

Section 5

Major Cross Section Elements

5.1 General

The major cross section elements considered in the design of streets and highways include the pavement surface type, cross slope, lane widths, shoulders, roadside or border, curbs, sidewalks, driveways, and medians. Due consideration should be given to the motoring and non-motoring users in designing the cross section.

5.2 Pavement

5.2.1 Surface Type

Pavement surface type is determined by soil conditions, traffic volume, traffic composition, material availability, initial cost, and the extent and cost of maintenance. All of these affect the relationship of cost to traffic service.

Generally, all roadways in the State are surfaced with bituminous materials or Portland cement concrete. These pavements provide good riding qualities, help to maintain the cross section, and adequately support the expected volume and weights of vehicles without failure due to fatigue. In considering cyclists and pedestrian traffic, other roadway surfaces include textured and colored asphalt, textured and colored concrete, and brick and other unit pavers. As part of urban design, landscape or streetscape treatments, these are used in crosswalks, bike lanes, shoulders, and traffic calming devices.

Important characteristics in relation to geometric design are the ability of a surface to sustain its shape and dimensions, the ability to drain, and the affect on driver, bicyclist, and pedestrian behavior.

5.2.2 Cross Slope

The cross slope of the pavement is the slope of the pavement surface measured transverse to the centerline of the highway. The high point of a normal cross slope of a roadway is known as the crown. Undivided pavements on tangents or on flat curves have a high point (crown) in the middle of the traveled way and slope downward toward both edges.

The minimum cross slope for concrete pavement and bituminous pavement should be 1.5 percent. The cross slope shall be uniform across the pavement section, from the high point to the edge of lane. The cross slope in each successive lane should be increased by 0.5 percent. However, it may be increased on each successive pair of lanes by 0.5 to 1 percent in order to cause the least disturbance to the existing border area, to limit the amount of resurfacing weight on a structure, or to minimize the cross slope in the outer lane when more than three lanes are sloped in the same direction.

In addition, if the cross slope of the left-turn lane is in the same direction as the adjacent lane, the adjacent lane cross slope may be used.

On a divided highway, each one-way pavement may be crowned separately, as on a two-lane highway, or it may have a unidirectional slope across the entire width of pavement, which is almost always downward to the outer edge.

A cross section where each roadway has a separate high point (crown) has an advantage of rapidly draining the pavement as shown in the top two drawings of Figure 5-A. In addition, the difference between high and low points in the cross section is kept to a minimum. The disadvantage is, additional drainage inlets and subsurface drainage

lines are required. In addition, treatments of at-grade intersections are more difficult because of the creation of several high and low points on the cross section. Preferably, use of such sections should be limited to regions of high rainfall. A cross section having no curbing and a wide depressed median are particularly well suited for high rainfall conditions.

Roadways that slope only in one direction provide more comfort to drivers because vehicles tend to be pulled in the same direction when changing lanes (As shown in the bottom four drawings of Figure 5-A). Roadways with a unidirectional slope may drain away from or toward the median. Providing drainage away from the median may affect a savings in drainage structures and simplify treatment of intersecting streets. Advantages of drainage toward the median are:

1. An economical drainage system, in that all surface runoff is collected into a single conduit.
2. Outer lanes, used by most traffic, are freer of surface water.

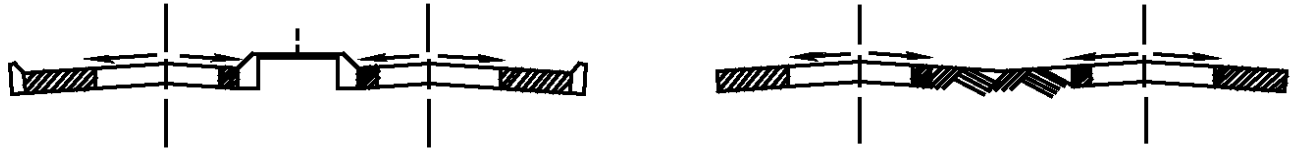
A major disadvantage of drainage toward the median is all the pavement drainage must pass over the inner, higher speed lanes. Where curbed medians exist, the drainage is concentrated next to and on higher speed lanes. This concentration of drainage, when the median is narrow, results in annoying and undesirable splashing onto the windshields of opposing traffic.

The rate of cross slope on curves as well as on tangent alignment is an important element in cross section design. See Section 4, "Basic Geometric Design Elements," for speed-curvature relationships to determine pavement superelevation on curves.

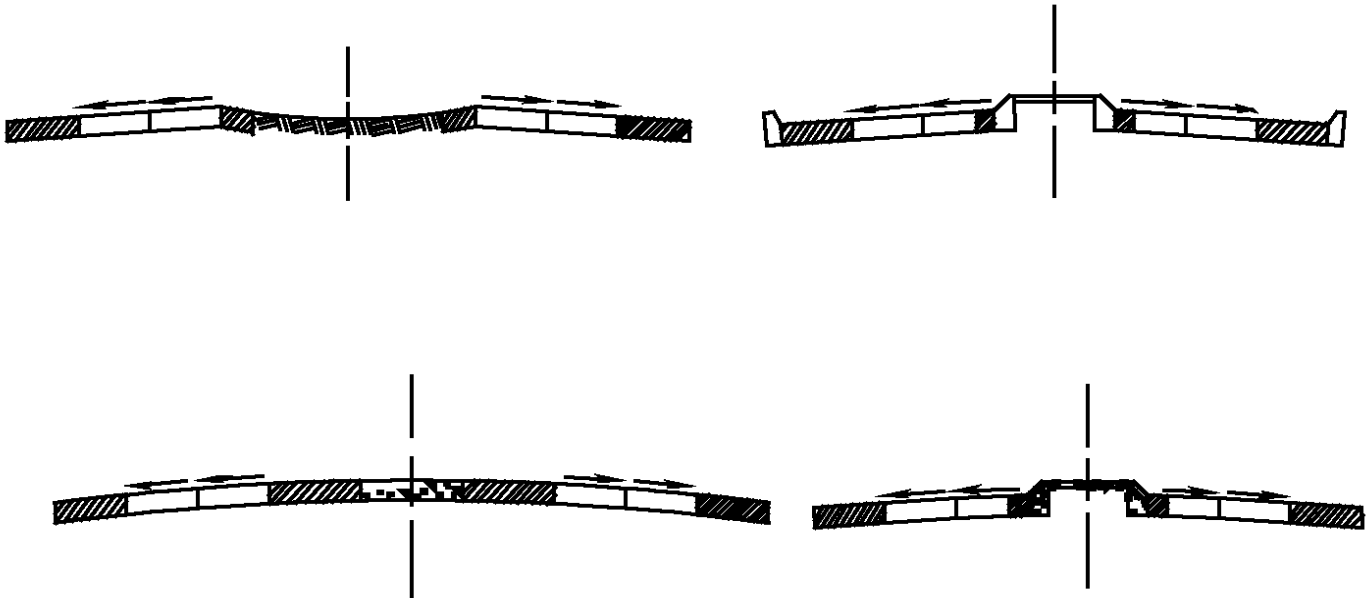
PAVEMENT CROSS SLOPES

FIGURE: 5-A

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EACH PAVEMENT SLOPES TWO WAYS



EACH PAVEMENT SLOPES ONE WAY

5.3 Lane Widths

Lane widths have a great influence on driving safety and comfort. The predominant lane width on freeways and land service highways is 12 feet.

While lane widths of 12 feet are desirable on land service highways, circumstances may necessitate the use of lanes less than 12 feet. Lane widths of 11 feet in urban areas are acceptable. Existing lane widths of 10 feet have been provided in certain locations where right of way and existing development became stringent controls and where truck volumes were limited. However, new or reconstructed 10 foot wide lanes would not be proposed today, except in traffic calming areas.

On land service highways, where it is not practical to provide a shoulder adjacent to the outside lane, the outside lane width shall be 15 feet to accommodate bicyclists. Where alternate bike access is provided, the outside lane width should be 1 foot wider than the adjacent through lane width. The designer should strive to accommodate the bicyclist and pedestrian on all projects.

When resurfacing existing highways that have lane widths of 10 feet or less, the existing lanes should be widened to either 11 foot minimum or 12 foot desirable.

Auxiliary lanes at intersections are often provided to facilitate traffic movements. Such lanes should be equal in width to the through lanes but not less than 10 foot wide when constructed adjacent to a shoulder. When there is no right shoulder adjacent to a new or reconstructed auxiliary lane, the width of the auxiliary lane shall be designed to accommodate the bicyclist. Where alternate bike access is provided, the auxiliary lane width should be 1 foot wider than the adjacent through lane width. The criteria in this paragraph shall also apply to auxiliary lanes at interchanges on land service highways.

On Interstates and freeways, the width of the auxiliary lane shall be 12 feet. Lane widths for specific types of highways are enumerated as part of the typical sections illustrated at the end of this section.

For the width of climbing lanes and left-turn lanes, see Section 4, "Basic Geometric Design Elements" and Section 6, "At-Grade Intersections," respectively.

5.4 Shoulders

5.4.1 General

A shoulder is the portion of the roadway contiguous with the traveled way for accommodation of stopped vehicles, for emergency use, and for lateral support of subbase, base and surface courses.

Some of the more important advantages of providing shoulders are:

1. Space for the motorist to pull completely off the roadway for emergencies.
2. An escape zone to allow motorists to avoid potential accidents or reduce accident severity.
3. An aid to driver comforts by creating a sense of openness; improves highway capacity.
4. An improvement in sight distance in cut sections.
5. A provision to enhance lateral clearance for the placement of signs, guide rails, or other roadside appurtenances.
6. Space for pedestrians where there is no sidewalk and for bicycle usage.

New Jersey shoulder pavement design is based on the following engineering considerations.

- A. The New Jersey state highway system constitutes the heart of our state's surface transportation network. As a corridor state, the New Jersey highway system is subjected to the highest traffic count and loading in the nation.
- B. New Jersey highways continue to be faced with a serious backlog of deficient pavements in poor to fair condition. As such, many of the pavements are in the process of or will eventually be rehabilitated or reconstructed.
- C. Due to frequent traffic encroachment over the longitudinal joints next to the shoulder and the need to stage traffic on shoulders during rehabilitation, progressive shoulder deterioration will result if adequate shoulder pavement strength is not provided in the original construction.
- D. Shoulders of adequate pavement strength will carry traffic during the future construction of additional lanes, and the widening, resurfacing, rehabilitation and recycling of the existing lanes. The shoulders will also be used as an additional riding lane during peak hours relieving traffic congestion, such as in the case of "bus/shoulder" lanes.

The following shoulder pavement design policy is based on the above consideration. The term "Full Pavement Shoulder" is a shoulder pavement equal to that of the mainline pavement.

Full pavement shoulders shall be used as follows:

Full pavement shoulders shall be used for all new construction, reconstruction and widening on all portions of the NJ highway system.

For mainline pavement rehabilitation projects, shoulder pavement shall be designed to carry mainline traffic for a minimum period of 2 years or the following minimum section (whichever is greater):

- 2" Hot Mix Asphalt ___ Surface Course
- 3" Hot Mix Asphalt ___ Intermediate Course
- 8" Dense Graded Aggregate Base Course

5.4.2 Width of Shoulders

Desirably, a vehicle stopped on the right shoulder should clear the pavement edge by at least 1 foot, preferably by 2 feet. On land service highways, in difficult terrain, or in areas where right of way is restricted due to roadside development or environmental factors, a minimum 8 foot wide shoulder may be provided. On 3R projects, the existing shoulder width may be reduced to 8 feet to provide wider lanes. New or reconstructed shoulders on heavily traveled and high-speed land service highways, especially those carrying large numbers of trucks (250 DHV), where turning volumes are high or dualization is anticipated, should have usable shoulders at least 10 feet and preferably 12 feet wide. Shoulders should be provided adjacent to all new acceleration and deceleration lanes at interchanges, where practical, in major new construction or reconstruction projects along major land service highways having an AADT of 10,500 per lane (DHV of 1,500 per lane) or greater, for the project design year. "Practical" is defined as given consideration to social, economic, and environmental impacts in concert with safe and overall efficient traffic operations.

Shoulder widths on freeways and Interstate highways shall be 10 feet minimum. However, where truck traffic exceeds 250 DDHV, a 12 foot shoulder should be provided. A 10 foot

shoulder shall be provided adjacent to all new or reconstructed auxiliary lanes. Where no right shoulder exists, the existing auxiliary lane width may be maintained on Interstate and freeway resurfacing, restoration and rehabilitation (3R) projects. However, whenever practical, a 10 foot desirable or a 6 foot minimum shoulder should be provided on Interstate and freeway 3R projects.

Shoulder widths for specific types of highways are enumerated as part of the typical sections illustrated at the end of this section.

Although it is desirable that a shoulder be wide enough for a vehicle to be driven completely off the traveled way, narrower shoulders are better than none at all. Partial shoulders are sometimes used when full shoulders are unduly costly, as on long span bridges or in mountainous terrain. Regardless of the width, a shoulder should be continuous where feasible.

Left shoulders are preferred on all divided highways. The desirable median shoulder width on a 4-lane and 6 to 8-lane highway is 5 feet and 10 feet respectively. The minimum left shoulder width on land service highways is 3 feet and on a freeway is 4 feet. In order to provide wider lanes on 3R projects, the left shoulder width on an existing divided multilane land service highway may be reduced to 1 foot (Programmatic Design Exception).

Shoulders on structures should have the same width as the usable shoulders on the approach roadways, both right and left. This design is essential on freeways, and is desirable on all arterials where shoulders are provided. Long span, high-cost structures usually warrant detailed special studies to determine feasible dimensions. Wherever practicable, full shoulders should be included, but as has been indicated, for some cases, it may be judged proper to use only partial-width shoulders.

5.4.3 Cross Slope

Shoulders are important links in the lateral drainage systems. A shoulder should be flush with the roadway surface and abut the edge of the through lane/auxiliary lane. On a divided highway with a depressed median, all shoulders should be sloped to drain away from the traveled way. With a raised narrow median, the median shoulder may slope in the same direction as the traveled way. All shoulders should be pitched sufficiently to rapidly drain surface water.

Desirably, a shoulder cross slope should not be less than 4 percent to minimize ponding on the roadway. As a minimum, a shoulder cross slope should not be less than 2 percent. However, when a left shoulder is less than 5 feet in width and the median slopes away from the roadway or where the median and adjacent lane both slope toward the median gutter, the shoulder cross slope may be at the same rate and direction as the adjacent lane for ease of construction.

On 3R and reconstruction projects, shoulder cross slope may be increased to 6 percent to minimize impacts on existing curb, drainage, adjacent properties, access, etc. But, shoulder cross slope should not exceed 5 percent where a curb ramp is present since the angle of incidence between a wheelchair descending a curb ramp and the counter slope of the gutter must be limited to avoid catching the wheelchair footrest.

Shoulder on the high side of a superelevated section should be designed to drain away from the adjacent traffic lanes. A shoulder cross slope that drains away from the paved surface on the high side of a superelevated section should be designed to avoid too great a cross slope break. The cross slope of the shoulder shall be as follows:

1. The shoulder cross slope should be 4 percent where the superelevation rate is 3 percent or less.

2. For superelevation rates greater than 3 percent and less than 5 percent, a maximum rollover rate of 7 percent will be used to establish the shoulder cross slope.
3. When superelevation rates range from 5 percent to 6 percent, the shoulder cross slope will be 2 percent.

On an existing superelevated curve where there is a history of run-off-the-road accidents, the location should be evaluated for proper clear zone, sight distance, superelevation, and signing. The shoulder cross slope on the outside of the curve may be constructed in the same direction as the adjacent lane. However, consideration should be given to snow storage in border area (snow melting in border area then draining and refreezing on roadway surface) by sloping the border away from roadway or by providing slotted drainage along shoulder.

The shoulder on the inside of a curve or on the low side of a superelevated section should be sloped at 4 percent, or equal to the superelevation of the adjacent lane, whichever is greater.

5.4.4 Intermittent Shoulders or Turnouts

It will not always be economically feasible to provide desirably wide shoulders continuously along the highway through high cut areas or along steep mountainsides. In such cases, consideration should be given to the use of intermittent sections of shoulders or turnouts that can be placed at favorable locations along the highway. Where intermittent shoulders or turnouts are provided, the length of the transition section should be approximately 50 feet to encourage usage and to permit safe entry and exit.

5.4.5 Rumble Strips

Rumble strips shall be constructed on inside shoulders that are 3 feet or greater in width and outside shoulders that are 8 feet or greater in width, along the mainline on all Interstate highways, freeways and other limited access highways.

Rumble strips should be constructed on inside shoulders that are 3 feet or greater in width and outside shoulders that are 8 feet or greater in width, along the mainline of land service highways at locations where:

- Accident data indicates a nighttime run-off-the road accident problem.
- The shoulder approaching a bridge overpass or underpass is reduced or eliminated. The rumble strips should be provided a minimum of 500 feet in advance of the bridge.

Rumble strips shall not be constructed 100 feet in advance of and beyond all street intersections and driveways. The minimum length of rumble strip measured longitudinally along the shoulder is 100 feet.

Rumble strips shall not be constructed across bridge decks.

5.5 Roadside or Border

5.5.1 General

The area between the roadway and the highway right of way is referred to as the roadside or border. The term "roadside" generally applies to freeways and the term "border" applies to land service highways. The distance between the outside edge of roadway and the hinge point may be less than the width of the roadside or border area.

5.5.2 Width

The right-of-way width on rural and urban freeways is typically 300 feet and 150 feet respectively. Depending upon the median, traveled way and shoulder widths, the roadside width is in the range of 70 feet for rural freeways and 25 feet for urban freeways.

Desirably, the width of the border should be sufficient to permit the placement of utility poles and all fixed obstructions beyond the clear zone area. Normally an additional 5 feet should be added to the clear zone distance to provide the necessary placement of the utilities within the highway right-of-way yet beyond the clear zone recovery area. The acquisition of additional right-of-way should be considered if it is economically and socially feasible. If right-of-way is acquired, it should accommodate all current project needs and any foreseeable future widening.

See Section 8 for the required clear zone distance for various design speeds.

When it is not practical to provide for the clear zone width, a border width on land service highways of 15 feet is preferred. The designer should determine the practical border width by taking into account pedestrian needs, bicyclist needs and the proper placement of roadside appurtenances such as longitudinal barriers, longitudinal barrier end treatments, utility poles, signal pole foundations, signs and foundations, existing and/or future sidewalks, underground utilities, etc. A border width would typically range from 10 feet to 15 feet on land service highways. The border can be adjusted more or less on a property by property basis. In order to avoid obstacles and preclude unnecessary right-of-way acquisitions, the border width may be reduced at spot locations or random length sections. For example, you may want to reduce the 15 feet proposed border on one property to a 12 feet border in order to avoid a parking lot or a building. These reduced border areas will need to provide for safe and feasible accommodations of all roadside appurtenances.

The goal should be to provide the optimum border width considering all project costs, such as construction, utilities, permits, design, right-of-way, etc.

5.6 Curbing

5.6.1 General

The type and location of curbing appreciably affects driver behavior, which affects the safety and utility of a highway. Curbing may be used to separate pedestrian walkways from the roadway, to control drainage and to control ingress and egress from roadside development. Where required, curbing may be permitted at intersections for channelization or for sustaining the integrity of pavement (ex: curb at intersection radius returns). To fit the definition of "curb," some raised aspect or vertical element is required. Curbing is not a substitute for pavement markings.

Curb is used extensively on urban land service highways. However, on rural land service highways, caution should be exercised in the use of curb. In the interest of safety, new installations of vertical curb shall not be constructed on freeways and Interstate highways; however, sloping curb may be used for drainage control.

5.6.2 Types of Curb

The two general classes of curb are vertical curb and sloping curb. Each may be designed as a separate unit, or integrally with the pavement. Vertical and sloping curb may be designed with a gutter to form a combination curb and gutter section.

Sloping curb is designed to allow an errant vehicle to cross it readily without further loss of vehicular control. It is low with a flat sloping face. On a land service highway, sloping curb can be used at the median edge to discourage a vehicle from illegally crossing a grass median or to outline channelizing islands in intersection areas. Sloping curb may also be

provided at the outer edge of the shoulder. It is the preferred treatment for left-turn slots. Sloping curb permits a vehicle with large off-tracking to have a less damaging effect to both vehicle and curb. However, vertical curb may be used on left-turn slots where there is existing vertical curb in the median.

Vertical curb and a safety walk may be desirable along the faces of long walls, bridges, and tunnels, particularly if full shoulders are not provided.

New installation of vertical curb shall not be constructed on freeways and Interstate highways; and are considered undesirable on other high-speed arterials. When accidentally struck at high speeds, it is difficult for the operator to retain control of the vehicle. In addition, most vertical curbs are not adequate to prevent a vehicle from leaving the roadway. Where positive protection is required, such as along a long narrow median or adjacent to a bridge substructure, suitable median barrier or guide rail should be provided.

Generally, vertical curb should not be provided inside the face of bridge parapets. A preferred and more widely used method is to design the parapet in the shape of the Department's concrete barrier curb. On an urban street, vertical curb may be used on bridges with the same curb height as the approach roadway curb. Inlets should be provided in the gutter or the curb, or both.

Generally, it is not practical to design a gutter section to contain all of the runoff, even from frequent rains, and some overflow onto the traveled surface can be expected. The spread of water on the traveled way is kept within tolerable limits by the proper spacing of inlets. Grate inlets and depressions or curb-opening inlets should not be placed in the travel lane because of their adverse effect on drivers and bicycle riders who veer away from them. Warping of the gutter for curb-opening inlets should be limited to the portions within 4 feet of the curb to minimize adverse driving effects. See *NJDOT Drainage Design Manual* for the proper spacing of inlets.

5.6.3 Placement of Curb

Curb introduced intermittently along a street should be offset 3 feet from the edge of lane if there is no shoulder: where the curb is continuous, the offset should be at least 1 foot. See Figure 6-K for offsets of curbs for islands with and without shoulders.

5.6.4 Curb Height

For new installations of sloping curb, the overall curb height shall not exceed 4 inches.

For new installations of vertical curb, the curb height (face) shall conform to the following:

1. For posted speeds greater than 40 mph, the curb height shall not exceed a 4 inch face.
2. For posted speeds less than or equal to 40 mph, the desirable curb height is 4 inches. Where sidewalks are to be constructed, a 6 inch face may be used.
3. For traffic calming areas a 6 inch face may be used.

When curb is used in conjunction with guide rail, see Section 8, "Guidelines for Guide Rail Design and Median Barriers," for the placement of guide rail.

The vertical curb face on a bridge and on curb in front of retaining walls should match the vertical curb face on the approach roadway.

Where posted speeds are 40 mph or less and no guide rail exists, an 8 inch face vertical curb may be used to discourage parking of vehicles in the border area of the highway.

When resurfacing adjacent to curb, the curb should not be removed unless it is deteriorated or the curb face will be reduced to less than 3 inches. A curb face less than 3

inches is permissible, provided drainage calculations indicate the depth of flow in the gutter does not exceed the remaining curb reveal.

When replacing short sections of existing curb or installing short sections of new curb, the curb face should match the adjacent existing curb face. A short section of curb is approximately less than 100 feet long at each location. When there are closely spaced short sections of curb to be replaced, install the entire run of curb at the standard curb height and type as specified above.

5.7 Sidewalk

5.7.1 General

On new roadway construction, roadway rehabilitation, roadway reconstruction, new bridge construction, bridge replacement and bridge widening projects, sidewalk, where feasible, should be provided on both sides of land service highways and structures in urban areas. All of these projects should have some type of walking facility out of the traveled way. A shoulder will provide a safer environment for a pedestrian than walking in the live lane.

Generally, sidewalks will not be provided in rural areas. However, sidewalks may be provided to close short gaps in existing sidewalk and where there are major pedestrian traffic generators such as churches, schools, hospitals, public transportation facilities, etc., adjacent to the highway or where there is a worn pedestrian path. A worn path is an indicator of pedestrian traffic that requires a sidewalk. Individuals tend to walk in locations where continuous sidewalk connections are provided. A lack of pedestrian activity in a location with discontinuous sidewalks is therefore not necessarily an indication of a lack of pedestrian demand. Future development should also be considered for possible major traffic generators.

A sidewalk may be omitted from a project where there is insufficient border width or there is no anticipated pedestrian traffic due to the land use adjacent to the roadway.

In order to ensure that sidewalk installations provide satisfactory linkages and contribute to system connectivity, all designers should take the following actions:

1. When project limits are established, continuity of pedestrian travel should be a consideration relating to the ends of the project.
2. Sidewalks should extend to common destinations and logical terminal points.

Sufficient clear zone width, drainage patterns and infrastructure, grade issues, and the presence or future likelihood of bus transit stops are all key considerations of where to install sidewalks. The location of drainage ditches, buildings, retaining walls, utility poles, bus stops, vegetation, and significant roadside grade changes should be carefully coordinated with sidewalk alignment where possible to provide adequate sight distance and separation between pedestrians and vehicular traffic.

In general, sidewalks should be placed within the highway right of way. However, the exact alignment can vary throughout the section and practical considerations should be given to:

- maintaining adequate storm water runoff
- avoiding requirements for acquisition of construction easements
- designing around roadside features that cannot or should not be removed or relocated. At times, providing for adequate pedestrian and traffic safety and/or pedestrian continuity may warrant locating sidewalks outside of the highway right of way, and within easements.

- **Note:** Where sidewalks are not warranted by existing or latent demand, or cannot be constructed due to right of way, utility, environmental or other considerations, roadway shoulders designed to NJDOT standards should be provided.

On a bridge project in urban and rural areas where there is no existing or proposed sidewalk at the approaches to a structure and the structure is to be replaced or widened, sidewalk may be provided on the new structure where additional width would be required to maintain traffic during future bridge deck reconstruction.

Urban and rural areas shall be those identified in the current State Highway Straight Line Diagrams.

5.7.2 Pedestrian Needs

Walking is a fundamental form of transportation that should be accommodated on streets and land service highways in New Jersey. The capacity of roadways to accommodate pedestrians safely and efficiently, particularly in urban and developing suburban areas, depends on the availability of sidewalks, intersection and mid-block crossing provisions, and other general characteristics such as roadway width and design speed.

When a sidewalk will be provided only along one side of the highway, the designer should include provisions to accommodate pedestrian crossing of the highway to access the sidewalk if there is a substantiated existing or future need. Such provisions should include one or more of the following: signing, painted cross walks, at-grade pedestrian signals, pedestrian overpasses, etc.

Sidewalks should provide a continuous system of safe, accessible pathways for pedestrians. Sidewalks on both sides are desirable for pedestrian-compatible roadways.

5.7.3 Sidewalk Design

Sidewalk Width

The following widths apply in situations of pedestrian traffic typical in suburban, or rural areas, or traditional residential neighborhoods. In urbanized areas, especially downtowns and commercial districts, sidewalk width should be increased to accommodate higher volumes of users. Refer to the Highway Capacity Manual to calculate the desirable sidewalk width given current or projected pedestrian volumes. The designer should consider local input prior to any installation of new sidewalk.

The desirable width of a sidewalk should be 5 feet (4 feet minimum) when separated by a buffer strip. The 5 foot width accommodates continuous, two-way pedestrian traffic. Where the border width is 10 feet, the width of the buffer strip should be a minimum of three feet with a 4 feet wide sidewalk. However, where the border width is 15 feet, the minimum width of the buffer strip should desirably be 5 feet with a 5 feet wide sidewalk or 6 feet with a 4 feet wide sidewalk. If the border widths are other than 10 or 15 feet, look at the conditions out in the field to determine the widths of the sidewalk and buffer strip.

Where no buffer strip is provided, the desirable width of the sidewalk should be 7 feet (6 feet minimum), especially where there is no shoulder (aids in preventing truck overhands or side view mirrors from hitting pedestrians). Where utility poles, sign supports, fire hydrants, etc., are provided in the sidewalk, the minimum useable width of sidewalk shall be 3 feet to allow for wheelchair passage.

The sidewalk width should be clear of trees, signs, utility poles, raised junction boxes, hydrants, parking meters and other similar appurtenances. Where utility poles, sign supports, fire hydrants, etc. are provided in the sidewalk, the minimum usable width of sidewalk shall be 3 feet to allow for wheelchair passage.

On rehabilitation or reconstruction projects where improvements are constrained by the existing border and right-of-way areas, the desirable sidewalk width would be implemented where feasible.

It is recognized that on rehabilitation or reconstruction projects existing roadway elements such as beam guide rail, signs, utility poles, slopes, etc. may become problematic in implementing the desirable width.

When the improvements would be considered cost prohibitive, environmentally sensitive, or beyond the scope of work the use of a sidewalk width less than the desirable would be acceptable.

Sidewalk Border Design

Where sidewalks are adjacent to swales, ditches or other vertical drop offs, there should be a minimum of two feet of clear space between the edge of the sidewalk and the top of the slope. This clear space should be graded flush with the sidewalk.

Sidewalk Buffer Design

Designers should strive for a desirable quality of service for pedestrians. The width and quality of buffer between the sidewalk and the roadway influence the pedestrian's sense of protection from adjacent roadway traffic. Physical barriers between the sidewalk and roadway such as trees and other landscaping, parked cars, and concrete barriers and guide rail may increase pedestrian safety and comfort, and therefore encourage higher levels of walking.

The minimum width of a buffer strip is 3 feet (measured from the face of curb to the nearest edge of the sidewalk). The desirable width should be increased up to 6 feet when feasible.

Grades and Cross Slopes

The maximum sidewalk cross slope is 2%. The maximum grade is 12:1 (8.3%). For sidewalks along streets; however, the longitudinal grade of the sidewalk should be consistent with the grade of the adjacent roadway. If the 12:1 grade is not feasible due to topography and other physical constraints, the least practical grade greater than 8.3% should be used. When sidewalk grades steeper than 8.3% (12:1) for a maximum distance of 30 feet are unavoidable, a level 4 foot long landing should be included at regular intervals, if possible.

Surface Treatments

The sidewalk should have a firm, stable slip resistant surface. A concrete surface is preferred; brick or concrete pavers may be used if they are constructed to avoid settling or shifting of bricks. Bituminous sidewalks may also be used. It is important to avoid ponding on sidewalks.

5.7.4 Public Sidewalk Curb Ramps

General

Public sidewalk curb ramps shall be provided where sidewalks permit pedestrians to cross curbs such as at:

- Intersections
- Painted crosswalks at mid-block locations
- Crosswalks at exit or entrance ramps
- Driveways, alleys, passenger loading zones, handicapped parking stalls

- Channelized islands, divisional islands or medians served by crosswalks.

All new construction, reconstruction, and resurfacing projects are subject to the American with Disabilities Act (ADA) Accessibility Guidelines contained in this Sidewalks subsection which includes providing curb ramps. In alterations to existing facilities where compliance with the ADA Accessibility Guidelines is technically infeasible, the alteration shall comply with these standards to the maximum extent feasible. For less extensive projects, limited improvements to accessibility would generally be expected. For example, if an existing portion of sidewalk along a residential block were rebuilt or replaced, at a minimum the new portion of sidewalk would be subject to the ADA guidelines including curb ramps, among other things. However, compliance with these guidelines would not extend to untouched sections of sidewalk outside the planned alterations. AASHTO recommends that "roadway preservation and preventative maintenance should be exempt from the requirement to provide accessible upgrades." Based on the above, there are a number of unique projects that will not require curb ramps to be constructed. These projects may involve, but are not limited to:

- Bridge patching
- Demolition
- Fencing
- Fender repair
- Fiber optics
- Guide rail
- Landscape
- Raised pavement markers
- Signing
- Traffic/Electrical
- Utility
- Seismic retrofit
- Pavement patching
- Shoulder repair
- Restoration of drainage systems
- Crack sealing
- Bridge painting
- Scour countermeasures
- Other roadway preservation and preventative maintenance projects. The following are some examples of such projects.
 1. Pavement milling
 2. Pavement resurfacing
 3. Pavement repair
 4. Bridge bituminous resurfacing
 5. Bridge deck patching
 6. Joint replacement or repair
 7. Bridge deck restoration and component patching
 8. Rehabilitation of existing structures

In most cases, the unique projects mentioned previously will not modify a pedestrian route. However, the designer should consider every project as an opportunity to further the accessibility of its pedestrian network and should not unnecessarily restrict the scope of work so as to avoid the requirements for new curb ramps.

The sight distance should be checked to ensure curb ramps are not placed in such a location that a motorist will find it difficult to perceive the low profile of a wheelchair occupant crossing the roadway.

Curb ramps shall be designed to accommodate all users, thus, transitions from the sidewalk to the curb ramp or to the landing area shall be gradual. Relocation of the sidewalk at an intersection is permissible, and in some cases necessary in order to obtain the required sidewalk and curb ramp slope.

Gutters & Counter Slopes

Gutters require a counter slope at the point at which the ramp meets the street. (See Figure 15-K) This counter slope shall not exceed 6%, but it is desirable to be 5% or less. The change in angle must be flush, without a lip, raised joint or gap. Lips or gaps between the curb ramp slope and counter slope can arrest forward motion by catching caster wheels or crutch tips.

Landings

A curb ramp with a landing area is required wherever a public sidewalk crosses a curb or other change in level. Landings provide a nearly level area (2% cross slope) for wheelchair users to wait, maneuver into or out of a curb ramp, or to bypass the ramp altogether. A level landing 48x48-inch minimum is required. This accommodates the length and wheelbase of a standard wheelchair and scooter.

Landings or a level cut through should also be provided at raised medians or crossing islands.

Flares

Curb ramp flares are graded transitions from a curb ramp to the surrounding sidewalk. Flares are not intended to be wheelchair routes, and are typically steeper than the curb ramp with significant cross-slopes. For pedestrians who have visual impairments, flares may be one of the cues used to identify a curb ramp and upcoming street edge.

Flares are only needed in locations where the ramp edge abuts pavement. A curb edge is used where the ramp edge abuts grass or other landscaping. If the curb ramp is situated in such a way that a pedestrian cannot walk across the ramp sides, flares may be replaced with a curb adjacent to the ramp. Straight returned curbs are a useful orientation cue to provide direction for visually impaired pedestrians. (See CD-607-1)

Curb Ramp Types and Placement

The appropriate type of curb ramp to be used is a function of sidewalk and border width, curb height, curb radius and topography of the street corner. There are seven curb ramp types used in street corner designs as shown in the Construction Details. In all cases, the 4 foot wide ramp should be located entirely within the marked crosswalks (where they exist). Drainage grates or inlets should not be located in the area at the base of the curb ramp. Grates are a problem for wheelchairs, strollers and those who use walkers.

In general, two curb ramps are required at each corner, one on each highway within the crosswalk area. If the 4 foot wide curb ramp cannot be constructed within the existing crosswalk, the crosswalk shall be modified to include the ramp. The preferred location for a curb ramp is usually parallel to the sidewalk and out of the normal pedestrian path. However, where field conditions prohibit this location, one ramp at the center of the corner radius is acceptable. Curb ramp designs which result in wide painted cross walks greater than 10 feet should be avoided.

The *Standard Roadway Construction Detail* illustrates the design criteria for public sidewalk curb ramps. The designer should keep in mind that existing conditions at a curb ramp location may present special problems.

At a curb ramp location where the sidewalk is greater than 6 feet in width and there is no grass buffer strip, the approach sidewalk transition shall be as shown for Curb Ramp Type 1 and 3 in the *Standard Roadway Construction Details*. However, where a grass buffer strip exists between the curb and the sidewalk at a curb ramp location, the flared side slope and approach sidewalk transition should be altered as shown for Type 2 and 4 in the *Standard Roadway Construction Details*.

The designer may want to prohibit pedestrians from crossing the mainline on a high volume and/or high speed section of highway except at signalized intersections. Therefore, at unsignalized intersections along this section of highway, a curb ramp would be required on the side street corner but not on the mainline corner. Curb Ramp Type 5 and 6 in the *Standard Roadway Construction Details* are examples of curb ramp locations for crossing the side street only. The preferred treatment for Curb Ramp Type 5 and 6 is out of the normal pedestrian path, but not necessary where right of way width cannot accommodate the offset.

Where there is limited right of way (ROW) at a curb ramp location, the approach sidewalk transition should be altered and the landing made flush with the gutter line as shown for Curb Ramp Type 7 in the *Standard Roadway Construction Details*. These limited ROW locations are where the distance from the gutter line to the outside edge of sidewalk is 6 feet or less.

Intersections may have unique characteristics that can make the proper placement of curb ramps difficult, particularly in retrofit situations. However, there are some fundamental guidelines that should be followed.

- Their full width at the gutter line (exclusive of flares) must be within the crosswalk. Aligning the ramp to the crosswalk, if possible, will enable the visually impaired pedestrian to more safely navigate across the intersection and exit the roadway on the adjoining curb ramp.
- Curb ramps need to avoid storm drain inlets, which can catch wheelchair casters or cane tips.
- Curb ramps need to be adequately drained. A puddle of water at the base of a ramp can hide pavement discontinuities. Puddles can also freeze and cause the user to slip and fall.
- Curb ramps must be situated so that they are adequately separated from parking lanes.

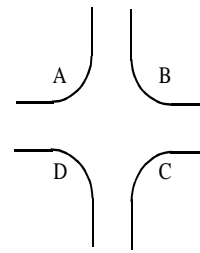
Curb Ramp Width

The clear width of a curb ramp should be a minimum of 4 feet, excluding flares.

The following criteria shall apply to providing curb ramps at intersections:

1. Where all the corners of an intersection have existing or proposed sidewalk, curb ramps shall be provided at each corner.
2. Where all the corners of an intersection do not have existing or proposed sidewalk, the following provisions shall apply:

- a. Where there is existing or proposed sidewalk at only one corner, A only, B only, C only or D only; no curb ramp is required. If the curb at the corner with sidewalk is to be constructed or reconstructed, it is optional to provide depressed curb for future curb ramps for compatibility with other corners.
- b. Where there is existing or proposed sidewalk at two adjacent corners only, such as A and B, curb ramps shall be constructed at corners A and B only.
- c. Where there is existing or proposed sidewalk at two diagonally opposite corners only, such as A and C, curb ramps shall be constructed at corners A and C together with a curb ramp at one of the other corners (B or D).
- d. Where there is existing or proposed sidewalk at three corners, curb ramps shall be constructed at each corner where existing sidewalk is to remain or where new sidewalk is proposed.



Where a corner at an intersection is without existing or proposed sidewalk, but with curb to be constructed or replaced or with existing curb to remain as is; it is optional to provide depressed curb for future curb ramps.

Where islands exist or are proposed at intersections with curb ramps, the following provisions shall apply:

1. Where a small channelizing island (50 to 75 square feet) is encountered at an intersection, it is not necessary to provide for a curb ramp or walkway opening for the island, but crosswalks shall be adjusted to safely accommodate a person with disabilities without encroaching into the adjacent traveled way.
2. Where a channelizing island is greater than 75 square feet, provide a 4 foot. wide walkway opening level with the street in the part of the island intersected by the crosswalk. Where the walkway opening would be long or would create drainage problems, an alternate design is to place curb ramps at both sides of the island where it is intersected by the crosswalks and have a level area of at least 4 feet. between the curb ramps.
3. At intersections where a left turn island or divisional island is encountered and the island cannot be moved back so that the nose is out of the crosswalk, provide a 4 foot wide walkway opening level with the street in the part of the island intersected by the crosswalk. See the *Standard Roadway Construction Details*.

At a location where a curb ramp is not presently required, the curb ramp area should be kept clear of obstructions such as light standards, traffic signals, meter boxes, controller boxes, junction boxes, utility poles, inlets, fire hydrants, guide rail, signs, planters, etc. which would interfere with future curb ramp construction.

The surface of a public sidewalk curb ramp shall be stable, firm and slip-resistant. The surface of a concrete curb ramp (excluding landing and flared sides) shall be the color red where the adjoining public sidewalk surface is also concrete. Where the adjoining public

sidewalk surface is not concrete, the surface of a public sidewalk curb ramp shall contrast visually with adjoining public sidewalk surfaces, either light-on-dark or dark-on-light.

The curb ramp area (curb ramp, landing area, and approach sidewalk transition) shall be kept clear of existing and proposed obstructions such as light standards, traffic signals, meter boxes, controller boxes, utility poles, inlets, fire hydrants, guide rail, signs, planters, etc. Existing obstructions should be relocated as necessary, so as to provide maximum visibility of and for the curb ramp user. Existing manholes, junction boxes, and valve boxes shall be reset to slope of curb ramp. Wherever possible, curb ramps should be located to avoid drainage low points in the gutter grade. Gratings or similar access covers shall not be located in the area at the base of the public sidewalk curb ramp.

5.8 Driveways

Driveway terminals are, in effect, low volume intersections. The number of driveways and their location has a definite effect on highway capacity, primarily on arterial highways.

Design requirements for driveways and the process under which the Department of Transportation will handle an access permit request are contained in the Department's publication, *New Jersey State Highway Access Management Code* and the *Memorandum to All Design Units* entitled "Access Control at Jughandles and Interchanges, and Driveway Reviews", October 3, 1994.

To determine the adequacy of the sight distance at driveways, see Section 6 for sight distance at intersections.

5.8.1 Pedestrian Accommodations at Driveways

In commercial areas, conventional driveways (i.e. where there is a change in grade between the street and abutting property and the driveway entrance is connected to the street via a sloped concrete apron) are preferred over access points that resemble at-grade street intersections where there is no grade change. In the design of conventional driveways, the pedestrian right of way is established more clearly and vehicles must turn more slowly into and out of the driveway. If an intersection-style driveway is used, vehicle turns can be slowed by using a small curb radius. In addition, driveway width should be made as small as possible. Wide driveways allow faster turns and more exposure for pedestrians. The sidewalk at driveways should remain at grade and may have the same surface material or crosswalk delineation across the driveway so motorists know they are crossing a pedestrian access route.

The intersection of driveways and sidewalks are the most common locations for severe cross slopes for sidewalk users. Sloped driveway entrances can cause wheelchair users to lose directional control, veer downhill toward the street and potentially tip over. Therefore, the following solutions are recommended:

- At locations with a buffer between the sidewalk and the street, provide a level path of pedestrian travel (as an extension of the regular sidewalk) through the driveway cut, and resume the driveway slope within the buffer.
- On narrow sidewalks against the curb, achieve a similar level landing area by moving the sidewalk back away from the highway as it crosses the driveway, where possible.
- Install a curb ramp type 7 (as per the *Standard Roadway Construction Details*) that lowers the driveway crossing to the grade of the street. (Note, although this solution is preferable to a severe cross slope, it can create steep grades on both sides of the driveway and can cause drainage problems on the landing.)

5.9 Medians

5.9.1 General

A median is a highly desirable element on all arterials carrying four or more lanes. It separates the traveled ways for traffic in opposing directions. The median width is expressed as the dimension between the through-lane edges and includes the left shoulders, if any. The principal functions of a median are to:

1. Provide the desired freedom from the interference of opposing traffic.
2. Provide a refuge area for pedestrians and bicyclists.
3. Provide a recovery area for out-of-control vehicles.
4. Provide a stopping area in case of emergencies.
5. Provide for speed changes and storage of left-turning and U-turning vehicles.
6. Minimize headlight glare.
7. Provide width for future lanes.
8. Add open green space in an urban area.
9. Serve as traffic calming devices on low speed roadways.

For maximum efficiency, a median should be highly visible both night and day and in definite contrast to the through traffic lanes. A median may vary in scope from pavement markings to an expansive grass area of varying width between two independently designed roadways. Medians may be depressed, raised, or flush with the pavement surface.

5.9.2 Islands, Medians, and Pedestrian Refuges

Along with their function of controlling and directing traffic movement (usually turns), and dividing traffic streams, islands serve to increase the safety and comfort of pedestrians crossing at intersections and midblock locations by providing a refuge. When channelizing islands are designed for this purpose, they are often termed "pedestrian crossing islands" or "median refuges." Figures 15-F and 15-G illustrate two examples of pedestrian refuge treatments. See Sections 5-09 and 6-05 for design details.

The effective width of a median used as a pedestrian refuge and for traffic calming purposes is the width of the raised portion. In order for a median to function as a refuge, the raised portion of the median must be at least 6 feet wide. Medians should be as wide as feasible, but of a dimension in balance with other components of the cross section. The general range of median widths is from a minimum of 6 feet, to a desirable dimension of 84 feet or more on freeways and rural areas. When not utilized as a refuge or for traffic calming, medians can be as narrow as 4 feet.

Desirable median width without a barrier for urban land service highways should be 32 feet to accommodate future widening (a future 12 foot lane, 3 foot shoulder in each direction with a 2 foot median concrete barrier curb) and 16 feet where no future widening is anticipated. Desirable and minimum median widths without a barrier for rural land service highways should be 46 feet (to accommodate future 12 foot lane and 5 foot wide shoulder in each direction with a 12 foot grass median) and 36 feet (to accommodate a future 12 foot lane and 5 foot shoulder in each direction with a 2 foot median concrete barrier curb), respectively grass median may have sloping curb on both sides. For minimum median widths with barrier and for median widths for freeways, see the typical sections illustrated at the end of this section.

Medians 5 feet or less in width will be paved, except where the special nature of an area might warrant the higher cost and risk involved in maintaining grass. Special areas might

be parks or refined areas in towns or cities where a narrow grass strip would be in harmony with the surroundings or where shrubbery is planted to reduce oncoming headlight glare.

Where practical, nose areas shall be paved back to a point where the distance is 5 feet between curblines.

In general, the median should be as wide as can be used advantageously. As far as the safety and convenience of motor vehicle operation are concerned, the farther the pavements are apart, the better. However, economic factors limit the width of median that can be provided. Construction and maintenance costs increase generally with an increase in the width of roadbed, but the additional cost may not be appreciable compared with the cost of the highway as a whole and may be justified in view of the benefits derived. A distinct advantage of wider medians on roadways, other than freeways, is to provide adequate shelter for vehicles crossing at intersections with public roads and at crossovers serving commercial and private drives. However, wide medians are a disadvantage when the intersection is signalized. The increased time for vehicles to cross the median may lead to inefficient signal operation.

If the right of way is restricted, the median should not be widened beyond a desirable minimum at the expense of narrowed roadside areas. A reasonable roadside width is required to adequately serve as a buffer between the private development along the road and the traveled way, particularly where zoning is limited or nonexistent. Space must be provided in the roadside areas for sidewalks, highway signs, utility lines, drainage channels and structures, and for proper slopes and any retained native growth. Narrowing these areas may tend to develop hazards and hindrances similar to those that the median is designed to avoid.

Raised medians have application on arterial streets where it is desirable to regulate left-turn movements. They are also frequently used where the median is to be planted, particularly where the width is relatively narrow. It must be pointed out, however, that planting in narrow medians creates hazardous conditions for maintenance operations.

Flush medians are used to some extent on all types of urban arterials. When used on freeways, a median barrier may be required. The median should be slightly crowned or depressed for drainage.

Additional discussion on median openings and intersections including emergency median openings on land service highways and freeways is discussed in Section 6, At-Grade Intersections.

5.9.3 Median Fencing on Land Service Highways

This section pertains to the installation of fence on top of median barrier curb or in grass medians along our State land service highways. The purpose of the fence is to prohibit the unlawful and potentially dangerous crossing of the highway by pedestrians where barrier curb or a grass median exists. It is the Department's policy to provide median fencing on a case by case basis only.

Fencing in the median may be considered when there is a known pedestrian/vehicle crash history, or the Department has been requested by the local municipality to eliminate an illegal pedestrian crossing of the median. Upon notification of such a problem or when requested by the local municipality; the local municipality (township engineer, police, etc.) should be contacted for their input, accident reports should be requested and analyzed and a field review of the site should be conducted in order to determine the exact location and reason for the illegal pedestrian crossings. An example of a reason for an illegal pedestrian crossing may be that pedestrians at a bus stop are crossing the highway to get to and from their vehicles parked on the opposite side of the highway.

If the pedestrian crossing is an isolated incident, fencing or other countermeasures are not warranted. If the pedestrian crossing is an ongoing patterned problem, evaluate the following safety countermeasures for use before installing fence in the median. They can be used by themselves or in combination with each other:

- Relocate the midblock bus stop and/or crossing closer to the signalized intersection.
- Provide mid-block crossing location(s) as per Section 14-12.1
- Coordinate the adjacent pedestrian network with safe crossing locations. For example, a pathway may be re-oriented so that it leads directly to an intersection, overpass or midblock crosswalk. The site may be graded to naturally direct pedestrians.
- Contact the local police department and request that they step up policing of jaywalkers.
- Encourage safe use of crosswalks at signalized intersections by providing clearly defined crosswalks, pedestrian actuated signals and signs. Provide proper traffic signal signs for the instruction of pedestrians and drivers, see "Section 2B-37" of the current *Manual on Uniform Traffic Control Devices for Streets and Highways* (MUTCD). Provide pedestrian crossing signs to selectively aid in limiting pedestrian crossing to safe places. For proper placement of these signs, see "Section 2B-36" of the MUTCD.
- Provide a pedestrian overpass if intersection/ interchange spacing exceeds one mile and if a user benefit cost analysis warrants an overpass. A pedestrian overpass is very effective when accompanied by median fencing.
- Provide roadway lighting.

Only after the previous countermeasures are evaluated and implemented should the engineer consider providing fencing in medians. That is, fencing should be used as a last resort. Fencing in medians should stop approximately 90 percent of the pedestrian crossings; however, it has its drawbacks. If the decision is made to install median fencing, the following issues should be recognized:

- Difficulty in maintaining fence on median barrier curb.
- Potential to reduce horizontal sight distance when installed on median barrier curb.
- Litter can be a problem along fence located in grass medians adjacent to high litter generators such as shopping malls.

Median fencing should be installed in well-lighted areas so that pedestrians can see the fence prior to attempting to cross the highway at night. Where existing roadway lighting is inadequate, provide additional roadway lighting in accordance with "Section 11, Roadway Lighting Systems."

Adequate sight distance at intersections and emergency U-turns should be provided when designing limits of fencing. Therefore, fencing on barrier curb shall stop a minimum of 300 feet from the median barrier curb terminal, and fencing in grass medians shall terminate a minimum of 200 feet from the end of the grassed island. Fencing shall not be installed in medians where there is substandard horizontal stopping sight distance.

When installed on median barrier curb, chain link fabric shall be 4 feet high, with 3 inches diamond mesh.

When installed in grass medians, the chain link fabric shall be 6 feet high, with 3 inches diamond mesh. All chain link fence posts within the clear zone shall be made breakaway (i.e., breakaway coupling).

5.10 Standard Typical Sections

Typical sections should be developed to provide safe and aesthetically pleasing highway sections within reasonable economic limitations.

The typical sections shown in the plans should represent conditions that are "typical" or representative of the project. It is not necessary to show a separate typical section to delineate relatively minor variations from the basic typical. The most common or predominant typical section on the project should be shown first in the plan sheets followed by sections of lesser significance.

Figures 5-B through 5-J inclusive illustrate the various control dimensions for single lane and multi-lane highways.

5.11 Bridges and Structures

5.11.1 General

Designers should make every effort during the early design phase to eliminate or minimize certain features on bridge decks such as, horizontal curves, vertical curves, variable horizontal widths and cross slopes. Locating these features off the structure simplifies construction, is more economical and reduces future maintenance requirements.

For further information, the designer should review Section 5.2., Geometrics on Bridges in the *Design Manual - Bridges and Structures*.

5.11.2 Lateral Clearances

It is desirable that the clear width on the bridge be as wide as the approach pavement plus shoulders.

On underpasses, the desirable treatment is to maintain the entire roadway section including median, pavements, shoulders and clear roadside areas through the structure without change.

Minimum lateral clearances are illustrated in Figures 5-K through 5-P inclusive.

On divided highways where the median width is less than 30 feet consideration should be given to eliminating the parapets and decking the area between the structures.

5.11.3 Vertical Clearance

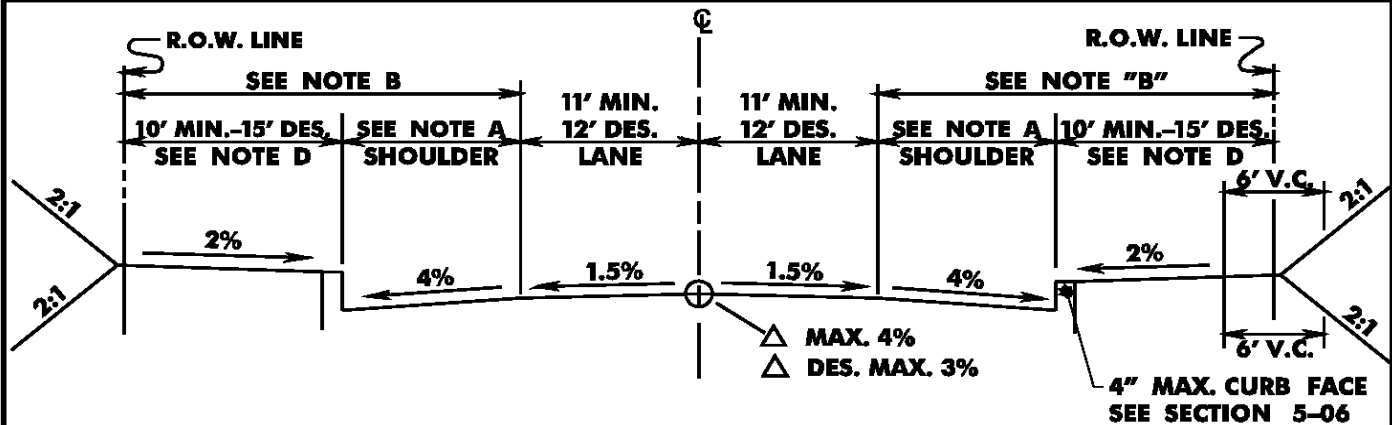
Vertical clearances for bridges and structures shall be in accordance with Section 3.2, Vehicular Bridge Structures, of the *Design Manual - Bridges and Structures*.

Bridges and Structures Design should be notified of all changes in bridge clearances.

LAND SERVICE HIGHWAYS

FIGURE: 5-B

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TWO-LANE ROADWAY

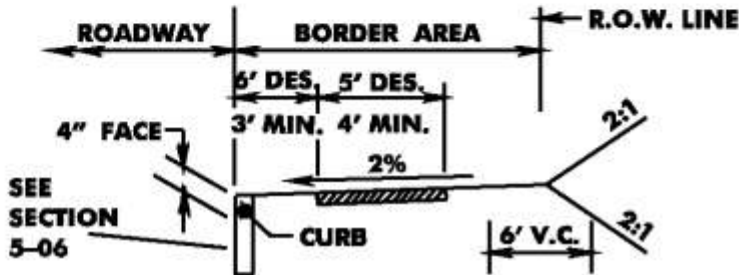
NOTES:

- A. Shoulder width shall be 8 feet absolute minimum or 10 feet minimum desirable. Shoulder width may be increased to 12 feet maximum when a large volume of trucks is anticipated (250 DHV), when turning volumes are high or dualization is anticipated.
- B. Desirably the clear zone distance plus 5 feet from the edge of thru lane to the Right of Way Line for the corresponding design speeds should be provided - 60 MPH, 35 feet; 55 MPH, 30 feet; 50 MPH or less, 25 feet.
- C. Curb section may be used with or without sidewalk. Curb section shall be used for access control, where pedestrian traffic is anticipated or where necessary for drainage.
- D. The border width on existing highway may be reduced to 8 feet to accommodate the widening of lanes and/or shoulders.
- E. All utility poles shall be located as close to the R.O.W. line as possible.
- F. Bicycle lanes may be incorporated into a roadway section when it is desirable to delineate available road space for preferential use by bicyclists. Generally, they are placed on the right side of the roadway and maybe separate from or within the shoulder area.
- G. Parking space maybe incorporated into a roadway section. Generally the space allocated for the shoulder within a roadway section would be designated as a parking area. Typically parking areas would be located on urban roadways or areas designated for traffic calming.

LAND SERVICE HIGHWAYS BORDER AREAS

FIGURE: 5-B1

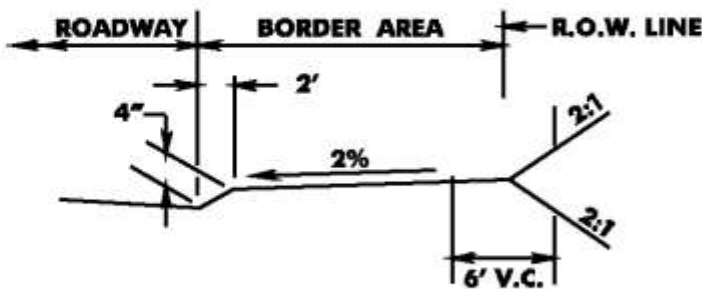
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CURB SECTION

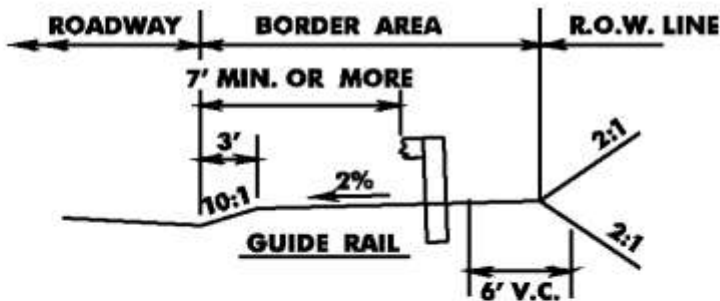
With Provision For
Sidewalk

SEE NOTE C
ON FIGURE 5-B



BERM SECTION

With Provision For
For Future Sidewalk



BERM SECTION

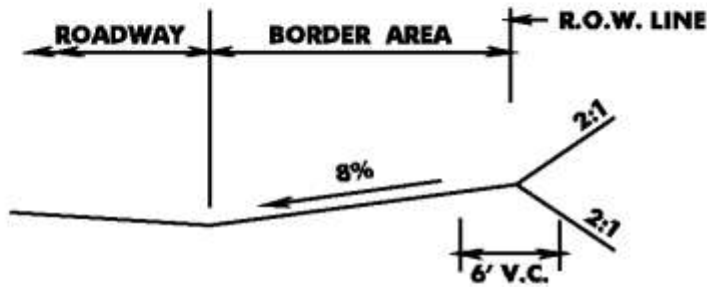
With Provision For
For Future Sidewalk
With Guide Rail

FOR ALL SECTIONS SEE NOTE "E" ON FIGURE 5-B

LAND SERVICE HIGHWAYS BORDER AREAS

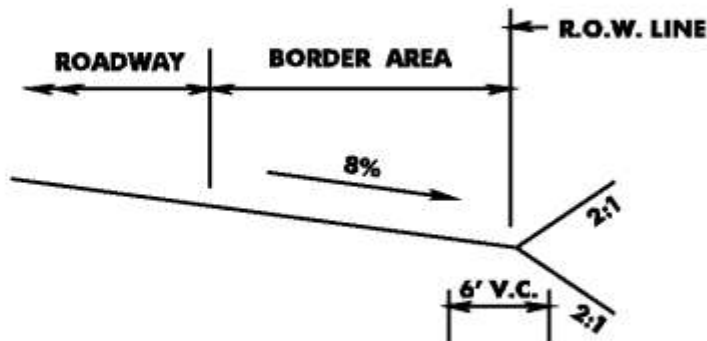
FIGURE: 5-B2

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NON-BERM SECTION

With No Provision
For Sidewalk



UMBRELLA SECTION

With No Provision For
Sidewalk

NOTES: SEE ATTACHMENT NO. 1

NOTES:

- A. UMBRELLA SECTION MAY BE USED WHERE THERE IS NO PROVISION FOR SIDEWALK AND CURBS ARE NOT REQUIRED FOR DRAINAGE AND ACCESS CONTROL (SUCH AS RURAL RESIDENTIAL DRIVEWAYS).

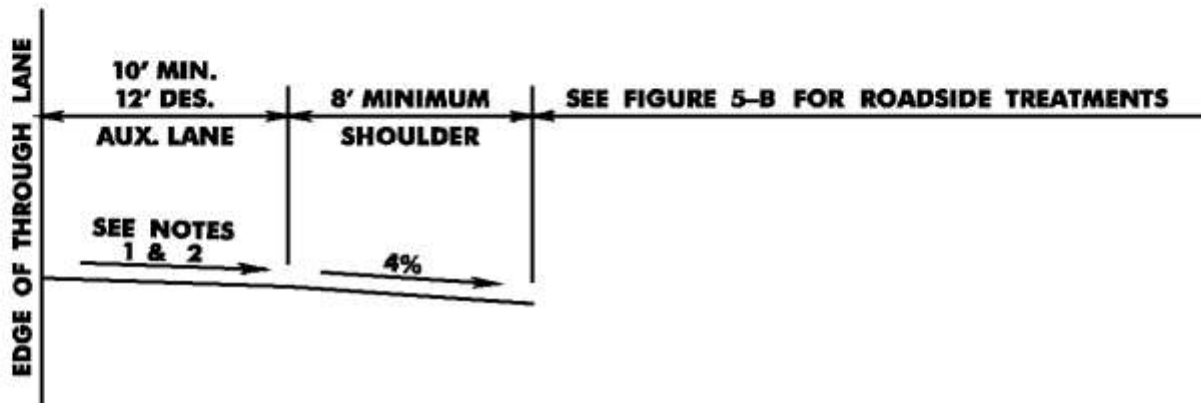
THIS SECTION MAY BE SUITABLE FOR SANDY AREAS, WETLAND AREAS, AND ALONGSIDE EXISTING OR PROPOSED DITCHES OR SWAILS.

SEE NOTE "E" ON FIGURE 5-B

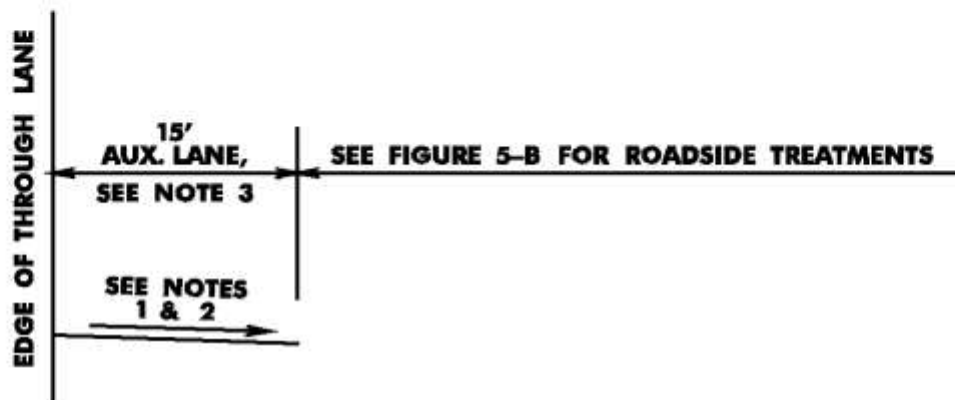
LAND SERVICE HIGHWAYS

FIGURE: 5-C

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PREFERRED AUXILIARY LANE AT INTERSECTION – TREATMENT



ALTERNATE AUXILIARY LANE AT INTERSECTION – TREATMENT

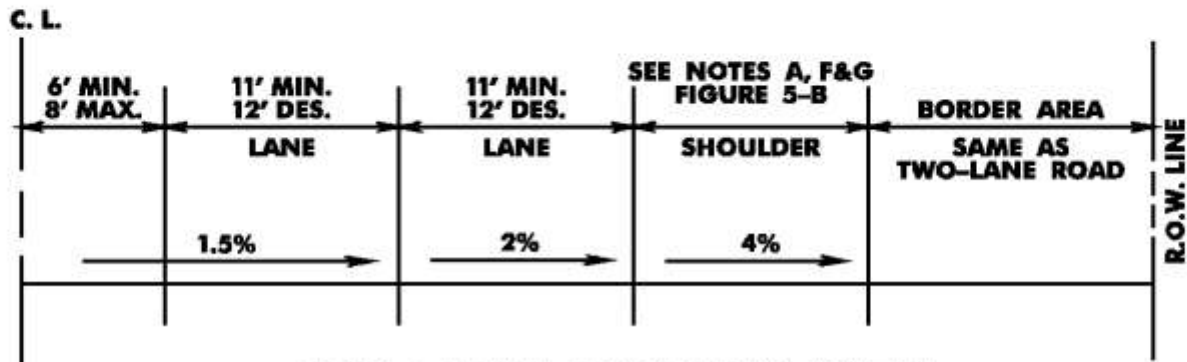
NOTES:

1. For Normal Crown Sections, cross slope should be 1/2% greater than adjacent through lane. Maximum cross slope desirably should not exceed 2.5%.
2. For Superelevated Section, the cross slope should be the same as the adjacent through lane. See Section 7-06.2 on the development of superelevation at Free-Flow Ramp Terminals.
3. Where alternate bike route is provided, alternate Auxiliary Lane width may be one foot wider than adjacent lane.

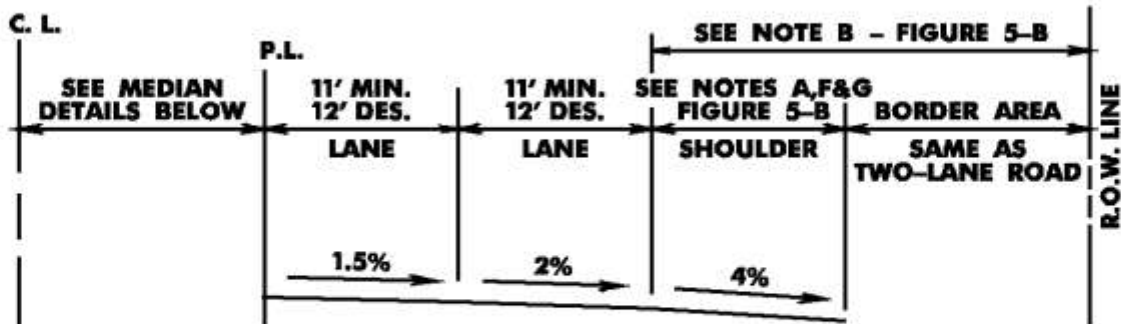
LAND SERVICE HIGHWAYS

FIGURE: 5-D

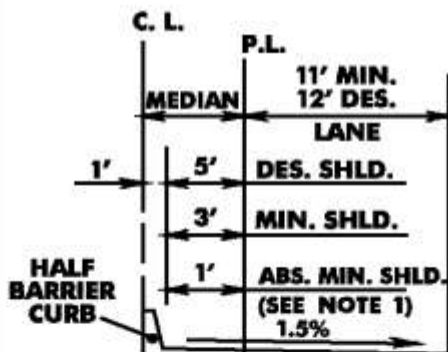
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FOUR LANE HIGHWAY WITH TWO-WAY LEFT TURN LANE HALF SECTION

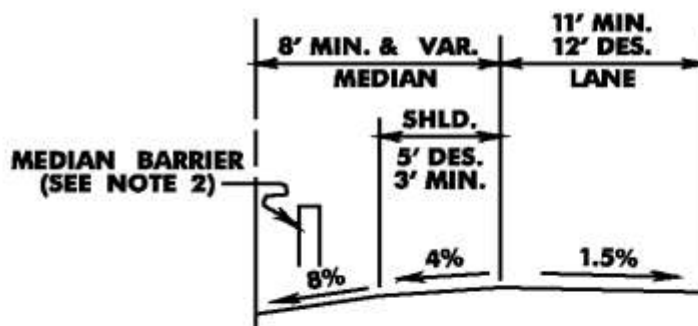


FOUR LANE - DIVIDED HIGHWAY HALF SECTION



MEDIAN HALF SECTION

NO DRAINAGE IN MEDIAN



MEDIAN HALF SECTION

DRAINAGE IN MEDIAN

NOTES:

1. Applicable to existing highways only.
2. Median Barrier may be located at or on either side of Low Point.

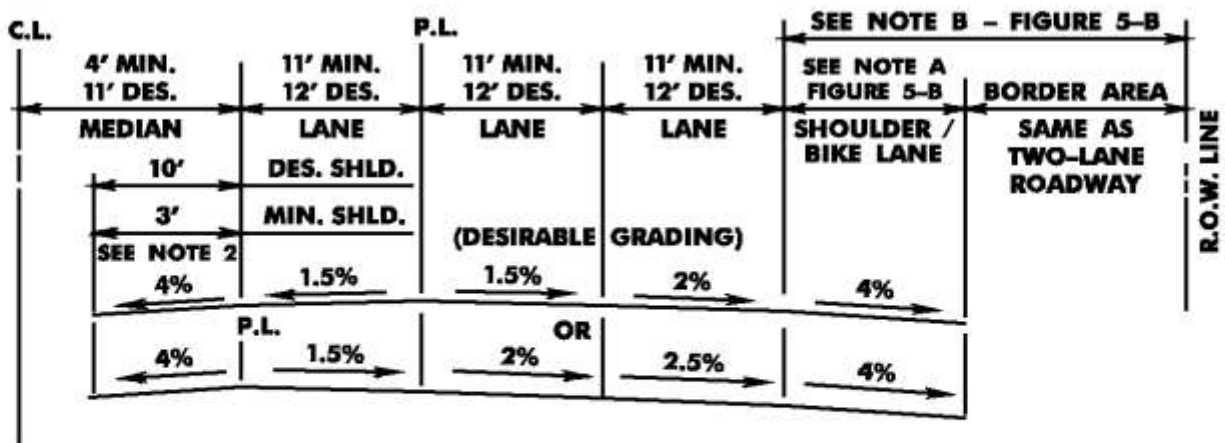
LAND SERVICE HIGHWAYS

FIGURE: 5-E

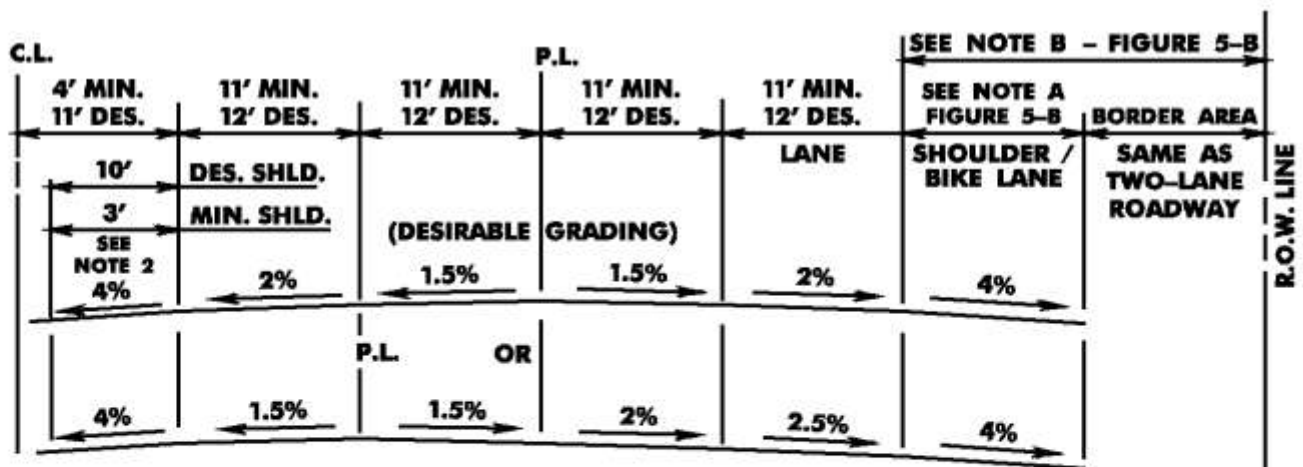
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NOTES:

1. Median Barrier will be selected as per Section 8, Guidelines for Guide Rail and Median Barriers.
2. Where left shoulder width is less than 5 feet and median slopes away from roadway, the shoulder cross slope may be at the same rate and direction as the adjacent lane.



SIX LANE - DIVIDED HIGHWAY HALF SECTION

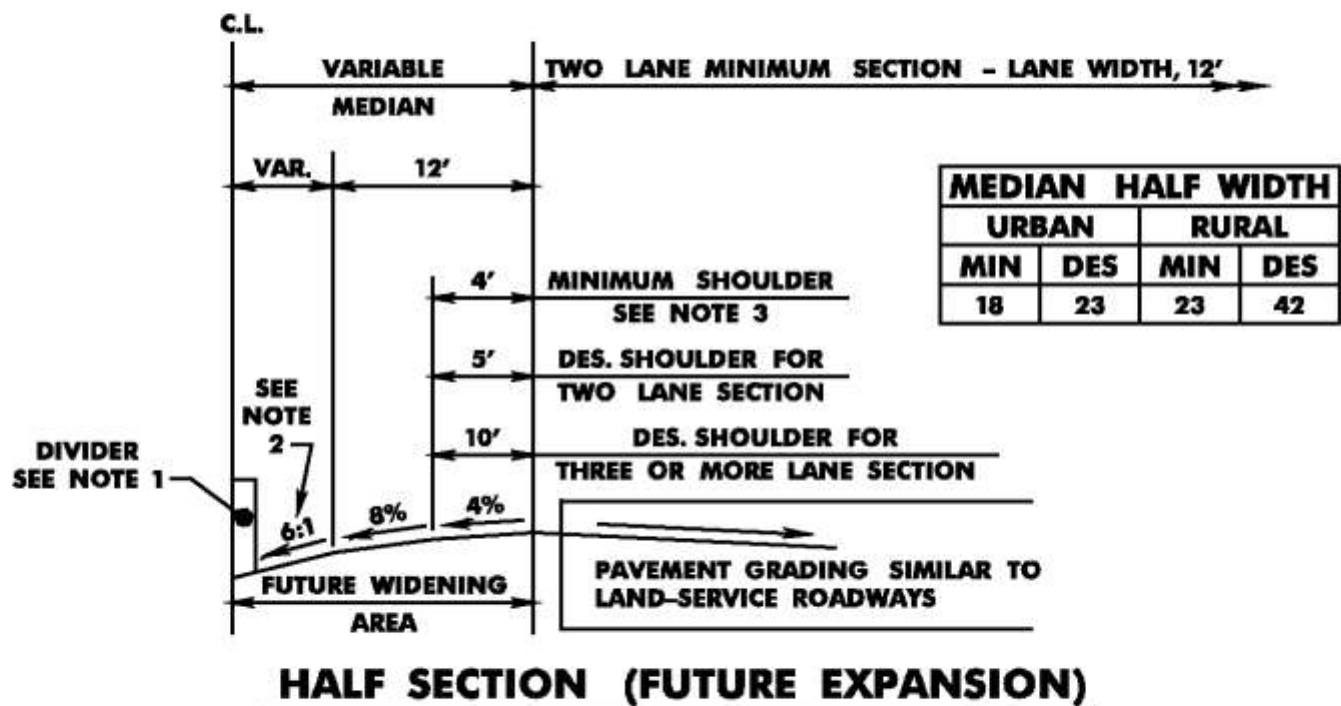
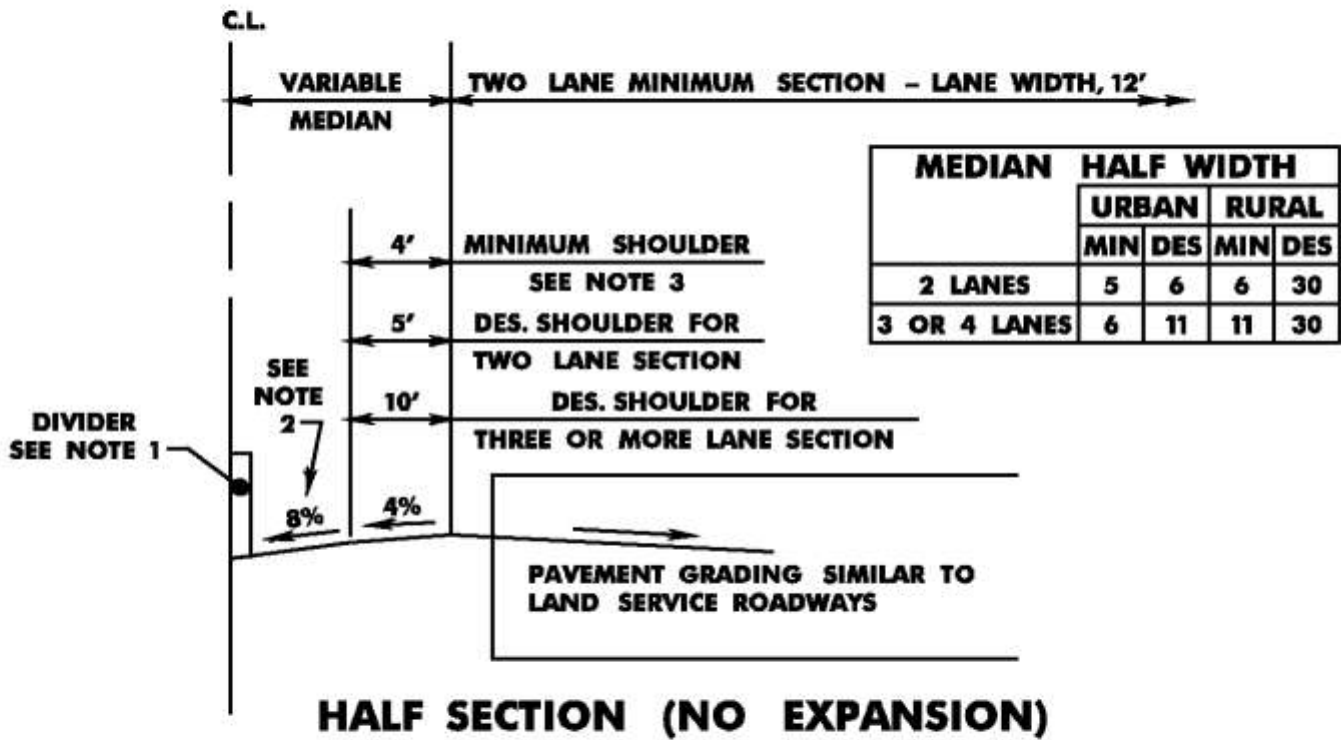


EIGHT LANE - DIVIDED HIGHWAY HALF SECTION

FREEWAY SECTIONS

FIGURE: 5-F

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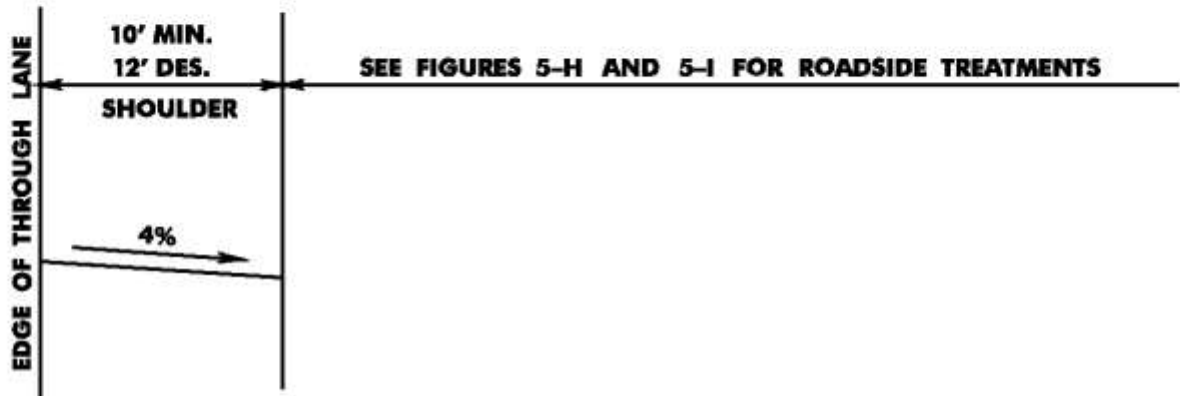
NOTES:

1. For Median Barrier Warrants see Section 8-06.1.
2. See Figure 5-E, Note 2.
3. Maximum sideslope adjacent to a Median Barrier is 10:1.

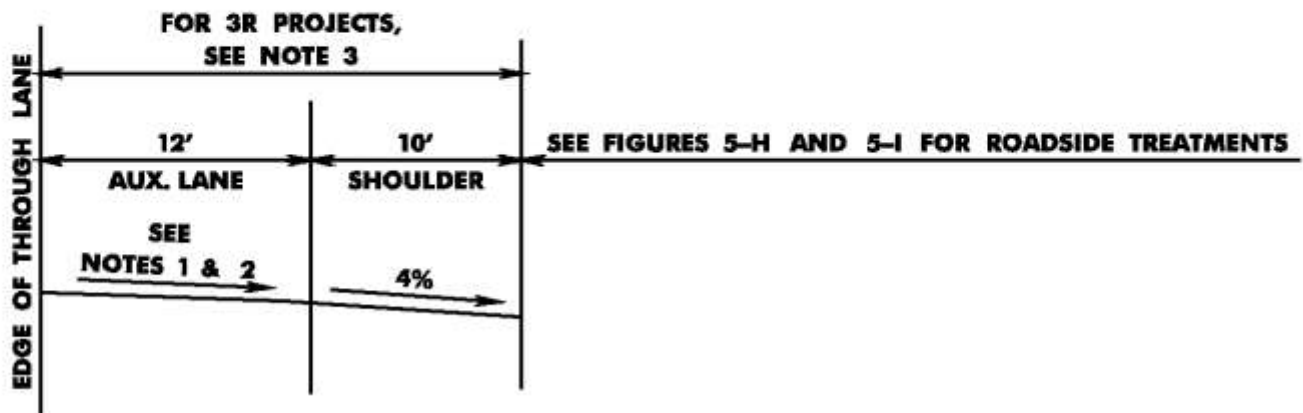
FREEWAY SECTIONS

FIGURE: 5-G

BDC07MR-04



SHOULDER TREATMENT



AUXILIARY LANE TREATMENT

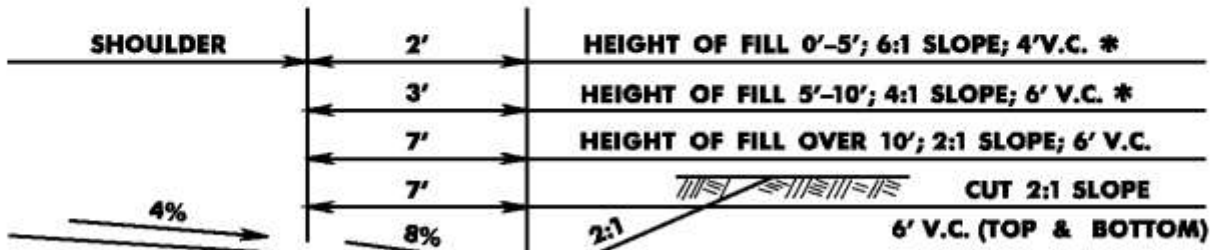
NOTES:

1. For Normal Crown Sections, cross slope should be 1/2% greater than adjacent through lane. Maximum cross slope desirably should not exceed 2.5%.
2. For Superelevated Sections, the cross slope should be the same as the adjacent through lane. See Section 7-06.2 on the development of superelevation at Free-Flow Ramp Terminals.
3. Where no shoulder exists, the existing Auxiliary Lane width may be maintained on 3R projects. However, whenever practical, a 10 foot desirable or a 6 foot minimum shoulder should be provided on 3R projects.

FREEWAY SECTIONS

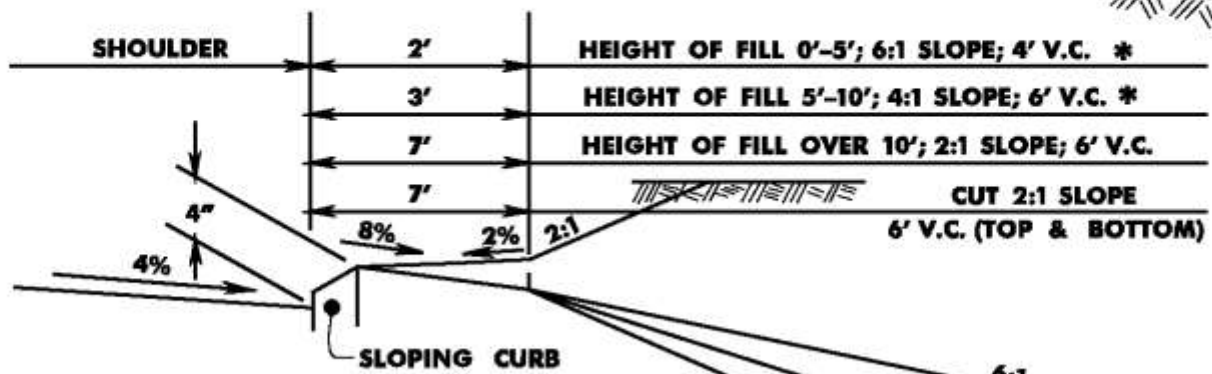
FIGURE: 5-H

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SLOPE DETAIL

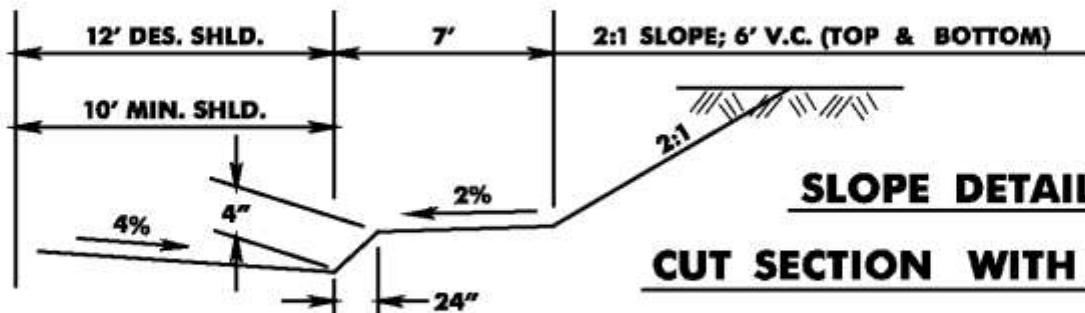
UMBRELLA SECTION



SLOPE DETAIL

CURBED SECTION (WHEN JUSTIFIED)

* GUIDE RAIL NOT REQUIRED FOR SLOPES 4:1 AND FLATTER.



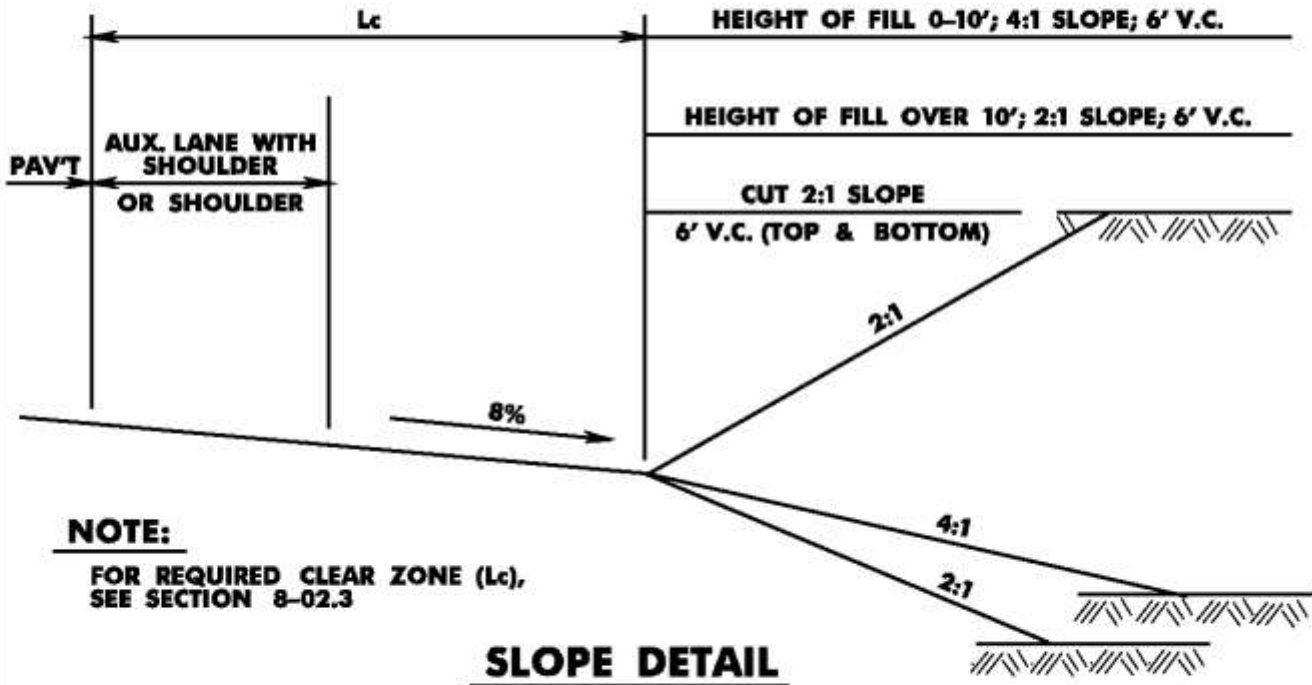
SLOPE DETAIL

CUT SECTION WITH BERM-

ALTERNATE SECTION

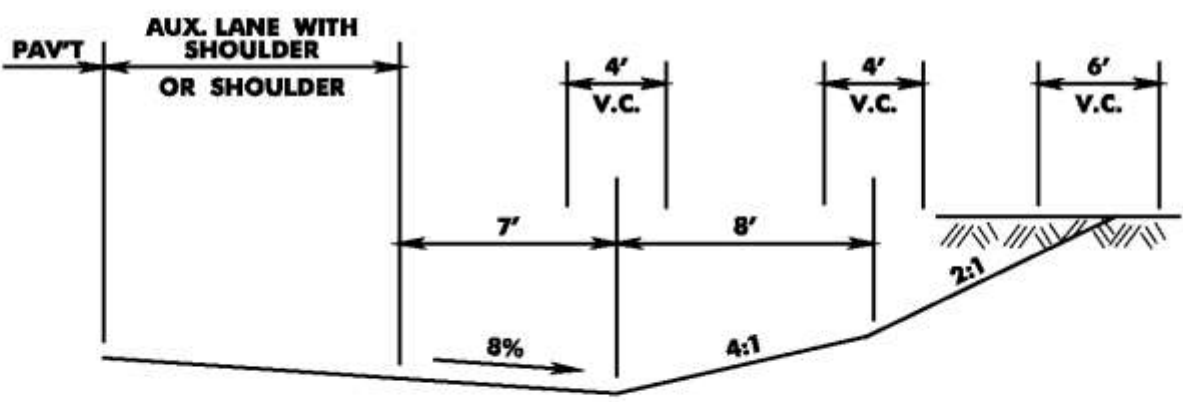
FREEWAY SECTIONS

FIGURE: 5-1
BDC07MR-04



SLOPE DETAIL

UMBRELLA SAFETY SECTION



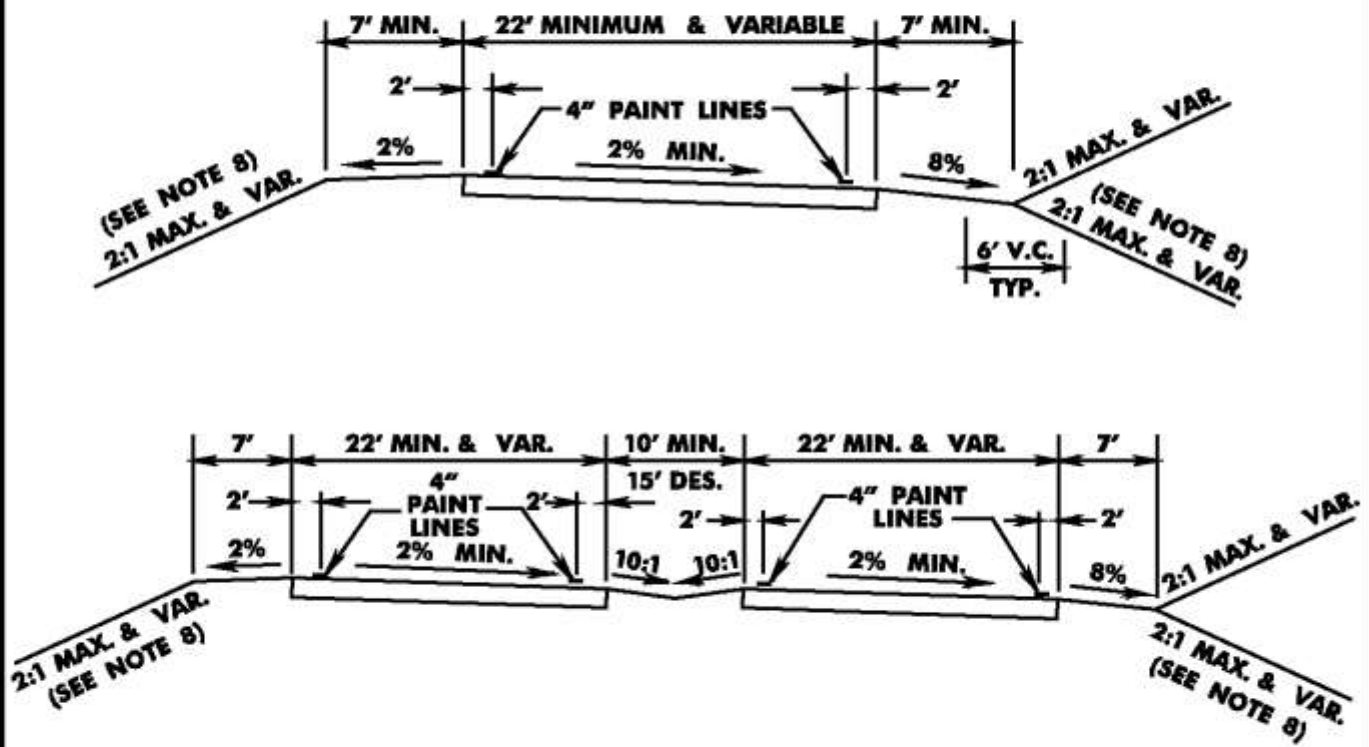
SLOPE DETAIL

ALTERNATE - CUT SAFETY SECTION

RAMP SECTIONS

FIGURE: 5-J

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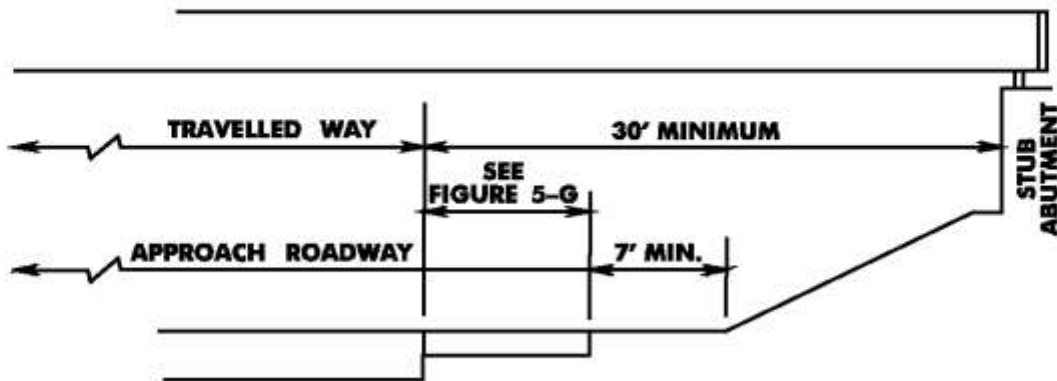
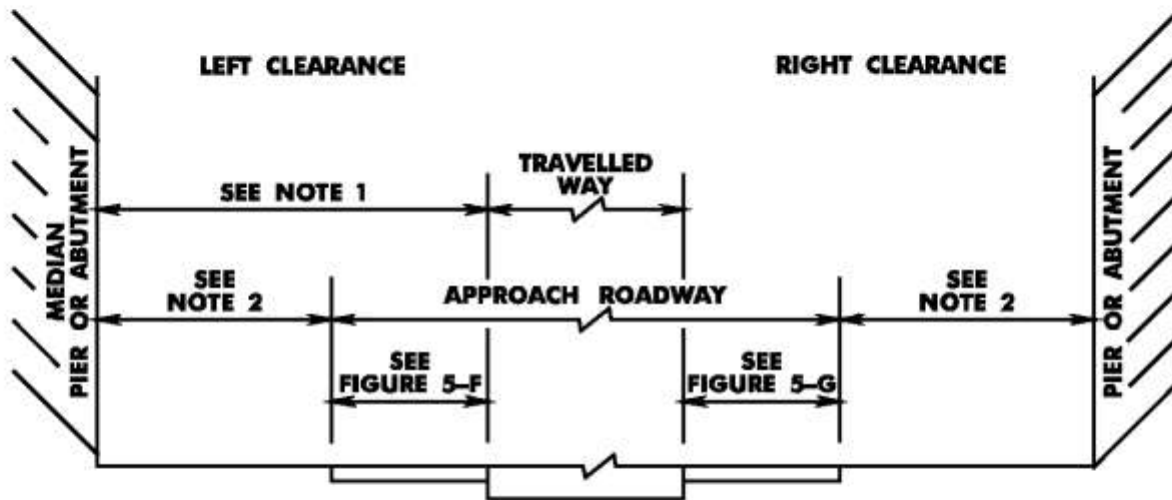
NOTES:

1. The minimum ramp width is 22 feet, the width should be adjusted based on various operating conditions, design vehicle and curvature. The required width should be based on the smallest radius of the ramp proper and is applicable throughout the full length of the ramp (See Figure 7-8).
2. Superelevation should be provided on ramps.
3. Side slopes where practical should be flattened to eliminate the need for guide rail.
4. Curb may be provided on ramps when required for drainage control or access control. Maximum curb height is 4 inches.
5. The median width on opposing ramps may be reduced to 4 feet where curb is provided and ramp speeds are 25 MPH or less.
6. Where barrier curb is provided to separate opposing directions of travel, the median width should be 8 feet.
7. Guide rail should be located according to the "Guidelines for Guide Rail Design and Median Barriers", Section 8.
8. Interior side fill slopes on ramps should be 4:1.
9. 2' paint line offset provided for inlet placement and to minimize covering of line with debris (dirt, grass clippings, etc.).

LATERAL BRIDGE CLEARANCES

FIGURE: 5-K

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INTERSTATE OR FREEWAY UNDERPASS

NOTES:

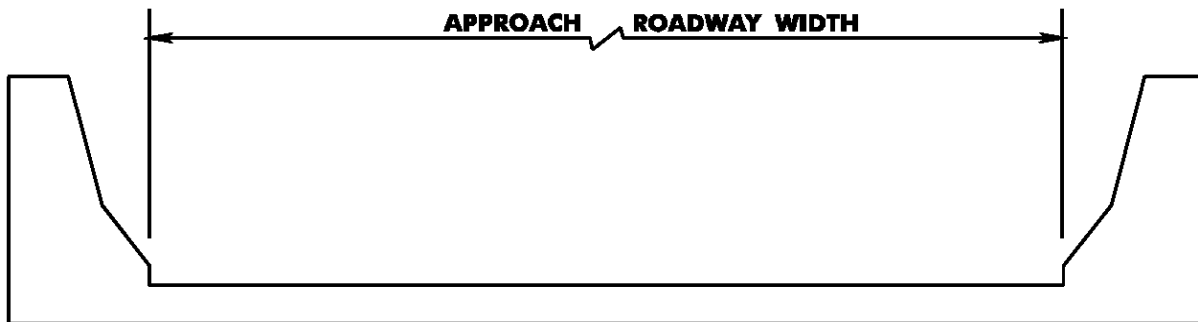
1. When practical, place pier at centerline of median. Provision for additional lanes should be considered when determining pier or abutment location. If there is a continuous median barrier the offset should be sufficient to construct the barrier in front of the pier without reducing the shoulder width.
2. Where guide rail is used for shielding and vertical curb is not present, the minimum offset from the edge of roadway to pier or abutment is 8'-3" (4' from back of rail element to pier) and 4'-9" (guide rail attached to abutment), respectively. Where barrier curb is used, use a 3'-3" offset from the gutter line to the face of median obstruction, since high profile vehicles have a tendency to lean when hitting barrier curb and may strike the obstruction behind it.

Note: These dimensions are minimums. Designs which eliminate the need for longitudinal barrier are preferred when practical.

LATERAL BRIDGE CLEARANCES

FIGURE: 5-L

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INTERSTATE OR FREEWAY OVERPASS

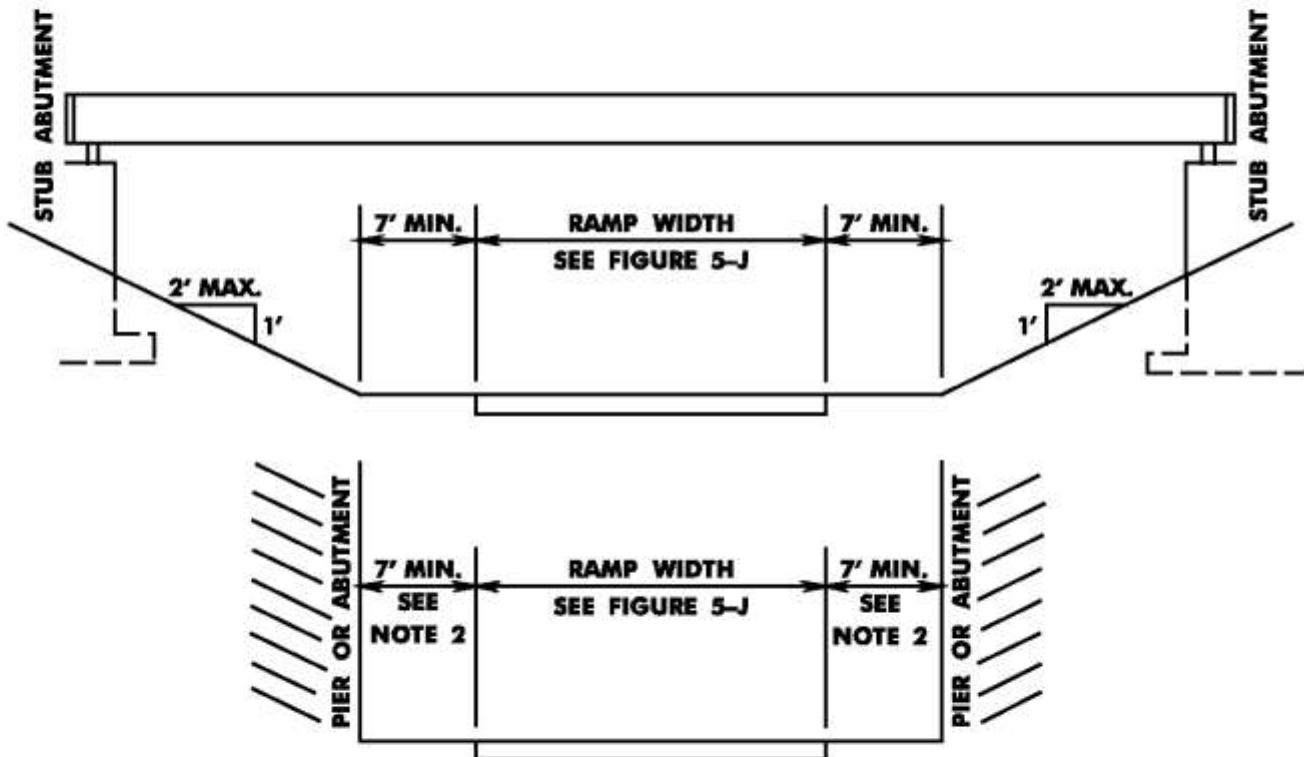
NOTE:

1. Stopping sight distance on horizontal curves governs lateral bridge width.

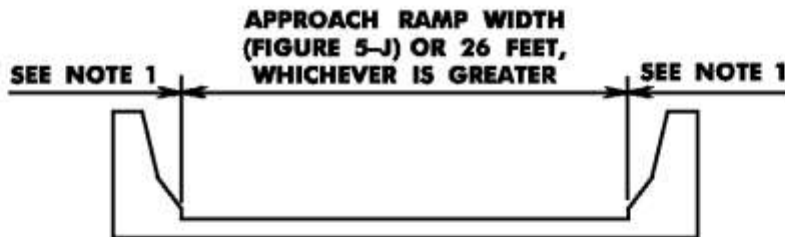
LATERAL BRIDGE CLEARANCES

FIGURE: 5-M

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RAMP UNDERPASS



RAMP OVERPASS

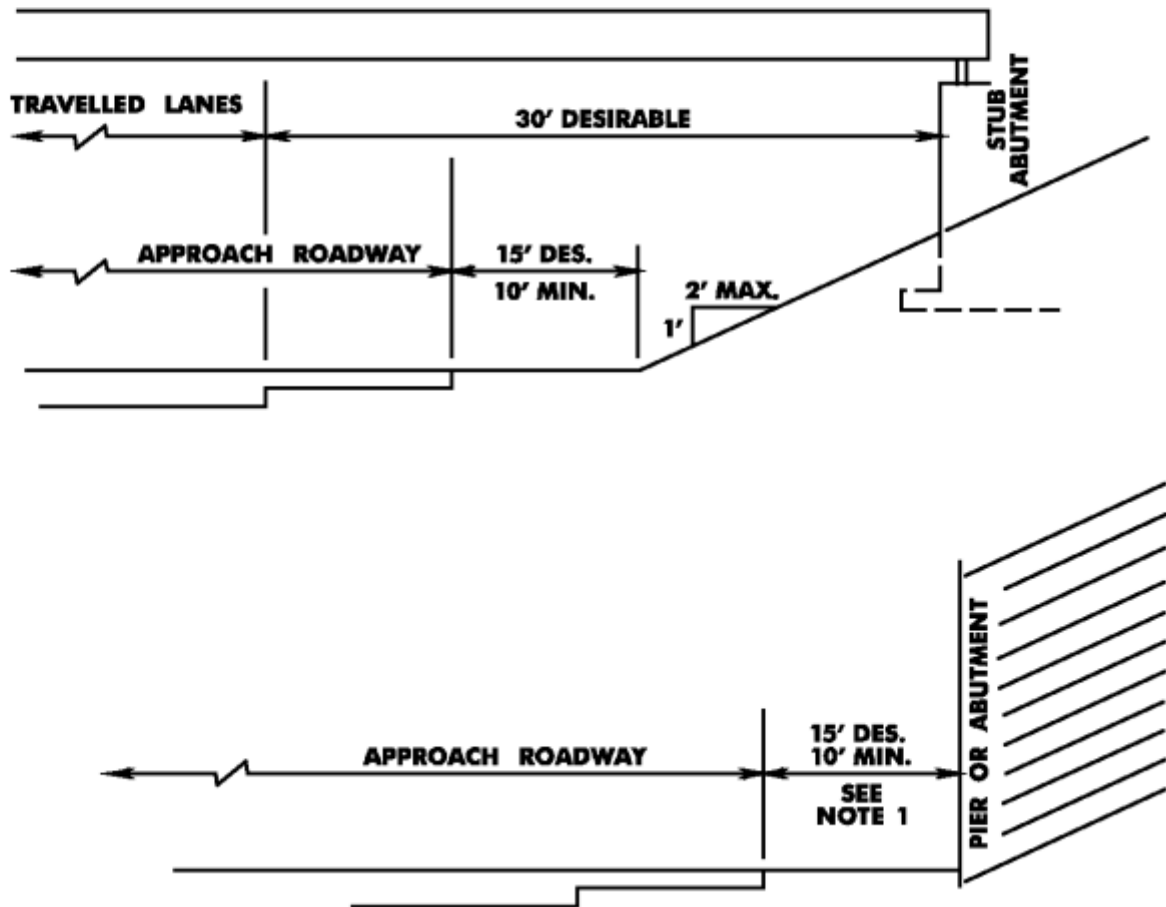
NOTES:

1. Stopping sight distance on horizontal curves governs width of ramp (See Figure 4-A).
2. Stopping sight distance on horizontal curves governs offset to pier or abutment.
3. The controlling width of 26 feet on the ramp overpass is to allow for future lane closings for maintenance such as deck patching or replacement.

LATERAL BRIDGE CLEARANCES

FIGURE: 5-N

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STATE HIGHWAY UNDERPASS

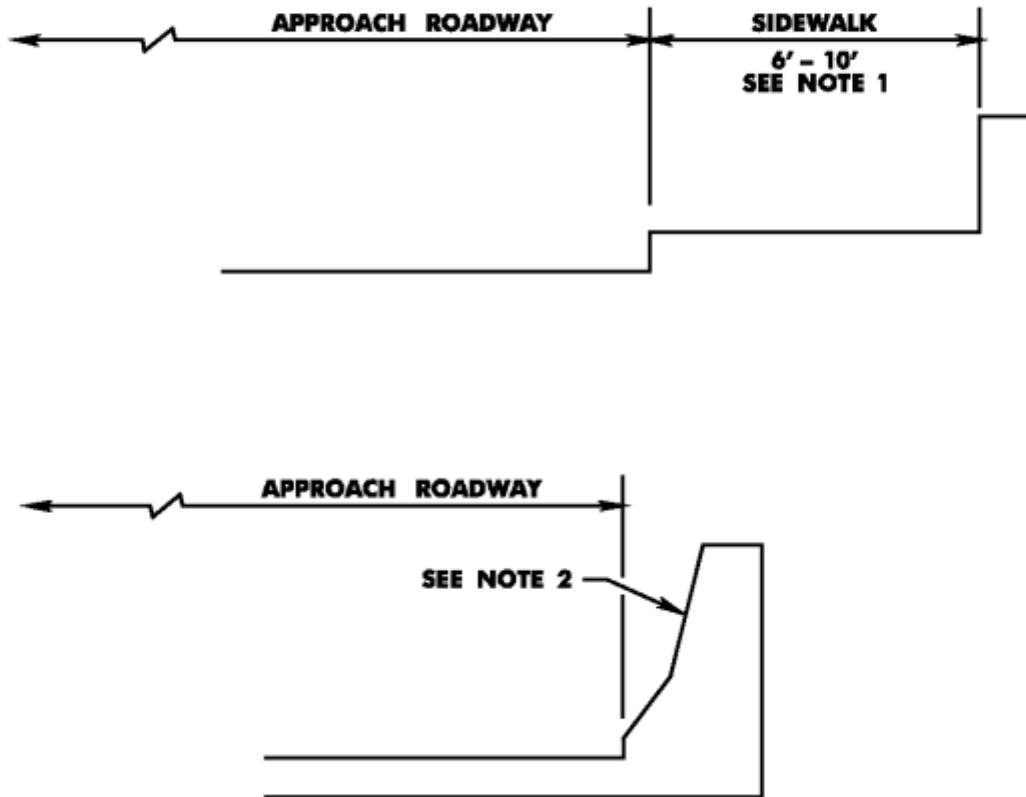
NOTE:

1. Stopping sight distance on horizontal curves governs (See Figure 4-A).

LATERAL BRIDGE CLEARANCES

FIGURE: 5-O

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STATE HIGHWAYS AND LOCAL ROAD OVERPASS

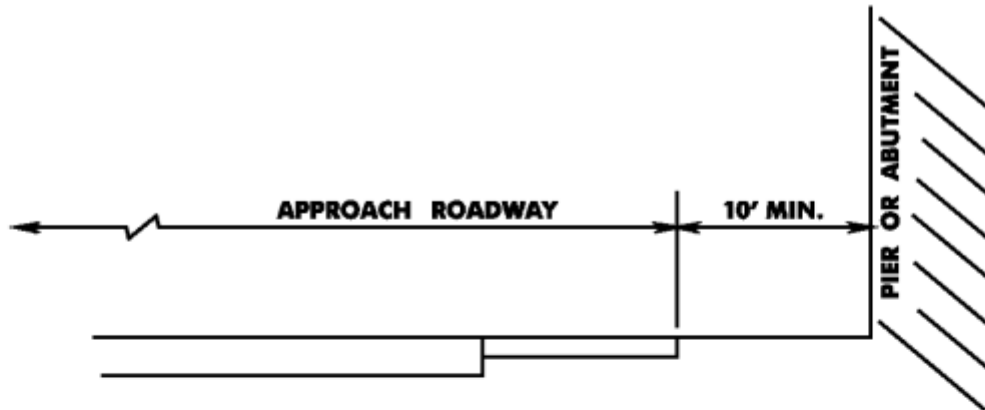
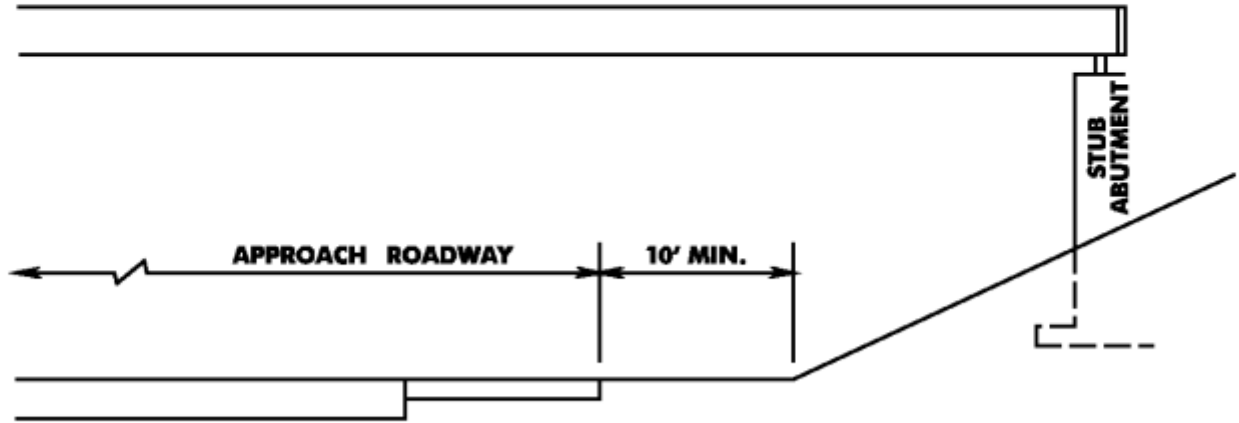
NOTES:

1. Sidewalks should be provided on both sides of an overpass structure in urban areas, See Section 5-07.1.
2. Barrier curb parapet should be used only when a sidewalk cannot be justified on both sides of a roadway.

LATERAL BRIDGE CLEARANCES

FIGURE: 5-P

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LOCAL ROAD OVERPASS