASHTO Green Book, Chapter 10.

M. Two-Exit Versus Single-Exit Interchange Design. For detailed discussion, refer to the section "Two-Exit versus Single-Exit Interchange Design" in the 2004 AASHTO Green Book, Chapter 10.

N. Wrong-Way Entrances. Signing in these areas should be in accordance with the sources of reference listed in Chapter 2, Section 2.18.A. For additional discussion, refer to the section "Wrong-Way Entrances" in the 2004 AASHTO Green Book, Chapter 10.

O. Other Interchange Design Features. Additional design considerations for interchanges involve the following features:

1. Testing for Ease of Operation.
2. Pedestrians.
3. Ramp Metering.
4. Grading and Landscape Development.
5. Models.

For more information concerning these additional design considerations, design concepts and features for interchanges, refer to the section "Other Interchange Design Features" in the 2004 AASHTO Green Book, Chapter 10.

4.6 WEAVING SECTIONS

Weaving sections represent highway segments where the patterns of traffic merging or diverging at contiguous points of access result in vehicle streams or paths that cross each other in the same direction. These weaving sections may occur within an interchange, between entrance ramps followed by exit ramps of successive interchanges and on segments of overlapping roadways.

For additional information, refer to the section "Weaving Sections" in the 2004 AASHTO Green Book, Chapter 10. For the capacity analysis of weaving sections, refer to the HCM.

4.7 RAMPS

A. Types and Examples. A ramp represents various types, arrangements and sizes of turning roadways that connect two or more legs at an interchange. The 2004 AASHTO Green Book, Chapter 10, Exhibit 10-55 illustrates several types of ramps and their characteristic shapes, each of which can be used to create numerous shape variations for an interchange. For additional information, refer to the section "Types and Examples" in the 2004 AASHTO Green Book, Chapter 10.

B. General Ramp Design Considerations. The section "General Ramp Design Considerations", found in the 2004 AASHTO Green Book, Chapter 10, describes the following items to be considered:

1. Design Speed. Refer to the 2004 AASHTO Green Book, Chapter 10, Exhibit 10-56 for guide values for ramp design speed as related to highway design speed.

2. Portion of Ramp to Which Design Speed is Applicable.

3. Ramps for Right Turns.

4. Loops.

5. Semidirect Connections.

6. Direct Connections.

7. Different Design Speeds on Intersecting Highways.

8. At-Grade Terminals.

9. Curvature. The design guidelines for turning roadways at interchanges apply directly to the design of ramp curves for various design speeds and are discussed in Chapter 2, Section 2.6.

10. Sight Distance. Decision sight distance, as discussed in Chapter 2, Section 2.17.E, is desired where feasible. For ranges in design values for stopping sight distance on horizontal and vertical curves for turning roadways and open road conditions, refer to Chapter 2.

11. Grade and Profile Design.

12. Vertical Curves. For additional information on design values and turning roadway conditions for vertical curvature, refer to Chapter 2, Section 2.12.

13. Superelevation and Cross Slope. For additional information on superelevation and cross slope, refer to Chapter 2, Section 2.13.

14. Gores.

C. Ramp Traveled-Way Widths. Ramp traveled-way widths are governed by the type of operation, curvature, and volume and type of traffic. The design width of pavements for ramps including shoulder and lateral clearances and pavement widening on curvature shall be in accordance with the design criteria and guidelines presented in the section "Ramp Traveled-Way Widths" in the 2004 AASHTO Green Book, Chapter 10.

D. Ramp Terminal Design. The terminal of a ramp is that portion adjacent to the through traveled way, including acceleration and deceleration (speed-change) lanes, tapers and islands. Ramp terminals may be the at-grade type, as at the crossroad terminal of a diamond or partial cloverleaf interchange, or the free-flow type where ramp traffic merges with or diverges from high-speed through traffic at flat angles.

Terminals are classified according to the number of lanes on the ramp at the terminal, as either single or multilane, and according to the configuration of the acceleration and deceleration (speed-change) lane, as either a taper or parallel type.

The section "Ramp Terminals", found in the 2004 AASHTO Green Book, Chapter 10, provides additional information about the following topics:

1. Ramp Terminals.

a. Left-hand Entrances and Exits.

b. Terminal Location and Sight Distance.

c. Ramp Terminal Design.

d. Traffic Control. Refer to Section 4.7.E when traffic signal controls are required at ramp terminals on the minor roadways containing sufficient volumes of through and turning movements.

e. Distance Between a Free-Flow Terminal and Structure. The terminal of a ramp should not be located near the grade separation structure but placed in advance of the structure using sight distances comparable to the guidelines established for decision sight distance in Chapter 2, Section 2.17.E.

f. Distance Between Successive Ramp Terminals. The values should be checked with the procedures outlined in the HCM especially where weaving considerations may govern (See Section 4.6).

g. Acceleration and Deceleration (Speed-Change) Lanes. For additional discussions concerning the factors to consider for the design of acceleration and deceleration (speed-change) lanes, refer to Chapter 1, Section 1.6 and the section "Speed-Change Lanes at Intersections" in the 2004 AASHTO Green Book, Chapter 9.

2. Single-Lane Free-Flow Terminals (Entrances). For the design of acceleration lanes on all Department projects, refer to the section "Single-Lane Free-Flow Terminals, Entrances" in the 2004 AASHTO Green Book, Chapter 10. The minimum lengths required for acceleration lanes are governed by the highway design speed and ramp design speed. The minimum lengths required are presented in the section "Single-Lane Free-Flow Terminals, Entrances" in the 2004 AASHTO Green Book, Chapter 10.

3. Single-Lane Free-Flow Terminals (Exits). For the design of deceleration lanes on all Department projects, refer to the section "Single-Lane Free-Flow Terminals, Exits" in the 2004 AASHTO Green Book, Chapter 10. The minimum lengths required for deceleration lanes are governed by the highway design speed and the ramp design speed. The minimum lengths required are presented in the section "Single-Lane Free-Flow Terminals, Exits" in the 2004 AASHTO Green Book, Chapter 10.

4. Free-Flow Terminals on Curves. The discussions in 2 and 3 above for acceleration and deceleration lanes are stated in terms of tangent through-lane alignment. Because curvature on most freeways is slight, there is usually no need to make any appreciable adjustments at ramp terminals on curves. However, where curves on a freeway are relatively sharp and there are exits and entrances located on these curves, adjustments in design may be desirable to avoid operational difficulties. The guidelines and methods of design to follow for exit and entrance terminals on curves are presented in the section "Single-Lane Free-Flow Terminals, Exits" in the 2004 AASHTO Green Book, Chapter 10.

5. Multilane Free-Flow Terminals. Multilane terminals may be appropriate where traffic is too great for single-lane operation. Other considerations that may call for multilane terminals are through-route continuity, queuing on long ramps, lane balance and design flexibility. The most common multilane terminals consist of two-lane entrances and two-lane exits, two-lane terminals on curved alignment and major forks and branch connections as discussed below:

a. Two-Lane Entrances. Two-lane entrances or two-lane acceleration lanes are warranted for two situations either as branch connections or because of capacity needs for the on-ramp. When using two-lane entrances, to satisfy lane-balance needs, at least one additional lane shall be provided downstream. The design of two-lane entrances on all Department projects shall use the taper type as presented in the 2004 AASHTO Green Book, Chapter 10, Exhibit 10-76.

b. Two-Lane Exits. Two-lane exits or two-lane deceleration lanes may be provided where the traffic volume leaving the freeway at an exit terminal exceeds the design capacity of a single lane. To satisfy lane balance needs and not to reduce the basic number of through lanes, it usually is necessary to add an auxiliary lane upstream from the exit.

The design of two-lane exits on all Department projects shall use the parallel-type as presented in the 2004 AASHTO Green Book, Chapter 10, Exhibit 10-77. Refer to Section 4.5.M for additional guidelines for two-exit versus single-exit design.

c. Two-Lane Terminals on Curved Alignment. The design of ramp terminals where the freeway is on curved alignment is discussed in 4 above for single-lane terminals. The same principles of design may be used in the layout of two-lane terminals.

d. Major Forks and Branch Connections. A major fork is defined as the bifurcation of a directional roadway, of a terminating freeway route into two directional multilane ramps that connect to another freeway or of a freeway route into two separate freeway routes of about equal importance. A branch connection is defined as the beginning of a directional roadway of a freeway formed by the convergence of two directional multilane ramps from another freeway or by the convergence of two freeway routes to form a single freeway route. For additional information concerning those two types of multilane free-flow terminals, refer to the section "Single-Lane Free-Flow Terminals, Exits" in the 2004 AASHTO Green Book, Chapter 10.

E. Ramp Capacity Analysis and Traffic Control. The capacity and service volume determination procedures for ramp analysis on all Department projects shall adhere to the concepts presented in the *HCM*. Where traffic signal controls may be required at ramp terminals, their installation shall be governed by Publication 149, *Traffic Signal Design Handbook*.

F. Ramp Design Sheet. In order to facilitate the preparation and checking of ramp designs and to avoid an oversight of the items that shall be considered, a Ramp Design Sheet (see Table 4.1) may be used to identify these items, to indicate the source of design criteria and to indicate the proposed design.

Where the proposed design does not comply with the identified design criteria, an explanation shall be submitted at the time of request for interchange approval.

TABLE 4.1
RAMP DESIGN SHEET

SR_________________
RAMP________________

DATE___________________
MADE BY_________________
CHECKED BY________________

ITEMS	SOURCE OF DESIGN CRITERIA AASHTO REFERENCE	REMARKS
(1) Design Speed of Highway		
(2) Ramp Design Speed*		
(3) Minimum Radius		
(4) Compound Curve Ratio*		
(5) Length of Circular Arc for Compound Curves Radius _________ Radius _________ Radius _________ Radius _________		
(6) Ramp Gradient		
(7) Superelevation Rates* Radius _________ Radius _________ Radius _________ Radius _________		
(8) Rate of Cross Slope Change		
(9) Maximum Algebraic Difference in Cross Slope at Terminals*		
(10) Design Width of Pavement Case Traffic Condition (Include Any Modifications) R _________ R _________ R _________ R _________		
(11) Internal Clearances (a) Post or Rails (b) Shoulder Right (c) Shoulder Left		

*Comments pertaining to specific items on the Ramp Design Sheet above are as follows:

(2) Desirable ramp design speeds should approximate the low volume running speed on the intersecting highways. Where it is not practical to maintain desirable ramp speeds, considerations should be given to provide acceleration and deceleration lanes at the intersected road to minimize the relative speed differential between the ramp and the intersected road.

(4) The ratio of the flatter radius to the sharper radius should not exceed 2 if practical; otherwise, spiral transitions should be utilized between the two curves.

(7) Superelevation rates should not exceed 8.0% in rural areas and 6.0% in urban areas.

(9) The maximum algebraic difference in cross slope at ramp terminals should be determined at the ramp nose.

During the design development, considerations should be given to the striping and the auxiliary lanes that may be required for safe operations even though total traffic volumes may not indicate their need.

TABLE 4.1 (CONTINUED)
RAMP DESIGN SHEET

ITEMS	SOURCE OF DESIGN CRITERIA AASHTO REFERENCE	REMARKS
(11) Internal Clearances (Cont'd) (d) Extent of Stabilization-Lt (e) Extent of Stabilization-Rt (f) Structures - Underpass (g) Structures - Overpass (h) Curbs - From Parapets (j) Curbs - From Traffic Lane (k) Other Clearances ____________________ ____________________ ____________________ ____________________		
(12) Deceleration Lane Length (a) 2% or Less (b) Greater than 2% (c) Taper Length		
(13) Acceleration Lane Length (a) 2% or Less (b) Greater than 2% (c) Taper Length		
(14) Sight Distance* (a) Ramp Proper (b) Terminals		
(15) Other Items ____________________ ____________________ ____________________ ____________________		

*Comments pertaining to specific items on the Ramp Design Sheet above are as follows:

14. Sight distance requirements for the ramp proper shall be determined similar to alignment and profile stopping sight distance for the main line and sight distance at the termini shall be determined in accordance with requirements for sight distance at intersections (See Chapter 2, Section 2.17).

During the design development, considerations should be given to the striping and the auxiliary lanes that may be required for safe operations even though total traffic volumes may not indicate their need.