PAVING DESIGN MANUAL

DEPARTMENT OF PUBLIC WORKS AND TRANSPORTATION

JUNE, 1998

THE CITY OF DALLAS

PAVING DESIGN MANUAL

by

THE DEPARTMENT OF PUBLIC WORKS AND TRANSPORTATION

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June, 1998

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COUNCIL CHAMBER

981754

June 10, 1998

WHEREAS, on May 13, 1998, Resolution 98-1430 authorized calling of a public hearing for the purpose of receiving public comments on proposed revisions to the Paving Design Manual of the Department of Public Works and Transportation; and,

WHEREAS, on June 10, 1998, a public hearing was held on this item; and,

WHEREAS, it is in the City's best interest to amend the Paving Design Manual in order to update the standards for paving projects.

Now, Therefore,

BE IT RESOLVED BY THE CITY COUNCIL OF THE CITY OF DALLAS:

Section 1. That the proposed Paving Design Manual of the Department of Public Works and Transportation is hereby approved and adopted.

Section 2. That the standards set forth in the proposed Paving Design Manual are the minimum criteria required by the City of Dallas to be used in engineering paving design.

Section 3. That any unusual circumstances or special designs requiring variance from the standards set forth in the proposed Paving Design Manual must be approved by the Director of Public Works and Transportation upon finding that unsafe conditions would result from strict enforcement of these standards, or a special design will enhance safety or traffic flow.

Section 4. That this resolution shall take effect immediately from and after its passage in accordance with the provisions of the Charter of the City of Dallas, and it is accordingly so resolved.

Distribution: Public Works and Transportation, Sandra Williams, OCMC, Room 101
City Attorney
City Controller
Budget and Management Services

APPROVED BY
CITY COUNCIL

JUN 10 1998

Shirley Ray
Acting City Secretary

APPROVED [signature] HEAD OF DEPARTMENT APPROVED [signature] CITY CONTROLLER APPROVED Ryan S. E. CITY MANAGER

ACKNOWLEDGMENTS

The City of Dallas wishes to acknowledge the assistance of many individuals and organizations who contributed in the preparation of this document revision.

This manual is the outgrowth of the concerns of current and former engineers in the Public Works and Transportation Department, namely Jill Jordan, P.E., David C. Dybala, P.E., Don Richardson, P.E., Jack Antebi, P.E., and Liz Fernandez, P.E. Much of the material presented apart from the new technology, city ordinances, and policies is a result of the wisdom of Stanley Blystone, P.E., former Program Manager, who sought to instill in young engineers, the vision of design excellence in providing the best, most cost effective streets, alleys and sidewalks to serve the public interest.

Primary responsibility for the compilation, review coordination, and authorship of much of the manual revisions was from Christian Y. Agnew, P.E. Others providing review and editorial assistance were Alan Hendrix, P.E., Kenneth Melston, P.E., Bill Jessup, P.E., Dinesh Valia, Jim Kusner, Don Richardson, P.E., Vince Thill, Steve Cherryholmes, P.E., Tom Rasco, Henry Nguyen, P.E., Leong Lim, P.E., Ben Cernosek, P.E., Elias Sassoon, P.E., Larry Billingsley, R.P.L.S., Charles Redd, R.P.L.S., Efren Garcia, Francena Holloway, Andrew Ruiz, and Bahman Bahramnejad.

Many outside organizations assisted in the review of this manual including the American Society of Civil Engineers, Texas Section, Dallas Branch; the Home and Apartment Builders Association of Metropolitan Dallas; the National Association of Industrial and Office Parks and Mark Farrow, P.E. of Terra-Mar.

Word processing, proofing, production and editorial assistance was provided by Lupe Aragon, Maritza Crouse, Craig Robinson, P.E. and Marion Johnson, P.E. In addition, Sophia Iliadou, P.E., was responsible for the City Council agenda scheduling and adoption process.

Many other organizations and City staff not mentioned also contributed to this manual. The City deeply appreciated the dedicated efforts of all the groups and individuals who have made this possible.

CITY OF DALLAS
Department of Public Works and Transportation
PAVING DESIGN MANUAL

I - INTRODUCTION

1.01 PURPOSE

The purpose of this Paving Design Manual is to provide guidelines for designing streets and thoroughfares and preparing construction plans in the City of Dallas, Texas. These guidelines will be used by the Department of Public Works and Transportation, other City departments, Consulting Engineers employed by the City for street and thoroughfare improvement projects, and Engineers for private developments in the City of Dallas. The standards set forth in this document are the minimum criteria permitted by the City of Dallas to be used in paving design. Unusual circumstances or conditions may arise which require variance from the standards. Any variances from the standards set forth in this manual must be accompanied by prior written approval of the Director of Public Works and Transportation.

1.02 SCOPE

The scope of this Paving Design Manual includes the various design elements, criteria, standards and instructions required to prepare paving plans for the Department of Public Works and Transportation. Included in the manual is the classification of the various streets according to the City Thoroughfare Plan. Geometric design standards to be used on the various classifications and criteria for design of pavement structures are also presented. These guidelines should result in the construction of safe, economical, comfortable riding streets and thoroughfares carrying acceptable traffic volumes while providing for pedestrian traffic as well.

1.03 OVERVIEW

This manual is divided into eight sections. **Section I, INTRODUCTION**, is a general discussion of the purpose, scope and organization of the manual and the related applicable standard documents to be used with the manual.

Section II, FUNCTIONAL AND DIMENSIONAL CLASSIFICATION, is a discussion of the City Thoroughfare Plan. The different type of thoroughfares and streets are defined, including minimum right-of-way, pavement, lane, median and parkway dimensions. The purpose of each type of thoroughfare and street is discussed.

Section III, ACCESS CONTROL, is a discussion of the guidelines and minimum requirements to be used in the location of access streets and driveways to properties adjoining City thoroughfares and streets.

Section IV, GEOMETRIC DESIGN, provides the design criteria to be used in the alignment and geometric design of thoroughfares and streets and discusses the guidelines and minimum requirements controlling the various design elements.

Section V, PAVEMENT STRUCTURE, provides the City's standard thoroughfare and street pavement structure designs and discusses when alternate pavement structure designs are required and the guidelines controlling the alternate designs.

Section VI, CONSTRUCTION PLAN PREPARATION, provides the minimum requirements and procedures to be used in the preparation of paving plans for constructing thoroughfare and street improvements for the City.

APPENDICES A, B, AND C, provide detailed recommended procedures referred to in Section VI. Detailed procedures for setting street grades and cross sectioning and the Standard Paving Plan checklist are included as guidelines. Together these items provide the minimum requirements controlling the preparation of paving plans for construction for the City.

1.04 STANDARDS

The following City standards, as currently amended, shall be used with the Paving Design Manual in the design of thoroughfare and street pavements and the preparation of paving plans for construction:

- THOROUGHFARE PLAN - CITY OF DALLAS, TEXAS
- 1985 DALLAS BIKE PLAN
- DRAINAGE DESIGN MANUAL, CITY OF DALLAS PUBLIC WORKS (MAY 1993)

- DEPARTMENT OF PUBLIC WORKS STANDARD CONSTRUCTION DETAILS, File 251D-1
- STORM WATER QUALITY BEST MANAGEMENT PRACTICES FOR CONSTRUCTION ACTIVITIES by North Central Texas Council of Governments
- DALLAS DEVELOPMENT CODE, Article VIII of Chapter 51A.

The THOROUGHFARE PLAN provides a detailed discussion of the history, purpose, approach and goals of the thoroughfare system within Dallas and details the current functional and dimensional classifications of the thoroughfares in the City. The plan provides descriptions of designated routes and provides minimum and standard pavement cross sections.

The 1985 DALLAS BIKE PLAN provides the routes for the bikeway system and gives minimum pavement design standards necessary to accommodate bicycles on the designated bike routes.

The DRAINAGE DESIGN MANUAL provides the guidelines for the design of storm drainage facilities in the City.

The STANDARD CONSTRUCTION DETAILS provides standard detailed paving, drainage, traffic control and related facility drawings showing construction items and features to be used with paving plans provided for the City of Dallas. Paving plan designs prepared for the City shall be consistent with the Standard Construction Details, as currently amended. Specific details have specific functions and uses, and this set of standard details must not be considered a catalog from which to choose. Special situations will require the designer to develop special details for the approval of the director of Public Works and Transportation.

The STORM WATER QUALITY BEST MANAGEMENT PRACTICES FOR CONSTRUCTION ACTIVITIES manual provides the guidelines, criteria, and standard details for the design of storm water pollution prevention plans which may be required on City construction projects.

The DALLAS DEVELOPMENT CODE, Article VIII of Chapter 51A provides the regulations governing plat applications and their review by the City departments. Paving infrastructure requirements for developments in the City of Dallas are given in this code.

The THOROUGHFARE PLAN and the 1985 DALLAS BIKE PLAN are maintained and updated by the Transportation Division of the Public Works and Transportation Department. The

DRAINAGE DESIGN MANUAL and the STANDARD CONSTRUCTION DETAILS are maintained and updated by the Engineering and Construction Division of the Department of Public Works and Transportation. The DALLAS DEVELOPMENT CODE is maintained and updated by the Department of Planning and Development.

Additional standards and requirements which may impact or control the design of thoroughfare and street pavements are found in the following documents:

- DALLAS DEVELOPMENT CODE

  Article V of Chapter 51A, as currently amended, Titled "Flood Plain and Escarpment Zone Regulations

  Article IX of Chapter 51A, as currently amended, Titled: "Thoroughfares"

When provisions of the City standards mentioned above conflict with this Paving Design Manual, the more restrictive regulations will govern.

II - FUNCTIONAL AND DIMENSIONAL CLASSIFICATION

2.01 CITY THOROUGHFARE PLAN

The legal requirements for the Thoroughfare Plan are governed by the City Charter and the Development Code. The Thoroughfare Plan is specifically addressed in Chapter 15, Section 8 in the City Charter. The City undertakes thoroughfare planning, in general, to fulfill its requirements under the Charter to protect the "...comfort, safety, convenience and welfare of the inhabitants of the city" and to "regulate and control the use, for whatever purpose, of the streets and all other public places."

In practice the Thoroughfare Plan should be thought of as a blueprint that establishes a set of terminology standards, and general principles that guide decision-making for all aspects of roadway planning, funding, construction/reconstruction, operation, and maintenance of the City's primary roadway system. As a long-range planning tool, it is intended to identify street needs for the next twenty years within the developed urban area, and to establish the thoroughfare system for undeveloped areas based on anticipated development patterns.

2.02 FUNCTIONAL CLASSIFICATION

2.02.01 General

Functional classification is the process by which streets are grouped into classes according to the type of service they are intended to provide. The purpose of functional classification is to describe how the street network operates by defining the role each roadway plays in the system. There are three distinct elements of every trip on the street network: main movement, distribution/collection, and access. These elements translate directly into the functional classes used in this plan:

1. Arterial streets provide the links between areas of the city. They typically define neighborhoods and serve the main function of movement from one part of the city to another.
2. Collector streets provide the links between the local streets and arterials. They penetrate neighborhoods and serve the function of collecting or distributing traffic between the arterial and local streets.
3. Local streets are usually contained within a neighborhood and provide access to adjacent property which is the origin or destination of every trip. The local

streets serve the function of internal circulation for all types of development.

Related to the idea of functional classification is the dual role that the roadway plays in providing access to property and travel mobility. The primary function of local streets is to provide access to adjacent property, while arterial streets emphasize a high level of mobility for through traffic movement. Regulation of access is necessary on arterials to enhance their primary function of mobility. Collector streets provide a balance between access to adjacent properties and traffic mobility. This concept is illustrated in Figure II-1 "Functional Classification: Relationship of Access to Mobility."

Each of the functional classes are further described in the following sections. In addition, Tables II-2A and II-2B define the classes according to several typical characteristics. Many roads will not fully match the definition of any one functional class; in these instances, a road should be categorized according to the class that it most closely matches. Some statistics were compiled regarding the typical 24 hour traffic volume found on thoroughfares in each of the functional classes. Those statistics, shown in Table II-3 show the variation in typical traffic volumes for given functional classes and geographic subarea.

2.02.02 Principal Arterial Freeways

The freeway system is the system of divided highways for moving through traffic with full control of access. Entrances and exits to and from the freeway are located to provide minimum differences between the speed of the through traffic and the speed of the vehicle entering or leaving the freeway. Ramps usually maintain access between freeways and grade separated crossroads, thus forming the freeway "interchange". Frontage roads are usually provided to serve access needs for properties adjoining the edges of the freeway corridor and to collect and distribute exit and entrance ramp traffic. Freeways are selected for principal arterial corridors which are to provide for the safe and efficient movement of high traffic volumes at relatively high speed.

Freeways are planned, designed, constructed and maintained by the State Highway Agency or State/Local Turnpike Authority, usually

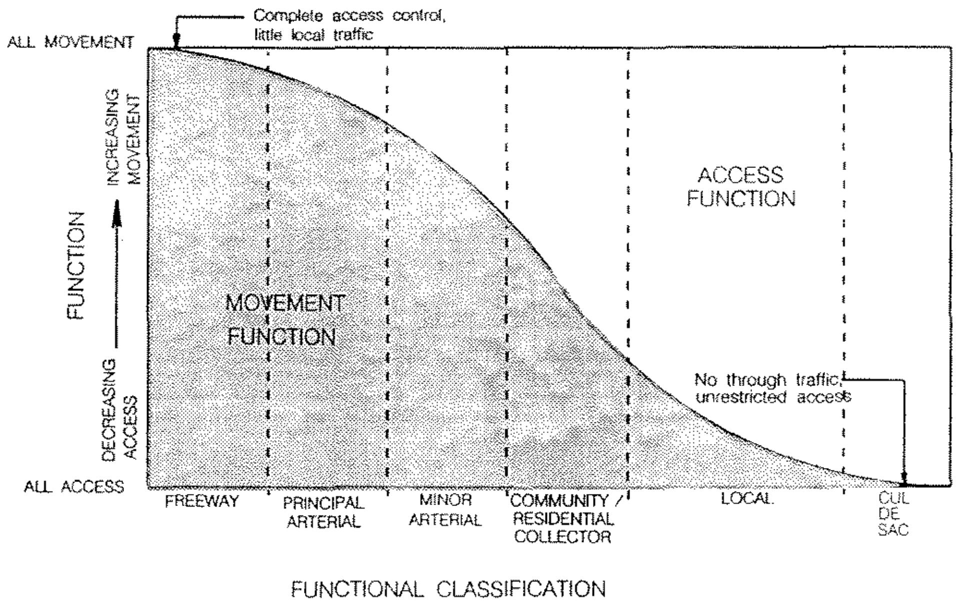


FIGURE II - 1 FUNCTIONAL CLASSIFICATION: RELATIONSHIP OF ACCESS TO MOBILITY

TABLE II-2A
TYPICAL CHARACTERISTICS OF FUNCTIONAL CLASSIFICATIONS

	DESIGNATED THOROUGHFARES			**UNDESIGNATED THOROUGHFARES** [2]	
	PRINCIPAL ARTERIAL	MINOR ARTERIAL	COMMUNITY COLLECTOR	RESIDENTIAL COLLECTOR	LOCAL
FUNCTION	Backbone of the street system; Mobility function is primary; Access function is minor; Serves long trip lengths	Provides route and spacing continuity with principal arterials; Mobility function is still primary; Access function is secondary; Serves moderate trip lengths	Collects/distributes traffic between local streets and arterial system; Mobility and access functions are balanced; Serves short trip lengths	Collects/distributes traffic between local streets and arterial system; Mobility and access functions are balanced; through traffic is undesirable; Serves short trip lengths	Remainder of surface streets; Access is primary; Through traffic is undesirable; Serves short trip lengths
SYSTEM CONTINUITY	Regional Continuity; Connects with freeway system; Crosses several community boundaries	Community continuity; Connects with freeway and arterial systems; Usually does not cross community boundaries	Neighborhood continuity; connects to arterial system; may extend across arterials	Neighborhood continuity; Connects to arterial system; Usually does not extend across arterials	Discontinuous
ROADWAY LENGTH	Greater than 5 miles	2 to 5 miles	1/2 to 2 miles	1/2 to 2 miles	Less than 1 mile
TRAFFIC VOLUME [1]	> 3500 vehicles/lane/day 8 lanes: > 28,000 vpd 6 lanes: > 21,000 vpd 4 lanes: > 14,000 vpd	2500 to 5000 veh/lane/day 5 lanes: 15,000-30,000 vpd 4 lanes: 10,000-20,000 vpd 2 lanes: 5,000-10,000 vpd	1250 to 3500 veh/lane/day 4 lanes: 5,000-14,000 vpd 2 lanes: 2,500-7,000 vpd	1250 to 2500 veh/lane/day 4 lanes: 5,000-10,000 vpd 2 lane: 2,500-5,000 vpd	< 1250 veh/lane/day 2 lanes: < 2,500 vpd
SPACING	1 to 2 miles	1/2 to 2 miles	1/2 mile from other thoroughfares	1/2 mile from other thoroughfare	300 to 500 feet from other streets
NEIGHBORHOOD RELATIONSHIP	Usually defines boundaries	Usually defines boundaries	Traverses boundaries	Usually internal to one neighborhood	Internal to one neighborhood
DIRECT LAND ACCESS	Restricted; Some movements may be prohibited; Driveway spacing and number strictly controlled	Restricted; Some movements may be prohibited; Design controls are used to ensure safety	Design controls are used to ensure safety; limited regulation	Design controls are used to ensure safety	Design controls are used to ensure safety
POSTED SPEED	30-45 mph	30-40 mph	30-35 mph	30 mph	30 mph
PARKING	Restricted	Restricted	Permitted	Permitted	Permitted
THROUGH TRUCK ROUTES	Permitted	Permitted in commercial areas	No	No	No
BUS ROUTES	Yes	Yes	Yes	Yes	Not encouraged
BICYCLE ROUTES	Not recommended	Not recommended	Limited	Encouraged	Encouraged
SIDEWALKS	Yes	Yes	Yes	Yes	Yes

[1] The symbol ">" means "greater than" and the symbol "<" means "less than"; "vpd" means "vehicles per day"
[2] Residential Collectors are only designated on the Thoroughfare Plan if they do not yet exist or have a substandard pavement width.

TABLE II-2B
DESCRIPTION OF CATEGORIES USED TO DEFINE FUNCTIONAL CLASSES

TERM	DESCRIPTION
FUNCTION	A basic statement of the role that each classification plays in the street system; Identifies the relative balance of land access versus travel mobility provided; and specifies the average trip length served.
SYSTEM CONTINUITY	Identifies whether streets in a particular functional class are continuous through neighborhoods, communities, or large portions of the city/region; and how the functional classes interconnect.
ROADWAY LENGTH	The length of a roadway that is generally recognized and used by the traveling public according to a given function.
TRAFFIC VOLUME	The average daily traffic volume specified in vehicles per lane per day; represents a balance between volumes currently observed and desirable volumes for a given functional type.
SPACING	Spacing commonly found between thoroughfares in urban areas; spacing should decrease as the density of land use increases.
NEIGHBORHOOD RELATIONSHIP	Identifies whether a given functional type defines neighborhoods or traverses neighborhoods.
DIRECT LAND ACCESS	The level of access control that will be exercised in locating and designing driveways.
POSTED SPEED	The posted speed limit.
PARKING	Indicates whether on-street parking will be restricted; limitations are handled on a case-by-case basis.
THROUGH TRUCK ROUTES	Identifies whether truck routes are permitted; truck routes are identified in the Dallas City Code, Motor Vehicles and Traffic, Article X, Section 28-69.
BUS ROUTES	Identifies where bus routes would be desirable.
BICYCLE ROUTES	Routes are identified in the 1985 Bicycle Plan. These routes should be discouraged on arterial thoroughfares except when they are needed to maintain continuity.
SIDEWALKS	Sidewalks are required for all new streets, unless waived according to City policy; sidewalks are only installed in existing areas by petition.

TABLE II-3
TYPICAL DAILY VOLUMES OF FUNCTIONALLY DESIGNATED THOROUGHFARES

FUNCTIONAL CLASS	GEOGRAPHIC SUBAREA OF THE CITY					
	Citywide	Far North Subarea	Northeast Subarea	Northwest Subarea	Southeast Subarea	Southwest Subarea
Principal Arterials	17,600[1]	25,600	18,800	22,000	11,600	13,300
Minor Arterials	10,000	13,800	10,700	14,400	7,500	9,400
Community Collectors	6,000	5,100	8,200	6,600	4,400	4,100
Residential Collectors	2,800	2,700	3,700	2,900	2,300	2,300

[1]All numbers represent a daily volume in vehicles per day (vpd)

through the Texas Department of Transportation. Additional information on planning and design of freeways is available from the Texas Department of Transportation Dallas District office.

2.02.03 Arterial Thoroughfares

The arterial street system is divided into two sub-classifications, "principal" arterials and "minor" arterials. Arterials represent those thoroughfares that are used by the traveling public to travel between neighborhoods and communities within the City. Ideally, arterial thoroughfares define neighborhood boundaries and do not cross into neighborhoods.

Principal arterial streets are the backbone of the City's street system. They serve the major centers of activity and high volume traffic corridor, accommodate the longest trip desires, and carry a high proportion of total area travel on a small percentage of total system mileage. The network formed by the principal arterials is fully interconnected, and provides links to the freeway system and to the areas outside the City. Geometric design and traffic control measures are used to enhance the movement of through traffic on principal arterials, while access to abutting property may be restricted, or managed, to protect the traffic carrying capacity of the roadway. Access to abutting land is subordinate to the provision of travel service for major traffic movements.

Minor arterial streets interconnect with and augment the principal arterial network. They serve traffic with a smaller geographic area of influence, accommodate trip lengths of moderate length, and offer greater opportunities for emphasis on land access than the principal system. The minor arterials carry significant through traffic volumes and are needed to provide route and spacing continuity for the arterial system.

2.02.04 Collector Thoroughfares

The collector street system is divided into two sub-classifications, "community" collector and "residential" collector. They provide both land access service and traffic circulation within residential neighborhoods and commercial/industrial areas. They differ from the arterial system in that collectors penetrate neighborhoods and distribute trips from the arterials through the area to their ultimate destinations. Conversely, the collector street also collects traffic from local streets in neighborhoods and channels it into the arterial street system.

Collectors should accommodate short trip lengths, and do not typically extend across arterial thoroughfares or carry a high percentage of through trips. Although, in some circumstances collectors serve as a relief valve when the arterial system is congested. Traffic control devices may be installed to protect or facilitate traffic on a collector street.

Community collectors serve both residential and commercial neighborhoods. The mobility and access functions of this type of collector are generally balanced. The effective operation of community collectors is critical to the access and circulation needs of the area they serve.

Residential collectors serve predominantly single family and multi-family neighborhoods. In some cases, a neighborhood served by a residential collector may also include a small amount of local serving retail. A roadway is only identified as a residential collector on the Thoroughfare Plan if it has a substandard pavement width and some improvement is desired by the community, or it is in an undeveloped/under-developed area and does not yet exist. Once a residential collector has been built to its planned width, its official thoroughfare designation will be removed and it will automatically be dropped from the Thoroughfare Plan maps.

2.02.05 Local Streets

Local streets comprise all roadways not identified as an arterial or collector thoroughfare; they are not specifically incorporated into the Thoroughfare Plan. Local streets offer the lowest level of mobility. Their primary function is to provide direct access to abutting land and access to higher order systems.

Through traffic should be discouraged on local residential streets. New residential subdivisions should be laid out with irregular street patterns and cul-de-sacs to minimize the opportunity for through traffic. Existing residential streets may be modified through the application of traffic control measures or traffic diverters.

2.02.06 Alleys

To supplement certain local streets in meeting access and parking needs, the City Development Code requires alleys be provided in these cases. Alleys are required only in residential zoning districts and then only when required by Section 51-8.604 of the Development Code to supplement smaller street pavement widths and higher zoning density cases. Alleys are required to supplement residential local streets with section designation L-2-U(B) (Local streets with a 26-foot wide pavement width). Alleys are required to supplement residential local streets with section designation L-2-U(A) (Local streets with a 33-foot wide pavement width) if the local street serves property with zoning designations of R-5, MH, D, TH-1 or TH-2.

Alleys must provide continuous vehicular access regardless of zoning.

2.03 DIMENSIONAL CLASSIFICATION

2.03.01 General

Dimensional classification establishes the basic physical dimensions of a thoroughfare, including the number of lanes, right-of-way width, and pavement width. The dimensional classification that is applied to a road in the thoroughfare plan determines the design configuration for the road when it is funded for construction or reconstruction.

The thoroughfare plan contains four dimensional classification categories: (1) standard, (2) minimum, (3) existing, and (4) special roadway sections. These are described in the following sections and detailed in Table II-4.

Standard Roadway Sections

Standard roadway sections are based on desirable criteria as defined by current state-of-the-art in transportation engineering. The standard sections should be used in all newly developed areas, and wherever possible, in existing areas. Elements incorporated into the standard cross section are:

TABLE II-4
STREET & THOROUGHFARE
GEOMETRIC STANDARDS

Functional Classification	Dimensional Classification Category	Section Designation	Pavement Width (Ft.) [1]	Median Width (Ft.)	Parkway Width (Ft.)	Normal Right-of-Way (Ft.)
Principal Arterial	Standard (Divided)	S-8-D	2-48	15	9.5	130
Principal Arterial	Standard (Divided)	S-6-D	2-36	15	10	107
Principal Arterial	Minimum (Divided)	M-6-D (A)	2-33	15	9.5	100
Principal Arterial	Minimum (Divided)	M-6-D (B) [2]	2-30	15	7.5 [3]	90
Principal Arterial	Standard (Couplet)	S-4-U	44	-	8 [3]	60
Principal Arterial	Standard (Couplet)	S-3-U	36	-	10	56
Principal Arterial	Minimum (Couplet)	M-4-U	40	-	10	60
Principal Arterial	Minimum (Couplet)	M-3-U	33	-	8.5	50
Minor Arterial	Standard (Divided)	S-4-D	2-24	15	8.5	80
Minor Arterial	Minimum (Divided)	M-4-D (A)	2-22	15	10.5	80
Minor Arterial	Minimum (Divided)	M-4-D (B) [2]	2-20	15	10	75
Minor Arterial	Standard (Undivided)	S-4-U	44	-	8 [3]	60
Minor Arterial	Minimum (Undivided)	M-4-U [2]	40	-	10	60

1) All pavement dimensions measured from face of curb. Additional pavement width is required for all thoroughfares on a bike route designated in the 1985 Dallas Bike Plan. For those thoroughfares, parking widths are adjusted as necessary to stay within the normal right-of-way width listed. See the 1985 Dallas Bike Plan for further details.
2) Section designations using ten foot lanes should not be used for arterial streets carrying significant bus or truck traffic. Changes in thoroughfare sections require Thoroughfare Plan amendments. Use of section designations using ten foot lanes should be specifically approved by the Director of Public Works and Transportation.
3) Use of Section designations with parkways narrower than 8.5 feet may require special sight distance considerations in curved sections and may require larger than normal corner clips at street intersections..

TABLE II-4
STREET & THOROUGHFARE
GEOMETRIC STANDARDS
(cont.)

Functional Classification	Dimensional Classification Category	Section Designation	Pavement Width (Ft.)	Median Width (Ft.)	Parkway Width (Ft.)	Normal Right-of-Way (Ft.)
Collectors (Community/ Residential)	Standard	M-4-U*	40	-	10	60
Collectors (Community/ Residential)	Standard	S-2-U	36	-	10	56
Collectors (Community/ Residential)	Minimum	M-2-U	36	-	7 3)	50
Local Streets	Standard	S-2-U	36	-	10	56
Local Streets	Minimum	M-2-U	36	-	7 3)	50
Local Streets	Standard	L-2-U (A) 4)	33	-	10	53
Local Streets	Standard	L-2-U (B) 5)	26	-	12	50
Alleys	Standard/Minimum	Alley	10	-	2.5	15

* Striped for 2 lanes
4) Alleys may be required, depending on zoning
5) Alleys required

Collector thoroughfares which are designated with Minor Arterial Sections with four lanes of traffic shall be designed to Minor Arterial Standards.

For Arterial Thoroughfares:
Lane width -- 12 feet
Median width -- 15 feet (where applicable)
Parkway width -- 10 feet desirable/8 feet minimum

For Collector Thoroughfares:
Lane width -- 10 - 12 feet
Parking width -- 8 feet
Parkway width -- 10 feet

For Local Streets:
Pavement width -- 36 feet
Parking width -- 8 feet (each side)
Parkway width -- 10 feet
See Table II-4 for further details.

Minimum Roadway Sections

Minimum roadway sections are based on the roadway sections that have been used to design and construct streets in the City over the past thirty years. These cross sections represent minimum dimensions and would be applied where the application of a standard roadway section is undesirable because of economic, environmental, community concerns or physical constraints.

Elements incorporated into the minimum cross sections are:

For Arterial Thoroughfares:
Lane width -- 10 - 11 feet
Median width -- 15 feet (where applicable)
Parkway width -- 7 - 10 feet

For Collector Thoroughfares:
Lane width -- 10 feet
Parking width -- 8 feet
Parkway width -- 7 feet

For Local Streets:
Pavement width -- 26, 33 or 36 feet
Parking width -- 8 feet (each side)
Parkway width -- 7-12 feet (depends on pavement width)

See Table II-4 for further details.

Existing Roadway Sections

Existing Roadway Sections are thoroughfares that do not meet the minimal requirements of the standard or minimum roadway sections. They may be retained with their existing pavement and right-of-way width if no change is desirable due to community concerns or physical constraints. When a roadway is dimensionally classified as "existing", then its pavement will not be widened.

Special Roadway Sections

Special roadway sections are defined on a case-by-case basis when a unique design is needed that does not fit within either the standard or minimum categories. Circumstances warranting a special roadway section might include a five lane roadway, one way streets, or other types of alternatives.

2.03.02 Arterial Thoroughfares

Principal Arterial Thoroughfares

As shown in Table II-4, Principal Arterial Thoroughfares within the City are grouped into two categories: divided and couplets.

New divided principal arterial thoroughfares and improvements of existing two-way unimproved principal arterial thoroughfares shall be constructed using the S-6-D section designation unless the thoroughfare plan calls for the S-8-D section. The right-of-way width of the S-6-D section is 107 feet with six lanes for traffic, three in each direction. Traffic lanes are 12 feet wide with a 15-foot wide median in the center to provide sheltered left turn lanes of 10-foot width and a 5-foot wide median.

When construction of the S-6-D section is undesirable because of economic, environmental, community concerns or physical constraints, the M-6-D(A) section designation shall be used for the divided principal thoroughfare improvements. The right-of-way width of the M-6-D(A) section is 100 feet with six lanes for traffic, three in each direction. Traffic lane widths are 11 feet with a 15 foot wide median in the center to provide sheltered left turn lanes of 10-foot width and a 5 -foot wide median.

The M-6-D(B) section description is to be used for the divided principal thoroughfare only in special cases where right-of-way costs are prohibitive. The M-6-D(B) section provides six 10-foot wide traffic lanes, a 15-foot wide median for turning lanes and a 90-foot wide right-of-way. Larger than normal corner clips are required for curb returns at intersecting streets. Use of the M-6-D(B) section requires specific approval of the Director of Public Works and Transportation.

Principal couplets consist of separated parallel streets for moving high traffic volumes in opposite directions. Three lane couplets shall be constructed to the S-3-U section designation with a 56 foot wide right-of-way and 12-foot wide traffic lanes. Four lane couplets shall be constructed to the S-4-U section designation with a 60-foot wide right-of-way and 11-foot wide traffic lanes. When construction of these standard sections are undesirable because of economic, environmental, community concerns or physical constraints, the three lane couplet shall be constructed using the M-3-U section designation and the four lane couplet shall be constructed using the M-4-U section designation.

For further details on the sections for principal arterial thoroughfares, see Table II-4, "Street and Thoroughfare Geometric Standards".

Minor Arterial Thoroughfares

As shown in Table II-4, the two types of undivided minor arterial thoroughfares used in the City have section designations of S-4-U and M-4-U, and the three types of divided minor arterial thoroughfares used in the City have section designations of S-4-D, M-4-D(A) and M-4-D(B).

Minor arterial thoroughfare type S-4-U is the standard undivided section for minor arterials and shall be used to serve high density residential, commercial, office, and industrial districts with moderate to high traffic volumes. The S-4-U section consists of a 60-foot wide right-of-way with four 11-foot wide traffic lanes. When major turning movements are required, the corresponding divided minor arterial thoroughfare type with section designation of S-4-D is the standard divided section for minor arterials. The S-4-D section consists of a 80-foot wide right-of-way, with four 12-foot wide traffic lanes, two in each direction, separated by a 15-foot wide median. The median provides for sheltered 10-foot wide left turn lanes with a 5-foot wide median. The divided minor arterial thoroughfare type with the S-4-D section serves as a minor arterial collector for high traffic volume areas of high density residential, commercial, office and industrial districts.

Minor arterial thoroughfare type M-4-U is the minimum section for undivided minor arterials and shall only be used when approved by the Director of Public Works and Transportation. This type minor arterial section is used to serve low density single-family and duplex districts where bus and truck traffic is very low. The M-4-U section consists of a 60-foot wide right-of-way with four 10-foot wide traffic lanes. When major turning movements are required, the corresponding divided minor arterial thoroughfare type with designation of M-4-D(A) is the minimum divided section for minor arterials. The M-4-D(A) section consists of a 80-foot wide right-of-way with four 11-foot wide traffic lanes, two in each direction, separated by a 15-foot wide median. The median provides for sheltered 10-foot wide left turn lanes with a 5-foot wide median. The divided minor arterial thoroughfare type with the M-4-D(A) section serves as a minor arterial collector for low to moderate traffic volume areas of low density single-family and duplex districts where bus and truck traffic is low. Use of the M-4-D(A) section instead of the standard S-4-D section must be approved by the Director of Public Works and Transportation.

The M-4-D(B) section shall not be used for a divided minor arterial thoroughfare unless specifically approved by the Director of Public Works and Transportation. This type section is to be used when construction of the M-4-D(A) type section is warranted but not desirable because of economic, environmental, community concerns or physical constraints. This section shall be used only for low traffic volume areas of low density single-family districts where bus and truck traffic is very low. The M-4-D(B) section consists of a 75-foot wide right-of-way with four 10-foot wide traffic lanes, two in each direction, separated by a 15-foot wide median. The median provides for sheltered 10-foot wide left turn lanes with a 5-foot wide median. Larger than normal corner clips are required for curb returns at street intersections.

Minor Arterial thoroughfares which are designated with Principal Arterial sections with six traffic lanes (3 each way) shall be designed to Principal Arterial standards.

For further details on the sections for minor arterial thoroughfares, see Table II-4.

2.03.03 Collector Thoroughfares

As shown in Table II-4, the three types of collector (community and residential) thoroughfares used in the City have section designations of M-4-U*, S-2-U, and M-2-U.

Collector thoroughfare type S-2-U is the standard section for collector thoroughfares. Where right-of-way permits, the M-4-U* section may be used for collector thoroughfares where one 8-foot lane is striped off on each side for parking. The S-2-U section consists of a 56-foot wide right-of-way with 36 feet of pavement provided for two lanes of two-way traffic with parking. In high volume traffic areas, such as in high density residential, commercial, office, and industrial districts, or near schools and parks, the M-4-U* section is recommended if right-of-way permits. The M-4-U* section consists of a 60-foot wide right-of-way with 40 feet of pavement provided for two lanes of two-way traffic with parking.

Collector thoroughfare type M-2-U is the minimum section for collector thoroughfares and shall only be used when approved by the Director of Public Works and Transportation. This type section is to be used when construction of the S-2-U type section is not desirable because of economic, environmental, community concerns or physical constraints. The M-2-U section is identical to the S-2-U section except the right-of-way width is reduced to a 50-foot width.

Collector thoroughfares which are designated with Minor Arterial sections with four traffic lanes shall be designed to Minor Arterial standards.

For further details on the sections for collector thoroughfares, see Table II-4.

2.03.04 Local Streets

As shown in Table II-4, the four types of local streets used in the City have section designations of S-2-U, M-2-U, L-2-U(A) and L-2-U(B).

Local street types S-2-U, L-2-U(A) and L-2-U(B) are the standard sections for local streets. The local street types S-2-U may be used in all zoning districts. The S-2-U section consists of a 56-foot wide right-of-way with 36 feet of pavement provided for two-way traffic and parking. When the S-2-U section is used, alleys are not required to supplement access and traffic needs.

Local street type L-2-U(A) may require alleys to supplement access and traffic needs. The local street type L-2-U(A) shall be used only in low and moderate density residential districts with zoning designations of R-1 through R-7.5, R-5, MH, D, TH-1, and TH-2. The L-2-U(A) section consists of a 53-foot wide right-of-way with 33 feet of pavement provided for two-way traffic and parking. Alleys are required with the local type L-2-U(A) section when serving higher density residential property with zoning designations of R-5, MH, D, TH-1 or TH-2.

Local street type L-2-U(B) shall only be used in areas serving low density residential property with zoning designations of R-1 through R-7.5 and requires alleys to supplement areas and traffic needs. The L-2-U(B) section consists of a 50-foot wide right-of-way with 26 feet of pavement provided for two-way traffic and parking.

Local street type M-2-U is the minimum section for local streets requiring the standard S-2-U section and shall only be used when approved by the Director of Public Works and Transportation. This type section is to be used when construction of the S-2-U type section is not desirable because of economic, environmental, community concerns or physical constraints. The M-2-U section is identical to the S-2-U section except the right-of-way width is reduced to a 50-foot width.

For further details on the sections for local streets, see Table II-4.

2.03.05 Alleys

As shown in Table II-4, the minimum width of paved alley in the City is ten feet with a right-of-way of fifteen feet. Alley right-of-way width shall not exceed 20 feet. Where integral curbs are added to increase drainage capacity, an additional 0.5 feet of driving width is added to the required ten feet of width for each integral curb added.

For further details on the section for alleys, see Table II-4.

III- ACCESS CONTROL

3.01 GENERAL

Regulation of access is necessary to provide for adequate mobility and safe movement of traffic on streets and to ensure that adequate and appropriate access is provided in an equitable manner to the adjoining property owners. Street intersections and driveway approaches should be located to minimize conflicting traffic movements and to minimize unsafe intrusions into the arterial street system. The result of following these guidelines will help ensure that city streets are designed with primary concern for public safety. Section 4.03.03 Horizontal Alignment of this manual provides the horizontal geometric design requirements for streets. Section 4.03.11 Median Openings of this manual provides the geometric design requirements for median openings. Section 4.03.12 Driveways and Curb Openings of this manual provides the geometric design requirements for driveway approaches and curb openings. Section 4.03.14 Alleys of this manual provides the geometric requirements for alleys.

The following guidelines shall be used in the location of street intersections, median openings, alleys and driveway approaches which affect access to streets from adjoining properties.

3.02 STREETS

3.02.01 Intersections

An intersection shall not have more than four street approaches. Proposed intersections along one side of an existing cross-street must, wherever practical, align with existing intersections on the opposite side of the cross street. Street centerline offsets of less than 150 feet are not permitted unless the cross-street is divided by a median without openings at either intersection. The intersection of two streets must not be located within 115 feet of a railroad right-of-way if one of the streets crosses the railroad right-of-way at grade. This 115 foot separation is measured from the nearest point of the intersection of the street right-of-way and the nearest point of the railroad right-of-way.

Spacing between street intersections shall be sufficient to insure adequate space is provided for turning movements on the intersecting streets and that access to adjoining properties can be made in a safe manner. The minimum spacing required depends on individual streets and thoroughfares. Using the driveway access requirements for the standard AASHTO passenger car "P" vehicle for non-thoroughfare streets and the left turn storage and transition requirements provided in Section 4.03.03 Horizontal Alignment for thoroughfare streets, the following minimum spacing requirements, as measured from centerline of intersection to centerline of intersection, should be followed in locating street intersections:

a. Local and Residential Collector Streets

1. Local street to local street intersections should be no less than 150 feet apart.
2. Spacing between residential collectors and local streets intersecting local and residential collector streets should be no less than 170 feet.
3. Spacing between local and residential collector streets intersecting non-divided thoroughfare streets should be no less than 190 feet.
4. Spacing between local or residential collector streets and collector thoroughfares intersecting undivided thoroughfare streets should be no less than 190 feet (allows 140 feet for turn vehicle stacking without overlap).
5. Spacing between local or residential collectors streets and minor arterial streets intersecting undivided thoroughfare streets should be no less than 250 feet (allows 190 feet for turning vehicle stacking without overlap).
6. Spacing between local or residential collector streets and principal arterial streets intersecting undivided thoroughfare streets should be no less than 290 feet (allows 240 feet for turning vehicle stacking without overlap).

For cases 5 and 6 above, add 160 feet to the minimum spacing for median transitioning and storage for intersections along divided arterial thoroughfare streets.

b. Community Collector Thoroughfares

1. Spacing between Community Collector and Minor Arterial thoroughfares intersecting undivided thoroughfare streets should be no less than 305 feet.

2. Spacing between Community Collector and Principal Arterial thoroughfares intersecting undivided minor arterial streets should be no less than 325 feet.

3. Spacing between Community Collector and Principal Arterial thoroughfares intersecting undivided principal arterial streets should be no less than 375 feet.

For cases 1, 2 and 3 above, add 110 feet to the minimum spacing for median transitioning for intersections along divided arterial thoroughfares.

c. <u>Minor Arterial Thoroughfares</u>

1. Spacing between Minor Arterial and Principal Arterial streets intersecting collector thoroughfare streets should be no less than 280 feet.

2. Spacing between Minor Arterial and Principal Arterial streets intersecting undivided minor arterial streets should be no less than 380 feet.

3. Spacing between Minor Arterial and Principal Arterial streets intersecting undivided principal arterial streets should be no less than 430 feet.

For cases 2 and 3 above, add 135 feet to the minimum spacing for median transitioning for intersections with divided arterial thoroughfares.

d. <u>Principal Arterial Thoroughfares</u>

1. Spacing between Principal Arterial Thoroughfares intersecting collector thoroughfare streets should be no less than 300 feet.

2. Spacing between Principal Arterial Thoroughfares intersecting undivided minor arterial streets should be no less than 400 feet.

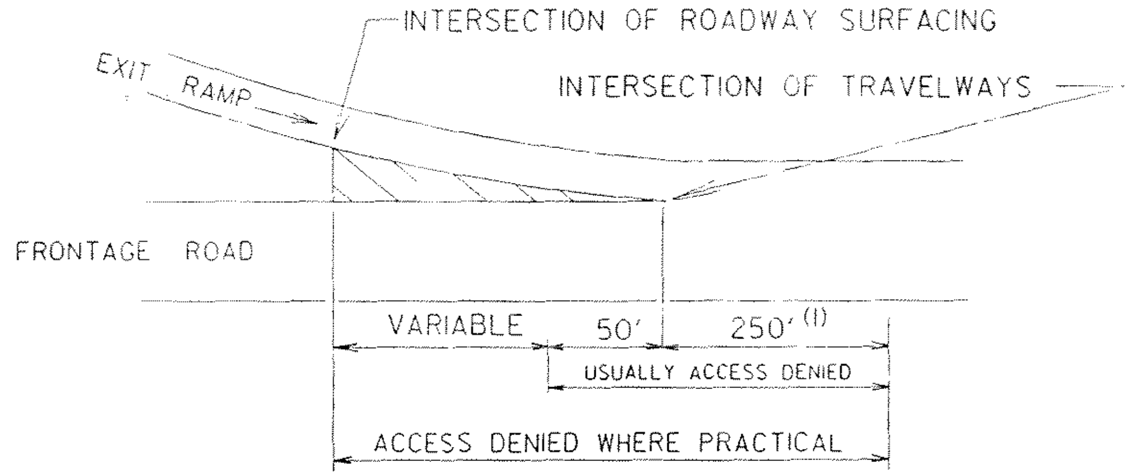
3. Spacing between Principal Arterial Thoroughfares intersecting undivided principal arterial streets should be no less than 500 feet.

For cases 2 and 3 above, add 135 feet to the minimum spacing for median transitioning for intersections with divided arterial thoroughfares.

e. <u>Freeways</u>

Street access along freeway frontage roads must be reviewed and approved by the responsible governmental agency. General access guidelines near ramp areas are provided in Figure III-1.

PREFERRED ACCESS CONTROL AT EXIT RAMP JUNCTION WITH FRONTAGE ROAD



(1) Longer distance desirable particularley for high volume exit range and / or frontage road

NOTE: IT MAY BE DESIRABLE TO PLACE JIGGLE BARS IN CROSS-HATCHED AREA TO DISCOURAGE CROSSING

PREFERRED ACCESS CONTROL AT ENTRANCE RAMP JUNCTION WITH FRONTAGE ROAD

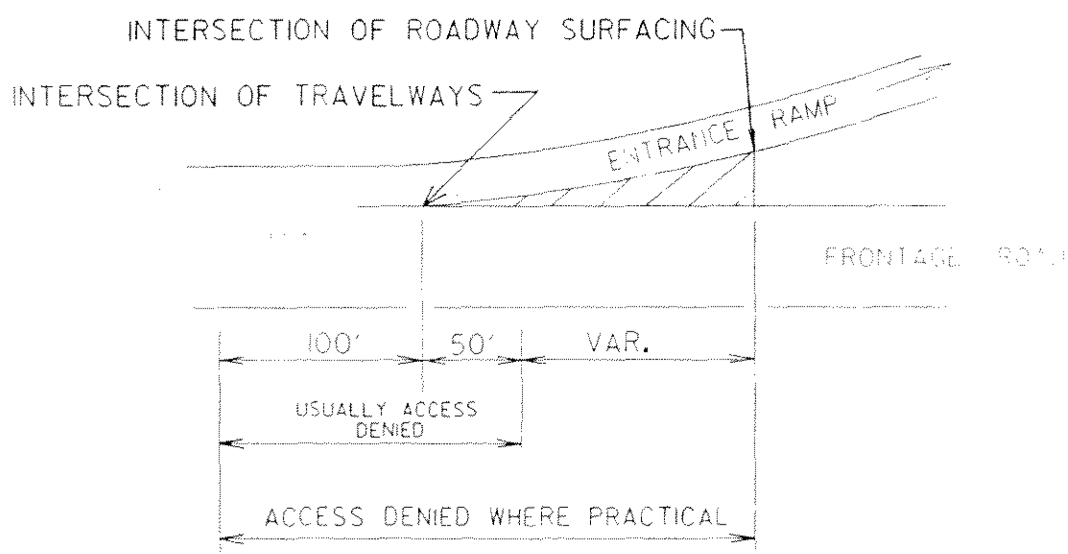


FIGURE III-1

3.02.02 Traffic Barriers

Traffic barriers shall be provided on all streets when paralleling alleys. The traffic barriers shall be located along the common line between the street right-of-way and the alley right-of-way, to separate the alley from access directly to street.

The traffic barriers shall be of a material and construction approved by the Director of Public Works and Transportation. Normally, traffic barriers such as wood posts with cable or a 9 inch high integral curb wall will be sufficient. Additional details are provided in the Dallas City Code, Section 51A-8.618 Traffic Barriers.

3.02.03 Median Openings

The following standards for median openings on divided arterial thoroughfares are established to facilitate traffic movement and promote public safety.

a. Warrants

Median openings shall be provided at all intersections with public or private streets and at certain driveway approaches which generate a minimum traffic count of 250 vehicles in a 12-hour period as determined by the Director of Public Works and Transportation. Exceptions shall be made at certain local streets and driveway approaches where, due to proximity to other warranted median openings or due to unusual conditions, a hazardous situation will result. All exceptions must be approved by the Director of Public Works and Transportation.

Appropriate median curb transitions and left turn storage lanes shall be provided to serve all median openings.

Mid-block median openings are warranted on six-lane divided streets whenthe spacing between existing and/or proposed median openings near the location exceeds 1,200 feet and there is sufficient median width for a left turn. The requirements provided in Section 3.02.03.b. Spacing of Median Openings shall be followed.

b. **<u>Spacing of Median Openings</u>**

The following spacing requirements are measured between the noses of the medians:

1. The spacing between median openings should be no more than 1,200 feet.
2. Median openings serving nonarterial streets and driveway approaches along a divided thoroughfare should occur no closer than 300 feet.
3. Median openings serving railroad crossings along a divided thoroughfare should occur no closer than 210 feet from another nonarterial opening.
4. Mid-block median openings should occur no closer than 300 feet from any other median opening.
5. Median openings shall not occur in left turn storage lanes or left turn transition curb areas.
6. Median openings shall be located wherever feasible to serve both sides of the street.
7. The following minimum spacing limitations from arterial thoroughfare intersections should be observed for the following types of median openings on divided principal arterials <u>as measured between the noses of the medians</u>:

   (a) <u>Railroad Crossing Type Openings</u>

   - No closer than 260 feet from minor arterial intersections.
   - No closer than 335 feet from principal arterial intersections.

   (b) <u>Driveway Approach Type or Mid-block Openings</u>

   - No closer than 350 feet from minor arterial intersections.
   - No closer than 425 feet from principal arterial intersections.

   (c) <u>Nonarterial Street Type Opening</u>

   - No closer than 350 feet from minor arterial intersections.
   - No closer than 425 feet from principal arterial intersections.

(d) Minor Arterial Street Type Openings

- No closer than 410 feet from minor arterial intersections.
- No closer than 485 feet from principal arterial intersections.

(e) Principal Arterial Street Type Openings

- No closer than 535 feet from principal arterial intersections.

c. **Relocation of Openings**

Existing median openings may be relocated if:

1. The existing opening does not provide service to a public or private street;
2. The proposed median opening meets the spacing requirements stated in Section 3.02.03.b. Spacing of Median Openings;
3. The existing opening is no longer in use and the owners of the properties being served by the existing opening sign a document requesting or approving the change, and the document is approved by the Director of Public Works and Transportation.

d. **Freeways and Expressways**

1. There shall be no median openings except as designed and approved by the responsible governmental agency.
2. Median openings shall not be used to provide access to any existing or proposed ramp.

3.03 ALLEYS

3.03.01 General

Alleys are required only in residential zoning districts when certain zoning conditions exist. (See Section 2.02.06 Alleys).

Alleys must provide continuous vehicular access regardless of zoning. Permanent dead-end alleys are prohibited. Alleys must either intersect with a dedicated public or private undivided street or another alley, or an approved turnaround must be provided. The distance between access points from streets or other alleys should not exceed 1200 feet, as measured along the centerline of alley. The length may be increased to 2000 feet upon approval of the Director of Public Works and Transportation if extraordinary topography or shape of the property unduly limits the development potential or if it is in the best interest of the City. Alleys must function without reliance on fire lanes or access easements. An alley must provide vehicular access from a dedicated public right-of-way or easement to another dedicated public right-of-way along pavement which is all within dedicated public right-of-way.

Alleys should not be directly accessed from divided streets. Alleys adjoining and parallel to a street must be separated from the street (see Section 3.02.02 Traffic Barriers).

Geometric requirements for alleys are provided in Section 4.03.14 Alleys.

3.03.02 Intersections

An alley approach must not be located within 50 feet of a railroad right-of-way, as measured from the closest point of the railroad right-of-way and the closest point of the alley throat (excluding the alley approach flares). Access spacing requirements from street intersections are the same as for driveway approaches. See Figure III-2, Minimum Distance From Intersections For Driveways.

3.04 DRIVEWAY APPROACHES AND CURB OPENINGS

3.04.01 General

a. Definition

A driveway approach is defined in the Dallas City Code, Section 43-32 as "An area, construction, or facility between the roadway of a public or private street and private property intended to provide access for vehicles from the roadway of a public or private street to private property."

b. Restrictions

Driveways should not be located and designed to encourage high traffic volume or truck use of residential local and residential collector streets. Where single family, townhouse, duplex, or other low to medium density zoned lots abut a divided principal thoroughfare, driveway access to the thoroughfare is prohibited unless there exists an extraordinary topography or shape of the property which unduly limits alternate access to the property. All such exceptions must be approved by the Director of Public Works and Transportation. Traffic barriers shall be provided as given in Section 3.02.02 Traffic Barriers unless otherwise approved by the Director of Public Works and Transportation.

Additional guidelines concerning the geometric design of driveway approaches and curb openings is provided in Section 4.03.12 Driveways and Curb Openings.

3.04.02 Spacing

Standard geometric details for driveway approaches are provided in Section 4.03.12, in Figure IV-19, Driveway Standards. The minimum distance between driveways, measured from edge of driveway throats, is normally 20 feet. The minimum spacing between one way, 90 degree driveways is 4 feet, with a 20 feet minimum spacing recommended. The island between angle driveway approaches should equal or exceed 75 square feet in area.

Numbers of driveway approaches serving an adjoining property, especially on arterial thoroughfares should be minimized. No more than two driveway approaches should be designed on any parcel of property with a frontage of 150 feet or less (Dallas City Code, Section 43-84). Driveways generating at least 250 vehicles in a 12 hour period should be located and designed to align with existing or proposed median opening to facilitate efficient, safe traffic access. Excessive use of driveway approaches usually results from poor traffic circulation design on the adjoining property. Accident rates increase as the number of driveway approaches serving the property increase.

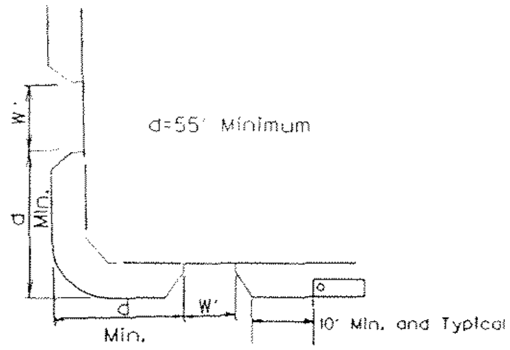
3.04.03 Intersections

Driveway approaches shall not be located too close to street intersections. Locating driveways too close to an intersection results in blockage of driveway access due to vehicles stopped at the intersection. Two driveways near an intersection may encourage vehicular traffic to illegally bypass the intersection by driving through adjoining properties.

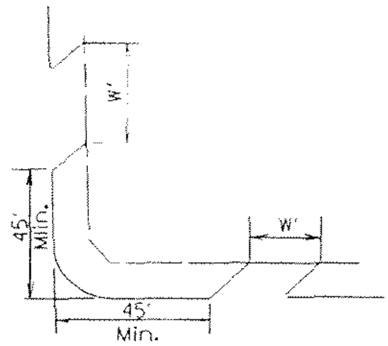
The minimum distances for driveway approaches and curb openings at intersections are given in Figure III-2.

FIGURE III-2
MINIMUM DISTANCES FROM INTERSECTIONS FOR DRIVEWAYS

I. INTERSECTION- ARTERIAL THOROUGHFARES WITH ARTERIAL AND COLLECTOR THOROUGHFARES OR PEDESTRIAN OR SCHOOL CROSSING

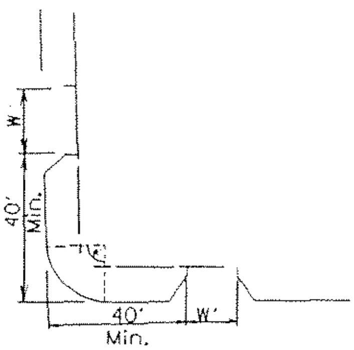


(A) 90° Driveway Approaches

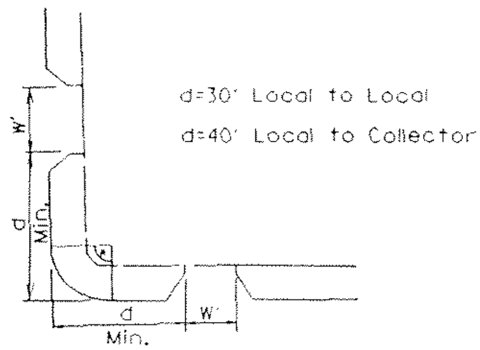


(B) Angle Or Oneway Approaches

II. INTERSECTION-ALL OTHER CASES (WITHOUT FREE RIGHT TURN LANE)

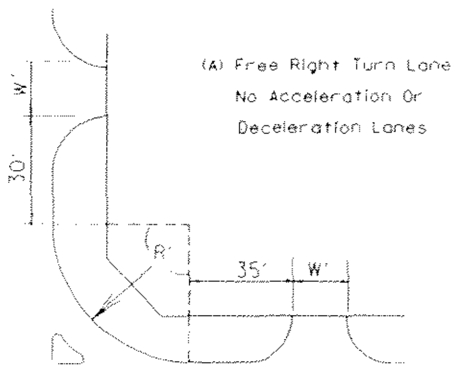


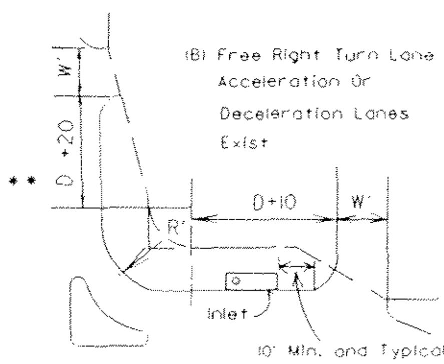
(A) Arterial Thoroughfare With Local/ Residential Collector

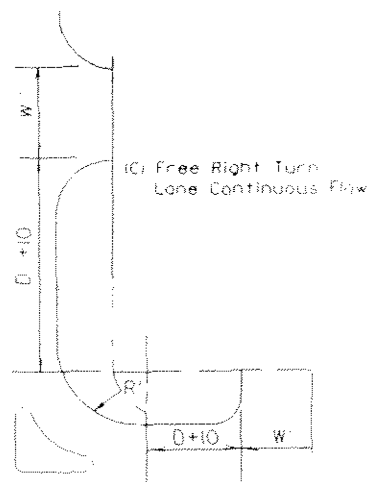


(B) All Other Cases

III. INTERSECTION- FREE RIGHT TURNS







** See Table III-3 for D Values

For Arterial Thoroughfares (standards apply to both 90° and angle approaches)

Location of driveway dependent upon speed and free right turn traffic volumn return percent

NOTE: For minimum street corner curb return radii, see Plate IV-12, IV-13, and IV-14 Tables

For minimum Driveway flare and width standards see Figure IV - 19.

Table III-3, D-Value Chart

(D Values are in feet)

ARTERIAL DESIGN SPEED	M.P.H.	Percent of Right Turns		
		<10%	**10% - 20%**	**>20%**
	35	30	40	50
	40	35	50	60
	45	40	55	65
	50	45	60	70
	55	75	80	85

Use with Figure III-2

Driveway approaches at arterial thoroughfare intersections with other thoroughfares should be located no closer than 55 feet as measured from the edge of the driveway throat to the projected face of curb line of the thoroughfare at the intersection. Angle or one way driveway approaches require a minimum distance of 45 feet. At residential collector and thoroughfare intersections with local and residential collector streets, driveway approaches should be located no closer than 40 feet. A minimum spacing of 30 feet should be followed from local street to local street intersections.

Driveway locations at free right turn designs have different minimum spacing requirements as shown in Figure III-2. Values for "D" on Figure III-2 are given in Table III-3.

Driveway approaches must not be located within 50 feet of a railroad right-of-way as measured from the closest point of the railroad right-of-way and the closest point of the driveway throat (excluding the driveway approach fares).

3.04.04 Freeways and Expressways

All driveway approaches and curb opening cuts on freeway and expressway service roads must be approved by the responsible governmental agency. Figure III-1, provides general guidelines for access standards as required by the Texas Department of Transportation for access located near frontage road ramps. Driveway approaches and curb openings shall not be designed on existing or proposed freeway or expressway ramps.

4.0 - GEOMETRIC DESIGN

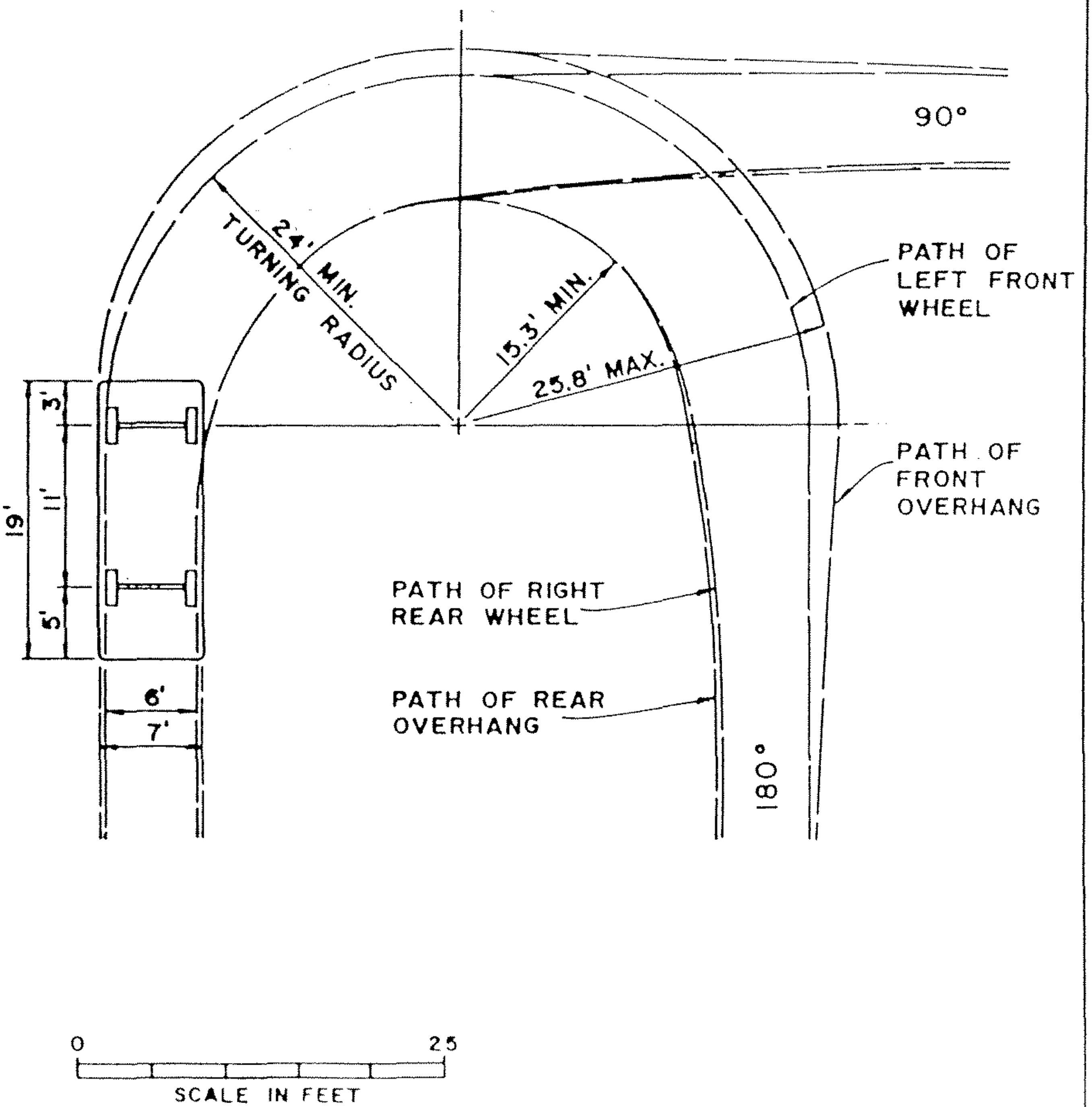
4.01 GENERAL

Geometrics of city streets and thoroughfares may be defined as the geometry of the curbs or pavement areas which governs the movement of traffic within the confines of the rights-of-way. Included in the geometrics are the pavement width, degree of curvature, width of traffic lanes, parking lanes, or turning lanes, median width separating opposing traffic lanes, median nose radii, curb radii at street intersections, crown height, cross fall, geometric shapes of islands separating traffic movements and other features. Since city streets and thoroughfares are differentiated by their functions and location, there is also a variance in the geometry which describes the path vehicular traffic should follow.

4.02 DESIGN CRITERIA

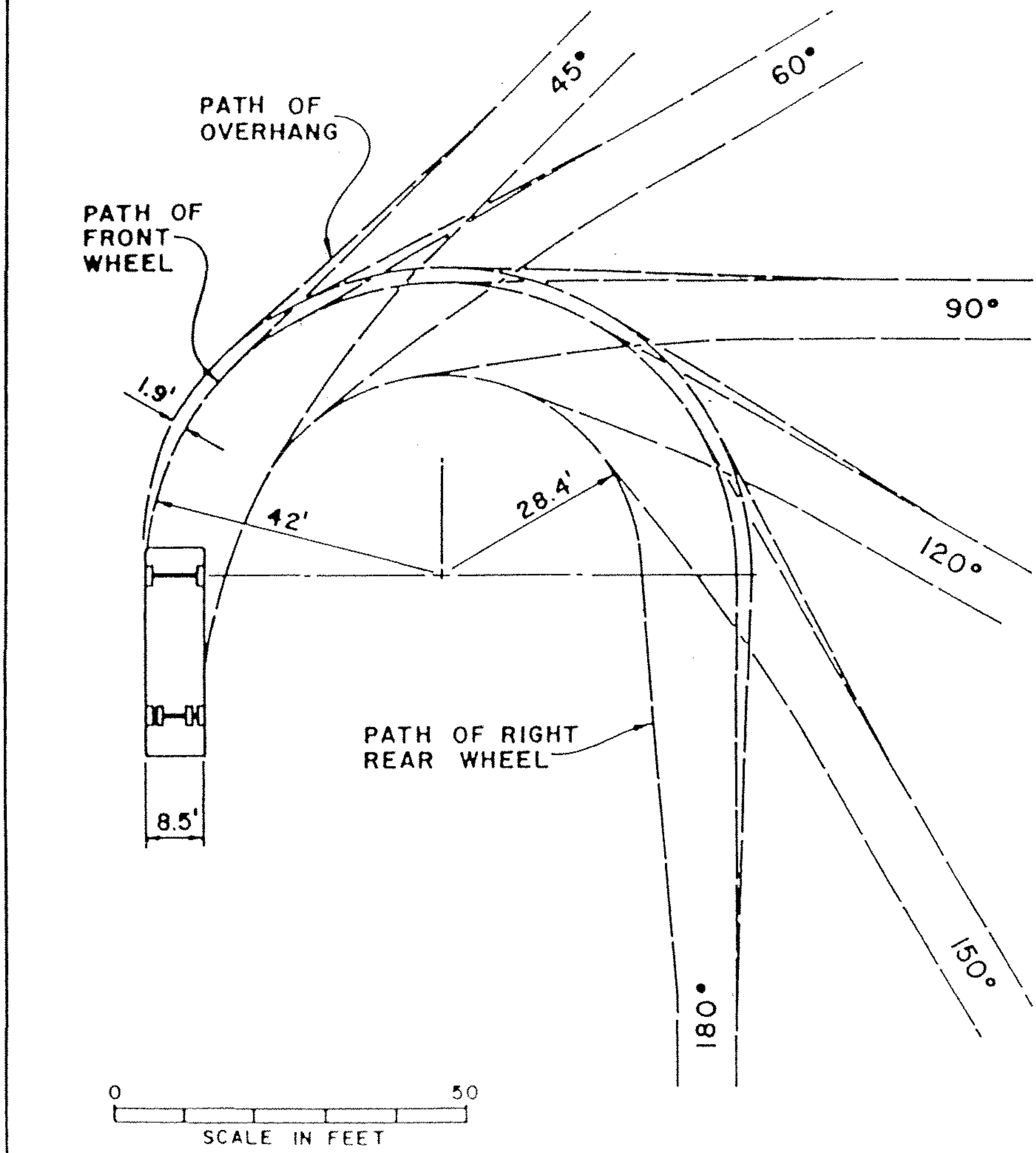
4.02.01 Design Vehicles

The geometrics of city street and thoroughfare intersections vary with the different dimensions of the intersecting facilities. Criteria for the geometric design of intersections must be based on certain vehicle operating characteristics, and vehicle dimensions. The American Association of State Highway and Transportation Officials have standardized vehicle criteria into three general designs, and this vehicle data is published in the AASHTO Publication, A Policy on Geometric Design of Highways and Streets dated 1990. In the design of street and thoroughfare intersections for the City of Dallas, these vehicle designs are adopted for use and a sketch of each design vehicle is shown on Figure IV-1, IV-2, and IV-3. Unless otherwise determined by the Department of Public Works and Transportation, Table IV-4, Design Vehicle Criteria, shall serve as a guide in the selection of the design vehicle to be used in the design of intersections.



PASSENGER CAR
P DESIGN VEHICLE
MINIMUM TURNING RADIUS = 24'

FIGURE IV-1

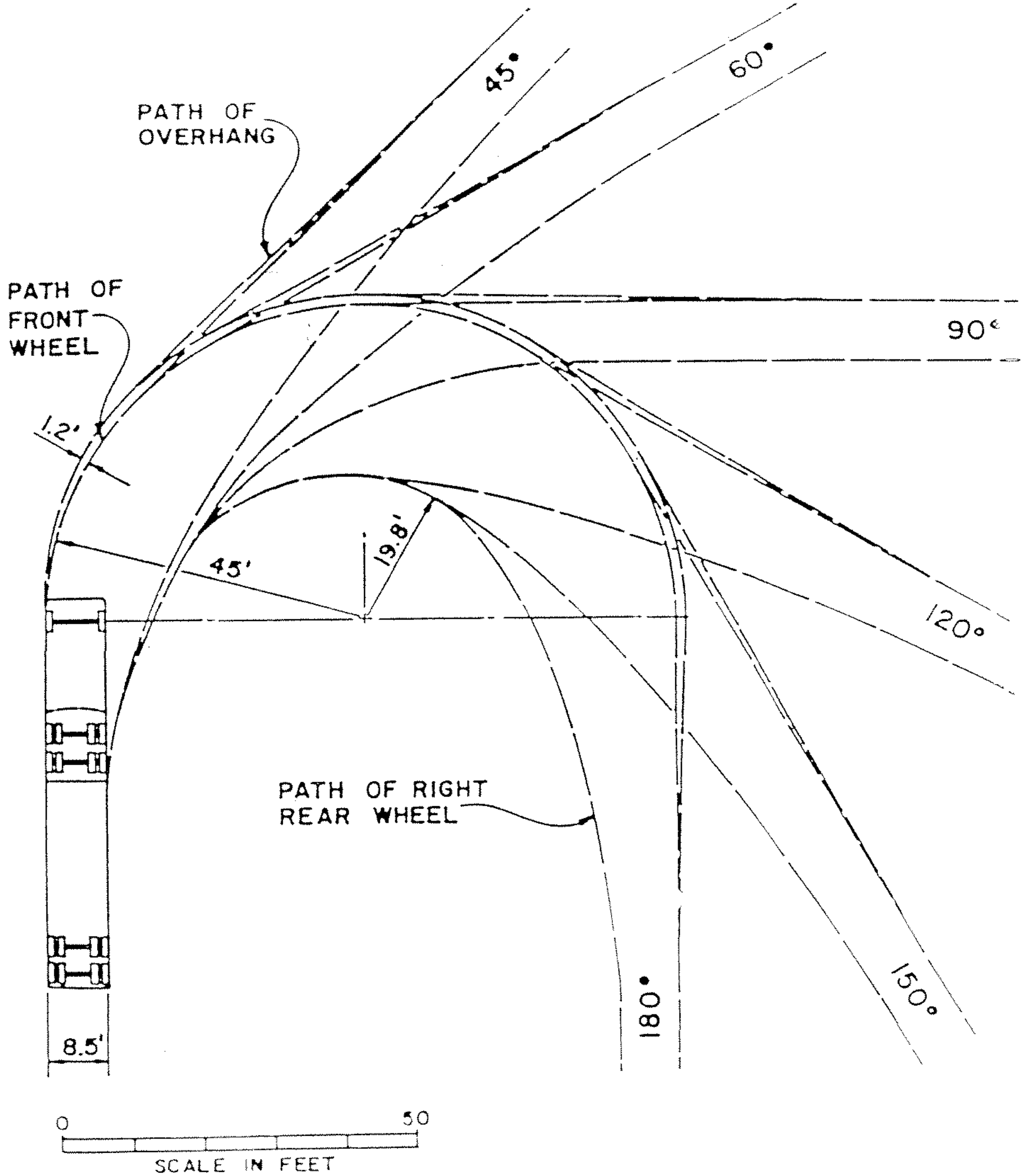


SINGLE UNIT TRUCK

SU DESIGN VEHICLE

MINIMUM TURNING RADIUS = 42'

FIGURE IV - 2



SEMITRAILER COMBINATION
WB-50 DESIGN VEHICLE
MINIMUM TURNING RADIUS = 45'

FIGURE IV-3

TABLE IV-4
DESIGN VEHICLE CRITERIA

	Design Vehicle Used in Intersection Design		
Intersecting Streets	Passenger (P)	Single Unit Truck (SU)	Tractor Semi-Trailer Combination (WB-50)
Local with Local	X		
Local with Residential Collector		X	
Local with Community Collector		X	
Local with Minor Arterial		X	
Local with Principal Arterial		X	
Collector with Collector		X	
Residential Collector with Minor Arterial		X	
Residential Collector with Principal Arterial		X	
*Community Collector with Minor Arterial		X	
Community Collector with Principal Arterial			X
Minor Arterial with Minor Arterial			X
Minor Arterial with Principal Arterial			X
Principal Arterial with Principal Arterial			X

*Collector thoroughfares which are designated with Minor Arterial sections with four lanes of traffic shall be designed to Minor Arterial standards.

4.02.02 Design Speed

The design speed is a primary factor in the horizontal and vertical alignment of city streets and thoroughfares. Design features such as curvature, superelevation, radii for turning movements and sight distance are directly related to the design speed. The design speed also affects features such as lane widths, pavement width, pavement cross-fall, pavement crown, and clearances.

The design speed is defined as the approximate maximum speed that can be maintained safely by a vehicle over a given section of road when conditions are so favorable that the design features of the roadway govern. The speed limit or posted speed is the maximum legal speed set by local authorities for a certain roadway or area. As a rule of thumb, the posted speed limit should be at least five (5) miles per hour less than the design speed for a collector or arterial thoroughfare. The design speed should never be less than the likely legal speed limit for minor and principal arterial thoroughfares. Ranges of posted speed limits for the various classifications of thoroughfares and streets are given in Table II-2A of Section II of this manual.

The various street and thoroughfare classifications, which make up the system within the city, require different design speeds according to their use and location. Presented in Table IV-5 are the allowable design speeds for the various classifications within the City. Lower design speeds will be permitted for all classifications for unusual conditions of terrain or alignment.

4.02.03 Design Traffic Volumes

The general unit of traffic volume measurement on a thoroughfare or street is the average daily traffic volume (ADT). AASHTO in its manual titled <u>A Policy on Geometric Design of Highways and Streets</u>, 1994, defines the average daily traffic on a street as the total number of vehicles which pass a point on the street during a given time period (expressed in whole days), greater than one day and less than one year, divided by the number of days in the given time period. Average daily traffic (ADT) is expressed in number of vehicles per day. The ADT is easily determined when continuous traffic counts

TABLE IV-5

DESIGN SPEED AND SIDE FRICTION FACTORS FOR THOROUGHFARES

Street Classification	Design Speed MPH/KPH	Side Friction Factor (f)
Principal Arterial		
• S-6-D and S-8-D Sections	55 / 88	0.131
• M-6-D(A) Section	* 50 / 80	0.140
• M-6-D(B) Section	* 45 / 72	0.163
***Minor Arterial (Divided)		
• S-4-D Section	* 50 / 80	0.140
• M-4-D(A) Section, 11 foot lanes	* 45 / 72	0.163
• M-4-D(B) Section, 10 foot lanes	* 40 / 64	0.179
***Minor Arterial (Undivided)		
• S-4-U Section	* 45 / 72	0.163
• M-4-U Section	* 40 / 64	0.179
***Community Collector	* 40 / 64	0.179
Residential Collector	* 35 / 56	0.197
Local		
** S-2-U and M-2-U Sections, 36' wide pavement	30 / 48	0.220
L-2-U(A) Section, 33' wide pavement	25 / 40	0.248
L-2-U (B) Section, 26' wide pavement	25 / 40	0.248
CBD Streets		
Couplets, divided 4 to 8 lane, and 5 lane streets	45 / 72	0.163
Undivided 4 to 8 lane streets	40 / 64	0.179
All other streets	35 / 56	0.197

* The design speed to be used on these thoroughfares may depend on the level of urbanization present. Undeveloped or rural areas usually require higher design speeds than urban areas. In these areas, the design speed to be used shall be determined by the Director of Public Works and Transportation.

** All pavement dimensions are measured face of curb to face of curb.

*** Collector Thoroughfares which are designated with Minor Arterial sections with four traffic lanes shall be designed to Minor Arterial standards. Minor Arterial thoroughfares which are designated with Prinicipal Arterial sections with six traffic lanes (3 lanes each direction) shall be designed to Principal Arterial standards.

are available for the street at the particular location. Where only periodic counts are taken, ADT volume can be established by adjusting the periodic counts according to controlling factors such as day of the week, month or season.

The average daily traffic, including the percentage of trucks and buses is a primary factor in the design of the thoroughfare function, number of lanes, and the thickness of the pavement structure. Other factors which affect the pavement design thickness are the required service and pavement life of the thoroughfare or street. Table IV-6 shows typical volumes and capacities for streets of given designs within Dallas:

TABLE IV-6
TYPICAL VOLUMES AND CAPACITIES FOR STREETS OF GIVEN DESIGN

	Typical 24 Hour Volume	Typical 24 Hour Capacity
6 Lane Divided	21,500 vpd[1]	42,000 vpd
4 Lane Divided	14,500 vpd	28,000 vpd
4 Lane Undivided	8,900 vpd	20,000 vpd
2 Lane Undivided	3,600 vpd	10,000 vpd

[1]vpd = vehicles per day

The City prepares traffic counts on all the thoroughfares in the City approximately once every 5 to 7 years and publishes a "Traffic Volume Data Book" once every year. The City counts the number of vehicle axles and divides this number by 2 to provide an average daily traffic count for the particular day. Peak A.M. and P.M. hour counts are also provided. Traffic counts are not adjusted for truck or seasonal impacts. Special traffic counts are performed at requested locations to determine the percentage of trucks and buses. For standard design purposes, the following Table IV-7 provides average daily traffic and percent trucks and buses used in the City Standard designs for pavement structure sections:

TABLE IV-7
DESIGN TRAFFIC VOLUMES FOR STREETS

Functional Classification	Number Lanes	Traffic Loading	Weekday ADT (vpd)	Weekend ADT (vpd)	% Trucks & Buses
Principal Arterial	6	Normal	25,000	12,500	2%
	6	Heavy	40,000	20,000	10%
Minor Arterial	4	Normal	18,000	9,000	2%
	4	Heavy	25,000	12,500	10%
Community Collector	2	Normal	7,000	3,500	5%
	2	Heavy	7,000	3,500	20%
Residential Collector	2	Normal	5,000	2,500	3%
Local	1-2	Bus Route	2,500	1,250	<1.5%
	1-2	Not Bus Route	2,500	1,250	< .2%

4.02.04 Drainage

Standard paving sections for city streets and thoroughfares provides integral 6-inch high curb and gutter with the concrete pavement with underground storm drain systems.

Storm drainage systems for streets shall be designed to provide capacity to drain runoff for the 100 year rainfall event. Street overflow capacity may be used together with the underground storm drainage system with certain restrictions. Section 4.03.06 Inlets And Storm Drainage Facilities of this manual provides more details concerning allowable street overflow and placement of inlets. The City "Drainage Design Manual" provides the requirements for the design of storm drainage systems in the City. Pavement grades at drainage crossings that are not bridges shall be designed to meet the 2-foot freeboard requirement between the design water surface (100-year flood water surface or design flood of record water surface, whichever is higher) and the proposed top of curbs. Bridges are defined as span type structures, not culverts. At bridges, the pavement grades shall be designed to provide at least two feet of freeboard between the design water surface and the lowest point of the supporting structure (low beam). Pavement grades for street approaches to drainage crossings and streets paralleling flood plains shall be designed to provide at least one foot of freeboard between the design flood plain water surface and the proposed top of curb. Drainage from adjoining properties shall be maintained.

4.03 DESIGN ELEMENTS

4.03.01 Typical Cross Sections

Each paving project shall be defined by one or more typical paving sections. The typical section(s) shall be placed on the quantity summary/general note sheet or on a separate detail sheet. Information which shall be shown on the typical section(s) includes:

- paving stations for which the typical section(s) applies
- right-of-way width
- proposed type and dimension of pavement
- subgrade stabilization including width and depth of treatment and amount of lime or cement to be added to the existing soil. Percent compaction should also be shown.
- type, width, depth and treatment of base (if required)
- curb
- driveways and driveway grades
- location and width of sidewalks including minimum and maximum slope which will be allowed. If the sidewalk abuts the curb, a sidewalk lug with all necessary details shall be included.
- median width and location
- pavement crown or cross slope (min. and max.)
- parkway dimensions and requirements
- ties to existing grade
- existing typical ground line and features
- retaining walls (if required)

- removal limits and pay limits with associated item numbers

4.03.02 Sight Distance at Intersections

a. <u>General Requirements</u>

An important consideration in the design of City streets and thoroughfares is the vehicle attempting to enter or cross the street or thoroughfare from a side street, alley or drive. The operator of the vehicle attempting to enter or cross should have an unobstructed view of the whole intersection and a sufficient length of the street to be crossed to permit control of the vehicle to avoid collisions. The minimum sight distance considered safe under various assumptions of physical conditions and driver behavior is related directly to vehicle speeds and to the resultant distance traversed during perception and reaction time and during braking. This sight distance, which is termed intersection sight distance, can be calculated for different street or thoroughfare widths and for various grades both upwards and downwards. Figure IV-8 shows the method for measuring the intersection sight distance. The eye of the driver is assumed to be 3.5 feet above the road surface and the oncoming vehicle is assumed to be at least 4.25 feet above the pavement surface.

Recommended intersection sight distances are shown in Table IV-9 and were developed from the AASHTO manual, <u>A Policy on Geometric Design of Highways and Streets</u>, dated 1994 using the following derived formula:

$$S_d = \tfrac{1}{2} V_d t_a + 2 V_d + (\tfrac{\pi}{2} - 2) R + D + (T + L + M) + \tfrac{1}{2} T_L + T.G. + L_v$$
$$t_a = V_a / a_a$$

where

S_d = ***required sight distance in feet.***

V_d = ***design velocity in feet per second.***

t_a = ***time in seconds for the stopped design vehicle to accelerate at a_a acceleration in feet per second per second to speed V_a in feet per second in making the turning movement.***

R = ***radius in feet of turning path for design vehicle entering the cross street traffic, assumed to be 28 feet for cars and 42 feet for "SU" design vehicle trucks for left turns and 25 feet for cars and 42 feet for "SU" design vehicle trucks for right turns.***

T = *the width in feet of the half of the pavement crossed in the turning movement (equals to 0 for right turns).*

D = *the distance in feet from the front of the stopped design vehicle to the projected intersecting street face of curb line just before the vehicle begins the turning movement, assumed to be zero feet or equal to $R - (\frac{3}{2}\,T + L + M)$, whichever is greater for left turns and 0 feet or equal to $R - \frac{1}{2}\,T$, whichever is greater for right turns.*

L = *the width in feet of the left turn lane (if any) crossed in the turning movement (equals to 0 for undivided streets and for right turns).*

M = *the width in feet of the median (projected) (if any) crossed in the turning movement (equals to 0 for undivided streets and for right turns).*

T_L = *the width in feet of the lane being turned into (assumed to be the half of the street pavement in the direction of the turning movement for "P" design vehicles and the outside 12' of pavement in the direction of the turning movement for "SU" design vehicles..*

T.G. = *Tailgate distance in feet between turning vehicle and oncoming cross traffic vehicle after turning vehicle accelerates to speed V_a*

L_v = *length of design vehicle in feet.*

a_a = *Acceleration (assumed constant) for turning design vehicle in feet per second per second.*

V_a = *reduced velocity in feet per second that the oncoming cross traffic vehicle slows down to and that the stopped turning design vehicle accelerates to.*

Using the AASHTO manual, the values for a_a can be determined for the passenger car "P" design vehicle and the small truck "SU" design vehicle from which t_a can be determined. Using the 2 second gap rule for T.G. and converting V_d and V_a to miles per hour, the sight distance formula becomes:

$$S_d = 0.7335\,V_d\,t_a + 2.934\,V_d - 0.4292R + D + (T + L + M) + \tfrac{1}{2}\,T_L + 2.934V_a + L_v$$

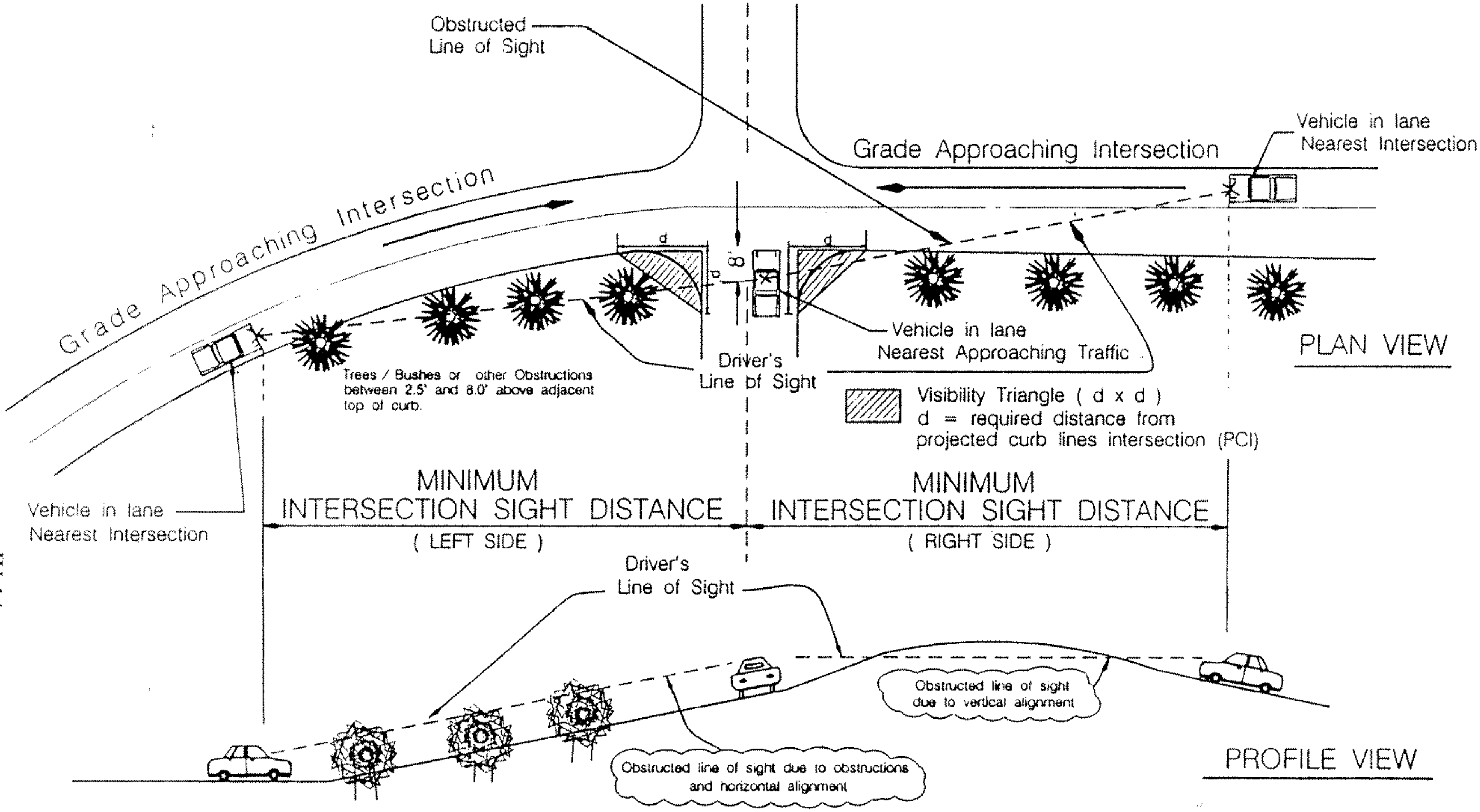
To insure safety at intersections, the intersection sight distance must not be less than the minimum intersection sight distances shown in Table IV-9. The minimum intersection sight distances were determined from AASTHO minimum stopping distance requirements adjusting for the degree of driver recognition complexity present to provide an absolute minimum intersection sight distance.

The desirable intersection sight distances, given in Table IV-9, were determined using the standard AASHTO passenger car for all cases. The desirable intersection sight distance shall be used in design whenever practical. These desirable sight distances will provide the minimum required for urban areas for the design vehicle crossing or entering the specified cross street. Desirable sight distances assume the oncoming cross traffic is traveling the design speed and slows down for entering vehicles to a speed of 70% of the design speed (10 miles per hour less than the design speed for local and residential collector streets). A tailgate distance equivalent to a 2 second following distance between vehicles is also assumed. Undeveloped or rural areas usually require larger intersection sight distances than urban areas due to higher vehicular speeds. In these areas, the desirable sight distance requirements shall be increased by using a speed of 85% of the design speed for V_a in the t_a and S_d formulae.

Depending on the grade of the thoroughfare, adjustments may need to be made to the intersection sight distance. Vehicles approaching an intersection on an upgrade need less distance in which to stop, and vehicles approaching an intersection on a downgrade need more distance in which to stop. Intersection sight distance grade adjustments are shown in Table IV-10.

It is very important that the designer check for intersection sight distance at all locations where a problem may occur. Examples of areas where potential for sight problems exist include:

- street and alley intersections where trees, bushes, utility poles, fences, guard rails, etc. may be present
- street and alley intersections which may be in close proximity to a retaining wall
- driveways subject to the problem conditions above



SIGHT DISTANCE AT INTERSECTIONS
FIGURE IV – 8
(USE WITH TABLE IV – 9)

TABLE IV-9
INTERSECTION SIGHT DISTANCES
(See Figure IV-8)

Design Speed	Street Section Type ***	Stopping Sight Distance (Feet)		Intersection Sight Distance - (Feet)			
				Left Side		Right Side	
		Min.	Desirable	Min.	Desirable	Min.	Desirable
25	L-2-U(B)	150	200	110	235	150	240
25	L-2-U(A)	150	200	110	235	150	240
30	M-2-U	200	200	145	315	200	315
30	S-2-U	200	200	145	315	200	315
35	M-2-U	225	250	180	405	225	410
35	S-2-U	225	250	180	405	225	410
35	M-4-U*	225	250	180	405	225	410
40	M-2-U	275	315	225	485	275	485
40	S-2-U	275	315	225	485	275	485
40	M-4-U*	275	315	225	485	275	485
40	M-4-U	275	315	225	485	275	485
40	M-4-D(B)	275	315	225	485	275	500
45	M-4-U couplet	325	385	270**	575**	270**	575**
45	S-4-U	325	385	270	575	325	580
45	M-4-D(A)	325	385	270	575	325	595
45	M-6-D(B)	325	385	270	575	325	610
45	M-3-U couplet	325	385	270**	575**	270**	575**
45	S-4-U couplet	325	385	270**	575**	270**	575**
45	S-3-U couplet	325	385	270**	575**	270**	575**
50	S-4-D	400	460	325	675	400	700
50	M-6-D(B)	400	460	325	675	400	705
50	M-6-D(A)	400	460	325	675	400	710
55	M-6-D(B)	450	540	375	780	450	815

TABLE IV-9 (Continued)
INTERSECTION SIGHT DISTANCES
(See Figure IV-8)

Design Speed	Street Section Type ***	Stopping Sight Distance (Feet)		Intersection Sight Distance - (Feet)			
				Left Side		Right Side	
		Min.	Desirable	Min.	Desirable	Min.	Desirable
55	M-6-D(A)	450	540	375	780	450	820
55	S-6-D	450	540	375	780	450	825
55	S-8-D	450	540	375	780	450	840

* Striped for two lanes
** Applicable for oncoming traffic side on one-way couplet
*** For street section types see Section II, Table II-4, "Street and Thoroughfare Geometric Standards"
For distance adjustment due to grade of street, use Table IV-10

TABLE IV-10
SIGHT DISTANCE ADJUSTMENTS DUE TO GRADE

Design Speed (MPH)	Upgrades (Decrease in Ft.)			Downgrades (Increase in Ft.)		
	3%	6%	9%	3%	6%	9%
25	4	8	10	5	15	25
30	6	10	20	10	20	30
35	8	15	25	15	30	50
40	10	20	30	20	40	70
45	15	25	40	25	50	95
50	20	30	50	30	70	120
55	25	40	60	40	90	145

b. Visual Obstruction Regulations

The Dallas Development Code, Section 51A-4.602.d Visual Obstruction Regulations requires that no one shall erect, place or maintain a structure, berm, plant life, or any other item on a lot if the item is in the "visibility triangle" between 2.5 feet and 8.0 feet in height measured from the top of the adjacent street curb or, if there is no curb, from the grade of the portion of the street adjacent to the visibility triangle. Poles with diameters not exceeding 12 inches are exempt from this requirement. Figure IV-8 illustrates the visibility triangle. The "visibility triangle" is defined as follows:

1. <u>Street to Street Intersection</u>

(a) Special Areas

In the central area districts, the Deep Ellum/Near Eastside District (Planned Development District (P.D.D.) No. 269) and the State-Thomas Special Purpose District (P.D.D. No. 225), the portion of a corner lot within a triangular area formed by connecting together the point of intersection of projected adjacent street face of curb lines (or, if no street curbs, what would be the normal street face of curb lines) and points on each of the projected street face of curb lines 30 feet from their intersection;

(b) All Other Areas

In all other zoning districts, the portion of a corner lot within a triangular area formed by connecting together the point of intersection or projected adjacent street face of curb lines (or what would be the normal street face of curb lines if no curbs exist) and points on each of the projected street face of curb lines 45 feet from their intersection;

2. <u>Street to Alley or Driveway Intersections</u>

In all zoning districts, the portion of a lot within a triangular area formed by connecting together the point of intersection of the projected edge of a driveway or alley pavement (not the transition flare) and an adjacent projected street face of curb line (or what would be the normal street face of curb line if no curb exists) and points on the projected driveway or alley pavement edge (not the transition flare) and the projected edge of street face of curb line 20 feet from their intersection.

All paving designs shall be in compliance with these Dallas Development Code visual obstruction regulations.

4.03.03 Horizontal Alignment

a. General

Streets must be designed in relation to the thoroughfare plan, existing and proposed streets, the terrain, streams, and other physical conditions. The arrangement of streets must provide for the continuation of streets and thoroughfares between adjacent properties when the continuation is necessary for the safe and efficient movement of traffic and/or utility efficiency. Local streets should be oriented in a manner that discourages their use by through-traffic and to allow efficient drainage systems, utility systems and general street improvements.

The horizontal alignment of City streets and thoroughfares shall be designed to provide safe, continuous operation for motorists and pedestrians while meeting the varying needs of the adjoining owners and the public. The horizontal alignment shall be designed to comply with the functional and dimensional classification requirements of the thoroughfare plan using the traffic requirements determined by the City and the design criteria provided in Section 4.02 Design Criteria of this manual. The various roadway classifications must have certain horizontal and vertical geometrics to provide a safe and economical facility for use by the public.

b. Horizontal Curves and Superelevation

The alignment of a city street or thoroughfare is based on the functional and dimensional classification of the street and is normally controlled by the alignment of the existing right-of-way or structures which cannot be relocated. Changes in the direction of a street or thoroughfare are minimized by constructing simple curves having radii which are compatible with the speed of vehicular traffic. To increase the safety and reduce discomfort to drivers traversing a curved portion of a street or thoroughfare, the pavement may be superelevated. Also, the intersection's sight distance must be considered to ensure safety in curved sections.

Curvature in the alignment of thoroughfares should be minimized to provide safe movement of large volumes of traffic. The lower design speeds and traffic volumes on local streets allow greater use of horizontal curves in the street alignment contributing an aesthetic value to urban residential neighborhoods.

Recommended minimum radii of curvature for various vehicle design speeds and pavement superelevations, without consideration of intersection sight distance requirements, are shown in Table IV-11A. Restrictions on the minimum radius of curvature due to intersection sight distance requirements are provided in Table IV-11B.

The following formulas were used in calculating the minimum radii of curvature and superelevations given in Table IV-11A:

$$R_{min} = \frac{V^2}{15\,(e + f)} \quad \text{and} \quad e = \frac{V^2}{15\,R_{min}} - f$$

where

e	=	rate of roadway superelevation, ft/ft
f	=	side friction factor (see Table IV-5)
v	=	vehicle speed, mph
Rmin	=	minimum street lane centerline radius of curve, feet

These minimum radii of curvature are based on traffic consisting of typical present day automobiles operating under optimum weather conditions.

Other important considerations which must be addressed in the design of curves on city streets and thoroughfares include the location of intersecting streets, drives, bridges and other topographic features. Horizontal curves greatly affect the intersection sight distance, especially on the inside portion of the curves. Intersecting streets on the inside portion of curved streets have reduced visibility of oncoming traffic at the intersection and thus, reduced sight distance from what is provided on a straight horizontal alignment.

The minimum centerline radius needed to provide a required intersection sight distance is dependent on the design speed, the pavement lane width, street section classification, and the parkway width. The narrower the lane and parkway widths, the less the area of visibility for the motorist stopped at an intersection and thus, the larger the centerline radius requirement to provide the required visibility.

Table IV-11B shows the minimum centerline radii required for the various street section classifications to provide the desirable and minimum intersection sight distances given in Section 4.03.02, Sight Distance at Intersections, Table IV-9. The specified "Desirable Minimum" centerline radii should be used for the horizontal centerline radii where practical instead of the smaller radii determined from Table IV-11A. If use of the "Desirable Minimum" radii from Table IV-11B is not practical, the "Safety Minimum" radii given in Table IV-11B shall be compared with the minimum centerline radii determined from Table IV-11A and the larger of the radii shall be used. **The minimum centerline radius for a street must not be less than the "Safety Minimum" radius given in Table IV-11B unless additional sight easements are provided.**

TABLE IV-11A

MINIMUM CENTERLINE RADIUS FOR THOROUGHFARES

Rate of superelevation		* Minimum Centerline Radius (Feet) Design Speed (MPH)						
(in./ft.)	(ft./ft.)	25	30	35	40	45	50	55
-1/2	-0.0417	210	340	530	780	1,120	1,700	2,260
-3/8	-0.0313	200	320	500	730	1,030	1,540	2,030
-1/4	-0.0208	190	310	470	680	950	1,400	1,830
-1/8	-0.0104	180	290	440	640	890	1,290	1,680
0	0	170	280	420	600	830	1,200	1,540
+1/8	+0.0104	160	260	400	570	780	1,110	1,430
+1/4	+0.0208	160	250	380	540	740	1,040	1,330
+3/8	+0.0313	**150	240	360	510	700	980	1,250
+1/2	+0.0417	**150	230	350	490	660	920	1,170

* Minimum centerline radius for Local L-2-U (B) section streets is 150 feet, for Local L-2-U(A) section streets is 200 feet, and for Local S-2-U and M-2-U section streets is 230 feet for residental zoned districts and 280 feet for all other zoned districts.

** Minimum centerline radius is 150 feet

TABLE IV-11B
HORIZONTAL CURVE RESTRICTIONS DUE TO INTERSECTION SIGHT DISTANCES

Classification Section	Design Speed (mph)	Left Side (feet)				Right Side (feet)			
		Desirable Minimum		Safety Minimum		Desirable Minimum		Safety Minimum	
		Sight Distance	Radius	Sight Distance	Radius	Sight Distance	Radius	Sight Distance	Radius
Local									
L-2-U(B)	25	235	460	110	**150	240	350	150	**150
L-2-U(A)	25	235	540	110	***200	240	360	150	***200
M-2-U	30	315	1,290	145	275	315	745	200	290
S-2-U	30	315	970	145	210	315	605	200	230
Residential Collector:									
M-2-U	35	405	2,130	180	425	410	1,280	225	370
S-2-U	35	405	1,600	180	320	410	1,040	225	300
M-4-U*	35	405	1,550	180	310	410	985	225	280
Community Collector:****									
M-2-U	40	485	3,060	225	660	485	1,800	275	565
S-2-U	40	485	2,300	225	495	485	1,470	275	455
M-4-U*	40	485	2,220	225	480	485	1,390	275	430
Minor Arterial:**** (undivided):									
M-4-U	40	485	3,050	225	660	485	2,050	275	645
S-4-U	45	575	5,450	270	1,210	580	4,320	325	1,350
(divided):									
M-4-D (B)	40	485	3,050	225	660	500	1,640	275	475
M-4-D (A)	45	575	3,900	270	865	595	2,120	325	610
S-4-D	50	675	6,650	325	1,560	700	3,570	400	1,150
Principal Arterial: (couplet*****):									
M-3-U	45	575	5,030	270	1,110	575	5,030	270	1,110
M-4-U	45	575	4,280	270	950	575	4,280	270	950
S-3-U	45	575	3,980	270	880	575	3,980	270	880
S-4-U	45	575	5,460	270	1,210	575	5,460	270	1,210
(Divided):									
M-6-D (B)	45	575	6,300	270	1,400	610	3,110	325	865
M-6-D (A)	50	675	6,040	325	1,420	710	2,850	400	880
S-6-D	55	780	7,330	375	1,710	825	3,500	450	1,020
S-8-D	55	780	7,770	375	1,810	840	3,290	450	910

* Striped for two lanes
** Minimum centerline radius for street set to 150'
*** Minimum centerline radius for street set to 200'
**** Collector thoroughfares which are designated with Minor Arterial sections with four lanes of traffic shall be designed to Minor Arterial Standards. Minor Arterial thoroughfares which are designated with Principal Arterial sections with six lanes of traffic (3 lanes in each direction) shall be designed to Principal Arterial Standards.
***** Applicable for oncoming traffic side on one-way couplet.

If additional sight easements are provided, the required "Safety Minimum" centerline radius can be reduced in some cases. Table IV-11C, <u>Sight Easement Requirements Due to Intersection Sight Distances</u> lists the street classification sections in which the "Safety Minimum" centerline radius can be reduced by providing additional sight easements. These sight easements are required along the inside portions of the curved right-of-way alignment in addition to the required street right-of-way and parkway widths.

Some street classification sections also require sight easements on the outside portions of the curved right-of-way alignment to achieve the reduced centerline radii shown in parenthesis. This is due to the high design speeds required and narrow parkways provided. These street classification sections are noted with a double asterisk in Table IV-11C with the reduced "Safety Minimum" radius allowed shown in parenthesis. For these cases, the outside curve sight easements shall be equal in width to the inside curve sight easements required.

<u>**In all cases, the minimum centerline radius must not be less than the minimum centerline radius determined from Table IV-11A "Minimum Centerline Radius for Thoroughfares."**</u>

For examples on the use of Table IV-11A, Table IV-11B, and Table IV-11C see APPENDIX "D" <u>STREET CENTERLINE AND CORNER CURB RETURN RADII DETERMINATIONS-EXAMPLES.</u>

TABLE IV-11C

SIGHT EASEMENT REQUIREMENTS

DUE TO INTERSECTION SIGHT DISTANCES

Classification Section	Table IV-11A Radius (feet) (No Crossfall)	Minimum Radius With Sight Easement (Width in Feet)				
		0	1	2	3	4
Community Collector:						
M-2-U	600	660	595	565	565	565
**M-2-U	600	660	595	** (540)	** (495)	** (460)
Minor Arterial:						
(Undivided):						
**M-4-U	600	660	** (590)	** (540)	** (495)	** (455)
**S-4-U	830	1,350	**(1,040)	** (915)	** (820)	** (750)
(Divided):						
M-4-D (B)	600	660	590	540	495	475
M-4-D (A	830	865	785	715	660	-
S-4-D	1,200	1,560	1,360	1,210	1,150	1,150
**S-4-D	1,200	1,560	1,360	1,210	**(1,100)	**(1,010)
Principal Arterial:						
(Couplet):						
M-3-U	830	1,110	965	860	780	710
M-4-U	830	950	850	770	705	655
S-3-U	830	880	790	720	660	-
S-4-U	830	1,210	1,040	915	820	750
(Divided):						
M-6-D (B)	830	1,400	1,170	1,020	905	865
**M-6-D (B)	830	1,400	1,170	1,020	905	**(820)
M-6-D (A)	1,200	1,420	1,260	1,140	1,050	965
S-6-D	1,540	1,710	1,540	1,410	1,300	1,200
S-8-D	1,540	1,810	1,620	1,470	1,350	1,250

Notes:

1. Sight easements are required along the inside right-of-way curves only to achieve the above minimum centerline radii except for the M-4-U and S-4-U sections and for those cases footnoted below in which cases, sight easements are required along both the inside and outside right-of-way curves.

** This section requires sight easements along both sides of the street right-of-way to achieve reduced minimum centerline radii shown in parenthesis.

c. **Turning Lanes**

Turning lanes are provided at intersections to accommodate left-turning and right-turning vehicles. The primary purpose of these turning lanes is to provide storage for the turning vehicles. The secondary purpose is to provide space to decelerate from normal speed to a stopped position in advance of the intersection or to a safe speed for the turn if a stop is unnecessary. Single left-turn lanes at intersections shall be at least 10 feet in width. Left turn lanes shall provide a reverse curve transition for deceleration and adequate storage for turning vehicles. When turning traffic is too heavy for a single lane and the cross street is wide enough to receive the traffic, dual left turning lanes may be provided. Lane widths for dual left-turning lanes should be at least 11 feet. Availability of right-of-way may limit locations where dual left-turning lanes are feasible. The geometrics for most intersection involving left turn lanes are shown on Plate Tables IV-13 and IV-14.

The location of the median nose at the end of the left turn lane should be set such that left-turning traffic will clear the median nose while making a left turn. The median nose should also be placed such that no portion of the nose is located in any proposed crosswalk. The back of the crosswalk is generally 12 feet from the face of the curb on the intersecting street.

The minimum storage requirements "S" for left turn lanes at the various type street intersections are provided in Plate Tables IV-13 and IV-14. The minimum storage requirements for left turn lanes serving driveways and mid-block median openings shall be 80 feet and for local streets shall be 90 feet. Low traffic cases may warrant smaller storage requirements for driveways and certain local streets. Use of smaller storage for left turn lanes must be approved by the Director of Public Works and Transportation.

Right turn lanes are provided to increase the capacity of an intersection by providing an extra lane exclusively for right turn movements. These lanes shall be at least 10 feet in width. Right turn lanes shall provide at least 100 feet of storage for vehicles, and shall include a taper or reverse curve transition for deceleration.

Right turn and acceleration lanes may be required for certain driveway approaches to move the accessing traffic off and onto the travel lanes of a street. Factors that may warrant addition of right turn and acceleration lanes are development use, square footage and trip generation. The Transportation Division of Public Works and Transportation shall review and approve the addition of all right turn and acceleration lanes.

The normal requirement for right and left turn lane reverse curve curb geometry for S-8-D, S-6-D, M-6-D(A), S-4-D and M-4-D(A) type arterial thoroughfares at non-principal arterial intersections shall be a 400 foot radius for curve #1 and a 200 foot radius for curve #2. The normal requirement for right and left turn lane reverse curve curb geometry for M-6-D(B) and M-4-D(B) type divided arterial thoroughfares at non-principal arterial intersections shall be a 300 foot radius for curve #1 and a 150 foot radius for curve #2. The radii required for left turn lane curb geometry is increased when an arterial thoroughfare intersects principal arterial and divided minor arterial thoroughfares. Details on required radii are provided on Plates IV-13 and IV-14.

Additional details concerning left and right turn lanes on divided arterial thoroughfares are provided in the City of Dallas Standard Construction Details, File 251D-1.

d. <u>Street Intersections</u>

1. <u>General</u>

The following regulations govern the alignment of intersections:

(a) All streets must intersect as close to a right angle as permitted by topography or other natural physical conditions. A street must not intersect with another street or railroad at an angle of more than 105 degrees or less than 75 degrees.

(b) An intersection must not have more than four street approaches.

Additional regulations governing the alignment of intersections are provided in Section III <u>Access Control</u> of this manual.

2. Standard Intersections

The standard street intersection is defined as the at-grade intersection of arterial, collector, or local streets at or near right angles. The various geometrics at street intersections including pavement widths, lane widths, curb radii, median widths, turning lane data, crossfall, crown height and other features differ according to the classifications and sections of the intersecting streets. The three basic standard intersection types include the Type I intersection - "Street Without Median Intersecting Street Without Median", Type II intersection - "Street With Median Intersecting Street With Median" and Type III intersection - "Street With Median Intersecting Street Without Median".

Plate Nos. IV-12, IV-13 and IV-14 show the standard dimensional and geometric requirements for most of the possible street classification and section combinations for each of the three basic standard intersection types. Each plate shows the layout of the type of street intersection and gives the street section data. The accompanying plate table provides the minimum intersection curb return radii requirements. The minimum required intersection curb return radii depend on the classifications of both intersecting streets and the direction of the turning movement. The plate tables define the turning movement direction by "initial street" (the street on which the turning movement begins) and by "destination street" (the street onto which the traffic is turning.)

The design for curb radii is controlled by the right turn movement and is determined using the minimum radius requirements for the appropriate design vehicle as given in Table IV-4 Design Vehicle Criteria and Figure IV-1, Figure IV-2, and Figure IV-3. The design vehicle is required to stay in its lane on the approach and to be able to comfortably complete the turn onto its half of the intersecting street without hitting any curbs or encroaching into oncoming traffic lanes.

Each plate table also provides an estimated corner clip for each street intersection combination. The estimated corner clip is based on an isosceles

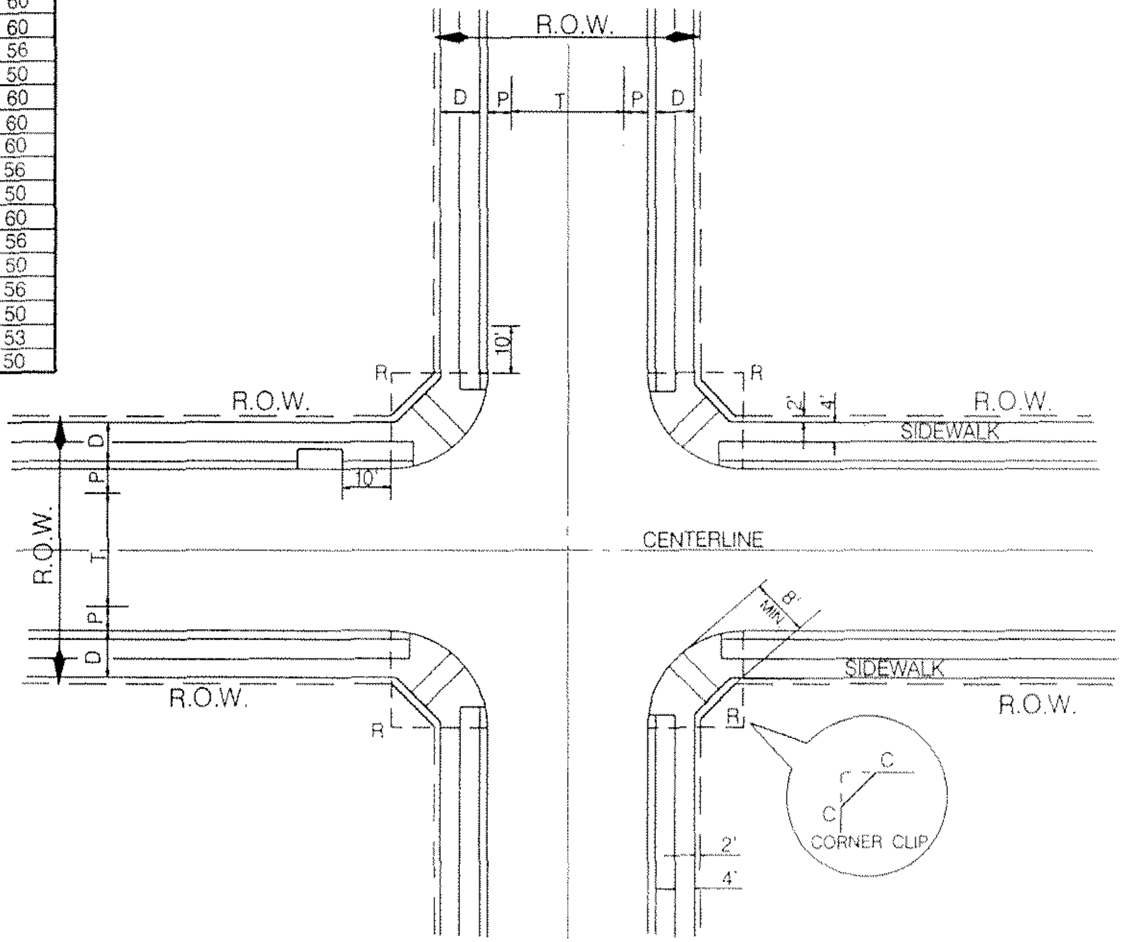
STREET SECTION DATA
Streets Without Medians

Functional Classification	Street Section Type	Traffic Lanes No.	Traffic Lanes Width	T Ft.	Parking Lanes (P) No.	Parking Lanes (P) Ft.	D Ft.	R.O.W Ft.
Principal Couplet	S-4-U	4	11	44	0	0	8.0	60
Principal Couplet	M-4-U	4	10	40	0	0	10.0	60
Principal Couplet	S-3-U	3	12	36	0	0	10.0	56
Principal Couplet	M-3-U	3	11	33	0	0	8.5	50
Minor	S-4-U	4	11	44	0	0	8.0	60
Minor	M-4-U	4	10	40	0	0	10.0	60
Community Collector	M-4-U*	2	12	24	2	8	10.0	60
Community Collector	S-2-U	2	10	20	2	8	10.0	56
Community Collector	M-2-U	2	10	20	2	8	7.0	50
Residential Collector	M-4-U*	2	12	24	2	8	10.0	60
Residential Collector	S-2-U	2	10	20	2	8	10.0	56
Residential Collector	M-2-U	2	10	20	2	8	7.0	50
Local	S-2-U	2	10	20	2	8	10.0	56
Local	M-2-U	2	10	20	2	8	7.0	50
Local	L-2-U (A)	1	17	17	2	8	10.0	53
Local	L-2-U (B)	1	10	10	2	8	12.0	50

* Striped for two lanes.

SEE PLATE IV - 12 TABLE for minimum R values and estimated required corner clips. C x C.

NOTE: LOCATION OF MEDIAN NOSE AND DIMENSIONS F & G SHALL BE DETERMINED BY USE OF WB - 50 AND SU TURNING RADIUS.



Right-of-way width (R.O.W.) = Distance between property lines of dedicated street.

Travel-way width (T) = Distance between inside edges of parking lanes (if any) or face of curb (s).

Parking Lane width (P) = Width of curbside parking lane, measured from face of curb, set to 0 if none.

Parkway width (D) = Width of parkway, face of curb to property line; both assumed equal.

TYPE I INTERSECTION

STREET WITHOUT MEDIAN INTERSECTING STREET WITHOUT MEDIAN

PLATE IV - 12

PLATE IV-12 TABLE
TYPE I INTERSECTION SUMMARY
STREET WITHOUT MEDIAN INTERSECTING STREET WITHOUT MEDIAN

Intersecting Streets		Typical Curb Return Radii (feet)	Typical Corner Clip C x C
Initial Street	**Destination Street**		
Principal Couplet	Principal Couplet	35'	15' x 15'
" "	Minor Arterial	45'	25' x 25'
" "	Community Collector	45'	20' x 20' *
" "	Residential Collector	30'	10' x 10' *
" "	Local [All except L-2-U(B)]	20'	10' x 10'
" "	Local [L-2-U(B)]	30'	10' x 10'
Minor Arterial	Principal Couplet	35'	15' x 15'
" "	Minor Arterial	45'	25' x 25'
" "	Community Collector	30'	10' x 10' *
" "	Residential Collector	30'	10' x 10' *
" "	Local [All except L-2-U(B)]	20'	10' x 10'
" "	Local [L-2-U(B)]	30'	10' x 10'
Community Collector	Principal Couplet	20'	5' x 5' *
" "	Minor Arterial	20'	5' x 5' *
" "	Community Collector	20'	3' x 3' *
" "	Residential Collector	20'	3' x 3' *
" "	Local [All except L-2-U(B)]	20'	3' x 3' *
" "	Local [L-2-U(B)]	25'	4' x 4' *
Residential Collector	Principal Couplet	20'	5' x 5' *
" "	Minor Arterial	20'	5' x 5' *
" "	Community Collector	20'	3' x 3' *
" "	Residential Collector	20'	3' x 3' *
" "	Local [All except L-2-U(B)]	20'	3' x 3' *
" "	Local [L-2-U(B)]	25'	4' x 4'
Local	Principal Couplet	20'	5' x 5' **
"	Minor Arterial	20'	5' x 5' **
"	Community Collector	20'	3' x 3' **
"	Residential Collector	20'	3' x 3' **
"	Local	20'	3' x 3' **

* Collector M-2-U requires a larger corner clip
**Local M-2-U requires a larger corner clip

For more detailed information, refer to the following detailed Plate IV-12 Table

PLATE IV-12 TABLE
TYPE I INTERSECTION
STREET WITHOUT MEDIAN INTERSECTING STREET WITHOUT MEDIAN

INTERSECTING STREETS						R	CORNER CLIP**
Initial Street			Destination Street				
Classification	Section	ROW	Classification	Section	ROW	Ft.	C x C
Principal Couplet	S-4-U	60	Principal Couplet	S-4-U	60	30	14' X 14'
Principal Couplet	S-4-U	60	Principal Couplet	M-4-U '	60	30	11' X 11'
Principal Couplet	S-4-U	60	Principal Couplet	S-3-U	56	35	14' X 14'
Principal Couplet	S-4-U	60	Principal Couplet	M-3-U	50	35	16' X 16'
Principal Couplet	S-4-U	60	Minor Arterial	S-4-U	60	45	25' X 25'
Principal Couplet	S-4-U	60	Minor Arterial/Community Collector	M-4-U	60	45	23' X 23'
Principal Couplet	S-4-U	60	Community Collector	S-2-U	56	45	23' X 23'
Principal Couplet	S-4-U	60	Community Collector	M-2-U	50	45	28' X 28'
Principal Couplet	S-4-U	60	Residential Collector	M-4-U*	60	30	11' X 11'
Principal Couplet	S-4-U	60	Residential Collector	S-2-U	56	30	11' X 11'
Principal Couplet	S-4-U	60	Residential Collector	M-2-U	50	30	15' X 15'
Principal Couplet	S-4-U	60	Local	S-2-U	56	20	5' X 5'
Principal Couplet	S-4-U	60	Local	M-2-U	50	20	8' X 8'
Principal Couplet	S-4-U	60	Local	L-2-U (B)	50	30	9' X 9'
Principal Couplet	M-4-U	60	Principal Couplet	S-4-U	60	30	11' X 11'
Principal Couplet	M-4-U	60	Principal Couplet	M-4-U	60	30	9' X 9'
Principal Couplet	M-4-U	60	Principal Couplet	S-3-U	56	35	12' X 12'
Principal Couplet	M-4-U	60	Principal Couplet	M-3-U	50	35	14' X 14'
Principal Couplet	M-4-U	60	Minor Arterial	S-4-U	60	45	23' X 23'
Principal Couplet	M-4-U	60	Minor Arterial/Community Collector	M-4-U	60	45	18' X 18'
Principal Couplet	M-4-U	60	Community Collector	S-2-U	56	45	18' X 18'
Principal Couplet	M-4-U	60	Community Collector	M-2-U	50	45	27' X 27'
Principal Couplet	M-4-U	60	Residential Collector	M-4-U*	60	30	9' X 9'
Principal Couplet	M-4-U	60	Residential Collector	S-2-U	56	30	9' X 9'
Principal Couplet	M-4-U	60	Residential Collector	M-2-U	50	30	12' X 12'
Principal Couplet	M-4-U	60	Local	S-2-U	56	20	3' X 3'
Principal Couplet	M-4-U	60	Local	M-2-U	50	20	6' X 6'
Principal Couplet	M-4-U	60	Local	L-2-U(B)	50	30	7' X 7'
Principal Couplet	S-3-U	56	Principal Couplet	S-4-U	60	30	11' X 11'
Principal Couplet	S-3-U	56	Principal Couplet	M-4-U	60	30	9' X 9'
Principal Couplet	S-3-U	56	Principal Couplet	S-3-U	56	35	12' X 12'
Principal Couplet	S-3-U	56	Principal Couplet	M-3-U	50	35	14' X 14'
Principal Couplet	S-3-U	56	Minor Arterial	S-4-U	60	45	23' X 23'
Principal Couplet	S-3-U	56	Minor Arterial/Community Collector	M-4-U	60	45	18' X 18'
Principal Couplet	S-3-U	56	Community Collector	S-2-U	56	45	18' X 18'
Principal Couplet	S-3-U	56	Community Collector	M-2-U	50	45	27' X 27'
Principal Couplet	S-3-U	56	Residential Collector	M-4-U*	60	30	9' X 9'
Principal Couplet	S-3-U	56	Residential Collector	S-2-U	56	30	9' X 9'
Principal Couplet	S-3-U	56	Residential Collector	M-2-U	50	30	12' X 12'
Principal Couplet	S-3-U	56	Local	S-2-U	56	20	3' X 3'
Principal Couplet	S-3-U	56	Local	M-2-U	50	20	6' X 6'
Principal Couplet	S-3-U	56	Local	L-2-U (B)	50	30	7' X 7'

*Striped for two lanes (12' width, each)

**Estimated corner clip based on longest leg required. Actual corner clip dimensions required shall be determined on a case by case basis, based on actual width needed for proposed curb radius and barrier free sidewalk construction.

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PLATE IV-12 TABLE (Continued)
TYPE I INTERSECTION
STREET WITHOUT MEDIAN INTERSECTING STREET WITHOUT MEDIAN

INTERSECTING STREETS						R	CORNER CLIP **
Initial Street			Destination Street				
Classification	Section	ROW	Classification	Section	ROW	Ft.	C x C
Principal Couplet	M-3-U	50	Principal Couplet	S-4-U'	60	30	13' X 13'
Principal Couplet	M-3-U	50	Principal Couplet	M-4-U	60	30	11' X 11'
Principal Couplet	M-3-U	50	Principal Couplet	S-3-U	56	35	14' X 14'
Principal Couplet	M-3-U	50	Principal Couplet	M-3-U	50	35	16' X 16'
Principal Couplet	M-3-U	50	Minor Arterial	S-4-U	60	45	25' X 25'
Principal Couplet	M-3-U	50	Minor Arterial/Community Collector	M-4-U	60	45	22' X 22'
Principal Couplet	M-3-U	50	Community Collector	S-2-U	56	45	22' X 22'
Principal Couplet	M-3-U	50	Community Collector	M-2-U	50	45	27' X 27'
Principal Couplet	M-3-U	50	Residential Collector	M-4-U*	60	30	11' X 11'
Principal Couplet	M-3-U	50	Residential Collector	S-2-U	56	30	11' X 11'
Principal Couplet	M-3-U	50	Residential Collector	M-2-U	50	30	15' X 15'
Principal Couplet	M-3-U	50	Local	S-2-U	56	20	5' X 5'
Principal Couplet	M-3-U	50	Local	M-2-U	50	20	8' X 8'
Principal Couplet	M-3-U	50	Local	L-2-U (B)	50	30	9' X 9'
Minor Arterial	S-4-U	60	Principal Couplet	S-4-U	60	30	14' X 14
Minor Arterial	S-4-U	60	Principal Couplet	M-4-U	60	30	11' X 11'
Minor Arterial	S-4-U	60	Principal Couplet	S-3-U	56	35	14' X 14'
Minor Arterial	S-4-U	60	Principal Couplet	M-3-U	50	35	16' X 16'
Minor Arterial	S-4-U	60	Minor Arterial	S-4-U	60	45	25' X 25'
Minor Arterial	S-4-U	60	Minor Arterial	M-4-U	60	45	23' X 23'
Minor Arterial	S-4-U	60	Collector	M-4-U*	60	30	11' X 11'
Minor Arterial	S-4-U	60	Collector	S-2-U	56	30	11' X 11'
Minor Arterial	S-4-U	60	Collector	M-2-U	50	30	15' X 15'
Minor Arterial	S-4-U	60	Local	S-2-U	56	20	5' X 5'
Minor Arterial	S-4-U	60	Local	M-2-U	50	20	8' X 8'
Minor Arterial	S-4-U	60	Local	L-2-U (B)	50	30	9' X 9'
Minor Arterial	M-4-U	60	Principal Couplet	S-4-U	60	30	11' X 11'
Minor Arterial	M-4-U	60	Principal Couplet	M-4-U	60	30	9' X 9'
Minor Arterial	M-4-U	60	Principal Couplet	S-3-U	56	35	12' X 12'
Minor Arterial	M-4-U	60	Principal Couplet	M-3-U	50	35	14' X 14'
Minor Arterial	M-4-U	60	Minor Arterial	S-4-U	60	45	23' X 23'
Minor Arterial	M-4-U	60	Minor Arterial	M-4-U	60	45	18' X 18'
Minor Arterial	M-4-U	60	Collector	M-4-U*	60	30	9' X 9'
Minor Arterial	M-4-U	60	Collector	S-2-U	56	30	9' X 9'
Minor Arterial	M-4-U	60	Collector	M-2-U	50	30	12' X 12'
Minor Arterial	M-4-U	60	Local	S-2-U	56	20	3' X 3'
Minor Arterial	M-4-U	60	Local	M-2-U	50	20	6' X 6'
Minor Arterial	M-4-U	60	Local	L-2-U (B)	50	30	7' X 7'

**Estimated corner clip based on longest leg required. Actual corner clip dimensions required shall be determined on a case by case basis, based on actual width needed for proposed curb radius and barrier free sidewalk construction.

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PLATE IV-12 TABLE (Continued)
TYPE I INTERSECTION
STREET WITHOUT MEDIAN INTERSECTING STREET WITHOUT MEDIAN

INTERSECTING STREETS						R	CORNER CLIP **
Initial Street			Destination Street				
Classification	Section	ROW	Classification	Section	ROW	Ft.	C x C
Collector	M-4-U*	60	Principal Couplet	S-4-U	60	20	5' X 5'
Collector	M-4-U*	60	Principal Couplet	M-4-U	60	20	3' X 3'
Collector	M-4-U*	60	Principal Couplet	S-3-U	56	20	3' X 3'
Collector	M-4-U*	60	Principal Couplet	M-3-U	50	20	5' X 5'
Collector	M-4-U*	60	Minor Arterial	S-4-U	60	20	5' X 5'
Collector	M-4-U*	60	Minor Arterial	M-4-U	60	20	3' X 3'
Collector	M-4-U*	60	Collector	M-4-U*	60	20	3' X 3'
Collector	M-4-U*	60	Collector/Local	S-2-U	56	20	3' X 3'
Collector	M-4-U*	60	Collector/Local	M-2-U	50	20	6' X 6'
Collector	M-4-U*	60	Local	L-2-U (B)	50	20	None
Collector	S-2-U	56	Principal Couplet	S-4-U	60	20	5' X 5'
Collector	S-2-U	56	Principal Couplet	M-4-U	60	20	3' X 3'
Collector	S-2-U	56	Principal Couplet	S-3-U	56	20	3' X 3'
Collector	S-2-U	56	Principal Couplet	M-3-U	50	20	5' X 5'
Collector	S-2-U	56	Minor Arterial	S-4-U	60	20	5' X 5'
Collector	S-2-U	56	Minor Arterial	M-4-U	60	20	3' X 3'
Collector	S-2-U	56	Collector	M-4-U*	60	20	3' X 3'
Collector	S-2-U	56	Collector/Local	S-2-U	56	20	3' X 3'
Collector	S-2-U	56	Collector/Local	M-2-U	50	20	5' X 5'
Collector	S-2-U	56	Local	L-2-U (B)	50	25	4' X 4'
Collector	M-2-U	50	Principal Couplet	S-4-U	60	20	8' X 8'
Collector	M-2-U	50	Principal Couplet	M-4-U	60	20	6' X 6'
Collector	M-2-U	50	Principal Couplet	S-3-U	56	20	6' X 6'
Collector	M-2-U	50	Principal Couplet	M-3-U	50	20	8' X 8'
Collector	M-2-U	50	Minor Arterial	S-4-U	60	20	8' X 8'
Collector	M-2-U	50	Minor Arterial	M-4-U	60	20	6' X 6'
Collector	M-2-U	50	Collector	M-4-U*	60	20	6' X 6'
Collector	M-2-U	50	Collector/Local	S-2-U	56	20	6' X 6'
Collector	M-2-U	50	Collector/Local	M-2-U	50	20	9' X 9'
Collector	M-2-U	50	Local	L-2-U (B)	50	25	7' X 7'
Local	S-2-U	56	Principal Couplet	S-4-U	60	20	5' X 5'
Local	S-2-U	56	Principal Couplet	M-4-U	60	20	3' X 3'
Local	S-2-U	56	Principal Couplet	S-3-U	56	20	3' X 3'
Local	S-2-U	56	Principal Couplet	M-3-U	50	20	5' X 5'
Local	S-2-U	56	Minor Arterial	S-4-U	60	20	5' X 5'
Local	S-2-U	56	Minor Arterial/Collector	M-4-U	60	20	3' X 3'

*Striped for two lanes (12' width, each)

**Estimated corner clip based on longest leg required. Actual corner clip dimensions required shall be determined on a case by case basis, based on actual width needed for proposed curb radius and barrier free sidewalk construction.

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PLATE IV-12 TABLE (Continued)
TYPE I INTERSECTION
STREET WITHOUT MEDIAN INTERSECTING STREET WITHOUT MEDIAN

INTERSECTING STREETS						R	CORNER CLIP **
Initial Street			Destination Street				
Classification	Section	ROW	Classification	Section	ROW	Ft.	C x C
Local	S-2-U	56	Collector/Local	S-2-U	56	20	3' X 3'
Local	S-2-U	56	Collector/Local	M-2-U	50	20	6' X 6'
Local	S-2-U	56	Local	L-2-U (B)	50	20	None
Local	M-2-U	50	Principal Couplet	S-4-U	60	20	8' X 8'
Local	M-2-U	50	Principal Couplet	M-4-U	60	20	6' X 6'
Local	M-2-U	50	Principal Couplet	S-3-U	56	20	6' X 6'
Local	M-2-U	50	Principal Couplet	M-3-U	50	20	8' X 8'
Local	M-2-U	50	Minor Arterial	S-4-U	60	20	8' X 8'
Local	M-2-U	50	Minor Arterial/Collector	M-4-U	60	20	6' X 6'
Local	M-2-U	50	Collector/Local	S-2-U	56	20	6' X 6'
Local	M-2-U	50	Collector/Local	M-2-U	50	20	9' X 9'
Local	M-2-U	50	Local	L-2-U (B)	50	20	4' X 4'
Local	L-2-U (B)	50	Principal Couplet	S-4-U	60	20	3' X 3'
Local	L-2-U (B)	50	Principal Couplet	M-4-U	60	20	None
Local	L-2-U (B)	50	Principal Couplet	S-3-U	56	20	None
Local	L-2-U (B)	50	Principal Couplet	M-3-U	50	20	3' X 3'
Local	L-2-U (B)	50	Minor Arterial	S-4-U	60	20	3' X 3'
Local	L-2-U (B)	50	Minor Arterial/Collector	M-4-U	60	20	None
Local	L-2-U (B)	50	Collector/Local	S-2-U	56	20	None
Local	L-2-U (B)	50	Collector/Local	M-2-U	50	20	4' X 4'
Local	L-2-U (B)	50	Local	L-2-U (B)	50	20	None

*Striped for two lanes (12' width)

**Estimated corner clip based on longest leg required. Actual corner clip dimensions required shall be determined on a case by case basis, based on actual width needed for proposed curb radius and barrier free sidewalk construction.

Page 4 of 4

STREET SECTION DATA

Streets With Medians

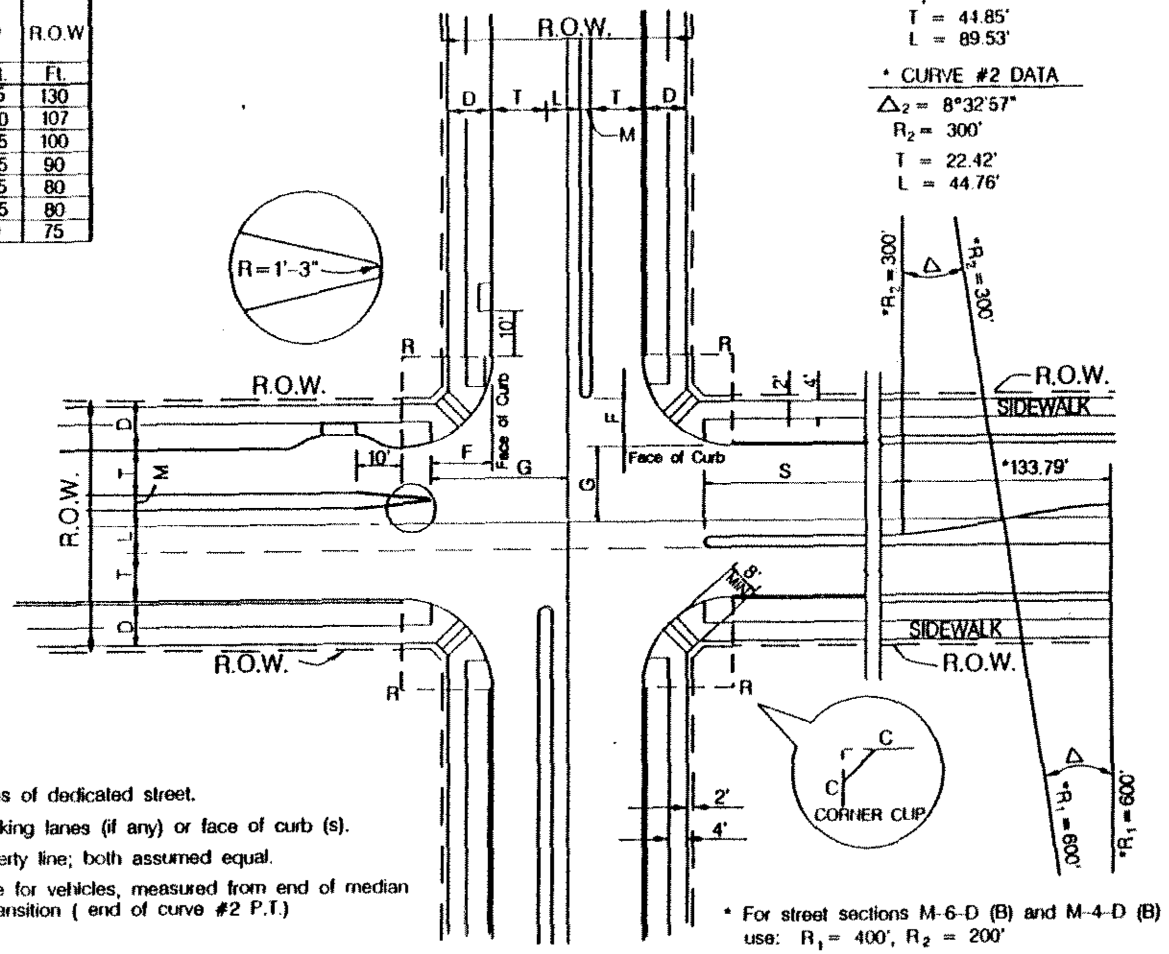
Functional Classification	Street Section Type	Traffic Lanes		T	Left Turn (L)	M	D	R.O.W
		No.	Width	Ft.	Ft.	Ft.	Ft.	Ft.
Principal Arterial	S-8-D	8	12	48	10	5	9.5	130
Principal Arterial	S-6-D	6	12	36	10	5	10.0	107
Principal Arterial	M-6-D(A)	6	11	33	10	5	9.5	100
Principal Arterial	M-6-D(B)	6	10	30	10	5	7.5	90
Minor Arterial	S-4-D	4	12	24	10	5	8.5	80
Minor Arterial	M-4-D(A)	4	11	22	10	5	10.5	80
Minor Arterial	M-4-D(B)	4	10	20	10	5	10	75

SEE PLATE IV – 13 TABLE for minimum S and R values and estimated required corner clips, C x C.

NOTE: LOCATION OF MEDIAN NOSE AND DIMENSIONS F & G SHALL BE DETERMINED BY USE OF WB – 50 TURNING RADIUS.

* CURVE #1 DATA
Δ_1 = 8°32'57"
R_1 = 600'
T = 44.85'
L = 89.53'

* CURVE #2 DATA
Δ_2 = 8°32'57"
R_2 = 300'
T = 22.42'
L = 44.76'



Right-of-way width (R.O.W.) = Distance between property lines of dedicated street.

Travel-way width (T) = Distance between inside edges of parking lanes (if any) or face of curb (s).

Parkway width (D) = Width of parkway, face of curb to property line; both assumed equal.

Storage length (S) = Length of left turn lane storage available for vehicles, measured from end of median nose to ending point of median curb transition (end of curve #2 P.T.)

* For street sections M-6-D (B) and M-4-D (B) use: R_1 = 400', R_2 = 200'

TYPE II INTERSECTION
STREET WITH MEDIAN INTERSECTING STREET WITH MEDIAN

PLATE IV – 13

PLATE IV-13 TABLE
TYPE II INTERSECTION SUMMARY
STREET WITH MEDIAN INTERSECTING STREET WITH MEDIAN

Intersecting Streets				Storage	Typical Corner Curb Return Radius	Typical Corner Clip
Initial Street		Destination Street				
Classification	Section	Classification	Section	S	R	C x C
Principal Arterial		Principal Arterial				
	S-8-D, S-6-D & M-6-D(A)		S-8-D, S-6-D & M-6-D(A)	200'	30'	11' x 11'
	S-8-D, S-6-D & M- 6-D(A)		M-6-D(B)	200'	35'	17' x 17'
	M-6-D(B)		S-8-D	200'	30'	13' x 13'
	M-6-D(B)		S-6-D & M-6-D(A)	200'	35'	17' x 17'
	M-6-D(B)		M-6-D (B)	200'	40'	25' x 25'
Principal Arterial		Minor Arterial				
	S-8-D & S-6-D		S-4-D & M-4-D(A)	150'	40'	18' x 18'
	S-8-D & S-6-D		M-4-D (B)	150'	45'	19' x 19'
	M-6-D(A)		All Sections	150'	45'	23' x 23'
	M-6-D(B)		All Sections	150'	50'	31' x 31'
Minor Arterial		Principal Arterial				
	S-4-D & M-4-D(A)		S-8-D, S-6-D, M-6-D(A)	150'	30'	12' x 12'
	S-4-D & M-4-D(A)		M-6-D(B)	150'	35'	17' x 17'
	M-4-D(B)		S-8-D	150'	30'	10' x 10'
	M-4-D(B)		S-6-D & M-6-D(A)	150'	35'	13' x 13'
	M-4-D(B)		M-6-D(B)	150'	40'	20' x 20'
Minor Arterial		Minor Arterial				
	S-4-D		S-4-D & M-4-D(A)	150'	40'	20' x 20'
	S-4-D		M-4-D(B)	150'	45'	22' x 22'
	M-4-D(A)		All Sections	150'	45'	21' x 21'
	M-4-D(B)		All Sections	150'	50'	25' x 25'

For more detailed information, refer to following detailed Plate IV -13 Table

PLATE IV-13 TABLE
TYPE II INTERSECTION
STREET WITH MEDIAN INTERSECTING STREET WITH MEDIAN

INTERSECTING STREETS						S	R	CORNER
Initial Street			Destination Street			Storage	Radius	CLIP **
Classification	Section	ROW	Classification	Section	ROW	Ft.	Ft.	C x C
Principal Arterial	S-8-D	130	Principal Arterial	S-8-D	130	200	30	11' X 11'
Principal Arterial	S-8-D	130	Principal Arterial	S-6-D	107	200	30	10' X 10'
Principal Arterial	S-8-D	130	Principal Arterial	M-6-D(A)	100	200	30	11' X 11'
Principal Arterial	S-8-D	130	Principal Arterial	M-6-D(B)	90	200	35	17' X 17'
Principal Arterial	S-8-D	130	Minor Arterial	S-4-D	80	150	40	18' X 18'
Principal Arterial	S-8-D	130	Minor Arterial	M-4-D(A)	80	150	40	15' X 15'
Principal Arterial	S-8-D	130	Minor Arterial	M-4-D(B)	75	150	45	19' X 19'
Principal Arterial	S-6-D	107	Principal Arterial	S-8-D	130	200	30	10' X 10'
Principal Arterial	S-6-D	107	Principal Arterial	S-6-D	107	200	30	9' X 9'
Principal Arterial	S-6-D	107	Principal Arterial	M-6-D(A)	100	200	30	10' X 10'
Principal Arterial	S-6-D	107	Principal Arterial	M-6-D(B)	90	200	35	16' X 16'
Principal Arterial	S-6-D	107	Minor Arterial	S-4-D	80	150	40	17' X 17'
Principal Arterial	S-6-D	107	Minor Arterial	M-4-D(A)	80	150	40	15' X 15'
Principal Arterial	S-6-D	107	Minor Arterial	M-4-D(B)	75	150	45	19' X 19'
Principal Arterial	M-6-D(A)	100	Principal Arterial	S-8-D	130	200	30	11' X 11'
Principal Arterial	M-6-D(A)	100	Principal Arterial	S-6-D	107	200	30	10' X 10'
Principal Arterial	M-6-D(A)	100	Principal Arterial	M-6-D(A)	100	200	30	11' X 11'
Principal Arterial	M-6-D(A)	100	Principal Arterial	M-6-D(B)	90	200	35	17' X 17'
Principal Arterial	M-6-D(A)	100	Minor Arterial	S-4-D	80	150	45	23' X 23'
Principal Arterial	M-6-D(A)	100	Minor Arterial	M-4-D(A)	80	150	45	19' X 19'
Principal Arterial	M-6-D(A)	100	Minor Arterial	M-4-D(B)	75	150	45	19' X 19'
Principal Arterial	M-6-D(B)	90	Principal Arterial	S-8-D	130	200	30	13' X 13'
Principal Arterial	M-6-D(B)	90	Principal Arterial	S-6-D	107	200	35	16' X 16'
Principal Arterial	M-6-D(B)	90	Principal Arterial	M-6-D(A)	100	200	35	17' X 17'
Principal Arterial	M-6-D(B)	90	Principal Arterial	M-6-D(B)	90	200	40	25' X 25'
Principal Arterial	M-6-D(B)	90	Minor Arterial	S-4-D	80	150	50	31' X 31'
Principal Arterial	M-6-D(B)	90	Minor Arterial	M-4-D(A)	80	150	50	28' X 28'
Principal Arterial	M-6-D(B)	90	Minor Arterial	M-4-D(B)	75	150	50	28' X 28'
Minor Arterial	S-4-D	80	Principal Arterial	S-8-D	130	150	30	12' X 12'
Minor Arterial	S-4-D	80	Principal Arterial	S-6-D	107	150	30	11' X 11'
Minor Arterial	S-4-D	80	Principal Arterial	M-6-D(A)	100	150	30	12' X 12'
Minor Arterial	S-4-D	80	Principal Arterial	M-6-D(B)	90	150	35	17' X 17'
Minor Arterial	S-4-D	80	Minor Arterial	S-4-D	80	150	40	20' X 20'
Minor Arterial	S-4-D	80	Minor Arterial	M-4-D(A)	80	150	40	17' X 17'
Minor Arterial	S-4-D	80	Minor Arterial	M-4-D(B)	75	150	45	22' X 22'
Minor Arterial	M-4-D(A)	80	Principal Arterial	S-8-D	130	150	30	10' X 10'
Minor Arterial	M-4-D(A)	80	Principal Arterial	S-6-D	107	150	30	9' X 9'
Minor Arterial	M-4-D(A)	80	Principal Arterial	M-6-D(A)	100	150	30	10' X 10'
Minor Arterial	M-4-D(A)	80	Principal Arterial	M-6-D(B)	90	150	35	16' X 16'
Minor Arterial	M-4-D(A)	80	Minor Arterial	S-4-D	80	150	45	21' X 21'
Minor Arterial	M-4-D(A)	80	Minor Arterial	M-4-D(A)	80	150	45	17' X 17'
Minor Arterial	M-4-D(A)	80	Minor Arterial	M-4-D(B)	75	150	45	18' X 18'
Minor Arterial	M-4-D(B)	75	Principal Arterial	S-8-D	130	150	30	10' X 10'
Minor Arterial	M-4-D(B)	75	Principal Arterial	S-6-D	107	150	35	12' X 12'
Minor Arterial	M-4-D(B)	75	Principal Arterial	M-6-D(A)	100	150	35	13' X 13'
Minor Arterial	M-4-D(B)	75	Principal Arterial	M-6-D(B)	90	150	40	20' X 20'
Minor Arterial	M-4-D(B)	75	Minor Arterial	S-4-D	80	150	50	25' X 25'
Minor Arterial	M-4-D(B)	75	Minor Arterial	M-4-D(A)	80	150	50	22' X 22'
Minor Arterial	M-4-D(B)	75	Minor Arterial	M-4-D(B)	75	150	50	23' X 23'

*Striped for two lanes (12' width)

**Estimated corner clip based on longest leg required. Actual corner clip dimensions required shall be determined on a a case by case basis, based on actual width needed for proposed curb radius and barrier free sidewalk construction.

** CURVE #1 DATA

Δ_1 = 10°28'31"
R_1 = 400'
T_1 = 36.67'
L_1 = 73.13'

** CURVE #2 DATA

Δ_2 = 10°28'31"
R_2 = 200'
T_2 = 18.33'
L_2 = 36.57'

** For Street Sections S-6-D at arterials use R_1 = 600' and R_2 = 300'.

For Street Sections M-6-D(B) and M-4-D(B) at Locals, Collectors, and Minor Arterials use:

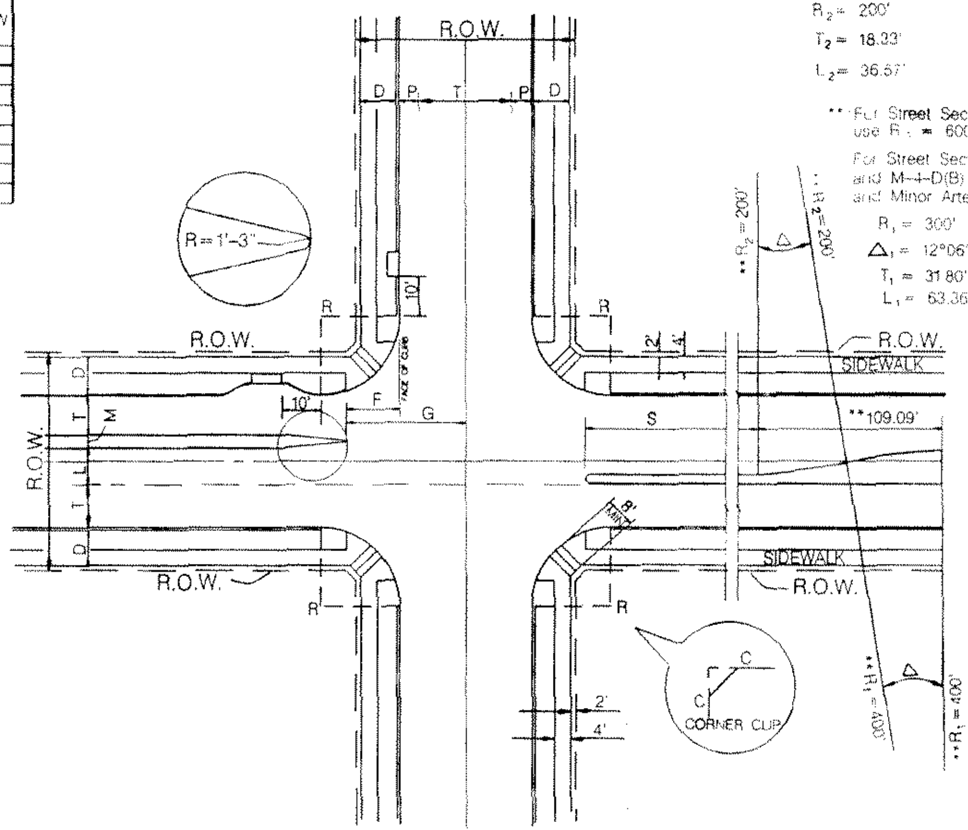
R_1 = 300'	R_2 = 150'
Δ_1 = 12°06'05"	Δ_2 = 12°06'05"
T_1 = 31.80'	T_2 = 15.90'
L_1 = 63.36'	L_2 = 31.68'

STREET SECTION DATA

Streets With Medians

Functional Classification	Street Section Type	Traffic Lanes		T	Left Turn (L)	D	M	R.O.W
		No.	Width	Ft.	Ft.	Ft.	Ft.	Ft.
Principal Arterial	S-8-D	8	12	96	10	5	9.5	130
Principal Arterial	S-6-D	6	12	72	10	5	10.0	107
Principal Arterial	M-6-D(A)	6	11	66	10	5	9.5	100
Principal Arterial	M-6-D(B)	6	10	60	10	5	7.5	90
Minor Arterial	S-4-D	4	12	48	10	5	8.5	80
Minor Arterial	M-4-D(A)	4	11	44	10	5	10.5	80
Minor Arterial	M-4-D(B)	4	10	40	10	5	10	75

SEE PLATE IV - 14 Table for minimum S and R values and estimated required corner clips, C x C.



STREET SECTION DATA

Streets Without Medians

Functional Classification	Street Section Type	Traffic Lanes		T	Parking Lanes (P)		D	R.O.W
		No.	Width	Ft.	No.	Ft.	Ft.	Ft.
Principal Couplet	S-4-U	4	11	44	0	0	8.0	60
Principal Couplet	M-4-U	4	10	40	0	0	10.0	60
Principal Couplet	S-3-U	3	12	36	0	0	10.0	56
Principal Couplet	M-3-U	3	11	33	0	0	8.5	50
Minor	S-4-U	4	11	44	0	0	8.0	60
Minor	M-4-U	4	10	40	0	0	10.0	60
Community Collector	M-4-U*	2	12	24	2	8	10.0	60
Community Collector	S-2-U	2	10	20	2	8	10.0	56
Community Collector	M-2-U	2	10	20	2	8	7.0	50
Residential Collector	M-4-U*	2	12	24	2	8	10.0	60
Residential Collector	S-2-U	2	10	20	2	8	10.0	56
Residential Collector	M-2-U	2	10	20	2	8	7.0	50
Local	S-2-U	2	10	20	2	8	10.0	56
Local	M-2-U	2	10	20	2	8	7.0	50
Local	L-2-U (A)	1	17	17	2	8	10.0	53
Local	L-2-U (B)	1	10	10	2	8	12.0	50

* Striped for two lanes.

NOTE: LOCATION OF MEDIAN NOSE AND DIMENSIONS F & G SHALL BE DETERMINED BY USE OF WB - 50 AND SU TURNING RADIUS.

Right-of-way width (R.O.W.) = Distance between property lines of dedicated street.

Travel-way width (T) = Distance between inside edges of parking lanes (if any) or face of curb (s).

Parking Lane width (P) = Width of curbside parking lane, measured from face of curb, set to 0 if none.

Parkway width (D) = Width of parkway, face of curb to property line; both assumed equal.

TYPE III INTERSECTION

STREET WITH MEDIAN INTERSECTING STREET WITHOUT MEDIAN

PLATE IV - 14

File name: usr4/hollowayarch

PLATE IV-14 TABLE
TYPE III INTERSECTION SUMMARY
STREET WITH MEDIAN INTERSECTING STREET WITHOUT MEDIAN

INTERSECTING STREETS				Storage	Typical Corner Curb Return Radius	Typical Corner Clip
Initial Street		Destination Street				
Classification	Section	Classification	Section	S	R	C x C
Principal Arterial (Divided)		Principal Couplet				
	All Sections		S-4-U & M-4-U	200'	30'	12' x 12' 1)
	All Sections		S-3-U & M-3-U	200'	35'	15' x 15' 1)
Principal Arterial (Divided)		Minor Arterial				
	S-8-D, S-6-D & M-6-D(A)		All Sections	150'	40' 2)	19' x 19'
	M-6-D(B)		All Sections	150'	45'	27' x 27'
Principal Arterial (Divided)		Community Collector				
	S-8-D, S-6-D & M-6-D(A)		All Sections 3)	100'	45'	19' x 19' 4)
	M-6-D(B)		All Sections 3)	100'	50'	28' x 28' 4)
Principal Arterial (Divided)		Residential Collector & Local				
	S-8-D, S-6-D & M-6-D(A)		All Sections	90'	30'	10' x 10' 4)
	M-6-D(B)		All Sections	90'	35'	16' x 16' 4)
Minor Arterial (Divided)		Principal Couplet				
	All Sections		S-4-U & M-4-U	150'	25' 5)	9' x 9' 5)
	All Sections		S-3-U & M-3-U	150'	30' 5)	11' x 11' 5)
Minor Arterial (Divided)		Minor Arterial				
	S-4-D & M-4-D(A)		All Sections	150'	40'	21' x 21' 6)
	M-4-D(B)		All Sections	150'	45'	23' x 23'
Minor Arterial (Divided)		Collectors & Local				
	S-4-D & M-4-D(A)		All Sections	90'	25'	8' x 8' 4)
	M-4-D(B)		All Sections	90'	30'	9' x 9' 4)
Principal Couplet		Principal Arterial (Divided)				
	All Sections		S-8-D & S-6-D	--	30'	11' x 11'
	All Sections		M-6-D(A) & M-6-D(B)	--	35' 7)	15' x 15' 1)
Principal Couplet		Minor Arterial (Divided)				
	All Sections		All Sections	--	45 8)	23' x 23' 8)

1) Principal Arterial M-6-D(B) requires a larger corner clip.
2) Principal Arterial M-6-D(A) requires a 45' corner curb return radius with the Minor Arterial M-4-U section.
3) Community Collector M-4-U* allows a 5' smaller corner curb return radius and smaller corner clip.
4) Local/Collector M-2-U requires a larger corner clip.
5) Minor Arterial M-4-D(B) requires an additional 5' corner curb return radius with a larger corner clip.
6) Minor Arterial M-4-U allows a smaller corner clip.
7) Principal Couplet M-4-U requires a 40' corner curb return radius with the Principal Arterial M-6-D(B)
8) Principal Couplet S-4-U, M-4-U & M-3-U require a 50' corner curb return radius with the Minor Arterial M-4-D(B) section with a larger corner clip.

PLATE IV-14 TABLE (Continued)
TYPE III INTERSECTION SUMMARY
STREET WITH MEDIAN INTERSECTING STREET WITHOUT MEDIAN

INTERSECTING STREETS				Storage	Typical Corner Curb Return Radius	Typical Corner Clip
Initial Street		Destination Street				
Classification	Section	Classification	Section	S	R	C x C
Minor Arterial		Principal Arterial (Divided)				
	All Sections		S-8-D & S-6-D	--	30'	11' x 11'
	All Sections		M-6-D(A) & M-6-D(B)	--	35' 9)	15' x 15' 1)
Minor Arterial		Minor Arterial (Divided)				
	All Sections		S-4-D & M-4-D(A)	--	45'	25' x 25'
	All Sections		M-4-D(B)	--	50'	27' x 27'
Community Collector		Principal Arterial (Divided)				
	All Sections		All Sections	--	20' 10)	4' x 4' 1),4)
Residential Collector		Principal Arterial (Divided)				
	All Sections		All Sections	--	20'	4' x 4' 1),4)
Collectors		Minor Arterial (Divided)				
	All Sections		All Sections	--	20'	5' x 5' 4),11),12)
Local		Principal Arterial (Divided)				
	All Sections		All Sections	--	20'	4' x 4' 4),13)
Local		Minor Arterial (Divided)				
	All Sections		All Sections	--	20'	5' x 5' 4),11),12),13)

1) Principal Arterial M-6-D(B) requires a larger corner clip.
3) Community Collector M-4-U* allows a 5' smaller corner curb return radius and smaller corner clip.
4) Community Collector M-2-U requires a larger corner clip.
9) Minor Arterial M-4-U requires a 40' corner curb return radius for the Principal Arterial M-6-D(B)
10) Community Collector M-2-U requires a 25' corner curb return radius for the Principal Arterial M-6-D(B)
11) Minor Arterial M-4-D(A) allows a smaller corner clip
12) Minor Arterial M-4-D(B) allows a smaller corner clip
13) Local L-2-U(B) allows no corner clip for Principal Arterial S-8-D, S-6-D & M-6-D(A) or for Minor Arterial M-4-D(A) and M-4-D(B).

For more detailed information, refer to following detailed Plate IV-14 Table

PLATE IV-14 TABLE
TYPE III INTERSECTION
STREET WITH MEDIAN INTERSECTING STREET WITHOUT MEDIAN

INTERSECTING STREETS						S	R	CORNER CLIP **
Initial Street			Destination Street					
Classification	Section	ROW	Classification	Section	ROW	Ft.	Ft.	C x C
Principal Arterial	S-8-D	130	Principal Couplet	S-4-U	60	200	30	12' X 12'
Principal Arterial	S-8-D	130	Principal Couplet	M-4-U	60	200	30	10' X 10'
Principal Arterial	S-8-D	130	Principal Couplet	S-3-U	56	200	35	13' X 13'
Principal Arterial	S-8-D	130	Principal Couplet	M-3-U	50	200	35	15' X 15'
Principal Arterial	S-8-D	130	Minor Arterial	S-4-U	60	150	40	19' X 19'
Principal Arterial	S-8-D	130	Minor/Community Collector	M-4-U	60	150/100	40	16' X 16'
Principal Arterial	S-8-D	130	Community Collector	S-2-U	56	100	45	19' X 19'
Principal Arterial	S-8-D	130	Community Collector	M-2-U	50	100	45	27' X 27'
Principal Arterial	S-8-D	130	Residential Collector	M-4-U*	60	90	30	10' X 10'
Principal Arterial	S-8-D	130	Residential Collector/Local	S-2-U	56	90	30	10' X 10'
Principal Arterial	S-8-D	130	Residential Collector/Local	M-2-U	50	90	30	13' X 13'
Principal Arterial	S-8-D	130	Local	L-2-U(B)	50	90	30	8' X 8'
Principal Arterial	S-6-D	107	Principal Couplet	S-4-U	60	200	30	11' X 11'
Principal Arterial	S-6-D	107	Principal Couplet	M-4-U	60	200	30	9' X 9'
Principal Arterial	S-6-D	107	Principal Couplet	S-3-U	56	200	35	12' X 12'
Principal Arterial	S-6-D	107	Principal Couplet	M-3-U	50	200	35	14' X 14'
Principal Arterial	S-6-D	107	Minor Arterial	S-4-U	60	150	40	18' X 18'
Principal Arterial	S-6-D	107	Minor/Community Collector	M-4-U	60	150/100	40	15' X 15'
Principal Arterial	S-6-D	107	Community Collector	S-2-U	56	100	45	18' X 18'
Principal Arterial	S-6-D	107	Community Collector	M-2-U	50	100	45	27' X 27'
Principal Arterial	S-6-D	107	Residential Collector	M-4-U*	60	90	30	9' X 9'
Principal Arterial	S-6-D	107	Residential Collector/Local	S-2-U	56	90	30	9' X 9'
Principal Arterial	S-6-D	107	Residential Collector/Local	M-2-U	50	90	30	12' X 12'
Principal Arterial	S-6-D	107	Local	L-2-U(B)	50	90	30	7' X 7'
Principal Arterial	M-6-D(A)	100	Principal Couplet	S-4-U	60	200	30	12' X 12'
Principal Arterial	M-6-D(A)	100	Principal Couplet	M-4-U	60	200	30	10' X 10'
Principal Arterial	M-6-D(A)	100	Principal Couplet	S-3-U	56	200	35	13' X 13'
Principal Arterial	M-6-D(A)	100	Principal Couplet	M-3-U	50	200	35	15' X 15'
Principal Arterial	M-6-D(A)	100	Minor Arterial	S-4-U	60	150	40	19' X 19'
Principal Arterial	M-6-D(A)	100	Minor/Community Collector	M-4-U	60	150/100	45	19' X 19'
Principal Arterial	M-6-D(A)	100	Community Collector	S-2-U	56	100	45	19' X 19'
Principal Arterial	M-6-D(A)	100	Community Collector	M-2-U	50	100	45	27' X 27'
Principal Arterial	M-6-D(A)	100	Residential Collector	M-4-U*	60	90	30	10' X 10'
Principal Arterial	M-6-D(A)	100	Residential Collector/Local	S-2-U	56	90	30	10' X 10'
Principal Arterial	M-6-D(A)	100	Residential Collector/Local	M-2-U	50	90	30	13' X 13'
Principal Arterial	M-6-D(A)	100	Local	L-2-U(B)	50	90	30	8' X 8'
Principal Arterial	M-6-D(B)	90	Principal Couplet	S-4-U	60	200	30	14' X 14'
Principal Arterial	M-6-D(B)	90	Principal Couplet	M-4-U	60	200	30	12' X 12'
Principal Arterial	M-6-D(B)	90	Principal Couplet	S-3-U	56	200	35	16' X 16'
Principal Arterial	M-6-D(B)	90	Principal Couplet	M-3-U	50	200	35	17' X 17'
Principal Arterial	M-6-D(B)	90	Minor Arterial	S-4-U	60	150	45	27' X 27'
Principal Arterial	M-6-D(B)	90	Minor/Community Collector	M-4-U	60	150/100	45	26' X 26'
Principal Arterial	M-6-D(B)	90	Community Collector	S-2-U	56	100	50	28' X 28'
Principal Arterial	M-6-D(B)	90	Community Collector	M-2-U	50	100	50	33' X 33'
Principal Arterial	M-6-D(B)	90	Residential Collector	M-4-U*	60	90	35	16' X 16'
Principal Arterial	M-6-D(B)	90	Residential Collector/Local	S-2-U	56	90	35	16' X 16'
Principal Arterial	M-6-D(B)	90	Residential Collector/Local	M-2-U	50	90	35	18' X 18'
Principal Arterial	M-6-D(B)	90	Local	L-2-U(B)	50	90	35	14' X 14'

*Striped for two lanes (12' width, each)

**Estimated corner clip based on longest leg required. Actual corner clip dimensions required shall be determined on a case by case basis, based on actual width needed for proposed curb radius and barrier free sidewalk construction.

PLATE IV-14 TABLE (Continued)
TYPE III INTERSECTION
STREET WITH MEDIAN INTERSECTING STREET WITHOUT MEDIAN

INTERSECTING STREETS						S	R	CORNER CLIP ***
Initial Street			Destination Street					
Classification	Section	ROW	Classification	Section	ROW	Ft.	Ft.	C x C
Minor Arterial	S-4-D	80	Principal Couplet	S-4-U	60	150	25	9' X 9'
Minor Arterial	S-4-D	80	Principal Couplet	M-4-U	60	150	25	8' X 8'
Minor Arterial	S-4-D	80	Principal Couplet	S-3-U	56	150	30	11' X 11'
Minor Arterial	S-4-D	80	Principal Couplet	M-3-U	50	150	30	13' X 13'
Minor Arterial	S-4-D	80	Minor Arterial	S-4-U	60	150	40	21' X 21'
Minor Arterial	S-4-D	80	Minor Arterial	M-4-U	60	150/100	40	17' X 17'
Minor Arterial	S-4-D	80	Collector	M-4-U**	60	90*	25	8' X 8'
Minor Arterial	S-4-D	80	Collector/Local	S-2-U	56	90*	25	8' X 8'
Minor Arterial	S-4-D	80	Collector/Local	M-2-U	50	90*	25	11' X 11'
Minor Arterial	S-4-D	80	Local	L-2-U(B)	50	90	25	6' X 6'
Minor Arterial	M-4-D(A)	80	Principal Couplet	S-4-U	60	150	25	8' X 8'
Minor Arterial	M-4-D(A)	80	Principal Couplet	M-4-U	60	150	25	6' X 6'
Minor Arterial	M-4-D(A)	80	Principal Couplet	S-3-U	56	150	30	9' X 9'
Minor Arterial	M-4-D(A)	80	Principal Couplet	M-3-U	50	150	30	11' X 11'
Minor Arterial	M-4-D(A)	80	Minor Arterial	S-4-U	60	150	40	18' X 18'
Minor Arterial	M-4-D(A)	80	Minor Arterial	M-4-U	60	150/100	40	15' X 15'
Minor Arterial	M-4-D(A)	80	Collector	M-4-U**	60	90*	25	6' X 6'
Minor Arterial	M-4-D(A)	80	Collector/Local	S-2-U	56	90*	25	6' X 6'
Minor Arterial	M-4-D(A)	80	Collector/Local	M-2-U	50	90*	25	8' X 8'
Minor Arterial	M-4-D(A)	80	Local	L-2-U(B)	50	90	25	4' X 4'
Minor Arterial	M-4-D(B)	75	Principal Couplet	S-4-U	60	150	30	11' X 11'
Minor Arterial	M-4-D(B)	75	Principal Couplet	M-4-U	60	150	30	9' X 9'
Minor Arterial	M-4-D(B)	75	Principal Couplet	S-3-U	56	150	35	12' X 12'
Minor Arterial	M-4-D(B)	75	Principal Couplet	M-3-U	50	150	35	14' X 14'
Minor Arterial	M-4-D(B)	75	Minor Arterial	S-4-U	60	150	45	23' X 23'
Minor Arterial	M-4-D(B)	75	Minor Arterial	M-4-U	60	150/100	45	18' X 18'
Minor Arterial	M-4-D(B)	75	Collector	M-4-U**	60	90*	30	9' X 9'
Minor Arterial	M-4-D(B)	75	Collector/Local	S-2-U	56	90*	30	9' X 9'
Minor Arterial	M-4-D(B)	75	Collector/Local	M-2-U	50	90*	30	12' X 12'
Minor Arterial	M-4-D(B)	75	Local	L-2-U(B)	50	90	30	7' X 7'
Principal Couplet	S-4-U	60	Principal Arterial	S-8-D	130	--	30	12' X 12'
Principal Couplet	S-4-U	60	Principal Arterial	S-6-D	107	--	30	11' X 11'
Principal Couplet	S-4-U	60	Principal Arterial	M-6-D(A)	100	--	35	15' X 15'
Principal Couplet	S-4-U	60	Principal Arterial	M-6-D(B)	90	--	35	17' X 17'
Principal Couplet	S-4-U	60	Minor Arterial	S-4-D	80	--	45	25' X 25'
Principal Couplet	S-4-U	60	Minor Arterial	M-4-D(A)	80	--	45	22' X 22'
Principal Couplet	S-4-U	60	Minor Arterial	M-4-D(B)	75	--	50	27' X 27'
Principal Couplet	M-4-U	60	Principal Arterial	S-8-D	130	--	30	10' X 10'
Principal Couplet	M-4-U	60	Principal Arterial	S-6-D	107	--	30	9' X 9'
Principal Couplet	M-4-U	60	Principal Arterial	M-6-D(A)	100	--	35	13' X 13'
Principal Couplet	M-4-U	60	Principal Arterial	M-6-D(B)	90	--	40	20' X 20'
Principal Couplet	M-4-U	60	Minor Arterial	S-4-D	80	--	45	22' X 22'
Principal Couplet	M-4-U	60	Minor Arterial	M-4-D(A)	80	--	45	18' X 18'
Principal Couplet	M-4-U	60	Minor Arterial	M-4-D(B)	75	--	50	23' X 23'

*For community collector thoroughfares, the storage(s) is increased to 100 feet.

**Stripped for two lanes (12' width, each)

***Estimated corner clip based on longest leg required. Actual corner clip dimensions required shall be determined on a case by case basis, based on actual width needed for proposed curb radius and barrier free sidewalk construction.

PLATE IV-14 TABLE (Continued)
TYPE III INTERSECTION
STREET WITH MEDIAN INTERSECTING STREET WITHOUT MEDIAN

INTERSECTING STREETS						S	R	CORNER CLIP **
Initial Street			Destination Street					
Classification	Section	ROW	Classification	Section	ROW	Ft.	Ft.	C x C
Principal Couplet	S-3-U	56	Principal Arterial	S-8-D	130	--	30	10' X 10'
Principal Couplet	S-3-U	56	Principal Arterial	S-6-D	107	--	30	9' X 9'
Principal Couplet	S-3-U	56	Principal Arterial	M-6-D(A)	100	--	35	13' X 13'
Principal Couplet	S-3-U	56	Principal Arterial	M-6-D(B)	90	--	35	16' X 16'
Principal Couplet	S-3-U	56	Minor Arterial	S-4-D	80	--	45	22' X 22'
Principal Couplet	S-3-U	56	Minor Arterial	M-4-D(A)	80	--	45	18' X 18'
Principal Couplet	S-3-U	56	Minor Arterial	M-4-D(B)	75	--	45	18' X 18'
Principal Couplet	M-3-U	50	Principal Arterial	S-8-D	130	--	30	12' X 12'
Principal Couplet	M-3-U	50	Principal Arterial	S-6-D	107	--	30	11' X 11'
Principal Couplet	M-3-U	50	Principal Arterial	M-6-D(A)	100	--	35	15' X 15'
Principal Couplet	M-3-U	50	Principal Arterial	M-6-D(B)	90	--	35	17' X 17'
Principal Couplet	M-3-U	50	Minor Arterial	S-4-D	80	--	45	23' X 23'
Principal Couplet	M-3-U	50	Minor Arterial	M-4-D(A)	80	--	45	21' X 21'
Principal Couplet	M-3-U	50	Minor Arterial	M-4-D(B)	75	--	50	25' X 25'
Minor Arterial	S-4-U	60	Principal Arterial	S-8-D	130	--	30	12' X 12'
Minor Arterial	S-4-U	60	Principal Arterial	S-6-D	107	--	30	11' X 11'
Minor Arterial	S-4-U	60	Principal Arterial	M-6-D(A)	100	--	35	15' X 15'
Minor Arterial	S-4-U	60	Principal Arterial	M-6-D(B)	90	--	35	17' X 17'
Minor Arterial	S-4-U	60	Minor Arterial	S-4-D	80	--	45	25' X 25'
Minor Arterial	S-4-U	60	Minor Arterial	M-4-D(A)	80	--	45	22' X 22'
Minor Arterial	S-4-U	60	Minor Arterial	M-4-D(B)	75	--	50	27' X 27'
Minor Arterial	M-4-U	60	Principal Arterial	S-8-D	130	--	30	10' X 10'
Minor Arterial	M-4-U	60	Principal Arterial	S-6-D	107	--	30	9' X 9'
Minor Arterial	M-4-U	60	Principal Arterial	M-6-D(A)	100	--	35	13' X 13'
Minor Arterial	M-4-U	60	Principal Arterial	M-6-D(B)	90	--	40	20' X 20'
Minor Arterial	M-4-U	60	Minor Arterial	S-4-D	80	--	45	22' X 22'
Minor Arterial	M-4-U	60	Minor Arterial	M-4-D(A)	80	--	45	18' X 18'
Minor Arterial	M-4-U	60	Minor Arterial	M-4-D(B)	75	--	50	23' X 23'
Community Collector	M-4-U*	60	Principal Arterial	S-8-D	130	--	20	4' X 4'
Community Collector	M-4-U*	60	Principal Arterial	S-6-D	107	--	20	3' X 3'
Community Collector	M-4-U*	60	Principal Arterial	M-6-D(A)	100	--	20	4' X 4'
Community Collector	M-4-U*	60	Principal Arterial	M-6-D(B)	90	--	20	6' X 6'
Collector	M-4-U*	60	Minor Arterial	S-4-D	80	--	20	5' X 5'
Collector	M-4-U*	60	Minor Arterial	M-4-D(A)	80	--	20	3' X 3'
Collector	M-4-U*	60	Minor Arterial	M-4-D(B)	75	--	20	3' X 3'
Community Collector	S-2-U	56	Principal Arterial	S-8-D	130	--	20	4' X 4'
Community Collector	S-2-U	56	Principal Arterial	S-6-D	107	--	20	3' X 3'
Community Collector	S-2-U	56	Principal Arterial	M-6-D(A)	100	--	20	4' X 4'
Community Collector	S-2-U	56	Principal Arterial	M-6-D(B)	90	--	20	6' X 6'
Collector/Local	S-2-U	56	Minor Arterial	S-4-D	80	--	20	5' X 5'
Collector/Local	S-2-U	56	Minor Arterial	M-4-D(A)	80	--	20	3' X 3'
Collector/Local	S-2-U	56	Minor Arterial	M-4-D(B)	75	--	20	3' X 3'
Community Collector	M-2-U	50	Principal Arterial	S-8-D	130	--	20	7' X 7'
Community Collector	M-2-U	50	Principal Arterial	S-6-D	107	--	20	6' X 6'
Community Collector	M-2-U	50	Principal Arterial	M-6-D(A)	100	--	20	7' X 7'
Community Collector	M-2-U	50	Principal Arterial	M-6-D(B)	90	--	25	10' X 10'

*Striped for two lanes (12' width, each)

**Estimated corner clip based on longest leg required. Actual corner clip dimensions required shall be determined on a case by case basis, based on actual width needed for proposed curb radius and barrier free sidewalk construction.

PLATE IV-14 TABLE (Continued)
TYPE III INTERSECTION
STREET WITH MEDIAN INTERSECTING STREET WITHOUT MEDIAN

INTERSECTING STREETS						S	R	CORNER CLIP **
Initial Street			Destination Street					
Classification	Section	ROW	Classification	Section	ROW	Ft.	Ft.	C x C
Collector/Local	M-2-U	50	Minor Arterial	S-4-D	80	--	20	8' X 8'
Collector/Local	M-2-U	50	Minor Arterial	M-4-D(A)	80	--	20	6' X 6'
Collector/Local	M-2-U	50	Minor Arterial	M-4-D(B)	75	--	20	6' X 6'
Residential Collector	M-4-U*	60	Principal Arterial	S-8-D	130	--	20	4' X 4'
Residential Collector	M-4-U*	60	Principal Arterial	S-6-D	107	--	20	3' X 3'
Residential Collector	M-4-U*	60	Principal Arterial	M-6-D(A)	100	--	20	4' X 4'
Residential Collector	M-4-U*	60	Principal Arterial	M-6-D(B)	90	--	20	6' X 6'
Residential Collector/Local	S-2-U	56	Principal Arterial	S-8-D	130	--	20	4' X 4'
Residential Collector/Local	S-2-U	56	Principal Arterial	S-6-D	107	--	20	3' X 3'
Residential Collector/Local	S-2-U	56	Principal Arterial	M-6-D(A)	100	--	20	4' X 4'
Residential Collector/Local	S-2-U	56	Principal Arterial	M-6-D(B)	90	--	20	6' X 6'
Residential Collector/Local	M-2-U	50	Principal Arterial	S-8-D	130	--	20	7' X 7'
Residential Collector/Local	M-2-U	50	Principal Arterial	S-6-D	107	--	20	6' X 6'
Residential Collector/Local	M-2-U	50	Principal Arterial	M-6-D(A)	100	--	20	7' X 7'
Residential Collector/Local	M-2-U	50	Principal Arterial	M-6-D(B)	90	--	20	9' X 9'
Local	L-2-U(B)	50	Principal Arterial	S-8-D	130	--	20	None
Local	L-2-U(B)	50	Principal Arterial	S-6-D	107	--	20	None
Local	L-2-U(B)	50	Principal Arterial	M-6-D(A)	100	--	20	None
Local	L-2-U(B)	50	Principal Arterial	M-6-D(B)	90	--	20	4' X 4'
Local	L-2-U(B)	50	Minor Arterial	S-4-D	80	--	20	3' X 3'
Local	L-2-U(B)	50	Minor Arterial	M-4-D(A)	80	--	20	None
Local	L-2-U(B)	50	Minor Arterial	M-4-D(B)	75	--	20	None

*Striped for two lanes (12' width, each)
**Estimated corner clip based on longest leg required. Actual corner clip dimensions required shall be determined on a case by case basis, based on actual width needed for proposed curb radius and barrier free sidewalk construction.

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triangle-shaped clip having legs equal to the longest required dimension needed to cover the required curb return and a theoretical diagonal construction line measured eight feet radially outward from the face of the curb at the center of the curb return (see Plate IV-12). The required corner clip is a function of the curb radius and the parkway width of the intersecting streets. The actual corner clip's shape and dimension requirements shall be determined on a case by case basis, based on the actual additional right-of-way needed for the proposed curb radius and barrier-free sidewalk construction.

For examples on the use of Plate IV-12 Table, Plate IV-13 Table, and Plate IV-14 Table see APPENDIX "D" STREET CENTERLINE AND CORNER CURB RETURN RADII DETERMINATIONS - EXAMPLES.

3. Special Intersections

Streets and thoroughfares often intersect at angles less than 90 degrees. The curb return radii required to fit the minimum paths of the design vehicles are larger than those for standard 90 degree intersections. Presented in Figures IV-1, IV-2 and IV-3 are drawings which show design data for the P, SU and WB-50 Design Vehicles. Special intersections shall be designed using this data and the principles provided in Section 4.03.03.d.1 Street Intersections, Page IV-26.

e. Dead-End Streets

A standard turnaround must be provided in the design of dead-end streets. Normally, the standard turnaround is circular. The minimum radius for the circular turnaround is 50 feet for the right-of-way and 43.5 feet for the pavement measured to the back of the curb. The alternate T-shaped turnaround may be provided when specifically approved by the Director of Public Works and Transportation. The length of permanent dead-end streets must not exceed 600 feet, measured along the dead-end street centerline from the block corner to the center of the cul-de-sac. The length of a permanent dead-end street may be extended upon specific approval of the Director of Public Works and Transportation.

4.03.04 Vertical Alignment

a. <u>Street Grades</u> (See Appendix "A")

The vertical alignment of City streets and thoroughfares shall be designed to insure the safe operation of vehicles by the traveling public and allow easy access to adjacent property. A vertical alignment which is safe for vehicles depends on operating speed, maximum grades, vertical curves and sight distance. Other factors affecting vertical alignment include storm drainage, crown or crossfall and the relationship between grade and right-of-way elevation. The grade of the street or thoroughfare, particularly at its intersection with another grade, is of prime importance in providing a safe, comfortable riding surface to the motoring public. The intersection design of two arterials shall include grades which will result in a plane surface or at least a surface which approximates a plane surface. A motorist traveling on either thoroughfare shall be able to traverse the intersection at the design speed without discomfort. To accomplish a smooth transition, crossfall toward the median of one lane of each thoroughfare may be required. A storm drainage inlet may also be required in the median.

In presenting the grades of intersecting streets in the paving plans, profiles of all top of curbs (including median curbs) of a street shall be shown as a continuous grade through the intersection of the other street.

1. <u>Minimum Grades</u>

Minimum longitudinal grades for streets and thoroughfares are required to insure proper flow of surface drainage toward inlets. The minimum desirable grade is five tenths (0.5) percent. The minimum acceptable grade is four tenths (0.4) percent where use of the minimum desirable grade is not practical. Drainage from the adjoining properties must be maintained.

Where valley gutters are used for intersecting drainage, the minimum grade for valley gutters is four tenths (0.4) percent for concrete. Asphaltic concrete valley gutters are not permitted.

2. Maximum Grades

Maximum longitudinal grades shall be compatible with the classification of street and the accompanying characteristics including the design speed, traffic conditions, and sight distance.

Arterial thoroughfares must move large volumes of traffic at higher speeds, and flatter grades will better accommodate these characteristics. Truck and bus traffic on these type facilities often control traffic movement, particularly if steep grades prevent normal speeds. The normal maximum street grades allowed for City of Dallas streets are shown in Table IV-15. Steeper grades may be permitted for short lengths when restricted by topographical features or the alignment of the street.

TABLE IV-15

MAXIMUM STREET GRADES

STREET TYPE	NORMAL MAXIMUM GRADE IN PERCENT
Local Streets	10%
All Collector Streets	8%
All Arterial Thoroughfares	6%

3. Superelevation (Crossfall)

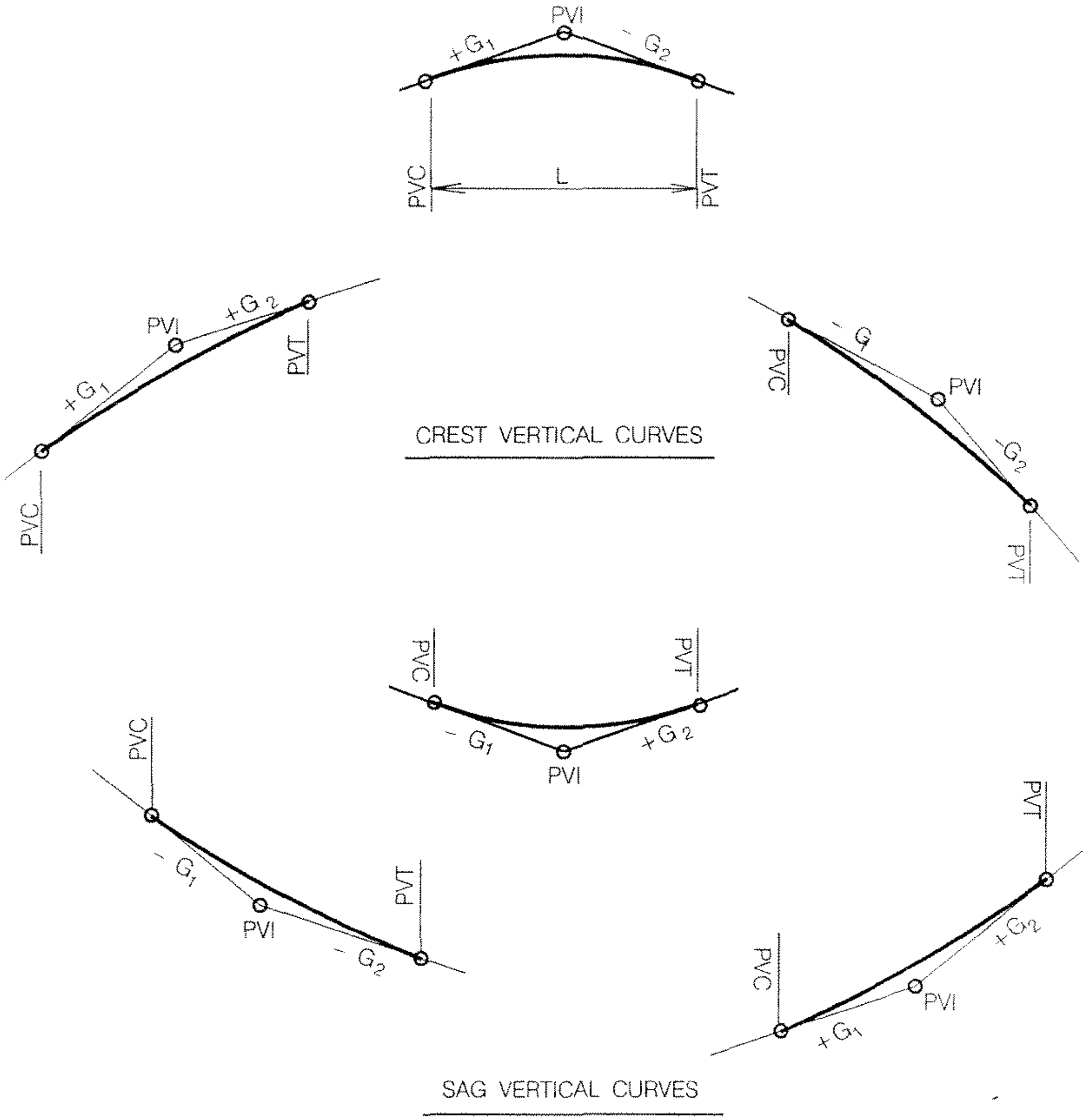
Minimum crossfall for street and thoroughfare pavements are required to insure proper flow of surface drainage to the gutter lines and storm drainage inlets. For longitudinal paving grades equal to or exceeding 1%, minimum pavement crossfall is 1/8 inch per foot (1%). For longitudinal paving grades less than 1% and at storm drainage inlets, the minimum pavement crossfall is 1/4 inch per foot (2%). The crossfall on divided arterials shall not be less than 0.5 foot across the traffic lanes between the gutter lines for each half of the thoroughfare.

Maximum street pavement crossfall permitted is 1/2 inch per foot (4%) at any point in the roadway. Crossfalls should normally not exceed 1/4 inch per foot (2%).

The standard street paving cross section for undivided streets is either the parabolic crown section or the "roof top" crown section where the street crossfalls from the pavement centerline down toward each gutter line. Elevation differences in excess of 0.2 foot should be avoided between gutter elevations on each side of the street for streets with parabolic crown pavement cross sections and must not exceed 0.5 feet. In cases where elevations are extreme between cross section points at the property lines, the street section may be transitioned to provide a pavement crossfall in the same direction for the full width of the street pavement. The street section should be transitional back to the standard street section as soon as the condition permits.

b. <u>Vertical Curves</u>

When two longitudinal street grades intersect at a point of vertical intersection (PVI) and the algebraic difference in the grades is greater than 1.0%, a vertical curve is required. Vertical curves are utilized in roadway design to affect a gradual change between tangent grades and should result in a design which is safe, comfortable in operation, pleasing in appearance and adequate for drainage. The vertical curve shall be formed by a simple parabola and may be a crest vertical curve or a sag vertical curve. The six possible conditions for crest and sag vertical curves are shown in Figure IV-16. The geometric elements of the parabolic vertical curve required in the design of pavement profiles are shown in Figure IV-17.

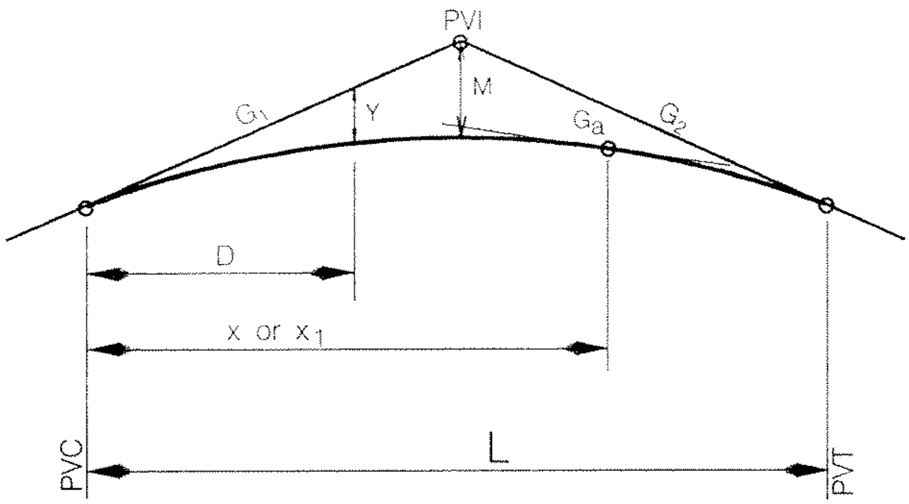


LEGEND

G_1 & G_2 = TANGENT GRADES IN PERCENT
L = LENGTH OF VERTICAL CURVE
PVI = POINT OF VERTICAL INTERSECTION
PVC = POINT OF VERTICAL CURVATURE
PVT = POINT OF VERTICAL TANGENCY

VERTICAL CURVE TYPES
FIGURE IV - 16

PATH NAME : USR4/HOLLOWAY.ARCH



IN A VERTICAL CURVE

$$M = \frac{A\,L}{8}$$

$$X_1 = \frac{-L\,G_1}{A}$$

$$Y = D^2 \times \frac{M}{(L/2)^2}$$

$$G\,a = G_1 + \frac{A\,X}{L}$$

WHERE :

G_1 & G_2 = TANGENT GRADES IN PERCENT

PVI = POINT OF VERTICAL INTERSECTION

PVC = POINT OF VERTICAL CURVATURE

PVT = POINT OF VERTICAL TANGENCY

M = ORDINATE FROM PVI TO CURVE IN FEET

A = $G_2 - G_1$,THE ALGEBRAIC DIFFERENCE IN TANGENT GRADES WHERE G_1 IS THE TANGENT GRADE AT THE REFERENCE POINT FROM WHICH D OR X IS MEASURED

L = LENGTH OF CURVE IN STATIONS

Y = ORDINATE FROM TANGENT TO CURVE IN FEET

D = DISTANCE FROM NEAREST PVC OR PVT TO ANY POINT ON CURVE

X = DISTANCE FROM PVC OR PVT IN STATIONS TO ANY POINT ON VERTICAL CURVE

X_1 = DISTANCE FROM PVC TO LOWEST OR HIGHEST POINT ON VERTICAL CURVE

G a = TANGENT GRADE AT ANY POINT IN PERCENT

GEOMETRIC ELEMENTS OF VERTICAL CURVES

FIGURE IV – 17

PATH NAME : USR4/HOLLOWAY.ARCH

c. Stopping Sight Distance

1. Crest Vertical Curve

When a vertical curve is required, it must not interfere with the driver's visibility over a certain length of street ahead, should sudden stopping be required. This length of street, called the stopping sight distance, should be sufficient to enable a person with a height of eye of 3.5 feet above the pavement surface and traveling at or near design speed to stop before reaching an object 0.5 foot in height which is in the pathway of the vehicle.

The minimum stopping sight distance is the sum of two distances: the distance traversed by a vehicle from the instant the driver sights an object for which a stop is necessary to the instant the brakes are applied and the distance required to stop the vehicle after brake application begins. The minimum safe stopping sight distances for the City of Dallas street types and design speeds are shown in Table IV-18. These sight distances are based on each design speed shown and wet pavement. The minimum length of crest vertical curve that provides a safe stopping sight distance for each street type may be calculated using the formula L = KA (the values of K for a crest vertical curve are shown in Table IV-18).

2. Sag Vertical Curve

When a sag curve is required, the vertical curve shall be of sufficient length to provide a comfortable ride during the change in vertical direction. The minimum length of sag vertical curve that provides a comfortable ride may be calculated using the formula L = KA, (the values of K for a sag vertical curve are shown in Table IV- 18). It is the policy of the City of Dallas to illuminate arterials; therefore, headlight distance is not a factor in the design of sag vertical curves on these facilities.

d. Intersection Grades

Arterial street to arterial street intersections shall be designed to approximate

TABLE IV-18
MINIMUM LENGTH OF VERTICAL CURVE

CREST VERTICAL CURVE	SAG VERTICAL CURVE
L = KA where	L = KA where
L = Minimum Length Vertical Curve required for safe stopping sight distance	L = Minimum Length Vertical Curve required for comfort
K = Horizontal Distance in feet required to effect a one percent change in gradient	K = Horizontal Distance in feet required to effect a one percent change in gradient
A = Algebraic Difference in grade	A = Algebraic Difference in grade

Street Classification	Design Speed MPH	Minimum Safe Stopping Sight Distance (feet)	Normal Crest Vertical Curve K Min. (feet)	Normal Crest Vertical Curve K Desirable (feet)	Normal Sag Vertical Curve K Recommended
Principal Arterial					
S-6-D and S-8-D Sections	55	540	140	220	65
M-6-D(A) Section	50	460	107	160	54
M-6-D(B) Section	45	385	76	110	44
Minor Arterial (Divided)					
S-4-D Section	50	460	107	160	54
M-4-D(A) Section, 11 foot lanes	45	385	76	110	44
M-4-D(B) Section, 10 foot lanes	40	315	70	80	44
Minor Arterial (Undivided)					
S-4-U Section	45	385	76	90	44
M-4-U Section	40	315	70	80	34
Community Collector					
ALL	40	315	70	80	34

TABLE IV-18 (Continued)
MINIMUM LENGTH OF VERTICAL CURVE

Street Classification	Design Speed MPH	Safe Stopping Sight Distance (feet)	Normal Crest Vertical Curve K Min. (feet)	Normal Crest Vertical Curve K Desirable (feet)	Normal Sag Vertical Curve K Recommended
Residential Collector					
ALL	35	250	36	50	26
Local					
S-2-U and M-2-U Section 36' wide pavement	30	200	24	30	20*
L-2-U(A) Section 33' wide pavement	25	200	24	30	20*
L-2-U(B) Section 26' wide pavement	25	200	24	30	20*
CBD Streets					
Couplets, divided 4 to 8 lane, and 5 lane	45	385	76	90	44
Undivided 4 to 6 lane streets	40	315	70	80	40
All other streets	35	250	36	50	30
* Minimum K is 20					

a plane surface to provide a smooth ride for the driver at the design speed. See Section 4.03.04.a Street Grades.

For local streets intersecting arterial and collector thoroughfares, the grade of the local secondary street from the principal arterial or collector street gutter shall not be more than four (4) percent either up or down within the first twenty (20) feet beyond the curb line of the principal street, except that in very hilly terrain a intersecting grade of up to a maximum of six (6) percent may be considered. For all non-arterial street intersections of equal classification and for collector street intersections with arterial thoroughfares, intersection grade changes of more than one (1) percent require vertical curves for transitioning to the intersection grades. Valley gutters shall not be used across collector and arterial streets to make grade changes.

4.03.05 Transitions To Existing Grade

a. General

All projects require transitioning from new or proposed paving and grading to the elevations of existing pavement or natural ground. Areas which must be considered for transitions include the beginning and end of a project, intersecting streets, driveways, drainage ditches, parkways and adjoining properties. Transitions are also necessary when the new or proposed paving is wider than the existing pavement leading into or away from the proposed paving. When tapers are used for transition pavement, the following formulas shall be used to determine the minimum length taper required:

- For streets and thoroughfares with design speeds of 45 mph or greater, $L = W \times S$
- For streets and thoroughfares with design speeds less than 45 mph, $L = (WS^2)/60$

where L is the minimum length of taper in feet, S is the posted speed limit in mph, and W is the lateral shift of traffic in feet required in going from the new pavement to the existing pavement due to reduced number of lanes or pavement traveling width.

b. **Pavement Transitions**

1. Transitions to Improved Street Pavement

Transitions to improved streets shall be constructed to the standard pavement thickness out of Portland Cement concrete as required for City standard street and thoroughfare paving. The design criteria for improved streets as outlined in this manual shall be followed. Pavement widths and sections shall be adjusted in the transition to provide a smooth and safe pavement transition to existing street pavement sections using the design speed of the street or thoroughfare and the curb or edge of pavement radii which are not less than the centerline radii given in Table IV-11A. When transitions to existing improved streets involve a reduction in the number of lanes, the total transition taper lengths shall be no less than that required in Section 4.03.05.a General. Grades shall be designed to tie to existing street gutter and top of curb elevations. Plans shall show actual field shots on the existing street tops of curb and gutters at the point of tie using the datum of the proposed paving plans.

Full length standard street turnouts shall be provided when tying portland cement concrete streets to existing improved intersecting streets. Pavement removal and replacement shall be included in the paving design plans as required to provide standard paving design transitions and to maintain drainage. The pavement design shall include standard pavement connection details to the existing portland cement concrete pavement and base.

Standard connection details include a doweled expansion joint at the end of proposed street turnouts using redwood header expansion material and also dowel bars or reinforcing steel splices when connecting to existing portland cement concrete pavement and base, unless there is an existing concrete street header for connection. Standard concrete street headers shall be provided when connecting to improved full depth asphaltic concrete streets and to existing portland cement concrete pavement and base that is in too poor condition for doweled connections.

Connections to existing resurfaced portland cement concrete streets should be made with standard 6 inch high curbs matching the existing top of curb elevation. Additional existing street pavement removal and hot mix asphaltic concrete transition overlay may be required to provide proper gutter drainage. Pavement and curb and gutter removal and replacement, milling and asphalt overlay shall be included in the proposed paving plans as required to maintain at least a four inch elevation difference between the top of curb and gutter in transition areas when tying proposed paving to existing resurfaced improved concrete streets.

2. <u>Transition to Unimproved Streets</u>

Standard concrete street headers shall be provided at the ends of proposed portland cement concrete streets when connecting to existing unimproved street pavement. Street headers shall be of standard length as required for the future improved pavement sections and transition grading and pavement shall be provided to connect to the existing pavement. Drainage transitions between street gutters and ditches shall be provided to maintain drainage.

When drainage and right-of-way constraints permit, full length standard street turnouts shall be provided when connecting to intersecting unimproved streets. Drainage transitions shall be provided from street gutters to existing drainage ditches with any required drainage facilities to maintain drainage standards. Standard concrete street headers shall be provided at the ends of street turnouts. Street headers shall be of standard length as required for the future improved pavement section connection.

Transitions to unimproved streets on either end of the new pavement or at intersecting streets which arise from an elevation difference or a difference in pavement width are generally constructed out of hot mix asphaltic concrete pavement at least six inches thick. On arterials, transitions to unimproved streets shall consist of at least 4 inches of asphaltic concrete fine-grade binder course under a 2 inch thick asphaltic concrete fine grade surface course. The transition shall extend a sufficient distance to eliminate "bumps" or uneven pavement and shall provide for a safe, smooth riding surface. Minimum and maximum grades as outlined in Section 4.03.04 Vertical Alignment shall be followed on the pavement transitions as well as the new or proposed pavement. Transition pavement shall also be of sufficient length and taper to provide for a smooth connection to existing pavement. Vertical curves shall be required for grade breaks on asphalt transition pavements exceeding 2%. The minimum centerline radii given in Table IV-11A shall be used in designing curb or edge of pavement radii for transition pavements.

3. Transitions to Driveways and Parking Lot Pavement

Requirements for transitions at driveways and parking lot pavements are provided in Section 4.03.12 Driveways and Curb Openings.

Adequate traffic control devices shall be provided at parkway ties to existing parking lots to provide for pedestrian and vehicular safety. Access to parking lots shall be limited to approved driveway or street access points. Curbs or fences may be required at the property line or top of slope to prevent vehicles from entering the street at unauthorized locations or to protect or provide for pedestrian safety.

Transitions in parking lots shall be limited to what is required to provide a safe, smooth tie to the existing parking lot pavement. Pavement shall be replaced with similar pavement. Asphalt pavement shall be replaced with hot mix asphaltic concrete fine-grade surface course of six inch thickness. (Heavy commercial parking lots may require thicker pavement.) Portland Cement concrete shall be replaced with six inch thick "Hand Finish Class" concrete pavement. Parking lot transition grades shall be no flatter than 0.5 percent and no steeper than 8 percent or the existing parking lot grade, whichever is greater. Grade breaks shall not exceed 12% without vertical curves provided. Vertical curves shall be at least 20 feet in length.

c. **Parkway Transitions**

1. Sloped Transitions

The parkway areas which are adjacent to the new or proposed pavement must also be properly transitioned to natural ground at or beyond the property line. Sloping shall be utilized to make the transition whenever practical, however, the slope must not be steeper than 3:1 nor flatter than ¼ inch per foot of fall (except across sidewalks) and care must be exercised in grading on private property. Sloping shall be used to the greatest extent practical, and where sloping occurs on private property, letters of permission to slope or slope easements must be obtained from the affected property owner.

Sidewalks shall be placed against the back of curb if necessary to avoid excessive sloping on private property, providing the standard five feet wide sidewalk and one foot wide strip of mildly-sloped parkway with crossfall of ¼" per foot adjoining the sidewalk. Crossfall from one foot behind the sidewalk to the match with natural ground shall not exceed 3:1. See Section 4.03.09 Parkways for details on parkway grading requirements.

2. Retaining Walls

If sloping alone cannot be used because of conflicts with existing improvements or due to excessive right-of-way costs, other solutions which may be utilized include retaining walls and sidewalk curbs. Retaining walls shall not be used along undeveloped property, parks, schools, or recreational facilities, except as requested by the owner, but only when approved specifically by the Director of Public Works and Transportation. Walls along parks, schools and recreational facilities should include a pedestrian barrier such as a 4 foot high chain link fence for pedestrian safety. Limits of the barrier shall be designed to not interfere with adequate sight distance at driveways and street and alley intersections.

Details for standard retaining wall and sidewalk curb designs are provided in the Standard Construction Details, File 251D-1. These cost effective standard wall designs shall be used whenever practical.

Retaining walls should be considered when grade differences between the proposed grades at the property line and the existing grade equals or exceeds 30 inches. The height of required retaining walls shall be kept to a minimum by sloping from behind the wall to the match point with existing ground. The minimum height for retaining walls is six inches from the proposed ground elevation at the base to the top of wall. The sloped grade above retaining walls shall generally be no steeper than 4:1, but no flatter than ¼ inch to 1 foot.

The two most cost effective retaining walls for small to medium height applications are the sidewalk curb and the Type 6 retaining walls. When small retaining walls are necessary, the sidewalk curb retaining wall is the most cost effective. This retaining wall is used behind the sidewalk for heights up to nine inches above the sidewalk surface. The standard Type 6 retaining wall is the most cost effective retaining wall for heights greater than 9 inches and less than 5 feet when sidewalks are being constructed. This wall is a sidewalk and wall combination design. The sidewalk is thickened and reinforced to serve as the wall footing.

When a guard fence is required at the top of the retaining wall for safety or security, the thicker Type 7 retaining wall section shall be used instead of the Type 6 retaining wall. The design provides inserts at the top for fence post embedment. The Type 7 retaining wall height can go up to six feet due to the thicker section design.

When a sidewalk is not to be used for the wall footing, the gravity wall design is the most cost effective retaining wall for wall heights greater than 9 inches and less than 3 feet in height. Thicker gravity wall sections are required when using a guard fence embedment at the top.

The Type 8 retaining wall is used in applications similar to the Type 6 and 7 wall when in driveway areas. The Type 8 wall is built integrally with the proposed reinforced concrete driveway throat, with additional driveway thickness required for the portion of the driveway within one foot of the retaining wall when the wall exceeds 3 feet in height. The driveway serves as the retaining wall footing providing an economical design. (See Standard Construction Details File 251D-1 for further details.)

When higher retaining walls are required, other standard retaining wall designs are provided in the Standard Construction Details. These designs are taken from the Texas Department of Transportation (TxDOT) standard wall designs. A low and a high footing pressure design is provided depending on the stability of the ground upon which the footing bears. The high footing pressure design is to be used when the footing will bear directly against unweathered, sound rock. The low footing pressure design shall be used in all other cases except for soft, spongy soils, in which case a geotechnical investigation shall be performed and special retaining wall design may be required.

Some site conditions will require modified or alternate retaining wall designs called special retaining wall designs. Special retaining wall and structural designs shall be submitted to the City project engineer with supporting calculations.

The following requirements shall apply to special retaining wall and structural designs:

- Retaining walls shall be designed to achieve a minimum safety factor of 2 against overturning and 1.5 against sliding, unless otherwise approved by the Director of Public Works and Transportation.

- Retaining wall design for roadway construction shall consider the following parameters/criteria:

  (1) Allowable soil and/or rock bearing capacity. It should be verified that the wall footing is not constructed in close proximity to steep slopes, non-compact utility trench backfill or non-compact fill soils.

  (2) Surcharge loadings and traffic live loads, existing and future.

  (3) Hydrostatic pressure due to stormwater, groundwater, irrigation, etc.

  (4) Backfill requirements including provisions for drainage (drainage layer with perforated pipe or weep holes), clay cap and surface drainage to prevent surface water infiltration.

  (5) Uplift if applicable.

  (6) Resistance to sliding; the potential for future deterioration of materials at the toe of the structure and the subsequent decrease in passive resistance pressures should be considered. If resistance to sliding is not adequate, a key should be provided below the base of wall. The key should be designed using an appropriate passive resistance value for soil and/or rock.

  (7) Location of slip plane; for proposed conditions, the design must ensure that the slip plane is not located below wall footing. A safety factor against a global failure below the wall footing should be at least 2.0.

  (8) Erosion at the ends of the wall, over top of wall, and undermining at the toe.

  (9) Adequate room and right-of-way for construction of the footing.

(10) Placement of adequately spaced construction and expansion joints.

(11) Potential for impact or abrasion; gabions and similar materials should be avoided in areas subject to direct impact from debris or falling water.

(12) Maintenance requirements.

(13) Lateral loads due to on-site material or select fill. Depending upon backfill materials to be used, structural details of wall and acceptable tolerance for long-term lateral wall movements, the wall design should be based on either active pressures or at-rest pressures. If clay soils are to be used as backfill or if lateral wall movements are to be minimized, at-rest pressures should be used.

(14) Specification requirements for backfill including backfill limits, gradation, plasticity index (PI) and compaction.

- Walls shall be designed to not obstruct intersection sight distance. (See Section 4.03.02 Sight Distance at Intersections)

- Top of wall elevations shall be designed to provide a minimum ¼ inch per foot cross slope parkway grade between the top of wall and the property line but generally not more than a 4:1 slope.

- Drainage behind retaining walls shall be designed to release hydrostatic pressure build-up and prevent surface water from eroding out or undercutting the top of wall area.

- Adequate protection must be provided at the front of the footing to prevent erosion or undercutting the footing cover and foundation.

- When adjoining developed properties, the parkway slope between the top of wall and property line should be protected with block sodding or equal.

- Retaining walls shall be designed to provide for pedestrian and vehicular safety. Retaining walls, adjoining higher level walkways and parking lots shall be designed to provide barriers such as 9 inch high curbs and fences as required for safety.

- Wall height transitions shall be provided on both ends and whenever transitioning into sloping transitions and natural ground. The maximum wall height at end of wall transitions shall not be greater than 6 inches. The top of wall slope shall not exceed 4:1 unless additional slope protection is provided.

4.03.06 Inlets and Storm Drainage Facilities

All storm drainage systems for new paving construction or reconstruction projects shall be designed for the 100 year rainfall event and shall be designed in accordance with the City of Dallas Drainage Design Manual. Inlets shall be placed to ensure that the 100-year flow in a street does not exceed the top of curb elevation, and that encroachment into the travelway does not violate the dry lane requirements shown below:

- Minor arterial and lower classifications - flow depth maximum of 6 inches in the travelway.
- Principal arterial - one ten foot wide lane for traffic in each direction must remain dry.

Inlets shall also be appropriately placed to avoid excessive water draining through an intersection. Inlets shall be provided on all streets intersecting minor and principal arterials to capture the surface drainage in the street with no drainage bypass. Items to consider when designing drainage in conjunction with a new paving construction or reconstruction project include:

- Recessed inlets shall be used on divided thoroughfares.

- The top of storm drainage conduits must not conflict with the pavement subgrade preparation zone. Special caution is required for storm drainage laterals close to inlets in the pavement warp down area to the inlet throat.

- Generally, the top of all drainage pipes should be at least 6 inches below the bottom of the paving subgrade in all locations to avoid damage during the construction process. This is usually 12 inches below the bottom of pavement for local streets and 14 inches below the bottom of pavement for arterial and collector streets as measured along the centerline of pipe. For 18 inch diameter class III reinforced concrete pipe, the top of the drainage pipe should be at least 12 inches below the bottom of the paving subgrade at all locations.

  In practice, usually much greater depths are required over storm drainage pipes due to hydraulic requirements.
- Inlets shall not be placed at inconvenient locations for property owners such as near driveways and lead walks.
- Inlets shall not be placed closer than 10 feet from an intersection curb return.

Storm Drainage mains and major storm drainage facilities normally are placed in the zone of the street between the back of curb and a plane 1.5 foot off of the pavement centerline (See Figure IV-20, Section 4.03.15 of this manual). Details on utility and storm drainage facility alignments are discussed in Section 4.03.15 Utilities.

Upon approval of proposed paving grades, a drainage area map shall be prepared as required for the project.

The drainage area map shall be prepared on a 1-inch equals 200 foot scale topographic map indicating the drainage areas and sub-areas with the runoff factors in accordance with the type of zoning and development, the points of concentration, sizes of the areas and calculations and quantity of storm water runoff at each concentration point in cubic feet per second. If more than five drainage areas are shown or the times of concentration are calculated, the data must be presented in table form.

Paving plans shall include separate storm drainage plans showing the proposed plan view locations of inlets and storm drainage conduits including ties to the paving centerline and horizontal control data. In profile view, the storm drainage mains and all laterals shall be shown with hydraulic computations and hydraulic gradient for both main system and laterals, proposed system flowline grades and ditch grades in relation to existing pavement or ground, proposed pavement or ground along centerline of proposed storm drain, existing and proposed utilities near or crossing proposed storm drainage system, all gutter, crown, and ditch elevations affecting drainage, and cross sections where needed.

The profile shall include stationing and flow line elevations at 50-foot intervals and at grade brakes and critical points including lateral connections, change in system size, and at drainage structures. Hydraulic characteristics and hydraulic gradient shall be shown on all storm drainage system main and lateral profiles. All existing and proposed utilities crossing or in close proximity to the pavement subgrade or storm drainage facilities shall be shown on the plans in both horizontal and vertical locations. See Section 4.03.15 Utilities for further details.

Storm drainage plans shall be designed and prepared in accordance with the requirements of the City of Dallas Drainage Design Manual.

See Appendix C - Section F of this manual for storm drainage items which shall be included in the paving plan view.

4.03.07 Crossings

a. At Grade Crossings

Crosswalks and railroad crossings require special pavement design consideration.

1. Crosswalks

Provision for pedestrian traffic during and after construction is required on most City paving projects and especially in the CBD and in the vicinity of high pedestrian traffic generator properties.

Crosswalks are normally warranted at signalized intersections and at schools, hospitals, parks, cultural facilities and other locations generating high pedestrian traffic volumes. The Transportation Division of Public Works and Transportation shall approve the location of all proposed crosswalks. For information on warrants and restrictions on median openings, and design of crosswalks in median openings, see Section 3.0 Access Control and Section 4.03.11 Median Openings of this manual.

The standard crosswalk width is ten feet. The inside crosswalk line is normally placed two feet from the face of projected curb or edge pavement of the intersecting street. Required standard markings and details are provided for in the Standard Construction Details, File 251D-1. Crosswalks shall be designed barrier free in accordance with the Federal American with Disabilities Act. See Section 4.04 <u>ADA Requirements</u> for details.

Special crosswalks may require use of special designs as well as nonstandard materials. Nonstandard materials and designs shall not be used unless specifically approved by the Director of Public Works and Transportation. Normally, construction of nonstandard designs with nonstandard materials will require a special maintenance agreement between the Director of Public Works and Transportation and the sponsoring entity. Plan/profile and special section details shall be provided with dimensions, pavement structure, reinforcing, special paving materials and patterns, and limits clearly shown and special notes controlling the work provided. The design shall provide for maintenance of pedestrian and vehicular traffic and any needed consequences of construction. Special materials shall extend no closer than 12 inches from the face of curb to allow for a standard concrete gutter and good construction practice.

2. <u>Railroad Crossings</u>

The designer shall verify railroad company requirements for the design and construction of railroad crossings. Such requirements shall be included in the paving, drainage and structural design plans and specifications after approval by the City project engineer.

Pavement grades must be designed to match the existing top of rail elevations at railroad crossings. Normally, the City's responsibility is to perform the paving improvements up to the railroad header on each side of the railroad crossing. The railroad header is provided on each side of the railroad crossing 5 feet from the centerline of rails. Crossing improvements between the railroad headers are generally performed by the railroad. The paving design shall provide temporary designs, details and sequence of construction to insure proper maintenance of traffic across the railroad crossing until the railroad crossing improvements are performed by the railroad.

b. Separated Crossings

Special consideration is required at bridge and facility underpasses. Paving grades must be designed to provide a clearance of at least 14.5 feet and preferably 15 feet or more between all points of the pavement travelway and the overlying lowest portion of the structure. A clearance of at least 16.5 feet must be provided over state roadways. Additional clearance may be required when sags between steep grades occur at underpasses. Due to structural constraints, special drainage designs may also be required when pavement sag areas occur below the crossing.

Some projects may include structural design of the crossing which allows more flexibility in setting the structure grades to compliment the pavement grade design.

Greater clearances are required over railroad facilities. The clearances required by the railway agency shall be used over their facilities.

c. Bridges

All street and thoroughfare bridges shall be designed in accordance with "Standard Specifications for Highway Bridges", latest edition adopted by the American Association of State Highway and Transportation Officials (AASHTO) using HS20-44 loading. Bridge deck concrete shall be at least "Hand Finish Class" concrete as provided for in Item 5.8.1.1 Classes of Concrete of the Addendum to the Standard Specifications. The requirements of Section 4.02.04 Drainage, this section 4.03.07 Crossings, and other related requirements of this manual shall govern the design. The standard street pavement width shall be maintained on the bridge. For divided arterials, one bridge shall be provided for each traffic direction to reduce bridge costs in the median area. Concrete barrier railing shall be provided at the interior median areas for vehicular safety. Normally, 2 feet shall be provided from edge of interior lane to the face of the concrete barrier railing/edge of structure. Long bridges may require embedded street light and traffic signal conduits to provide required street lighting and traffic signal interconnect.

Sidewalks shall be provided on both sides of bridge structures for pedestrian access. Outside curb height shall be increased to 7½ inches and parapet walls, rails or barriers shall be provided for vehicular and pedestrian safety. Structural approach slabs shall be provided with armor expansion joints to control expansion/contraction movements. Some design details for approach slabs, parapet walls, sidewalks, rail and concrete median barriers are provided in the Standard Construction Details, File 251D-1. Additional details shall be provided in the design to provide a complete set of paving and structural plans.

4.03.08 Sidewalks

a. <u>City Regulations</u>

The purpose of the public sidewalk is to provide a safe area for pedestrians and bicycle riders. City of Dallas policy requires that sidewalks be constructed with the paving of all public and private streets unless waived by the City Council upon recommendation of the Director of Public Works and Transportation. A waiver of the sidewalk requirement may be appropriate in the following instances:

- The potential pedestrian traffic in the area is so minimal that sidewalks are not warranted.

  For projects in a single family or duplex zoning district, at least 50 percent of the lots located on the same side of the block as the proposed plat or project have been developed with completed, approved structures without sidewalks.
- Permanent line and grade cannot be set within the public street right-of-way.
- It is desirable to preserve natural topography or vegetation preexisting the proposed project, and pedestrian traffic can be accommodated internally on the adjoining property through public easements or right-of-way.

b. <u>Design Geometry</u>

All sidewalks must be designed and constructed to be barrier-free to the disabled, and in accordance with the requirements contained in Section 4.04 ADA Requirements, the Standard Construction Details, File 251D-1, and in the central business district, the "Dallas Central Business District Pedestrian Facilities Plan", as currently amended. When poles, standards and fire hydrants must be placed in the proposed sidewalk alignment, the sidewalk must be widened as delineated in the Standard Construction Details to provide a three-foot-wide clear distance between the edge of the obstruction or overhang projection and the edge of the sidewalk. All sidewalks must be constructed of Portland cement concrete in accordance with the requirements of Section 5.02.05 Sidewalks of this manual.

The standard City of Dallas concrete sidewalk is four feet in width, and the edge of the sidewalk located nearest the street right-of-way is normally two feet from the right-of-way line. Special sidewalk designs include a 5-foot wide sidewalk located adjacent to the street or thoroughfare curb, a sidewalk encompassing the entire parkway width in commercial areas, and a sidewalk which serves as the footing for a concrete retaining wall. All sidewalks which abut the curb shall be constructed with a sidewalk lug. The Standard Construction Details, File 251D-1 provides further details for standard sidewalk design.

Sidewalk widening to provide a minimum clear width passing space of 60 inches for a distance of at least 5 feet shall be provided at a spacing not to exceed 200 feet unless the sidewalk intercepts driveways, alleys or other streets within this distance. See Section 4.04 ADA Requirements and the Standard Construction Details, File 251D-1.

Sidewalk alignments may be adjusted to avoid the removal of trees or the creation of excessive slopes. All adjustments shall be pre-approved by the project engineer.

Sidewalk designs shall provide the minimum feasible longitudinal grade for sidewalks consistent with slopes established for adjacent roadways. Longitudinal grades for sidewalks should not exceed 8%. Greater longitudinal sidewalk grades may be required for ties to leadwalks due to steep existing sidewalk grades and terrain. In these cases longitudinal grades for leadwalks should not exceed 20% or the existing sidewalk grade, whichever is steeper. The minimum longitudinal grade allowed is 0.4 percent. Crossfall across sidewalks shall be at least ⅛ inch per foot (1%) slope but should not exceed ¼ inch per foot (2%) except in barrier free ramp areas. Where sidewalk intersections serve two directions of pedestrian travel, the slope in any direction at the landing or intersection shall not exceed ¼ inch per foot (2%). Sidewalk transitions and landings shall be provided as required. For details concerning barrier free ramps and permissible grades, see section 4.04 <u>ADA Requirements</u>.

4.03.09 Parkways

The parkway is that portion of right-of-way which extends from behind the curb to the property line. Parkways vary in width but are generally between 7 feet and 12 feet wide as measured from face of curb to the property line. Table II-4, Section 2.0 of this manual provides the parkway widths for the various street section designations.

The parkway must be sloped in such a manner that storm water will drain toward the street from adjoining properties and provide erosion control. The crossfall slope of a parkway shall not be less than ¼ inch per foot at all points except across sidewalks. The crossfall slope shall not exceed 1 inch per foot between the back of curb and the edge of sidewalk. The crossfall slope across the sidewalk to a point one foot behind the sidewalk shall be no less than ⅛ inch per foot with a maximum allowable crossfall slope of ¼ inch per foot (See Section 4.04 <u>ADA Requirements</u> for details). Crossfall slope from one foot behind the sidewalk to the property line shall not exceed 3:1. For additional parkway details for sloped transitions and retaining walls, see Section 4.03.05.c <u>Parkway Transitions</u>.

The top of curb and parkway elevations must not be greater than the elevation of the existing ground at the property line unless the property line is in the flood plain or cross drainage is away from the street and some other means is available to address storm water runoff and ponding of water. The top of curb elevation should generally be at least 0.17 feet (2 inches) below the existing ground elevation at the property line and in flat areas (street grades less than 1%) at least 0.50 feet (6 inches) to insure proper cross and street drainage is maintained.

Items typically found in the parkway include grass and landscaping, trees and bushes, water meters, sewer cleanouts, sprinklers and sprinkler control valves, sidewalks, utility poles, retaining walls, manholes, signs and drainage inlets. *Trees, special landscaping, street furniture, signs, utility pole and appurtenances, irrigation systems, retaining walls and other miscellaneous structures should be located to provide at least 3 feet of clearance from outermost edge of structure to back of street curb.* Standard paving designs in developed areas should provide spot sodding or hydromulch between the back of curb and the edge of sidewalk, block sodding for the first two feet outside of the sidewalk and block sodding for the top two feet in cut areas and in highly erosive areas. Hydromulching is normally provided on large slope areas and elsewhere where ground cover is advisable.

4.03.10 Medians

The required improved section for most principal arterials and some minor arterials include a median. (See Table II-4, Section 2.0 of this manual.) A median is the raised portion of a divided roadway separating the traveled way for traffic in opposing directions. The principal functions of a median are to provide freedom from interference of opposing traffic, a recovery area for out-of-control vehicles, an area for speed changes and storage of left-turning vehicles, a barrier for minimizing headlight glare, and width for future lane widening if necessary.

The standard median width is 15 feet with a five foot wide median in left turn lanes, as measured from face of curb to face of curb. Transitions for left turn lanes will have a median width varying from 15 feet to 5 feet. Geometric details for median curbs and medians are provided in Plates IV-13 and IV-14 of this manual and in the Standard Construction Details, File 251D-1.

All median areas which are less than 7.5 feet wide shall be paved with four inch thick non-reinforced concrete median pavement. Alternate paving materials and designs may be used upon approval of the Director of Public Works and Transportation. All concrete median pavement shall be constructed with a lug against the back of curb to prevent shearing of the curb.

Median slopes will vary depending on the type of roadway involved. Fall or rise in curb elevations across medians shall not exceed ½ inch per foot at any paving station. Differentials in curb elevations on narrow median strips will vary from 0 to 3 inches. Median backfill on the 15 foot median shall extend no more than 12 inches above the top of the low curb. All median backfill shall be sloped and graded to provide for positive drainage to the adjoining pavement. Hydro mulching is normally provided on large slope areas where ground cover is advisable.

Items typically found in the median area include grass and landscaping, street lights and street light conduit, traffic signals and signal conduit, traffic signs, pull boxes, signs and water meters. *Trees, special landscaping, street furniture, signs, utility pole and appurtenances, irrigation systems, retaining walls and other miscellaneous structures should be located to provide at least 3 feet of clearance from outermost edge of structure to back of street curb.*

4.03.11 Median Openings

Warrants and restrictions on median openings are provided for in Section 3.0 Access Control of this manual. All median openings shall be constructed with a left turn lane. The centerline of proposed median openings shall be located to line up with the centerline of the proposed streets or driveway turnouts to be served.

The minimum median opening width is 60 feet. Wider openings may be required in order to facilitate truck turning movements. The location of the median opening and the median noses shall be designed to provide safe, efficient turning movements within the proper lane for access to driveways and intersecting streets to accommodate the WB-50 or SU design vehicle as determined by Table IV-4 of this manual. The appropriate design vehicle shall be used in the case of driveways. Geometric details for medians and left turn lanes are provided in Section 4.03.03.C Turning Lanes, Plate tables IV-13 and IV-14, and in the Standard Construction Details, File 251D-1.

Standard monolithic median noses shall be provided at the ends of left turn medians. Standard designs for median ends and noses are provided for in the Standard Construction Details, File 251D-1. When crosswalks are not required at a standard intersection, the median nose shall be set back at least 2 feet from the projected face of curb or edge of pavement line of the intersecting street. Median noses shall also be set to provide adequate space for crosswalks when crosswalks are warranted. The median nose shall be set back 2 feet from the outside crosswalk line.

Intersections not at 90 degrees may require greater setback distances for median noses and crosswalks. For these cases, edges of crosswalks and median noses shall be designed to provide at least a 2 foot setback from the face of projected curbline or edge of pavement of the intersecting street to the edge of crosswalk or, the closest extremity of a stopped left turn vehicle at the end of the median nose. Details on crosswalk design are provided in section 4.03.07 Crossings of this manual.

Median openings shall be designed-barrier free to existing crosswalks in accordance with the American Disabilities Act. See section 4.04 ADA Requirements for details.

4.03.12 Driveways and Curb Openings

a. Horizontal Layout

Driveway turnouts shall be provided to maintain access to adjoining properties in accordance with the access control requirements given in section 3.0 Access Control of this manual. Generally, driveway turnouts and connections are provided at all existing driveway access points. Some adjustments may be required in locations and numbers of driveway connections provided to comply with access control requirements, to serve joint owners and provide median opening access. Usually, driveway approaches shall be designed to line up with the centerline of existing driveways. A driveway approach must not be located within 50 feet of a railroad right-of-way.

Driveway approaches including turnout curb tie transitions shall be located entirely within the frontage of the property served by the approach. The driveway edge shall be located not less than five feet from each side of the property line (Dallas City Code, Sec. 43-86). The angle of the driveway approach with the curb line shall not be less than 45 degrees (Dallas City Code Sec. 43-87). No portion of any driveway shall be located within 3 feet of any fire hydrant, electrical pole, or any other surface public utility (Dallas City Code, Sec. 43-140). The City reserves the right to locate driveway approaches on City projects for the convenience of the City to meet access needs and to require relocation of conflicting surface public facilities to provide the 3 foot of clearance.

Driveways and intersecting streets across the street may influence the best location for driveway approaches. Offsets of opposing driveway approaches must be designed to avoid conflicting left-turn movements. The location of existing and future median openings should also be considered. Driveway approaches should line up with the centerline of median openings or be located so that drivers do not make dangerous or illegal movements in attempt to use median openings.

One-way driveway approaches shall be designed to encourage proper use. Use of angle driveway approaches or other channelization designs should be considered. Unless widely spaced, entrance driveway approaches should be located down-traffic from exit approaches.

Driveways shall be designed to provide safe sight distance and stopping sight distance in accordance with the standards given in section 4.03.02 <u>Sight Distance at Intersections</u> of this manual. Locating driveway approaches on the inside of horizontal curve sections of thoroughfares should be avoided. Driveway grades, sloping and retaining walls must be designed to provide an unobstructed visibility for a distance no less than the minimum required for the street section type and design speed involved.

Driveways shall be designed to provide proper drainage from adjoining properties to the street and maintain the conveyance of existing drainage in the street. Off-street drainage collection systems may be required to limit surface drainage so as not to exceed street surface drainage capacity and to meet dry lane requirements given in section 4.03.06 Inlets and Storm Drainage Facilities of this manual. The driveway approach turnout at the point of tie to the street curb shall not be located within the pavement transition warpdown to a curb inlet, typically 10 feet from the edge of the inlet. Driveway approaches on unimproved streets shall be designed to not block drainage. Drainage structures shall be designed as required to maintain road side ditch drainage. The minimum pipe size for driveway culverts is 15 inches for residential uses and 18 inches for other uses.

The standard driveway turnout used on City paving projects is the "dustpan" shaped turnout. For low and medium density residential properties with driveway turnouts on local and collector streets, the standard length for wings for driveway turnouts is 7 feet, as measured along the face of curb from the projected edge of driveway throat line. When driveway throats are 15 feet in width or greater, the wing length may be reduced to 5 feet on local and collector streets. The standard length of wings for driveway turnouts serving high density residential/commercial properties on local, collector and arterial streets is 10 feet.

The alternate radius driveway turnout may be used instead of the standard dustpan shaped turnout when existing driveway turnouts are radius turnouts or for special design cases when approved by the Director of Public Works and Transportation. The minimum radius for local and collector streets is 5 feet. The minimum radius for arterial streets is 10 feet. The design shall provide adequate curb return radii to serve the design vehicle so that turning movements are made within the proper lanes without encroachment upon oncoming traffic, curbs, sidewalks or parkways. For large truck design vehicles, increasing the curb return radius up to 30 feet or more may be more effective than increases in the driveway width.

Details for the geometric layout of driveway turnouts for various zoning and access cases are given in Figure IV-19 including minimum and maximum driveway throat widths. Details for the design of standard dustpan shaped and special radius curb return driveway turnouts are provided in the Standard Construction Details, File 251D-1.

Driveway throat widths should not be designed too large. Approach widths should match the existing driveway throat widths with the following exceptions. The minimum approach width for two way operation in low to medium density residential uses is 10 feet and for other uses is 20 feet. The maximum driveway approach throat width is 30 feet except for commercial driveways with WB-50 design vehicle type trucks. The recommended maximum width is 35 feet, with an absolute maximum width of 40 feet permitted in certain extreme conditions for regular, heavy-use WB-50 design vehicle cases.

b. <u>Driveway Grades</u>

The minimum driveway grade within the street right of way is set using one-quarter inch per foot (2%) rise above the top of curb to the property line. The minimum driveway grade on a project will depend on the parkway width and height of curb. The elevation of a driveway at the right-of-way line shall be no lower than 0.17 feet (2 inches) above the top of curb to insure proper street drainage is maintained.

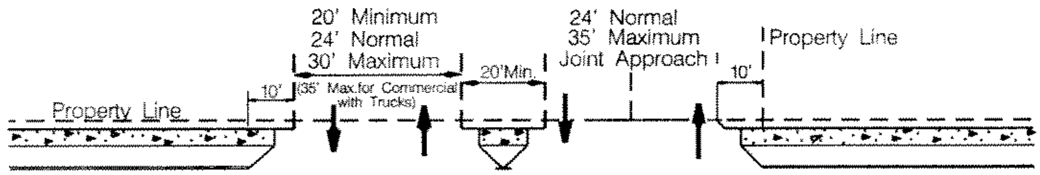
The maximum driveway grade permitted within 10 feet of the gutter line is determined by the street pavement crossfall at the driveway. The grade break at the gutter line, and at any point within 10 feet of the gutter line, must not exceed 12 percent unless a vertical curve is provided. This is necessary to avoid car bumper drag problems from occurring. Streets with a ¼ inch per foot crossfall to the gutter (-2%) will limit the maximum driveway grade to 10%. Streets with ½ inch per foot crossfall to the gutter line (-4%) require a maximum driveway grade of 8%, while streets with a ¼ inch per foot crossfall away from the gutter line (+2%) require a maximum driveway grade of 14%. When sidewalks are involved, barrier-free sidewalk construction requires that driveway grades not exceed eight (8) percent as measured from the gutter to the proposed outside edge of sidewalk.

When driveway construction or reconstruction must occur more than 10 feet from the gutter or beyond the street right-of-way, the usual maximum grade

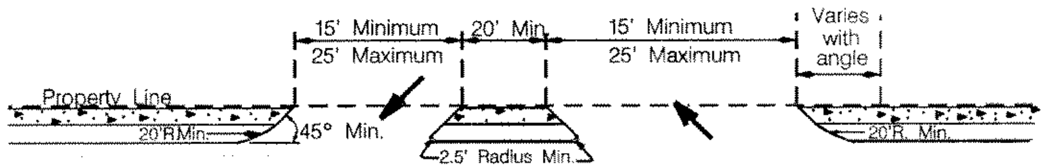
FIGURE IV – 19

Driveway Standards

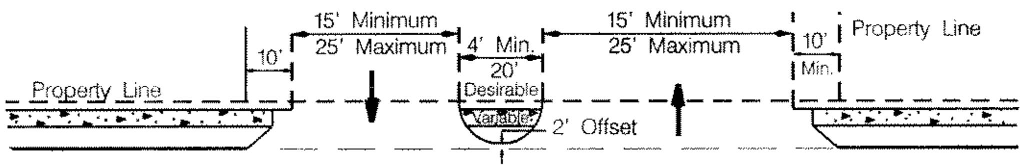
I. HIGH DENSITY RESIDENTIAL (TH3,TH4,MF,MH,CH) / COMMERCIAL



a) Two way operation



b) One way operation (angle approach)

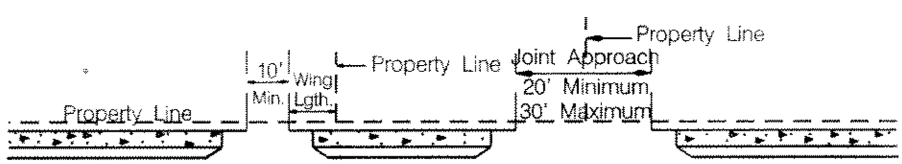


c) One way operation (90° approach)

NOTES:

1. Driveway widths exceeding maximum standards require special approval.
2. Driveway approaches for heavy commercial serving regular truck and bus traffic require special curb return radii designs.

II. LOW / MEDIUM DENSITY RESIDENTIAL (R – 1, through R – 7.5, Th1, and TH2)



Driveway approaches on Local and Collector streets
(Wings = 7' minimum (5' minimum for
driveways widths 15' or greater)

Driveway approaches on Arterial Streets
Wings = 10' minimum

Minimum Driveway spacing is normally 20'

CBD driveway approaches require special standards
For Standard driveway approach designs, see the
STANDARD CONSTRUCTION DETAILS, FILE 251D-1.

permitted is fourteen (14) percent. Greater driveway grades may occasionally be required due to steep existing driveway grades and terrain. Driveway grades shall be designed as mild as feasible to maintain adequate access and limit excessive removal costs. Grades in excess of 14% must be specifically approved by the Director of Public Works and Transportation. The maximum change in grade without a vertical curve is twelve (12) percent for any ten feet in distance.

Driveways should be profiled for a distance of at least twenty-five feet outside the right-of-way to insure adequate replacement design.

Since the "Americans with Disabilities Act (ADA)" requires barrier-free construction of sidewalks, steps or other abrupt changes in sidewalk grades are prohibited at driveways.

4.03.13 Street Lighting and Traffic Control Devices

a. Street Lighting

Paving design plans shall include street light foundations, conduit and pull boxes required for the project. Because street lighting offers increased roadway safety and ease of operation, the City of Dallas installs street lighting on all arterial roadways.

Thoroughfares which are divided by a median generally allow the location of the street lights and conduit in the median area. Street lighting on undivided thoroughfares must be accomplished by adding lights to existing or proposed utility poles in the parkway. Criteria for items such as spacing, foundation type, conduit, power sources, etc. shall be provided by the Public Works and Transportation Department Street Lighting Section. These items shall be shown on the plans. All street lighting designs shall be approved by the Street Lighting section before being used on City projects.

b. Traffic Control Devices

Paving design plans shall include required traffic control devices for the project. All traffic control device plans shall be reviewed and approved by the

Transportation Division of the Public Works and Transportation Department. Traffic control devices typically used within the city of Dallas include traffic signals, pavement markings, buttons, signage, and road humps. Combinations of items may be used for the project design depending on the particular circumstances.

Intersections which warrant placement of a traffic signal will be identified by the Transportation Division of the Public Works and Transportation Department. Specific requirements for the signal shall also be identified. The Transportation Division will also provide comments and requirements for specialized signage and markings.

Pavement markings, signage, and buttons are the commonly utilized traffic items. Streets from residential collector to principal arterial generally require utilization of these three items. Standard layouts are shown in the Standard Construction Details, File 251D-1. Special requirements will follow the recommendations of the Transportation Division.

4.03.14 Alleys

Section 2.03.05 Alleys and Table II-4 Street and Thoroughfare Geometric Standards of this manual addresses the dimensional requirements for alleys. Alleys are generally constructed with a 3-inch inverted crown for drainage, and to prevent potential bumper drag problems. A 6-inch inverted crown may be used as required for increased drainage capacity when integral curbs cannot be utilized provided driveway grades accessing the alley do not exceed 8.0% grade. If driveway grades exceed 8.0%, a 10 foot vertical curve shall be provided for these driveways when accessing alleys with six inch inverts or alternately, a transition to a 3-inch invert shall be used with integral curbs to prevent potential bumper drag problems.

The maximum grade for alleys is eight percent (8%) within thirty feet of an intersection with a street and fourteen percent (14%) elsewhere, unless otherwise approved by the Director of Public Works and Transportation. The minimum grade is 0.3%. Changes in grade shall not exceed 10% at street intersections without providing vertical curves.

Changes in grade, at all other locations, shall not exceed three percent (3%) without providing vertical curves.

The horizontal geometric standards for alleys are shown in the Standard Construction Details, File 251D-1. All curves, turnouts, or other changes in alignment for alleys in residential areas must conform to the minimum turning radius for a single unit truck (SU Design Vehicle) as shown in Figure IV-2. Alleys to be built in commercial areas shall be designed to accommodate larger collection vehicles. These alleys will require individual consideration to determine design standards. Additional restrictions affecting the horizontal alignment of alleys are provided in Section 3.0 Access Control of this manual.

4.03.15 Utilities

a. General Requirements

When utility design is included in the scope of the project design, utility alignments shall be designed in the zones indicated in Figure IV-20 and 21 wherever possible. If these alignments are impractical, or if the construction is to be in the Texas Department of Transportation right-of-way, a cost effective alignment shall be developed through coordination with the City project engineer.

The coordination of underground utilities in new or replatted sub-divisions shall be the responsibility of the developer. The developer shall follow the same guidelines as the utility companies in coordinating utility locations. Guidelines for utility company design and construction coordination are provided in the Public Works and Transportation Department's Utility Location and Coordination Policy. Copies are available through the Utility Coordination Section.

On all paving design projects, all existing utilities, including underground utilities, shall be located and shown in plan and profile views. Plans shall clearly show the source of all information used to locate underground facilities. The locations of all existing telephone poles, power poles, all other utilities located on or above the surface, water meters, double check assemblies, valves, manholes, vaults, structures, etc. in close proximity to the limits of the construction shall be determined or verified.

Figure IV – 20
UTILITY ZONES IN TYPICAL STREETS

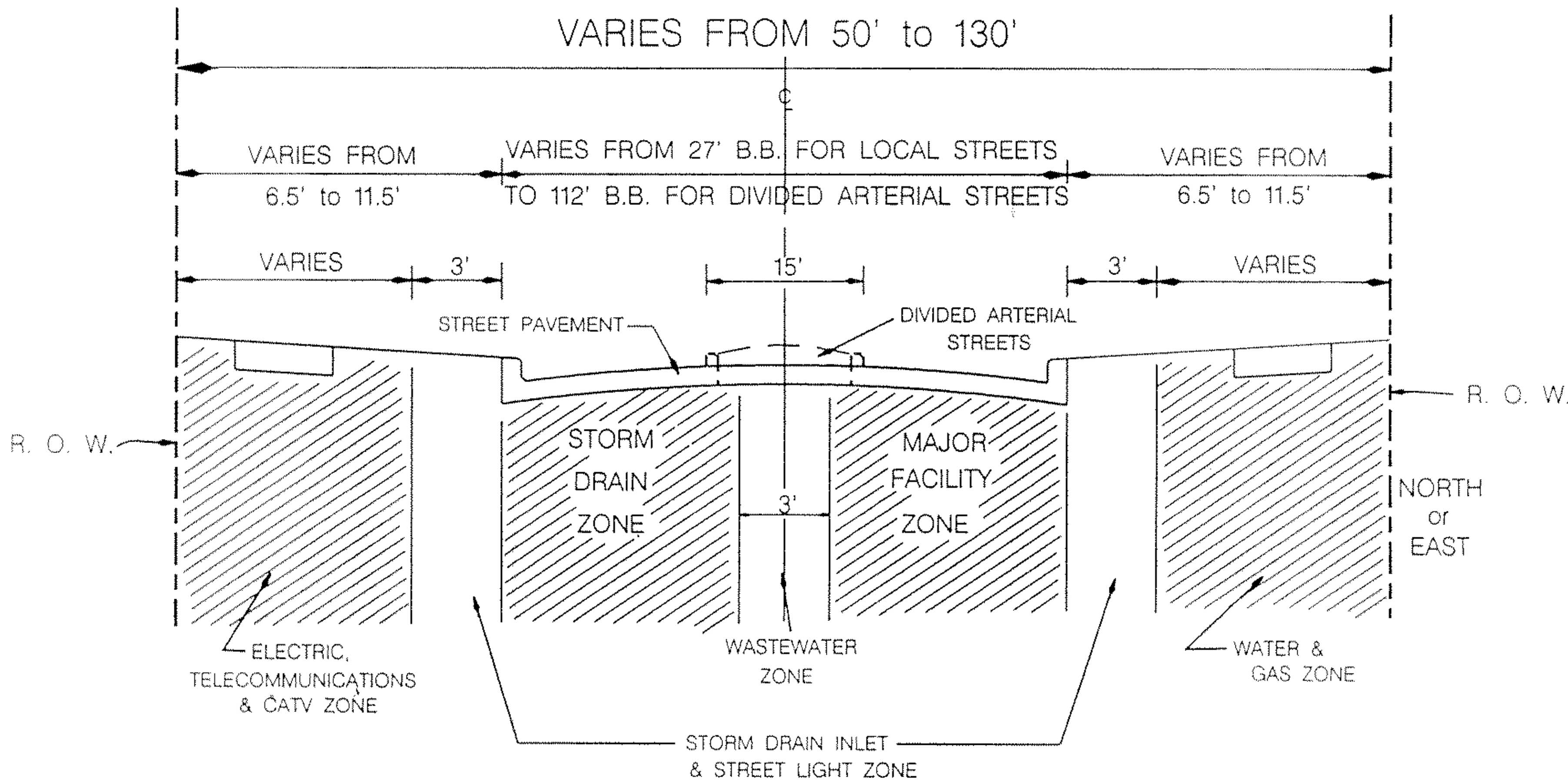
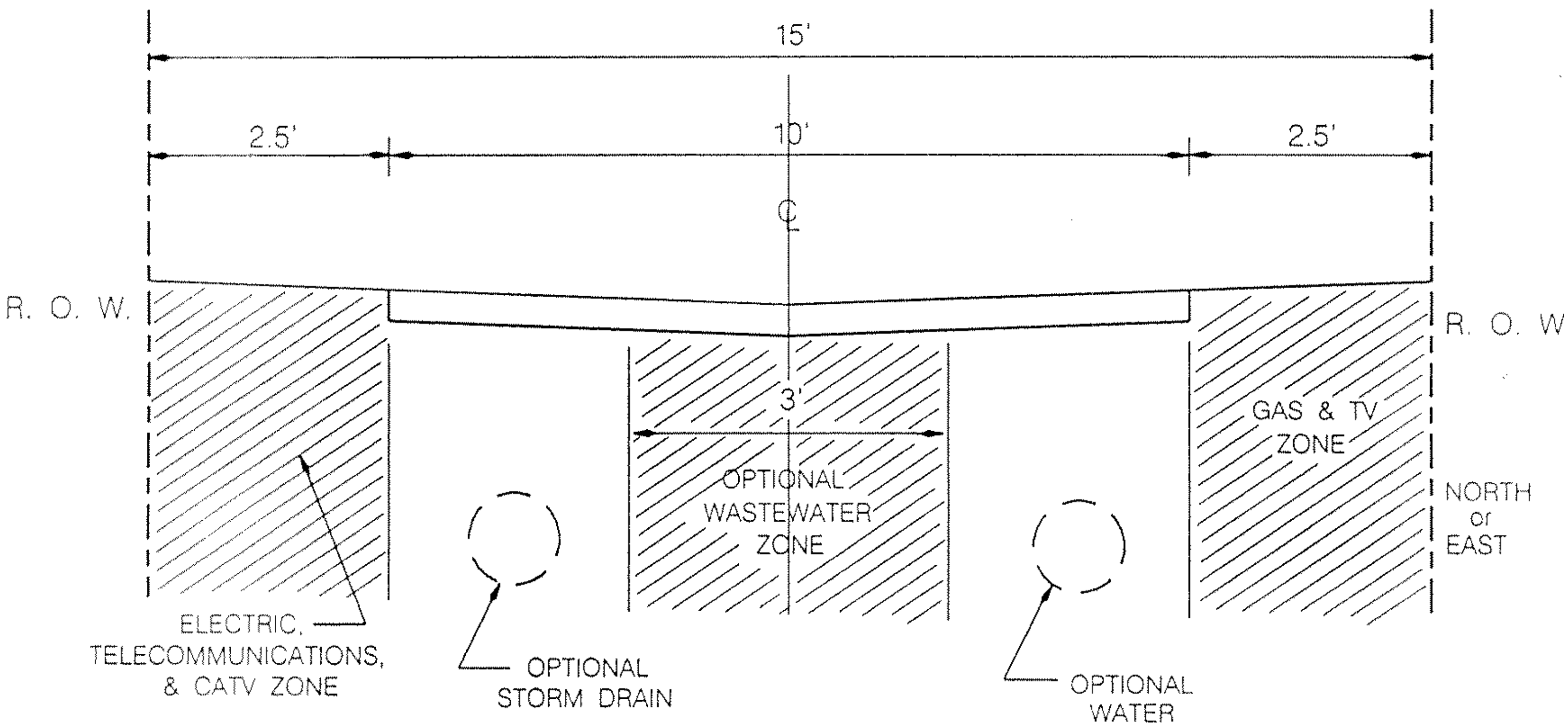


Figure IV – 21
UTILITY ZONES IN ALLEYS



The actual horizontal and vertical location of all underground utilities shall be determined where they cross any part of the proposed storm drainage system. Utilities crossing the proposed storm drainage system which may be in conflict or which may clear the drainage system by less than one (1) foot shall be exposed, whether under existing pavements (concrete or asphalt), grassed parkways or other cover. Probing will not be acceptable. Shots and field ties to the project horizontal and vertical control shall be made at these exposed utility locations. Excavation shall be made under the coordination or direction of the utility company. All necessary ties shall be made and all excavation properly backfilled. Any pavements or cover that have been damaged during excavations shall be promptly restored to equal or better than existing conditions.

The project designer shall determine from the utility companies their proposed improvements for all utilities either on the surface, below the surface or above the surface that will or might affect the project, and shall show those proposed improvements on the paving and drainage plans in both plan and profile views.

b. Joint Utility Design

As long as other utilities are not materially affected, wastewater mains and storm drains may be placed either in curvilinear alignment or in straight segments on curvilinear streets.

If significant changes in storm drainage or joint contract utility alignments are necessary during construction, all agencies whose facilities are or might be affected at the present or in the future shall be notified prior to making the design plan revision.

Alignments for utility designs shall comply with the utility zones discussed in Section 4.03.15.a General Requirements whenever possible.

The following guidelines shall be used in the design of joint water utility facilities and utilities (when part of the design contract) for those cases in which the designated zones cannot be used:

(1) Locations in roadway under pavement are to be avoided insofar as reasonably possible. All practical alternatives, including but not limited to, full use of the parkway, placement under sidewalks, utilization of median strip and joint use of trenches shall be employed to avoid placing utility facilities under pavements. When placement in the roadway is necessary, the following guidelines shall be observed:

- Placement of non-pressurized systems under pavement is satisfactory if adequate space is not otherwise available.
- Locations under curb and gutter areas of roadway are generally reserved for storm drainage facilities.
- Outside lane (adjacent to curb) shall be used insofar as possible for facilities placed under pavements.

(2) Wastewater and storm drainage lines shall have priority because of gravity flow characteristics. Non-gravity systems shall be installed parallel to and at elevations which do not interfere with gravity flow systems.

(3) Gas and water lines shall be located on the north and east side of street right-of-way.

(4) Electrical and communication lines shall be located on the south and west sides of street right-of-way.

(5) Wider than normal parkway space which is not reserved for future paving shall be available for utility use.

(6) Reservation of right-of-way space shall be made only for facilities which are definitely planned by the respective utility. In all cases, facilities shall be so placed as to minimize the total utility space required.

(7) Storm drainage facilities and utilities shall be placed consistently within the respective standard roadway zones (Figures IV-20 and 21), where standard right-of-way is available but the roadway is unimproved.

(8) The three foot area behind the curb shall be reserved for storm drainage facilities, street lighting and traffic control equipment.

Major underground facilities are defined as follows:

- Those involving multiple duct lines
- Water and wastewater lines 12 inches or larger in diameter

- Electrical cable systems of 69 kv or higher
- Gas mains 8 inches in diameter or larger
- Storm drainage facilities

In general, construction plans for major underground installations shall be complete and contain the following information:

Plan Requirements:

1. Locations of all proposed construction shall be shown.
2. All existing facilities that the proposed construction would cross shall be shown.
3. All parallel lines within street right-of-way shall be dimensioned per Item 4 below.
4. Dimensioned references shall be made to monument points in streets and to property lines in alleys and easements.
5. Topography shall be provided which is applicable either by plan, notes, or the use of aerial photographs.

Profile Requirements:

1. Elevations of proposed construction shall be given at 100 feet intervals and at points of conflict.
2. Surface grade elevations shall be provided for the entire length of the project, not just at ½ mile streets and mile streets.
3. Depth of underground facilities crossed by the proposed installation shall be shown.
4. Depth of parallel underground facilities within the rights-of-way shall be shown.
5. Elevation datum shall be City of Dallas and so indicated on the plans. (Public Works and Transportation Department, Survey and Records Section, will have elevation information.)
6. Indicate plan elevation of future facilities if furnished by the utility.

As-built drawings shall be prepared on all major underground installations except for storm drainage facilities.

Minor underground facilities are defined as all other proposed underground facilities not included as major underground facilities.

Construction plans for minor underground installations shall be complete and contain the following information:

Plan Requirements:

1. Locations of all proposed construction shall be shown.
2. All existing facilities that the proposed construction would cross or parallel in public right-of-way shall be shown.
3. Dimensional ties to monument points in streets or to property lines in alleys and easements shall be provided.

Profile Requirements:

1. Depth of proposed installations shall be provided by notes on the drawings, such as six inches below finished grade.
2. Profile sections at conflicts shall be provided.

As built drawings shall be prepared as required except for storm drainage facilities.

Joint water utility designs shall be in compliance with the Texas Natural Resources Conservation Commission regulations as currently amended and published by the State. Water utility designs shall also be in compliance with the Water and Wastewater Design Manual, the Dallas Water Utilities Drawings, Details and Standard Appurtenances for Water and Wastewater Pipe Construction Methods, and the Dallas Water Utilities Addendum to North Central Texas Standard Specifications for Public Works Construction, all as currently amended. Drafting for design plans shall be in compliance with the Dallas Water Utilities Water and Wastewater Drafting Manual, as currently amended. In case of conflict, the most restrictive requirement shall apply.

All joint water utility designs shall be coordinated and approved by the Dallas Water Utilities relocations engineer.

4.04 ADA REQUIREMENTS

4.04.01 General

a. Purpose

This section provides those guidelines for accessibility to buildings and facilities by individuals with disabilities under the Americans with Disabilities Act (ADA) of 1990, which may apply on paving design projects. These guidelines are to be applied during the design, construction and alteration of streets and facilities covered by titles II and III of the ADA to the extent required by regulations issued by Federal agencies, including the Department of Justice and the Department of Transportation under the ADA.

The Standard Construction Details file 251D-1 provides the City standard designs for public sidewalk curb ramps. These designs shall be used whenever feasible on paving projects. Special designs required due to site conditions or building and facility improvements shall comply with the requirements of this manual, this section and the ADA guidelines.

For additional details on guidelines for accessibility to buildings and facilities, see the federal document American with Disabilities Act (ADA) - Accessibility Guidelines for Buildings and Facilities.

b. General

1. *Provisions for Adults.* The requirements in these guidelines are based upon adult dimensions and anthropometrics.
2. *Equivalent Facilitation.* Departures from particular technical and scoping requirements of this section by the use of other designs and technologies are permitted where the alternative designs and technologies used will provide substantially equivalent or greater access to and usability of the facility.

c. Definitions

Access Aisle - An accessible pedestrian space between elements, such as parking spaces, seating and desks, that provides clearances appropriate for use of the elements.

Accessible - Describes a site, building, facility, or portion thereof that complies with these guidelines.

Accessible Element - An element specified by these guidelines (for example, telephone, controls, and the like).

Accessible Route - A continuous unobstructed path connecting all accessible elements and spaces of a building or facility. Interior accessible routes may include corridors, floors, ramps, elevators, lifts, and clear floor space at fixtures. Exterior accessible routes may include parking access aisles, curb ramps, crosswalks at vehicular ways, walks, ramps and lifts.

Accessible Space - Space that complies with these guidelines.

Alteration - An alteration is a change to a building or facility, including pedestrian facilities in the public right-of-way, that affects or could affect the usability of the building or facility or part thereof. Alterations include, but are not limited to, remodeling, renovation, rehabilitation, reconstruction, historic restoration, resurfacing, changes or rearrangement of the structural parts or elements, and changes or rearrangement in the plan configuration of walls and full-height partitions or pedestrian elements or surfaces in a developed right-of-way. Normal maintenance, re-roofing, painting or wallpapering, or changes to mechanical and electrical systems are not alterations unless they affect the usability of the building or facility.

Building - Any structure used and intended for supporting or sheltering any use or occupancy.

Circulation Path - An exterior or interior way of passage from one place to another for pedestrians, including, but not limited to, walks, hallways, courtyards, stairways, and stair landings.

Clear - Unobstructed.

Clear Floor Space - The minimum unobstructed floor or ground space required to accommodate a single, stationary wheelchair and occupant.

Continuous Passage - See section 4.04.02.a.2 (continuous passage).

Cross Slope - The slope that is perpendicular to the direction of travel (see running slope).

Curb Ramp - A short ramp cutting through a curb or built up to it. See also Section 4.04.02.a.2 (Public Sidewalk Curb Ramps).

Detectable Warning -	A standardized surface feature built in or applied to walking surfaces or other elements to warn visually impaired people of hazards on a circulation path.
Egress, Means of -	A continuous and unobstructed way of exit travel from any point in a building or facility to a public way. A means of egress comprises vertical and horizontal travel and may include intervening room spaces, doorways, hallways, corridors, passageways, balconies, ramps, stairs, enclosures, lobbies, horizontal exits, courts and yards. An accessible means of egress is one that complies with these guidelines and does not include stairs, steps, or escalators. Areas of rescue assistance or evacuation elevators may be included as part of accessible means of egress.
Element -	An architectural or mechanical component of a building, facility, space, or site, e.g., telephone, curb ramp, door, drinking fountain, seating, or water closet.
Entrance -	Any access point to a building or portion of a building or facility used for the purpose of entering. An entrance includes the approach walk, the vertical access leading to the entrance platform, the entrance platform itself, vestibules if provided, the entry door(s) or gate(s), and the hardware of the entry door(s) or gate(s).
Facility -	All or any portion of buildings, structures, site improvements, complexes, equipment, roads, walks, passageways, parking lots, or other real or personal property located on a site.
Marked Crossing -	A crosswalk or other identified path intended for pedestrian use in crossing a vehicular way.
Public Right-of-Way-	See Section 4.04.02.a.2. (Public Right-of-way).
Public Sidewalk -	See Section 4.04.02.a.2 (Public Sidewalk).
Public Sidewalk - Curb Ramp	See Section 4.04.02.a.2 (Public Sidewalk Curb Ramp)
Ramp -	A walking surface which has a running slope greater than 1:20.
Running Slope -	The slope that is parallel to the direction of travel (see cross slope).
Signage -	Displayed verbal, symbolic, tactile, and pictorial information.

Site - A parcel of land bounded by a property line or a designated portion of a public right-of-way.

Site Improvement - Landscaping, paving for pedestrian and vehicular ways, outdoor lighting, recreational facilities, and the like, added to a site.

Site Infeasibility - See Section 4.04.02.a.2 (Site Infeasibility).

Space - A definable area, e.g., room, toilet room, hall, assembly area, entrance, storage room, alcove, courtyard, or lobby.

Vehicular Way - A route intended for vehicular traffic, such as a street, driveway, or parking lot.

Walk - An exterior pathway with a prepared surface intended for pedestrian use, including general pedestrian areas such as plazas and courts.

4.04.02 Public Rights-Of-Way

a. General

1. Scope

All areas, elements, and facilities intended for pedestrian access, circulation, and use that are constructed, installed, or altered in the public right-of-way and which are subject to title II of the ADA shall comply with this section, the Standard Construction Details, File 251D-1 and with provisions of ADA guidelines Sections 4.1 through 4.35 that are not otherwise specified in this section.

2. Definitions

Continuous Passage - A continuous unobstructed pedestrian circulation path within a public sidewalk connecting pedestrian areas, elements, and facilities in the public right-of-way to accessible routes on adjacent sites. A continuous passage is provided in lieu of an accessible route in a public right-of-way.

Public Right-of-Way- The strip of land within the boundaries of which a public road and its appurtenances (e.g. shoulders, parkways, borders, and public

	sidewalks) are built or a public pedestrian easement providing access to a public facility through adjacent sites or properties.
Public Sidewalk -	An improved exterior pathway intended for pedestrian use along a vehicular way in the public right-of-way or in a public pedestrian easement.
Public Sidewalk - Curb Ramp	A combined ramp and landing within a public sidewalk to Curb Ramp accomplish a change of level at a curbed or otherwise separated street crossing. A perpendicular public sidewalk curb ramp runs perpendicular to and cuts through the curb; it connects to a street crossing at the bottom of its ramp run and to a landing at the top. A diagonal public sidewalk curb ramp is a variant of a perpendicular public sidewalk curb ramp that is located at the midpoint of a curb radius and serves two intersecting crossing directions at a corner. A parallel public sidewalk curb ramp has a ramped surface that is coincident with the public sidewalk and runs parallel to the curb in the direction of travel; it connects to the public sidewalk at the top and to a landing at the bottom of its run. The landing of a parallel public sidewalk curb ramp connects to the street crossing.
Site Infeasibility -	Existing site development conditions that prohibit the incorporation of elements, spaces, or features which are in full and strict compliance with the minimum requirements for new construction in the public right-of-way and which are necessary for pedestrian access, circulation, and use.

b. <u>New Construction: Minimum Requirements</u>

1. <u>Public Sidewalks</u>

Where provided, public sidewalks shall contain a continuous passage. The continuous passage shall connect to elements covered by this Section

4.04.02 and accessible routes provided on adjacent sites. Public sidewalks and the continuous passage within them shall comply with the following requirements:

(a) Width

(1) The minimum clear width of a continuous passage shall be 36 inches. If a person in a wheelchair must make a turn around an obstruction, the minimum clear width of the continuous passage shall be as shown in Figure IV-22.

(2) Public sidewalks less than 60 inches continuous width shall provide passing space at reasonable intervals not to exceed 200 feet. Passing space shall provide a 60 inches by 60 inches minimum clear space and may be provided at driveways, at building entrances, and at public sidewalk intersections.

(b) Slope

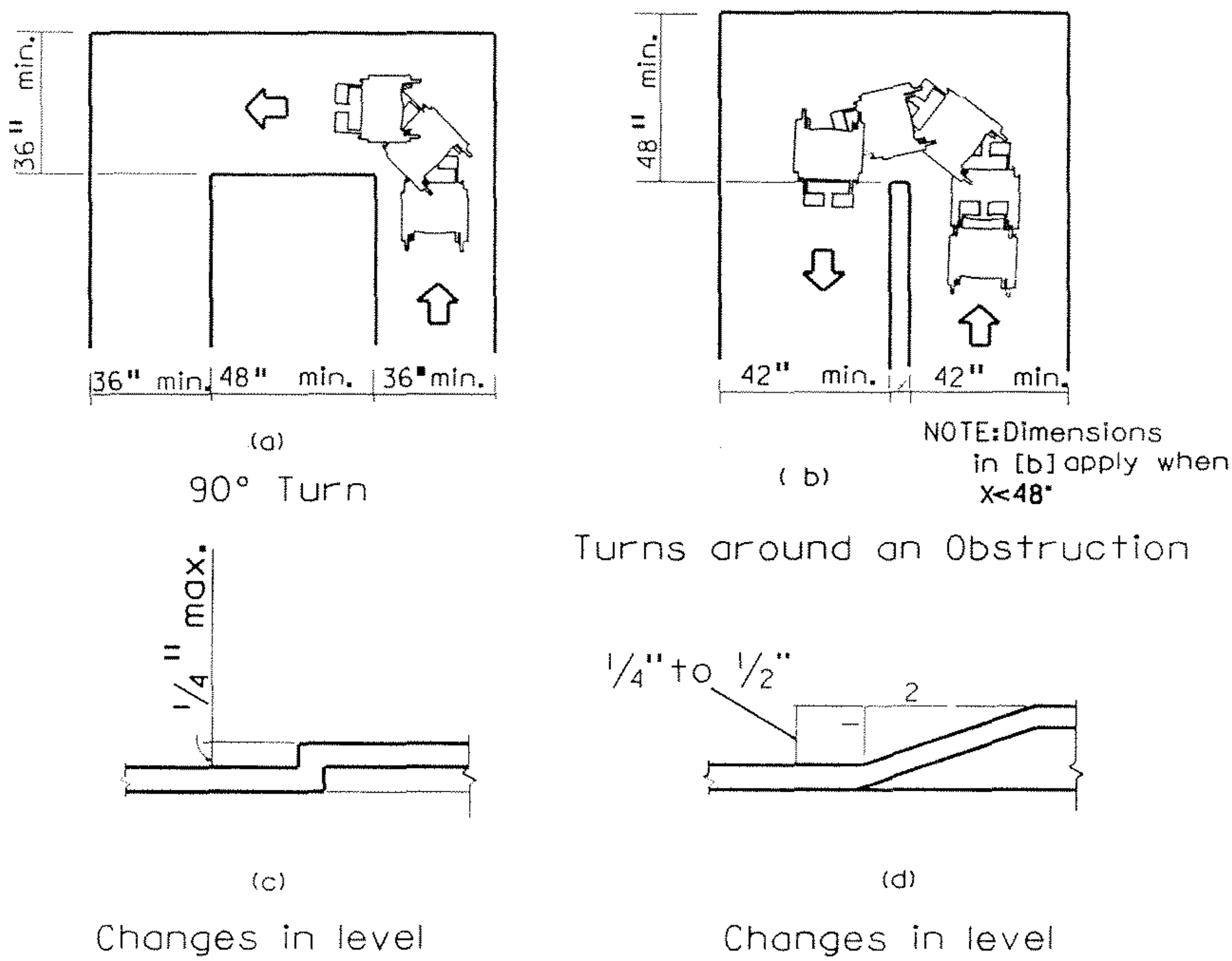
(1) The minimum feasible public sidewalk running slope consistent with slopes established for adjacent roadways shall be provided.

(2) Public sidewalk cross slope shall not exceed 1:50 (2 percent). Where public sidewalk intersections in the public right-of-way serve two directions of travel, the slope in any direction shall not exceed 1:50.

(c) Surfaces

(1) Surfaces of public sidewalks shall be stable, firm, and slip-resistant and shall lie generally in a continuous plane with a minimum of surface warping.

(2) Changes in level up to ¼ inch may be vertical and without edge treatment. Changes in level between ¼ inch and ½ inch shall be beveled with a slope no greater than 1:2 (see Figure IV-22 (d)). Changes in level greater than ½ inch shall be accomplished by means of a public sidewalk curb ramp that complies with the following Section 4.04.02.b.4 <u>Public Sidewalk Curb Ramp</u>, a ramp that complies with ADA guideline Section 4.8 <u>Ramps</u>, or an elevator that complies with ADA guideline Section 4.10 <u>Elevators</u>.



ACCESSIBLE ROUTE

Figure IV-22

(3) Gratings in public sidewalks shall have spaces no greater than ½ inch wide in the directions(s) of traffic flow and shall not be located in the continuous passage.

(4) Where public sidewalks cross rail systems at grade, the surface of the continuous passage shall be level and flush with the rail top at the outer edge and between the rails. The horizontal gap on the inner edge of each rail shall be the minimum necessary to allow passage of wheel flanges and shall not exceed 2½ inches maximum.

(d) Separation

Public sidewalks shall be raised to curb height or separated from vehicular ways by curbs, planted parkways, or other barriers, which shall be continuous except where interrupted by driveways, alleys or connections to accessible elements.

EXCEPTION: Unseparated public sidewalks may be constructed along undeveloped frontages of rural roadways.

2. Protruding Objects

(a) Wall-Mounted Objects

Objects projecting from walls (e.g., signs, fixtures, telephones, canopies) with their leading edges between 27 inches and 80 inches above the finished public sidewalk shall protrude no more than 4 inches into any portion of a public sidewalk. Objects mounted with their leading edges located less than 27 inches or more than 80 inches above the finished public sidewalk may project any amount provided that they do not reduce the required continuous passage along the public sidewalk.

(b) Pole-Mounted Object

Free-standing objects mounted on posts or pylons may overhang their mountings a maximum of 12 inches when located

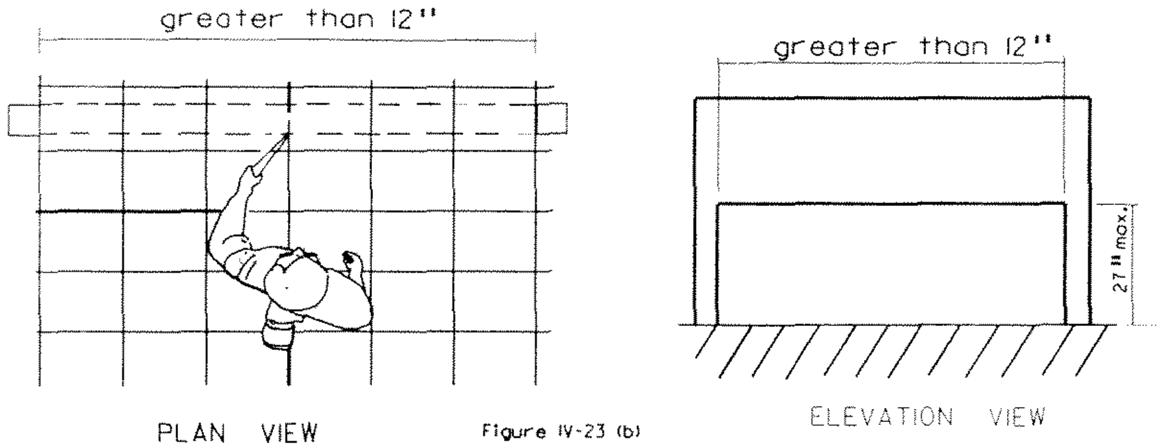


Figure IV-23 (b)

Free-Standing Overhanging Objects

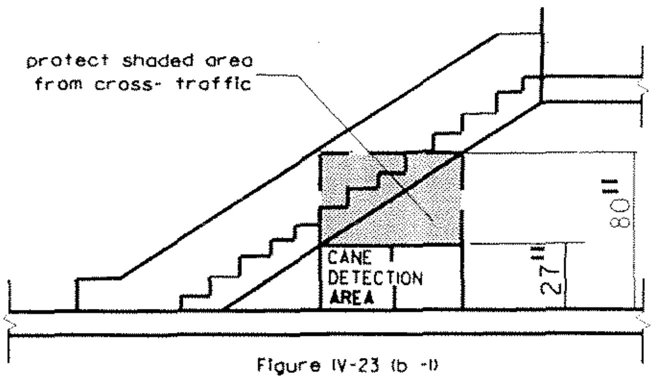


Figure IV-23 (b -1)

Overhead Hazards

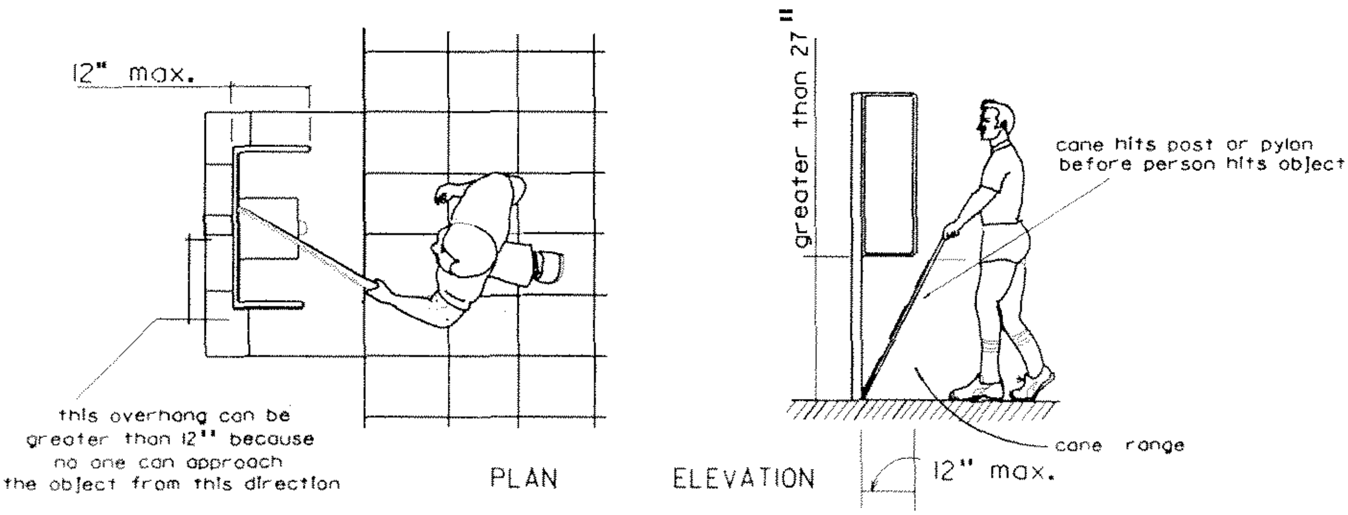


Figure IV-23 (a)

OBJECTS MOUNTED ON POSTS OR PYLONS

Figure IV-23

PROTRUDING OBJECTS

between 27 inches and 80 inches above the finished public sidewalk provided that they do not reduce the required continuous passage along the public sidewalk (see Figure IV-23(a)).

(c.) Head Room

Where the vertical clearance of an area on or adjoining a public sidewalk or continuous passage is less than 80 inches (e.g., at the underside of projecting stairs or other elements that exceed a 4 inches profile when mounted from a wall), guardrails or other barriers shall be provided. Leading edges of such barriers shall be located less than 27 inches above the finished public sidewalk, as shown in Figure IV-23(b-1). Barriers shall not reduce the required continuous passage.

3. Fixed Street Furnishings

Where provided for pedestrian use or operation, fixed street furnishings installed on or adjacent to a public sidewalk and accessed from the public pedestrian right-of-way shall be connected to the continuous passage and shall comply with the applicable following provisions:

(a) Drinking Fountains

Where drinking fountains are provided at a location, they shall be accessible to individuals who use wheelchairs in accordance with ADA guidelines Section 4.15 and to those who have difficulty bending or stooping. This can be accomplished by the use of a "hi-lo" fountain; by providing one fountain accessible to those who use wheelchairs and one fountain at a standard height convenient for those who have difficulty bending, or by such other means as would achieve the required accessibility for each group.

(b) Public Telephones

(1) Where a single unit public telephone is provided, it shall comply with ADA guidelines Sections 4.31.2

through 4.31.8.

(2) Where a bank of telephones (two or more adjacent public telephones often installed as a unit) is provided, at least one telephone per bank shall comply with ADA guidelines Sections 4.31.2 through 4.31.8.

(3) All public telephones shall be equipped with volume controls complying with ADA guidelines Section 4.31.5(2) and shall be hearing aid compatible.

(c) Single User Toilet Facilities

Where a single user toilet facility is provided, it shall comply with ADA guidelines Sections 4.22.2 through 4.22.7.

(d) Fixed Seating, Tables, and Benches

(1) Where fixed seating and tables are provided at a single location, at least five percent, but not less than one, shall comply with ADA guidelines Section 4.32.

(2) Where fixed benches are provided at a single location, at least 50 percent shall have a back and armrests. A 30 inches by 48 inches clear ground space for a wheelchair shall be provided at one end of at least one bench at each location where fixed benches are provided.

(e) Bus Shelters and Stops

Where a bus stop pad is provided, it shall comply with ADA guidelines Section 10.2.1(1). Where a bus shelter is provided, it shall comply with ADA guidelines Section 10.2.1(2).

(f) Street Identification and Other Pedestrian Signage

Where provided for pedestrian use, informational and directional signage and street identification signs shall comply with ADA guidelines Sections 4.30.2, 4.30.3, and 4.30.5. Where bus route identification signs are provided on or adjacent to a public sidewalk, they shall comply with ADA guidelines Section 10.2.1(3).

(g) Other Elements

Where provided, other fixed street furnishings intended for pedestrian operation or use, such as information kiosks, fire alarm boxes, fixed trash receptacles and similar elements, shall comply with ADA guidelines Section 4.27.

4. <u>Public Sidewalk Curb Ramps</u>

(a) General

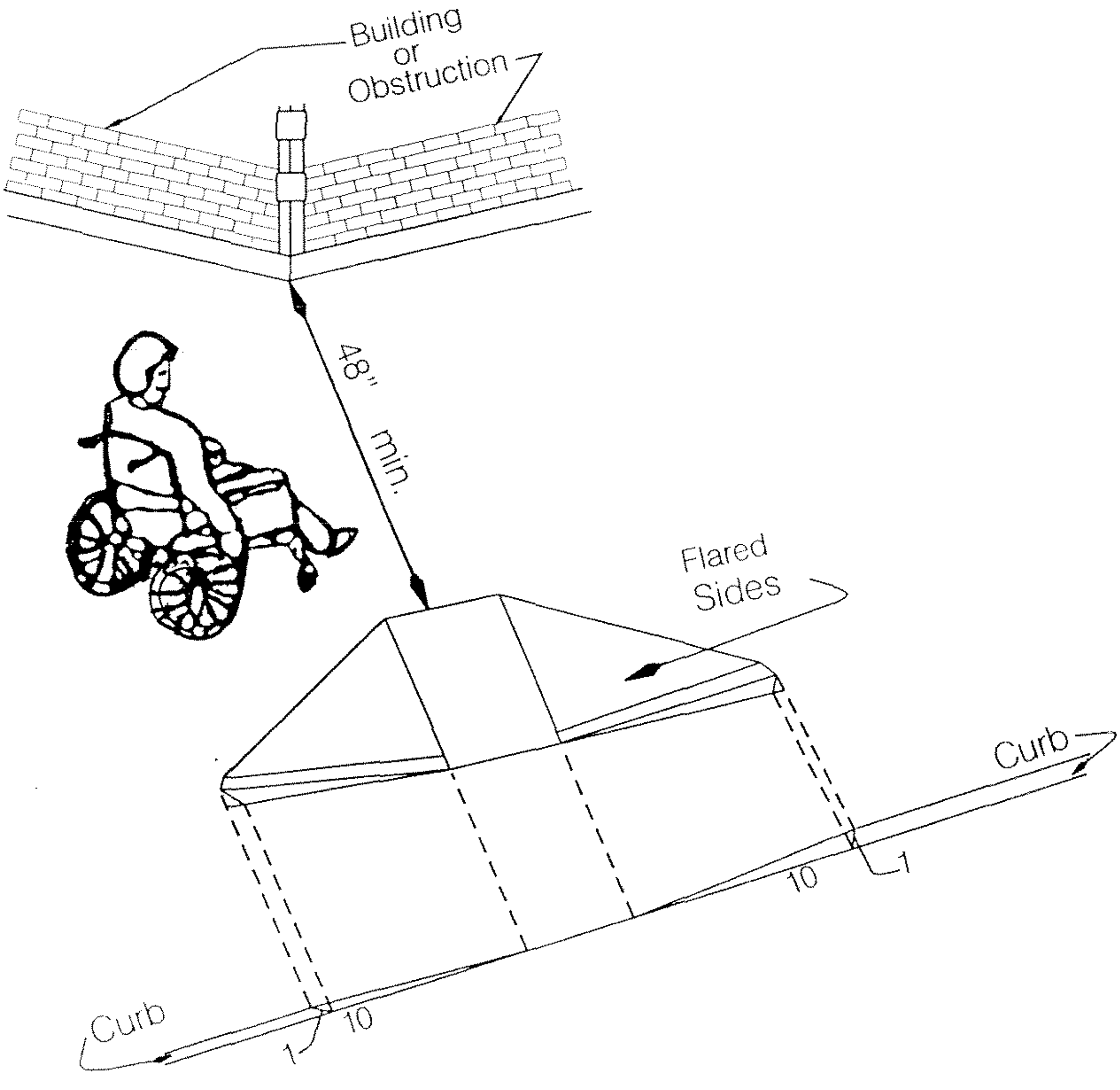
(1) A public sidewalk curb ramp and level landing complying with the Standard Construction Details, File 251D-1 and this section, 4.04.02.b.4, shall be provided wherever a public sidewalk crosses a curb or other change in level and each street crossing and where otherwise required in this section and shall be connected to a continuous passage in each direction of travel.

(2) The provisions of ADA guidelines Sections 4.7 and 4.8 do not apply to public sidewalk curb ramps.

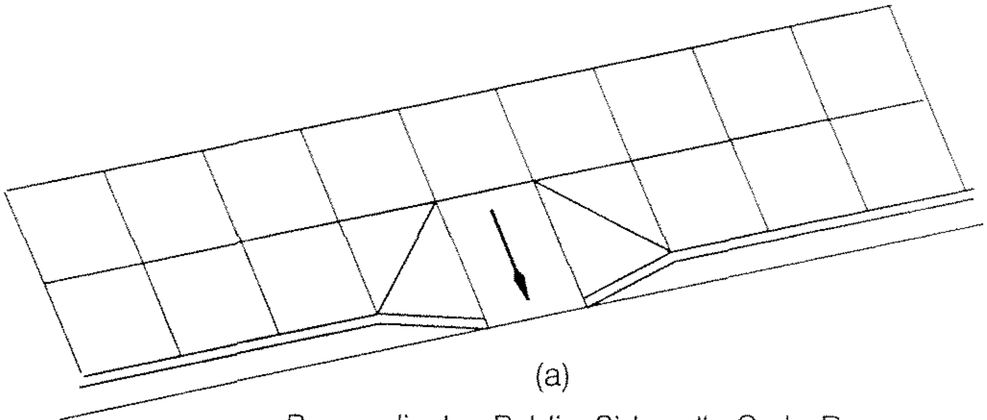
(b) Types of Public Sidewalk Curb Ramps

Public sidewalk curb ramps shall be perpendicular to the curb at street crossings and each shall have a level landing at the top (see Figures IV-24 and IV-25(a)). At marked crossings, the bottom of the ramp run, exclusive of flared sides, shall be wholly contained within the markings (see Figures IV-26(a) and (b)).

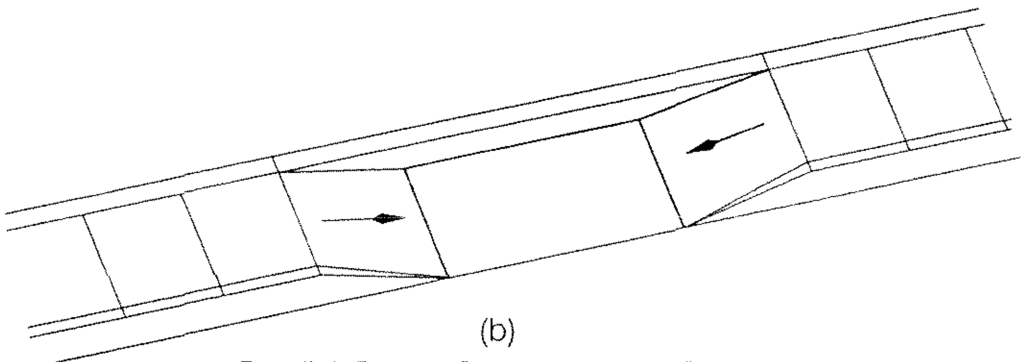
Single (i.e., diagonal or depressed corner) public sidewalk curb ramps serving two street crossing directions are the standard public sidewalk ramps for new construction. Design details for standard public sidewalk curb ramps are provided in the Standard Construction Details, File 251D-1. In the special case where right-of-way and street curb geometry permits, the perpendicular public sidewalk curb ramp and landing is the preferred design. Such special ramp design shall be included with the paving design as required by the City. Built-up (i.e., projected) public sidewalk curb ramps are not permitted in new construction.



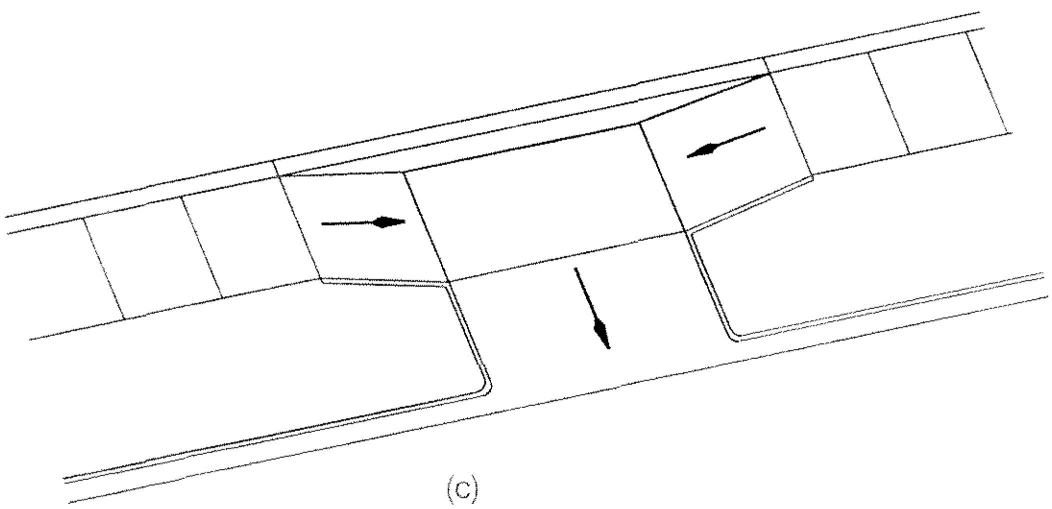
Level Landing at Top of Perpendicular Public
Sidewalk Curb Ramp
FIGURE IV – 24



(a)
Perpendicular Public Sidewalk Curb Ramp



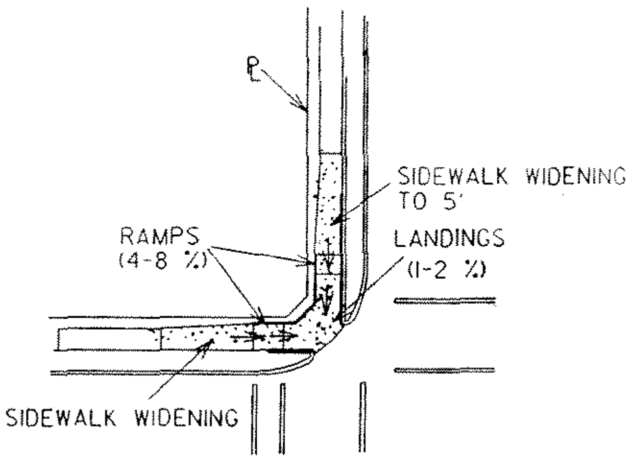
(b)
Parallel Public Sidewalk Curb Ramp



(c)
Combined (Parallel) / Perpendicular) Public Sidewalk Curb Ramp

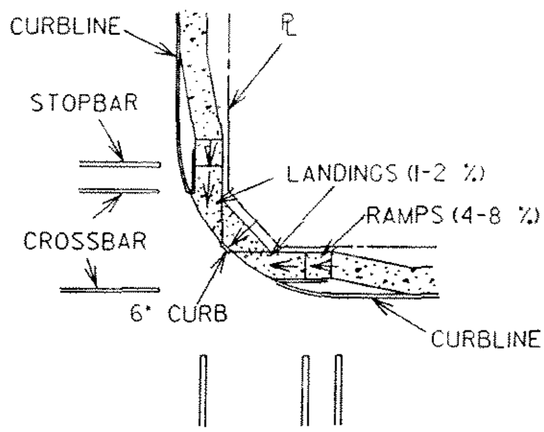
Figure IV – 25
PUBLIC SIDEWALK CURB RAMPS
VARIOUS CONCEPTS

FIGURE IV -26
PUBLIC SIDEWALK CURB RAMPS AT MARKED CROSSINGS



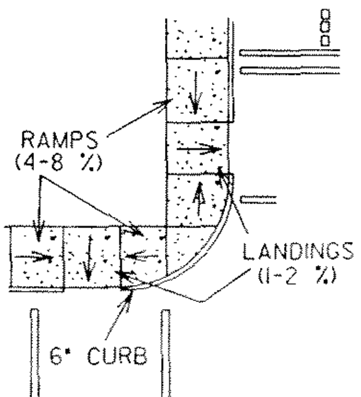
(a)

Perpendicular public sidewalk curb ramp for public sidewalk away from curb



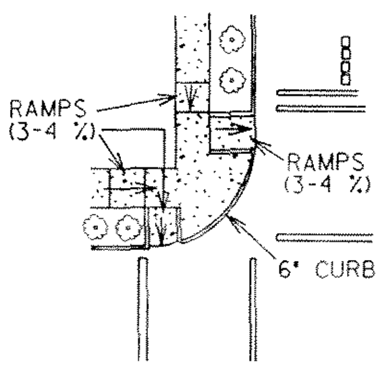
(b)

Perpendicular public sidewalk curb ramp for public sidewalk against curb



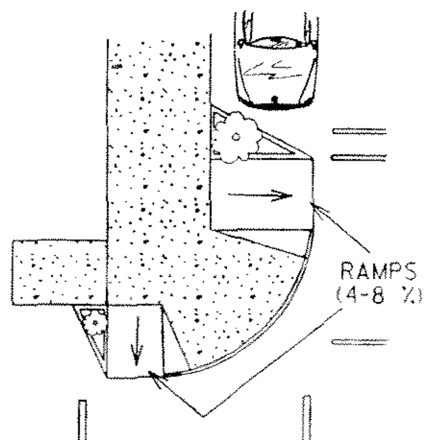
(c)

Parallel public sidewalk curb ramp in public sidewalk



(d)

Combination public sidewalk curb ramp in public sidewalk with parkway



(e)

Perpendicular public sidewalk curb ramp at projected intersection

EXCEPTION: Where public pedestrian right-of-way width established by local or State regulation, guideline, or practice will not accommodate a perpendicular public sidewalk curb ramp and landing complying with this Section of 4.04.02.b.4.(b), a parallel public sidewalk curb ramp with a level landing at its bottom shall be provided instead of a perpendicular public sidewalk curb ramp (see Figure IV-25(b)). At marked crossings, the landing at the bottom of the ramp run shall be wholly contained within the markings (see Figure IV-26). A combination of parallel and perpendicular public sidewalk curb ramps and landings may also be provided (see Figures IV-25c and IV-26).

(c) Width

Public sidewalk curb ramps shall be 36 inches wide minimum, exclusive of flares sides.

(d) Landings

(1) Where a perpendicular public sidewalk curb ramp is provided, a landing the width of the public sidewalk curb ramp shall be provided at the top of the ramp run (see Figure IV-24). The slope of the landing shall not exceed 1:50 in any direction. The landing shall be 48 inches minimum in length and shall connect to the continuous passage in each direction of travel.

(2) Where a parallel public sidewalk curb ramp is provided, as permitted in Section 4.04.02.b.4. Exception, a landing the width of the parallel public sidewalk curb ramp and a minimum of 60 inches in length in the direction of the ramp run shall be provided at the bottom of the parallel public sidewalk curb ramp. The slope of the landing shall not exceed 1:50 in any direction. At marked crossings, the required landing at the bottom of the parallel public sidewalk curb ramp shall be wholly contained within the markings.

(3) Where parallel and perpendicular public sidewalk

curb ramps are combined to serve a street crossing, as permitted in Section 4.04.02.b.4, the landing required for the perpendicular public sidewalk curb ramp may be coincident with that provided for the parallel public sidewalk curb ramp.

(e) Slope

The minimum feasible running slope shall be provided for any public sidewalk curb ramp and shall be measured from a level plane, as shown in Figure IV-27. The maximum running slope of any public sidewalk curb ramp shall be 1:12. The maximum cross slope of any public sidewalk curb ramp shall be 1:50.

EXCEPTION: A parallel public sidewalk curb ramp allowed by this Section 4.04.02.b.4. <u>Exception</u> shall have a maximum slope of 1:12 when measured from a level plane as shown in Figure IV-27 but shall not be required to exceed 96 inches in length.

(f) Edges

Where a side of a perpendicular public sidewalk curb ramp is contiguous with a public sidewalk, it shall be flared with a slope of 1:10 or flatter. A perpendicular public sidewalk curb ramp may have a returned side or flare of any slope when not contiguous with a public sidewalk or where protected by a guardrail or other barrier.

(g) Surfaces

(1) The surface of a public sidewalk curb ramp shall be stable, firm and slip-resistant. Gratings and similar access covers shall not be located on public sidewalk curb ramps or landings. The surface of a perpendicular public sidewalk curb ramp or the landing of a parallel public sidewalk curb ramp shall contrast visually with adjoining public sidewalk surfaces, either light-on-dark or dark-on-light.

(2) Detectable Warnings. Except at driveways, all public sidewalk curb ramps shall have a detectable warning and grooved surface to warn the visually impaired

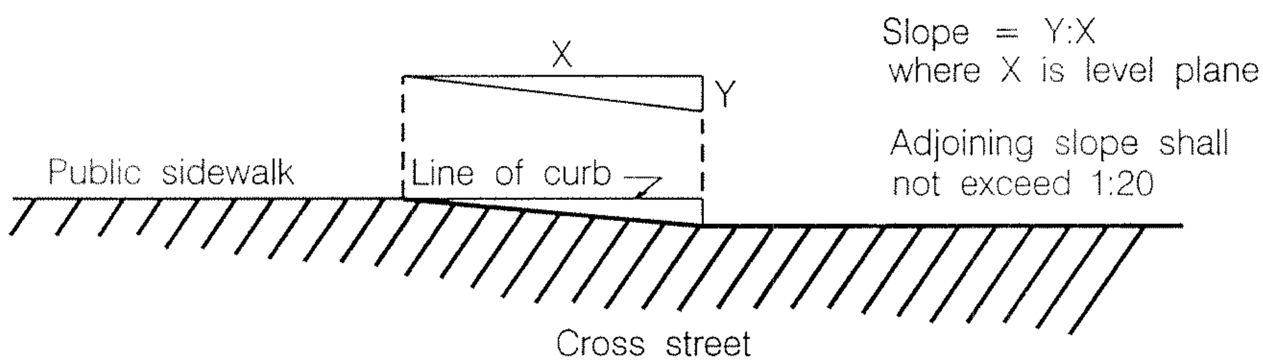


Figure IV – 27
MEASUREMENT of PUBLIC SIDEWALK CURB RAMP SLOPE

pedestrians before encountering the ramp and the crossing. The grooved surface or finish shall have grooves ¼ inch deep by ¼ inch wide at 4-inch centers providing a detectable warning band around the entrance edges of the curb ramp, perpendicular to the sidewalk longitudinal direction or pedestrian movement. In addition to the detectable warning band, the surface finish of the curb ramp shall have a grooved finish, with grooves ¼ inch deep by ¼ inch wide, 4 inch centers and aligned parallel with the crosswalk or pedestrian movement to the opposite side of the street. The marking pattern on the existing sidewalk shall be followed on the new sidewalk except in the curb ramp area. Grooves shall be clear and straight for clear detection by touch with a cane. See the Standard Construction Details, file 251D-1 for details.

(h) Transitions

Transitions shall be flush and free of abrupt changes. Counter slopes of adjoining gutters and road surfaces connecting to the full width of a public sidewalk curb ramp shall be 1:20 maximum for a distance of 24 inches as measured from the base of the public sidewalk curb ramp or landing edge at the street (see Figure IV-27). Gratings or similar access covers shall not be located in the area at the base of the public sidewalk curb ramp or landing.

(i) Obstructions

Public sidewalk curb ramps shall be located or protected to prevent their obstruction by parked vehicles.

5. <u>Pedestrian Street Crossings</u>

Where provided, pedestrian street crossings at, above, or below street grade shall comply with the applicable following provisions and be connected to the continuous passage:

(a) Crossing Controls

(1) Controls. Controls shall be raised from or flush with

their housings and shall be a minimum of 2 inches in the smallest dimension. The force required to activate controls shall be no greater than 5 lbs.

(2) Location. Controls shall be located as close as practicable to the public sidewalk curb ramp serving the controlled crossing and shall permit operation from a clear ground space.

(3) Mounting Height. Pedestrian-actuated crossing controls shall be a maximum of 42 inches above the finished public sidewalk.

(4) Clear Ground Space. A stable, firm, and slip-resistant area a minimum of 30 inches by 48 inches and complying with ADA guidelines Section 4.2.4(1) and (2) shall be provided to allow for a forward or parallel approach to the controls. Where a parallel approach is provided, controls shall be within 10 inches horizontally of and centered on the clear ground space. Where a forward approach is provided, controls shall abut and be centered on the clear ground space.

(b) Marked Crossings

Marked Crossings shall be delineated in materials or markings that provide a visual contrast with the surface of the street.

(c) Islands

Raised islands in crossings shall be cut through level with the street or have public sidewalk curb ramps at both sides and a level area 48 inches long minimum and a minimum of 36 inches wide in the part of the island intersected by the crossings (see Fig. IV-26(a) and (b)

(d) Pedestrian Overpasses and Underpasses

Where a public sidewalk is provided on a grade-separated overpass or underpass, changes in level shall be accomplished by a ramp or elevator complying with ADA guidelines Section 4.8 or 4.10. Stairs serving an underpass or overpass shall comply with ADA guidelines Section 4.9.

6. <u>Vehicular Ways and Facilities</u>

Where the following elements are provided on or adjacent to a public right-of-way for pedestrian use by motorists, the elements shall be served by a continuous passage and shall comply with the following provisions:

(a). <u>On-Street Parking</u>

(1) Where on-street public convenience parking is provided in commercial districts and at civic buildings, accessible on-street parking spaces shall be included in the total provided in the project or project area in accordance with the table in ADA guidelines Section 4.1.2(5)(a). Accessible spaces shall not be smaller in width or length than that specified by the local jurisdictions for other spaces. The accessible spaces shall be provided at locations with minimum street and public sidewalk slope to the extent this is consistent with reasonable dispersion within the overall project area in which they are provided.

(2) Accessible on-street parking spaces shall comply with the following provisions:

(i) Parallel Parking Spaces. A 60 inches wide minimum parallel access aisle shall be provided at street level the full length of the accessible parking space. The parallel access aisle shall connect at the head or foot of the parking space to a 60 inches wide minimum perpendicular access aisle which shall extend the full width of the parking space. A public sidewalk curb ramp complying with this Section 4.04.02.b.4 shall connect the access aisles to the continuous passage. Two parallel parking spaces may share a perpendicular access aisle. The driving lane shall not encroach on any required access aisle (See Figure IV-28).

EXCEPTION: Where the width of the public pedestrian right-of-way between the curb and boundary of the public right-of-way is less than 12 feet, a parallel access aisle is not required in parallel parking spaces.

(ii) Perpendicular Parking Spaces. A 60 inch wide minimum parallel access aisle shall be provided at street level the full length of the accessible parking space. A public sidewalk curb ramp complying with this Section 4.04.02.b.4 shall connect the access aisle to the continuous passage. Two perpendicular parking spaces may share an access aisle (see Figure IV-29).

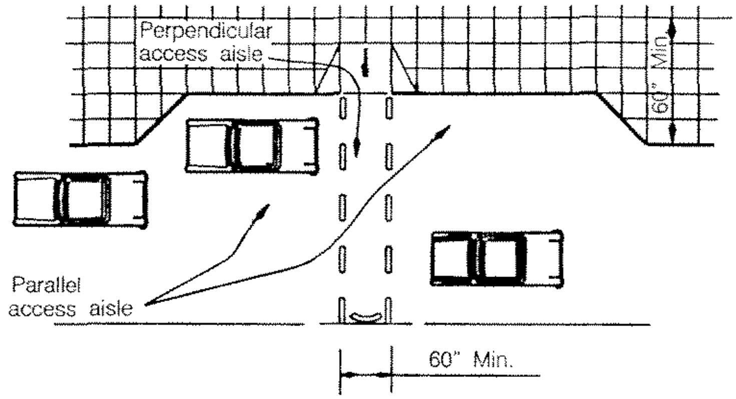
(iii) Angled Parking Spaces. A 60 inch wide minimum parallel access aisle shall be provided at street level the full length of the accessible parking space. A public sidewalk curb ramp complying with this Section 4.04.02.b.4 shall connect the access aisle to the continuous passage.

(iv) Van-Accessible Parking Spaces. Where perpendicular or angled parking is provided, one in every eight accessible parking spaces within the projected area, but not less than one, shall be served by a parallel access aisle that is 96 inches wide minimum.

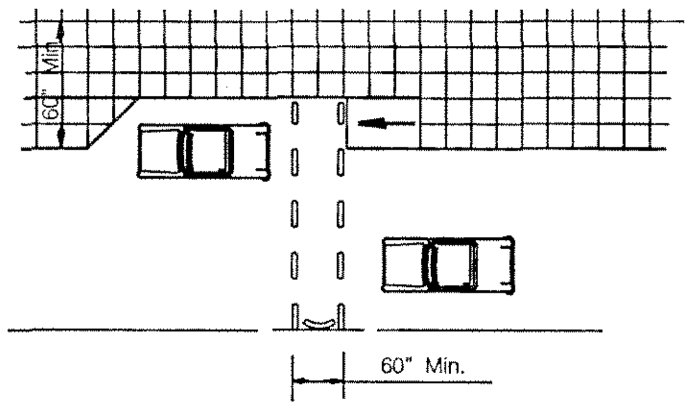
(v) Signage. Accessible parking spaces shall be designated as reserved by a sign that complies with ADA guidelines Section 4.30.7. Spaces complying with the previous Section 4.04.02.b.6.a.iv shall contain an additional sign "Van Accessible" mounted below the symbol of accessibility. Signs shall be located so they cannot be obscured by a vehicle parked in the space.

(b) Parking Meters

(1) Parking meter controls shall be 42 inches maximum above the finished public sidewalk. Controls and operating mechanisms shall be operable with one hand and shall not require tight grasping, pinching, or twisting of the wrist. The force required to activate controls shall be no greater than 5 lbs.



(a)
Double accessible parking space with perpendicular public sidewalk curb ramp



(b)
Single accessible parking space with perpendicular public sidewalk curb ramp

Figure IV – 28
EXAMPLES OF ACCESSIBLE PARALLEL ON – STREET PARKING

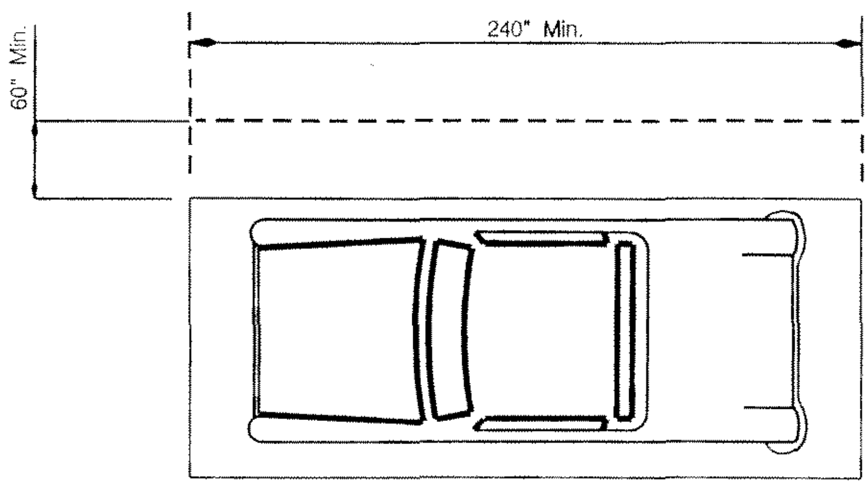


Figure IV – 30
ACCESS AISLE at PASSENGER LOADING ZONES

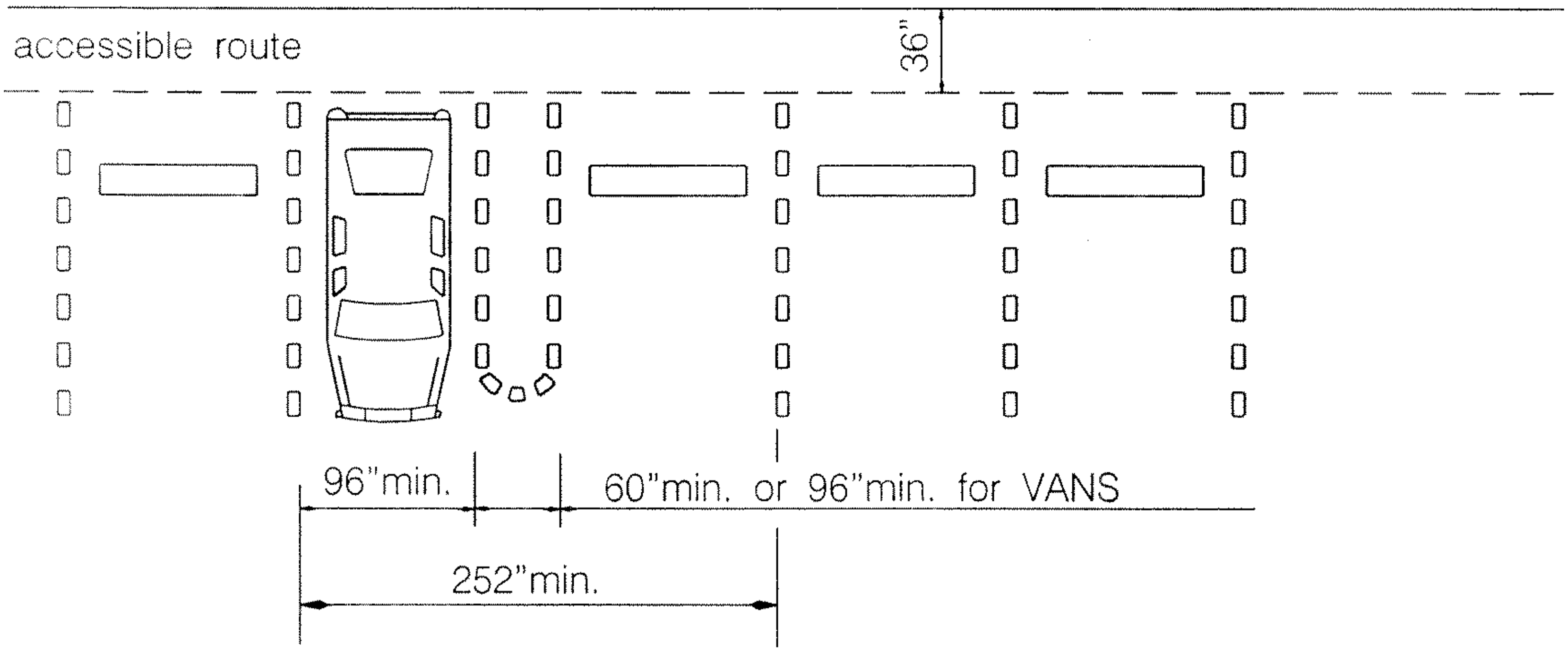


Figure IV – 29
DIMENSIONS OF PARKING SPACES

(2) Where parking meters serve accessible parking spaces, a stable, firm, and slip resistant clear ground space a minimum of 30 inches by 48 inches shall be provided at the controls and shall comply with ADA guidelines Sections 4.2.4.1 and 4.2.4.2. Where only a parallel approach is provided, controls shall be within 10 inches horizontally of and centered on the clear ground space. Where only a forward approach is provided, controls shall abut and be centered on the clear ground space. Parking meters shall be located at or near the head or foot of the parking space so as not to interfere with the operation of a side lift or a passenger side transfer.

(c) Passenger Loading Zones

(1) Each passenger loading zone shall provide a parallel access aisle at least 60 inches wide and 20 feet long adjacent and parallel to the vehicle pull-up space (see Figure IV-30). Signage complying with ADA guidelines Section 4.30.7 shall be provided.

(2) Where a continuous curb separates the access aisle and vehicle space, a public sidewalk curb ramp complying with Section 4.04.02.b.5 shall be provided outside the area of the access aisle and connecting to it.

(3) Where a single passenger loading zone serves multiple vehicle pull-up spaces (e.g. at transportation facilities), additional public sidewalk curb ramps shall be provided at reasonable intervals and shall be located to minimize travel distance and maximize availability during heavy use.

(d) Motorist Aid Communications Systems

(1) Controls and operating mechanisms at call boxes shall be operable with one hand and shall not require tight grasping, pinching, or twisting of the wrist. The highest operable part shall be 48 inches maximum above the finished surface at the callboy location. The force required to activate controls shall be no greater than 5 lbs.

(2) The system shall provide both visible and audible

indicators of call receipt and shall not require voice communication only.

(3) A stable, firm and slip resistant clear ground space a minimum of 30 inches by 48 inches with a slope no greater than 1:50 in any direction, shall be provided at the controls and shall comply with ADA guidelines Sections 4.2.4.1 and 4.2.4.2. Where only a parallel approach is provided, controls shall be within 10 inches horizontally of and centered on the clear ground space. Where only a forward approach is provided, controls shall abut and be centered on the clear ground space.

c. <u>Alterations</u>

If existing areas, elements, or facilities intended for pedestrian access, circulation, and use in an existing developed public right-of-way are altered they shall comply with this subsection.

1. <u>General</u>

Alterations to individual elements shall comply to the maximum extent feasible with the applicable requirements of Section 4.04.02.b consistent with the following requirements:

(a) No alterations shall be undertaken that decrease or have the effect of decreasing the accessibility or usability of existing pedestrian areas, elements or facilities.

(b) If alterations to existing public sidewalks, public sidewalk curb ramps, or pedestrian street crossings, when considered together, amount to a reconstruction of a block, intersection, or other substantial segment of the pedestrian circulation network in the public right-of-way, the entire segment shall, to the maximum extent feasible, comply with provisions for new construction.

(c) No alterations of an existing pedestrian area, element, or facility shall impose a requirement for greater accessibility than that which would be required for new construction.

(d) Alterations to a public sidewalk, public sidewalk curb ramp, or pedestrian street crossing in the public right-of-way shall be made so that adjacent segments of the continuous passage are readily accessible to and usable by individuals with disabilities, unless such alterations are disproportionate to the overall alterations in terms of cost and scope (as determined under criteria established by the Attorney General).

EXCEPTION: In alteration work, if site infeasibility precludes compliance with Section 4.04.02.b, the alteration work shall provide accessibility to the maximum extent feasible. Any elements or features of the public pedestrian right-of-way that are being altered and can be made accessible shall be made accessible within the scope of the alteration. (See definition for site infeasibility, Section 4.04.02.a.2)

2. <u>Special Technical Provisions for Alterations to Existing Pedestrian Areas, Elements, and Facilities in the Public Right-of-Way</u>

(a) Public Sidewalks

Where necessary to provide a continuous passage complying with Section 4.04.02.02.a, public sidewalk surfaces may be warped or blended. Where compliance with requirements for cross slope within the continuous passage cannot be fully met due to site infeasibility, the minimum cross slope feasible shall be provided. Existing gratings and similar appurtenances that comply with Section 4.04.02.b.1.(b) and 4.04.02.b.1.(c) may be located in the continuous passage if site infeasibility precludes their relocation during alterations.

(b) Public Sidewalk Curb Ramps

Where site infeasibility precludes the installation of a public sidewalk curb ramp complying with all provisions of Section

4.04.02.b.4, the maximum accessibility feasible shall be provided, according to each of the following special technical provisions:

(1) Types of Public Sidewalk Curb Ramps. Public sidewalk curb ramp type shall be determined by existing public right-of-way width and the existence of other site constraints, in the following recommended priority: (i) perpendicular, (ii) parallel or combined, and (iii) diagonal. A projected (built-up) public sidewalk curb ramp is permitted in alterations to public rights-of-way where other designs cannot be accommodated.

(2) Width. Where public pedestrian right-of-way width is less than 36 inches, a parallel public sidewalk curb ramp and landing in width of the existing public pedestrian right-of-way shall be provided.

(3) Landings. Landings shall be provided and shall comply with the following special technical provisions:

(i) Where public pedestrian right-of-way width is insufficient to accommodate a perpendicular public sidewalk curb ramp with a top landing 48 inches in length, a top landing of the maximum feasible length and a minimum length of 36 inches shall be provided.

(ii) Where site infeasibility precludes a parallel public sidewalk curb ramp with a bottom landing 60 inches in length, a bottom landing of the maximum feasible length and a minimum length of 48 inches shall be provided.

(iii) Where site infeasibility precludes a landing slope of 1:50 in any direction, the slope perpendicular to the curb face shall not exceed 1:50.

(iv) Where site infeasibility precludes a landing slope of 1:50 when measured perpendicular to the curb face, the minimum feasible slope in each direction shall be provided.

(4) Slope.

(I) Where public right-of-way width is insufficient to accommodate a landing and perpendicular public sidewalk curb ramp with a maximum running slope of 1:12, the minimum feasible running slope between 1:12 and 1:10 is permitted for a rise of 6 inches maximum.

(ii) Where public right-of-way width is insufficient to accommodate a landing and perpendicular public sidewalk curb ramp with a maximum running slope of 1:10, the minimum feasible running slope between 1:8 and 1:10 shall be permitted for a rise of 3 inches maximum.

(iii) A public sidewalk curb ramp shall have the maximum slope permitted in (i.) or (ii.) when measured from a level plane as shown in Figure IV-27, but shall not be required to exceed 72 inches in length.

(iv) Where compliance with requirements for cross slope cannot be fully met due to site infeasibility, the minimum feasible cross slope shall be provided.

(5) Surfaces.

(I) Existing gratings and similar appurtenances that comply with Section 4.04.02.b.1.b and 4.04.02.b.1.c may be located in public sidewalk curb ramps or landings if site infeasibility precludes their relocation during alterations.

(ii) Where counter slopes of existing adjoining gutters and road surfaces exceed 1:20, newly installed public sidewalk curb ramp surfaces may be slightly crowned and projected beyond the curb face provided the leading edge at the street surface can be smoothly blended and sides are flared, without abrupt drop-offs.

(c) On-Street Parking

Parallel on-street parking spaces designated for use by persons with disabilities and located immediately adjacent to intersections may be served by public sidewalk curb ramps located at street crossings when site in feasibility precludes the installation of a public sidewalk curb ramp and access aisles complying with Section 4.04.02.b.5. at the space, provided that motorists exiting their vehicles do not have to cross into perpendicular travel lanes to gain access to a public sidewalk curb ramp.

d. Temporary Work

Construction and repair work within the public right-of-way that affects pedestrian circulation elements, spaces, or facilities shall comply with the following provisions:

1. Construction sites in the public right-of-way shall be protected with barriers to warn of hazards on the pedestrian circulation network.
2. Where a temporary alternate circulation path is provided it shall comply with 14.3 and shall be clearly marked.

V - PAVEMENT STRUCTURE

5.01 GENERAL

Factors which influence the performance of street and thoroughfare pavement include the subgrade upon which the pavement structure rests, the quality of materials used to construct the pavement, thickness of the pavement, and the type and amount of traffic using the facility. In designing a pavement which will provide a reasonable degree of performance during an expected life, certain of these factors can be predetermined. The load bearing capacity of the subgrade can be determined by making a soils engineering investigation of the site for a proposed pavement. The strength of the pavement can also be established by specifications and quality control during construction. A reasonable estimate can also be made of the traffic including the number of equivalent 18-Kip axial loads anticipated during the expected life of the pavement. Of primary importance in determining traffic loading is the amount of truck and bus traffic expected on the street or thoroughfare during the design life.

Although the subgrade and traffic vary for different locations, the plasticity index (P.I.) of the subgrade, the street or thoroughfare classification (Local, Minor Arterial, etc.), and location of the thoroughfare in relation to industrial, heavy commercial, and bus routes and facilities reflect to a degree these factors. Standard pavement sections are established, therefore, for certain subgrade conditions, street classifications, and truck/bus traffic loadings and are included in the manual in Table V-1, "Standard Street and Thoroughfare Pavement Design". The "Normal Design" case given in Table V-1 is to be used on most city streets and thoroughfares and reflects a design adequate for reasonably high levels of truck, bus and Total Average Daily Traffic normally experienced in the City. To account for streets with heavy truck and/or bus traffic, a "Heavy Duty Design" case has been established and provided in Table V-1 for standard design of these streets. The levels of Average Daily Traffic, percent truck and bus traffic and traffic loading for the design lane are given for each case.

Unusual design conditions may be encountered or traffic loadings may exceed the assumed design traffic loading which will preclude the use of Table V-1. Alternate pavement designs accompanied by calculations and data based on accepted pavement design procedures will be made by the designer in such cases for consideration by the City Department of Public Works and Transportation.

TABLE V-1
STANDARD STREET AND THOROUGHFARE PAVEMENT DESIGN

Facility Type	Pavement Width	Usual Crown	[2] Subgrade Requirements P.I. = 15 or less	P.I. Greater Than 15	Base Pavement	[1] Portland Cement Concrete Pavement (Thickness)	Asphalt Concrete Pavement
Alley	10'	3" Invert	6" Compacted	8" Compacted	None	6"	Not Permitted
Sidewalks	Away from curb - 4'	None	Compacted	Compacted	None	4"	Not Permitted
	Against curb - 5'	None	P.I. 18 or less Compacted	Greater than 18 6" select or lime	None	4"	Not Permitted
LOCAL STREETS							
• **Residential Zoned Districts**							
Local, L2U(B)	26'	4"	6" Compacted	6" Lime Treated or [3] Cement Modified	None	6"	Not Permitted
Local, S2U	36'	6"	6" Compacted	6" Lime Treated or Cement Modified	None	6"	Not Permitted
• **Nonresidential Zoned Districts**							
Local, S2U	36'	6"	8" Compacted	8" LimeTreated or Cement Modified	None	8"	Not Permitted
COLLECTOR STREETS							
• **Normal Design**							
Residential (S2U)	36'	6"	8" Compacted	8" Lime Treated or Cement Modified	None	8"	Not Permitted
Community (S2U)	36'	6"	8" Compacted	8" Lime Treated or Cement Modified	None	9"	Not Permitted

TABLE V-1
STANDARD STREET AND THOROUGHFARE PAVEMENT DESIGN
(continued)

Facility Type	Pavement Width	Usual Crown	[2] Subgrade Requirements: P.I. = 15 or less	[2] Subgrade Requirements: P.I. Greater Than 15	Base Pavement	[1] Portland Cement Concrete Pavement (Thickness)	Asphalt Concrete Pavement
COLLECTOR STREETS							
• **Heavy Duty Design** (Heavy Truck/Bus Traffic)							
Community (S2U)	36'	6"	[3] 8" Cement Stabilized (6%)	8" Cement Stabilized (8%-10%)	None	10"	Not Permitted
Community (M4U*)	40'	6"	8" Cement Stabilized (6%)	8" Cement Stabilized (8%-10%)	None	10"	Not Permitted
MINOR ARTERIALS							
• **Normal Design**							
Type M4U	40'	6"	8" Cement Modified (4%)	8" Lime Treated or Cement Modified	None	9"	Not Permitted
Type S4U	44'	6"	8" Cement Modified (4%)	8" Lime Treated or Cement Modified	None	9"	Not Permitted
Type S4D	2-24'	¼"/Ft. cross slope	8" Cement Modified (4%)	8" Lime Treated or Cement Modified	None	9"	Not Permitted
• **Heavy Duty Design** (Heavy Truck/Bus Traffic)							
Type M4U	40'	6"	8" Cement Stabilized (6%)	8" Cement Stabilized (8%-10%)	None	11"	Not Permitted
Type S4U	44'	6"	8" Cement Stabilized (6%)	8" Cement Stabilized (8%-10%)	None	11"	Not Permitted
Type S4D	2-24'	¼"/Ft. cross slope	8" Cement Stabilized (6%)	8" Cement Stabilized (8%-10%)	None	11"	Not Permitted

* Striped for two lanes

TABLE V-1
STANDARD STREET AND THOROUGHFARE PAVEMENT DESIGN
(continued)

Facility Type	Pavement Width	Usual Crown	[2] Subgrade Requirements P.I. = 15 or less	P.I. Greater Than 15	Base Pavement	[1]Portland Cement Concrete Pavement (Thickness)	Asphalt Concrete Pavement
PRINCIPAL ARTERIALS							
• **Normal Design**							
Type M6D(A)	2-33'	¼"/Ft. cross slope	8" Cement Modified (4%)	8" Lime Treated or Cement Modified	None	9"	Not Permitted
Type M6D(B)	2-30'	¼"/Ft. cross slope	8" Cement Modified (4%)	8" Lime Treated or Cement Modified	None	9"	Not Permitted
Type S6D	2-36'	¼"/Ft. cross slope	8" Cement Modified (4%)	8" Lime Treated or Cement Modified	None	9"	Not Permitted
Type S8D	2-48'	¼"/Ft. cross slope	8"Cement Modified (4%)	8" Lime Treated or Cement Modified	None	9"	Not Permitted
• **Heavy Duty Design** (Heavy Truck/Bus Traffic)							
Type M6D(A)	2-33'	¼"/Ft. cross slope	8"Cement Stabilized (6%)	8"Cement Stabilized (8%-10%)	None	11"	Not Permitted
Type M6D(B)	2-30'	¼"/Ft. cross slope	8"Cement Stabilized (6%)	8"Cement Stabilized (8%-10%)	None	11"	Not Permitted
Type S6D	2-36'	¼"/Ft. cross slope	8"Cement Stabilized (6%)	8"Cement Stabilized (8%-10%)	None	11"	Not Permitted
Type S8D	2-48'	¼"/Ft. cross slope	8"Cement Stabilized (6%)	8"Cement Stabilized (8%-10%)	None	11"	Not Permitted

TABLE V-1
STANDARD STREET AND THOROUGHFARE PAVEMENT DESIGN
(continued)

Facility Type	Pavement Width	Usual Crown	[(2)] Subgrade Requirements P.I. = 15 or less	P.I. Greater Than 15	Base Pavement	[(1)]Portland Cement Concrete Pavement (Thickness)	Asphalt Concrete Pavement
CBD STREETS							
• **Standard Design**	As Required	6" or ¼"/Ft.	6" Compacted	6" Compacted	4", 650 psi CTB	10"	Not Permitted
• **Alternate Design**	As Required	6" or ¼"/Ft	8" Cement Treated (10%)	8" Cement Treated (10%)	None	10"	Not Permitted

(1) Concrete pavement as specified by Public Works Addendum to the Standard Specification 5.8.1.1.
  a) Alley pavement is specified as either,
     Machine Finish Class - test strength is 4000 psi compressive strength at 28 days after placement. or
     Hand Finish Class - test strength is 4500 psi compressive strength at 28 days after placement.
  b) Sidewalk pavement is specified as sidewalk, separate curb and gutter, and (4) inch thick median pavement class - test strength is 3000 psi compressive strength at 28 days after placement.
  c) Street pavement is specified as either,
     Machine Finish Class - test strength is 4000 psi compressive strength at 28 days after placement or
     Hand Finish Class - test strength is 4500 psi compressive strength at 28 days.
     Machine and Hand Finish classes of concrete mix designs have been designed to provide an ultimate compressive design strength of at least 6000 psi.

(2) Standard subgrade compaction under alley and street pavement is 98% standard proctor density at minus 2% to plus 4% of optimum moisture to the depth specified. See Paving Design Manual Section 5.02.01, "Standard Design Criteria" and 5.02.06, "Alleys" for details concerning compaction and treatment requirements.
Alternate acceptable substitutions for subgrade stabilization when approved by the City are as follows:
  6" or 8" lime stabilization = 1" reinforced concrete pavement
  8" cement stabilization (10%) = 1 1/2" reinforced concrete pavement,
Standard subgrade compaction for sidewalks against the street curb is 95% of standard Proctor density within minus 2% to plus 4% of optimum moisture content. For sidewalks away from the curb, the standard subgrade compaction is 90% of standard Proctor (ASTM D698). See Paving Design Manual section 5.02.05 "Sidewalks" for compaction and subgrade requirements.

(3) Cement stabilized subgrade shall require subgrade stabilization in accordance with Public Works Addendum Specification Item 4.9(A) "Cement Stabilization of Subgrade Soils" at the following rate of cement content of dry weight of soil:
  - 6% for subgrade soil P.I. equal to or less than 15;
  - 8% for subgrade soil P.I. equal to or less than 25 but greater than 15;
  - 10% for subgrade soil P.I. equal to or less than 45 but greater than 25;
  - At a rate to be determined by the testing laboratory for subgrade soil P.I. greater than 45.
Cement modified subgrade shall provide a cement application rate as follows:
  - 4% for subgrade soil P.I. equal to or less than 15.
  - When substituted for Lime Treatment in subgrade soils having a P.I. greater than 15, the rate shall be at least 2% higher than the required rate of lime content to reduce the soil P.I. to less than 15.

5.02 STANDARD PAVEMENT DESIGN

5.02.01 Standard Design Criteria

The standard pavement for city streets, alleys and sidewalks is Portland cement concrete. The standard city design criteria provides 30 year design life for new concrete streets using the City's concrete mix designs. The City's concrete mix designs for streets are specified in The Public Works Addendum to the Standard Specification section 5.8.1.1 under "Machine Finish" and "Hand Finish" classes of concrete. These two mix designs have been specified to provide 28 day compressive strength of 4000 psi for "Machine Finish" mixes and 4500 psi for "Hand Finish" mixes.

The standard concrete street design accounts for streets with heavy truck and bus traffic using state-of-the-art equivalent 18 kip axle load (EAL) design. The superior subgrade support capabilities of cement stabilization and cement treated base (CTB) are used in designs supporting heavy traffic loading.

The following design criteria has been used in developing the minimum required standard pavement structure designs:

Subgrade Design Parameters

Subgrade Soil:	Clay
Classification by USCS:	CH
Classification by AASHTO:	A-7-6
Proof Rolled Subgrade:	
California Bearing Ratio (CBR):	5
Modulus of Subgrade Reaction (k) compacted to 95% standard proctor density at -2% to +4% of optimum moisture:	150 pci
Modified Modulus of Subgrade Reaction (6 inches thick)	
(1) For Subgrade Soil P.I. greater than 15 using a 6-inch lime treated subgrade for residential zoned districts and 8-inch lime treated subgrade for non-residential zoned districts, compacted to 98% standard proctor density at - 2% to +4% of optimum moisture (Local Street Pavements):	200 pci

(2) For Subgrade Soil P.I. equal to or less than 15 using a 6-inch untreated subgrade for residential zoned districts and 8-inch untreated subgrade for nonresidential zoned districts, compacted to 98% standard proctor density at - 2% to +4% of optimum moisture (Local Street Pavements): 200 pci

Modified Modulus of Subgrade Reaction (8 inches thick)

(1) For Subgrade Soil P.I. greater than 15 using an 8-inch lime treated subgrade compacted to 98% standard proctor density at - 2% to +4% of optimum moisture (Normal Design Case - Collector and Arterial Thoroughfare Pavements): 250 pci

(2) For Subgrade Soil P.I. equal to or less Than 15

(a) using an 8-inch untreated subgrade compacted to 98% standard proctor density at - 2% to +4% of optimum moisture (Normal Design Case - Collector Thoroughfare Pavements): 200 pci

(b) using an 8-inch cement modified subgrade using 4% portland cement by dry weight of soil, compacted to 98% standard proctor density at - 2% to +2% of optimum moisture (Normal Design Case - Arterial Thoroughfare Pavements): 250 pci

Modified Modulus of Subgrade Reaction ("Heavy Duty Design")

(1) For Subgrade Soil P.I. greater than 45, using an 8-inch cement stabilized subgrade with a subgrade design and cement rate determined by a testing laboratory, compacted to 98% standard proctor density at -2% to +2% of optimum moisture (Heavy Duty Design Case for Collectors and Arterial Thoroughfare and alternate CBD design case pavements): 350 pci

(2) For Subgrade Soil P.I., equal to or less than 45 but greater than 25, using an 8-inch cement stabilized subgrade using 10% portland cement by dry weight of soil, compacted to 98% standard proctor density at

- 2% to +2% optimum moisture (Heavy Duty Design Case for Collector and Arterial Thoroughfare and alternate CBD design case pavements): 350 pci

(3) For Subgrade Soil P.I. equal to or less than 25 but greater than 15, using an 8-inch cement stabilized subgrade using 8% portland cement by dry weight of soil, compacted to 98% standard proctor density at -2% to 2% optimum moisture. (Heavy Duty Design Care for collector and arterial thoroughfare and alternate CBD design case pavements): 350 pci

(4) For Subgrade Soil P.I. equal to or less than 15, Using an 8-inch cement stabilized subgrade using 6% portland cement by dry weight of soil, compacted to 98% standard proctor density at -2% to +2% optimum moisture. (Heavy Duty Design Case for collector and arterial thoroughfare and alternate CBD design case pavements): 350 pci

Standard Public Works addendum specifications to the Standard Specifications provide full detail for the requirements for lime treated and cement stabilized subgrade. The requirements for cement modified subgrade is provided in the Standard Specifications under Item 4.9 "Portland Cement Modification of Subgrade Soils."

Pavement Analyses and Design

Pavement analyses and design was performed in accordance with AASHTO Guide for Design of Pavement Structures (1993), using the computer program '*Pavement Analysis Software (PAS)*', published by the American Concrete Pavement Association. The following parameters were used in the pavement analyses and design:

Annual Traffic Growth Rate:	0.163%
Design Life:	30 years
Terminal Serviceability Index:	2.25
Reliability:	85%

Pavement design studies require that all traffic data (buses, heavy trucks, automobile, etc.) be converted to 18-kip Equivalent Single Axle Loads (ESAL). Approximately 2,500 cars are equivalent to one (1) ESAL, whereas one (1) bus is equivalent to from one (1) to five (5) ESAL's depending on the thickness of the pavement and whether the bus is empty or fully loaded to capacity.

The following assumptions are used in the pavement analyses concerning traffic loading:

1) The standard AASHTO vehicles for SU vehicle and WB-50 vehicle are used for trucks. Use is made of the current five different City bus types carrying one half capacity load to establish the equivalent City bus loading. The equivalent bus loading per bus vehicle is determined for each street classification as follows:

EQUIVALENT CITY BUS LOADING DETERMINATION

	*LOADING CASES (IN ESALS)			PERCENT OF TOTAL BUSES PER STREET CLASSIFICATION		
TYPE BUS	**EMPTY BUS LOADING**	**HALF BUS CAPACITY LOADING**	**FULL BUS CAPACITY LOADING**	**LOCAL**	**COLLECTOR**	**ARTERIAL/ CBD**
Grumman/Flexible	1.06	2.30	4.38	12%	12%	9%
GMC RTS	0.95	1.8	3.15	25%	23%	19%
Neoplan/AN 440	0.98	2.03	3.71	63%	59%	47%
Neoplan/AN 460	1.79	3.00	5.00	0%	6%	5%
MCI	1.62	2.73	2.76	0%	0%	20%

* Based on 9" Pavement

	STREET CLASSIFICATION & PAVEMENT THICKNESS						
	Local	Collector			Arterial/CBD		
	6"	8"	9"	10"	9"	10"	11"
Equivalent Half Capacity Bus Loading Per Bus Vehicle (ESALS)	1.96	2.04	2.07	2.08	2.20	2.21	2.22

2) The portion of traffic called Truck/Bus traffic is broken down as follows:
   - Buses comprise 50%
   - WB-50 trucks comprise 25%
   - SU vehicle trucks comprise 25%

3) The remaining portion of the vehicular traffic is broken down as follows:
   - Cars comprise 50% with average loading of 2,000 lbs. on the front and rear axle.
   - Pickup trucks and small vehicles comprise 50% with average loading of 2,000 lbs. on the front axle and 4,000 lbs on the rear axle.

4) Calculations are based on the total traffic volume and percentage of heavy truck/bus traffic using the procedure given in AASHTO <u>Guide for Design of Pavement Structures (1993)</u>.

All subgrade beneath proposed pavements shall be treated as required in Table V-1 and to the depth required. All subgrade beneath street pavements, whether treated or untreated, shall be compacted to a 98% Standard Proctor density at - 2% to +4% of optimum moisture (ASTM D 698), except that the moisture range for cement stabilized or modified subgrade shall be at -2% to +2% of optimum moisture.

<u>Alternate Substitutions for Subgrade Preparation</u>

Where the pavement section has been designed using a lime treated subgrade and lime is deleted at the request of the Owner or Contractor and approved by the City Project Engineer, the pavement thickness shall be increased by at least one (1.0) inch. Where the pavement section has been designed using a cement stabilized subgrade and cement is deleted at the request of the Owner or Contractor and approved by the Owner, the pavement thickness shall be increased by at least one and one-half (1.5) inches. Where the pavement section has been designed using Cement Treated Base (CTB) and CTB is deleted at the request of the Owner or Contractor and approved by the Owner, the pavement thickness shall be increased by at least 2 inches for every 4 inches of CTB deleted.

If a substitution is made in the treatment additive, whereby lime is used in lieu of cement (where cement has been specified), the pavement thickness shall be increased by at least one-half (0.5) inch. If a Contractor proposes cement in lieu of lime to expedite construction (where lime has been specified), the rate of cement required shall be at least 2% more than the rate of lime required to meet specifications. Cement modification when used as a substitute for lime shall be performed in accordance with Standard Specification Item 4.9. "Portland Cement Modification of Subgrade Soils." No pavement thickness reduction shall be allowed for substitution of cement for lime stabilization.

If subgrade stabilization is not performed and the pavement thickness is increased accordingly, the upper eight (8) inches of subgrade soil must be compacted at - 2% to +4% of optimum moisture to a minimum of 98% Standard Proctor density (ASTM D698).

Granular Subgrade Soil Considerations

Cement stabilization shall be used for all subgrade soil conditions (clay or granular soils) where a cement stabilized subgrade has been specified for design unless an alternate substitution has been approved by the City. If an alternate substitution for cement stabilization has been approved, the concrete pavement section shall be increased appropriately as described above.

For the "Normal Design" case, cement modification shall be performed in accordance with Standard Specification Item 4.9. "Portland Cement Modification of Subgrade Soils" at a rate of 4% cement content of dry weight of soil, for modification of granular subgrades (having a PI of 15 or less) for all arterial streets and thoroughfares to help prevent possible subgrade pumping at the joints during the life of the street.

The "Heavy Duty Design" case requires cement stabilization of the subgrade in accordance with Addendum Standard Specification Item 4.9(A) "Cement Stabilization of Subgrade Soils" at a rate varying from 6% to 10% cement content of dry weight of soil depending on the soil P.I. for soils with a subgrade P.I. up to 45 for community collector and arterial streets and thoroughfares.

Steel Reinforcement and Pavement Joints

Minimal steel reinforcement is required for all standard concrete street pavements. Steel reinforcement and the various standard jointing requirements are provided in The Department of Public Works Standard Construction Details, File 251D-1.

The following should be noted in the use of Table V-1:

Street Classification and Design Case

Table V-1 shows the required pavement thickness and subgrade treatment requirements for certain soil conditions and for various street and thoroughfare types and traffic loading design cases within the City. The procedure for using this table requires that the classification of the street be determined and the appropriate traffic loading design case of "Normal" or "Heavy Duty" be selected. Information is available from the Transportation Division of the Public Works and Transportation Department which will establish the street classification and help determine which traffic loading design case is applicable. The traffic loading design case shall be determined by the consultant and approved by the City project engineer during the early stages of the Preliminary Design phase of the project.

Subgrade Treatment

The approximate plasticity index of the subgrade soil is also required to select the appropriate pavement structure for the project. A soil investigation may be required including obtaining soil borings, classifying the soils encountered and determining the strength and physical properties of the underlying and supporting soils system in the laboratory by means of Atterberg Limits, optimum moisture content, penetrometer compressive strength readings, and unit dry weight. For each soil classification encountered, the liquid limit shall be determined, the plasticity index shall be calculated, and depending on the proposed elevation of the subgrade and on whether the plasticity index is less or more than the critical value shown, the subgrade design shall be treated as shown in Table V-1. For subgrades on proposed fill sections, the subgrade soil shall be assumed to be equal to the predominate subgrade soil encountered on the project unless the Atterberg characteristics of the subgrade soil used for fill are specified in the plans.

For estimate purposes, 8-inch thick 10% cement stabilized subgrade shall be calculated as requiring 72 lbs. of cement per square yard. Eight inch thick 8% and 6% cement stabilized subgrade shall be calculated as requiring 63 lbs. and 52 lbs. of cement per square yard, respectively. Eight inch thick 4% cement modified subgrade shall be calculated as requiring 35 lbs. of cement per square yard.

Quantities of lime required for lime treated subgrade are dependent on the results of the Atterberg Limits testing, insitu soil density and the depth of stabilization required. The rate of lime specified for lime treated subgrade shall be an adjusted rate above the laboratory determined theoretical rate to allow for construction tolerances. As a rule of thumb, the adjusted rate of lime shall be no less than 4% commercial hydrated lime per dry weight of subgrade soil (for 6-inch depth treatment - 22 lbs per square yard, for 8-inch depth treatment - 29 lbs. per square yard) for subgrade soils having a liquid limit less than 50; the adjusted rate shall be no less than 6% for clay subgrade soils having a liquid limit of 50 or greater (for 6-inch depth treatment - 32 lbs. per square yard; for 8-inch depth treatment - 41 lbs. per square yard).

5.02.02 Arterial Thoroughfares

The following traffic loading and pavement parameters are used in the pavement analysis and standard design for Arterial Thoroughfares given in Table V-1:

Principal Arterials:

Roadway Class:	Case (1)	Principal Arterial (Normal Design)
	Case (2)	Principal Arterial (Heavy Duty Design)

Case (1) Normal Design:

Total Traffic Volume (Two Way):	25,000 Vehicles Per Day (vpd) weekdays 12,500 Vehicles Per day (vpd) weekends
Traffic Lanes:	6-Lane Divided Roadway
Pavement Width:	2 @ 33 feet (face curb-to-face curb)
Heavy Truck/Bus Traffic:	2% (1/2 truck and 1/2 bus)
Traffic (Design Lane):	8,450,000 18 kip ESAL

Case (2) Heavy Duty Design:

Total Traffic Volume (Two Way):	40,000 Vehicles Per Day (vpd) weekdays 20,000 Vehicles Per Day (vpd) weekends
Traffic Lanes:	6-Lane Divided Roadway
Pavement Width:	2 @ 33 feet (face-to-face)
Heavy Truck/Bus Traffic:	10% (1/2 truck and 1/2 bus)
Traffic (Design Lane):	67,365,000 18 kip ESAL
Concrete Compressive Strength	4,000 psi

CBD Pavement Sections:

Roadway Class:	Thoroughfare
Design Vehicle:	Equivalent City Bus

Estimated Bus Traffic:

Monday thru Friday	60 buses per hour for 8 hours, 30 buses per hour for 8 hours and 15 buses per hour for 8 hours
Saturday & Sunday	30 buses per hour for 8 hour, 15 buses per hour for 8 hours and 5 buses per hour for 8 hours

Pavement Widths:

(1) 3-Lane Roadway:	33 feet (face-to-face)
(2) 4-Lane Roadway:	44 feet (face-to-face)
Traffic (Design Lane)*:	17,700,000 18 kip ESAL
Concrete Compressive Strength	4,000 psi

* 100% Bus Traffic Assumed In Design Lane.

Minor Arterials:

Roadway Class:	Case (1)	Minor Arterial (Normal Design)
	Case (2)	Minor Arterial (Heavy Duty Design)

Case (1) Normal Design:

Total Traffic Volume (Two Way):	18,000 Vehicles Per Day (vpd) weekdays 9,000 Vehicles Per Day (vpd) weekends
Traffic Lanes:	4-Lane Undivided Roadway
Pavement Width:	40 feet, 44 feet (face-to-face)
Heavy Truck/Bus Traffic:	2% (1/2 truck and 1/2 bus)
Traffic (Design Lane):	7,400,000 18 kip ESAL

Case (2) Heavy Duty Design:

Total Traffic Volume (Two Way):		25,000 Vehicles Per Day (vpd) weekdays 12,500 Vehicles Per Day (vpd) weekends
Traffic Lanes:		4-Lane Undivided Roadway
Pavement Width:		40 feet, 44 feet (face-to-face)
Heavy Truck/Bus Traffic:		10% (1/2 truck and 1/2 bus)
Traffic (Design Lane):		54,133,000 18 kip ESAL
Concrete Compressive Strength		4,000 psi

5.02.03 Collector Thoroughfares

The following traffic loading and pavement parameters are used in the pavement analysis and standard design for Collector Thoroughfares given in Table V-1:

Collector Streets:

Roadway Class:	Case (1)	Residential Collector
	Case (2)	Community Collector (Normal Design)
	Case (3)	Community Collector (Heavy Duty Design)

***Case (1) Residential Collector:**

Total Traffic Volume (Two Way):		5,000 Vehicles Per Day (vpd) weekdays 2,500 Vehicles Per Day (vpd) weekends
Traffic Lanes:		2-Lane Undivided Roadway
Pavement Width:		36 feet (face-to-face) 40 feet (face to face)
Heavy Bus Traffic:		72 buses per day for 5 days a week (week days) & 30 Buses total for the weekend
Traffic (Design Lane):		1,310,000 18 kip ESAL

Case (2)Community Collector (Normal Design):

Total Traffic Volume (Two Way):	7,000 Vehicles Per Day (vpd) weekdays
	3,500 Vehicles Per Day (vpd) weekends
Traffic Lanes:	2-Lane Divided Roadway
Pavement Width:	36 feet (face-to-face) 40 feet (face to face)
Heavy Truck/Bus Traffic:	5% (1/2 truck and 1/2 bus)
Traffic (Design Lane):	7,830,000 18 kip ESAL

Case (3) Community Collector (Heavy Duty Design):

Total Traffic Volume (Two Way):	7,000 Vehicles Per Day (vpd) weekdays
	3,500 Vehicles Per Day (vpd) weekends
Traffic Lanes:	2-Lane Divided Roadway
Pavement Width:	36 feet (face-to-face) 40 feet (face to face)
Heavy Truck/Bus Traffic:	20% (1/2 truck and 1/2 bus)
Traffic (Design Lane):	33,130,000 18 kip ESAL
Concrete Compressive Strength	4,000 psi

* Residential Collectors were designed based on twice as much bus traffic loading as Case (2) Local Streets in section 5.02.04 of this manual.

5.02.04 Local Streets

The following traffic loading and pavement parameters are used in the pavement analysis and standard design for Local Streets given in Table V-1:

Local Streets:

Roadway Class:	Local Street
Total Traffic Volume (two way:	2,500 Vehicles Per Day (vpd) weekdays
	1,250 Vehicles Per Day (vpd) weekdays
Traffic Lanes:	1-Lane Roadway with two (2) parking lanes or 2-Lane Roadway with one (1) or two (2) parking lanes
Pavement Width:	26 feet (face-to-face) 36 feet (face to face)
Heavy Bus Traffic:	
Case (1) Not on Bus Route	4 Buses per day
Case (2) On Bus Route	36 Buses per day for 5 days a week (weekdays) & 15 Buses total for the weekend
Bus Design Vehicle:	Equivalent City Bus
Traffic (Design Lane):	
Case (1) Not On Bus Route: (Residential Zoned Districts)	125,000 18 kip ESAL
Case (2) On Bus Route: (Residential Zoned Districts)	658,000 18 kip ESAL
* **Case (3) Nonresidential Zoned Districts**	1,310,000 18 kip ESAL
Concrete Compressive Strength	4,000 psi

* Case (3) Local Streets were designed based on twice as much traffic loading as Case (2) Local Streets to account for truck traffic.

5.02.05 Sidewalks

The City's concrete mix design for sidewalks is specified in The Public Works Addendum to the Standard Specification, section 5.8.1.1 under "Sidewalks, separate curb and gutter, and four (4) inch thick median pavement" class of concrete, providing a minimum compressive strength of 3,000 psi after 28 days. Section details are provided in Table V-1. Sidewalks designed for pedestrian traffic only shall be a minimum of 4 inches thick and non-reinforced, except that barrier free ramps shall have minimal reinforcement. Sidewalks and barrier free ramps which are exposed to vehicular traffic shall be designed thick enough to carry the expected traffic loading for a 30 year life. When vehicular traffic loading is expected, sidewalk and barrier free ramps design thickness shall not be less than 6 inches.

Barrier free ramps require special consideration since they are at street intersections and could experience occasional vehicular loading. As a design guide, the following shall be used for barrier free ramp thickness when exposed to incidental vehicular loading:

1) For local streets, intersecting with Local and Residential Collector Streets, barrier free ramps shall be 4 inches thick;
2) For Local Streets intersecting with Community Collector and Arterial Thoroughfare Streets, barrier free ramps shall be 6 inches thick;
3) For Collector or Arterial Streets intersecting with Collector or Arterial Streets, barrier free ramps shall be 6 inches thick;

The subgrade for sidewalks away from the street shall be compacted to a density of at least 90% of standard proctor density at a moisture content of from -2% to +4% of optimum moisture content, as determined by ASTM D698, before placement of concrete pavement. The subgrade for sidewalks against the curb shall be either six inch thick lime treated soil or six inch thick select backfill, if the subgrade P.I. is greater than 18. The subgrade for all sidewalks against the curb shall be compacted to at least 95% of standard proctor density at a moisture content of from -2% to +4% of optimum moisture content, as determined by ASTM D698, before placement of sidewalk pavement.

Reinforcing, jointing, subgrade requirements and other standard requirements and details for sidewalks and barrier free sidewalk ramps are provided in The Department of Public Works Standard Construction Details, file 251D-1, in the Standard Specifications for Public Works Construction as currently amended by the Public Works and Transportation Department, and in the Public Works and Transportation special provisions.

5.02.06 Alleys

The City's new concrete mix design for alleys is specified in The Public Work Addendum to the Standards Specifications, section 5.8.1 under "Machine Finish" and "Hand Finish" classes of concrete, providing a 28 day compressive strength for "Hand

Finish" class concrete of 4500 psi. Section details are provided in Table V-1.

The subgrade for alleys shall be scarified to a depth of 8 inches and compacted to a density of at least 98% standard proctor at a moisture content of from -2% to +4% of optimum moisture content, as determined by ASTM D698, before placement of concrete pavement.

Reinforcing, jointing and other standard requirements and details for alley pavement are provided in The Department of Public Works Standard Construction Details, file 251D-1.

The following traffic loading and pavement parameters are used in the pavement analysis and standard design for alleys given in Table V-1:

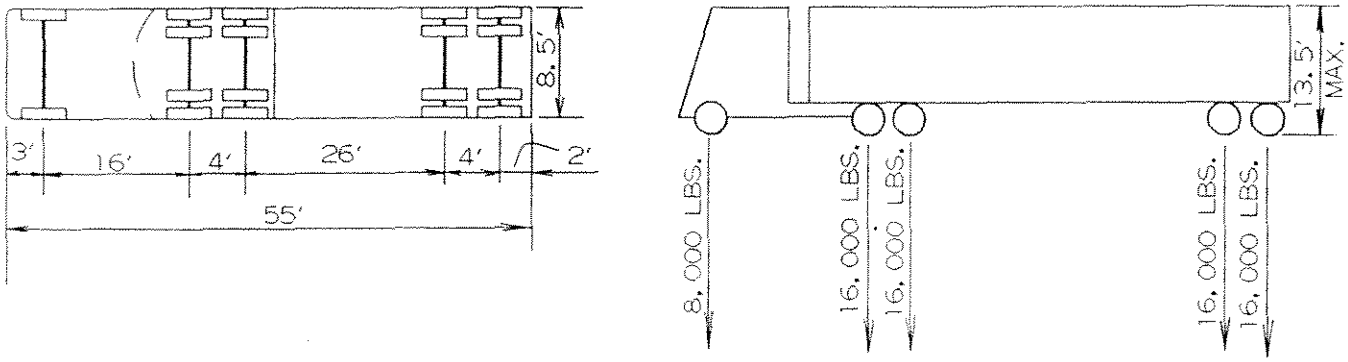
Alleys:

Total Traffic Volume:	500 Vehicles Per Day (Vpd)
Traffic Lanes:	One Lane
Pavement Width:	10 feet
Garbage Truck Traffic:	Assumed 3 trucks per week
Trash Truck:	8 kip single axle and 32 kip dual single axle
Traffic (Design Lane):	64,876 18 kip ESAL

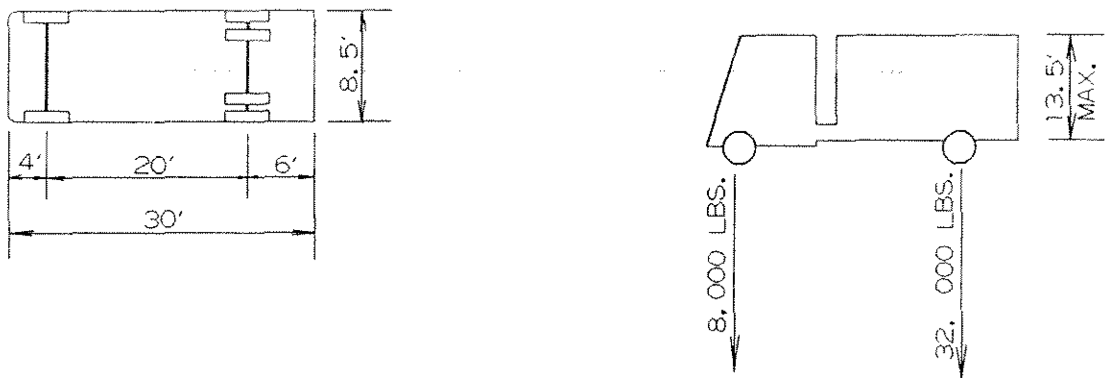
5.03 ALTERNATE PAVEMENT DESIGN

The designer shall perform a special pavement analysis and an alternate pavement design in lieu of selecting a design from Table V-1 when there are circumstances which warrant an individual design. The special pavement analysis and alternate pavement design shall be performed in accordance with the most current version of AASHTO Guide for Design of Pavement Structures. Alternate pavement designs shall be based on axle loads shown on Figure V-2. Soil testing data, design parameter values used and calculations shall be submitted to the City project engineer together with the proposed pavement structure design for review and approval.

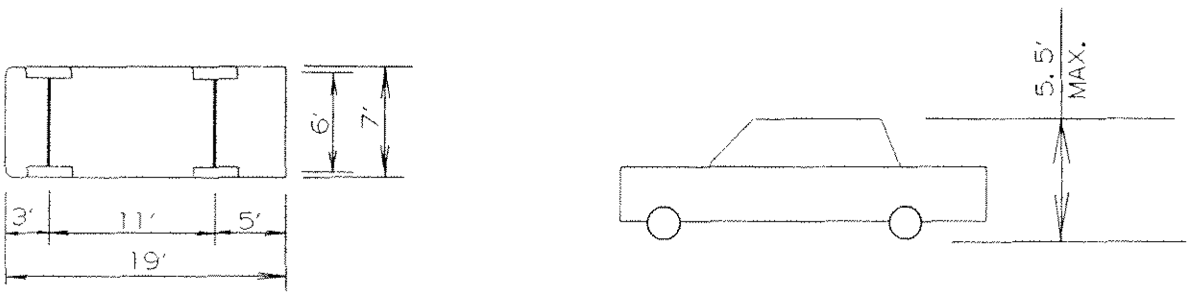
Certain recognized factors which may warrant a special pavement analysis and alternate design of street and thoroughfare pavement are as follows.



W B - 50 DESIGN VEHICLE



S U DESIGN VEHICLE



PASSENGER CAR DESIGN VEHICLE

LOADING & DIMMENSIONS FOR DESIGN VEHICLES

FIGURE V-2

5.03.01 Traffic

One of the important factors influencing the design of pavement structure is the magnitude and number of load applications expected during the life of the pavement. Each of the various pavement sections indicated in Table V-1 are standard street and thoroughfare pavement designs and have been designed using the traffic design parameters indicated for each respective roadway. If actual traffic data, including traffic volume frequency, frequency of heavy bus and truck traffic or total 18-kip Equivalent Single Axle Loads (ESAL's) exceeds the design parameters, an alternate pavement design shall be performed using actual traffic data.

Where heavy truck/bus traffic is indicated for the various standard pavement designs in Table V-1, the standard designs assume equal heavy truck and bus usage (50% heavy truck and 50% bus). Loadings assumed for buses and heavy trucks for the standard pavement designs are discussed in detail in section 5.02.01, "Standard Design Criteria".

If these loading conditions are exceeded, an alternate pavement design shall be performed based on actual bus and truck loading conditions.

5.03.02 Subgrade soils

Another important factor influencing the design of pavement structure is the subgrade. The subgrade is the top of the usual grading operation in the construction of a street pavement, including the subgrade treatment upon which the pavement is placed. Standard pavement designs usually require subgrade treatment with lime or cement to a specified depth.

A special pavement analysis shall be performed and an alternate pavement design may be required by the designer when proposed pavements involve subgrades within the outcropping of the Eagle Ford Shale or Taylor Marl Shale Formations. This is due to the potential for high soluble sulfate concentrations within the Eagle Ford Shale and Taylor Marl Shale Formations and the resulting potential for "Lime Induced Heave" associated with lime or cement stabilization. Recent research studies performed by the University of

Texas at Arlington regarding "Lime Induced Heave" on subgrade soils of the Eagle Ford Shale Formation show that a potential for "Lime Induced Heave" is indicated by a soluble sulfates content of 2,000 mg/kg or larger (threshold limit). A concentration of 5,000 mg/kg indicates a high probability for "Lime Induced Heave". A level of 10,000 mg/kg indicates that a serious problem with "Lime Induced Heave" could occur during or after construction. Therefore, soluble sulfates concentrations above the threshold limit indicate the probability for "Lime Induced Heave" if the subgrade soils are treated using lime or cement.

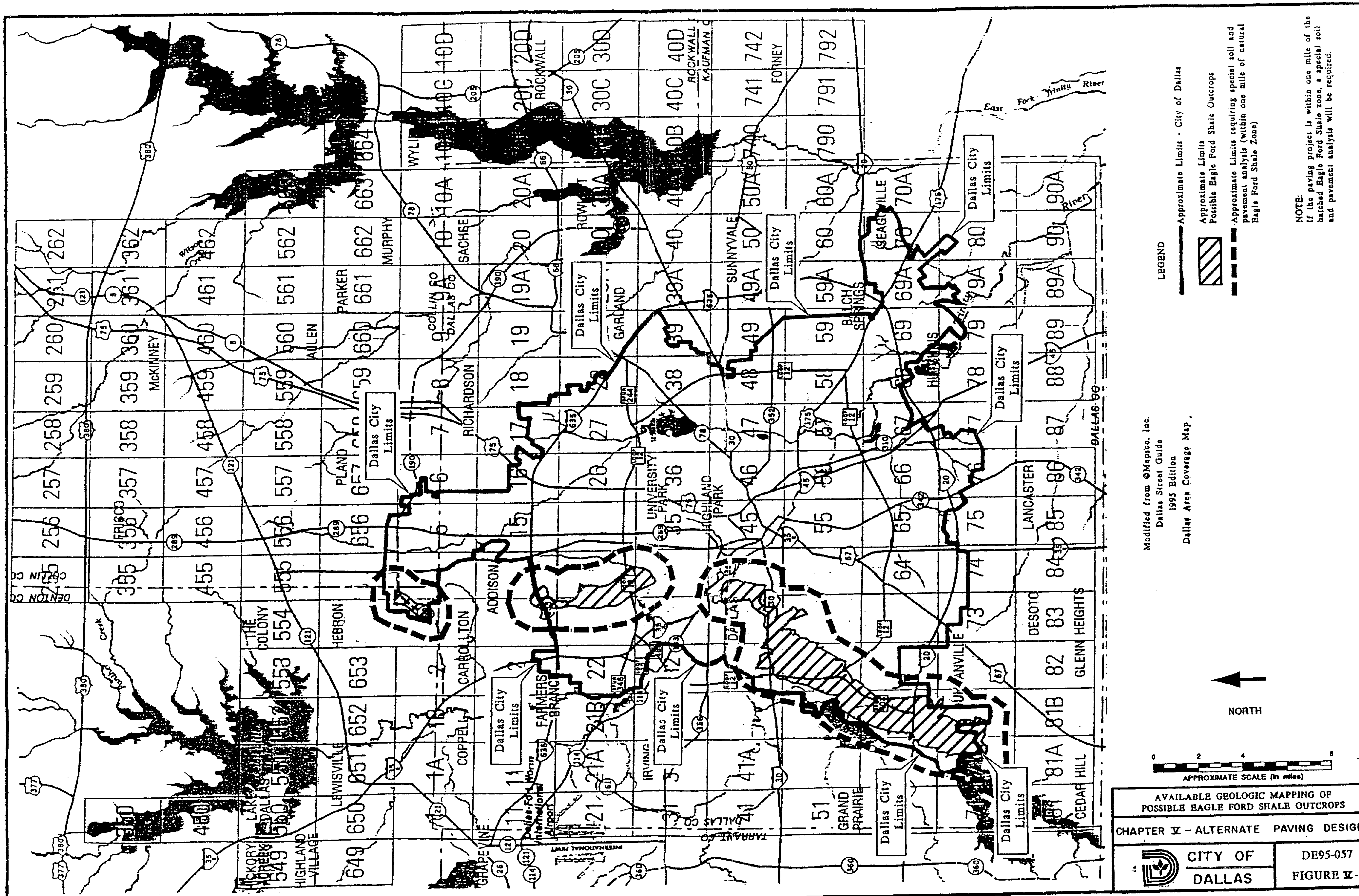
Also, within the Eagleford Shale Formation, subgrade soil may contain highly plastic bentonitic clay. These clays characteristically do not respond well to lime or cement treatment.

Such soils are highly expansive and soften excessively when exposed to water. Subgrades involving bentonitic clay require special pavement analysis and alternate pavement designs to provide adequate subgrade support and limit differential pavement deflections to tolerable levels.

Based on available geologic data, approximate mapped limits of probable Eagle Ford Shale and Taylor Marl Shale outcrops within the city of Dallas are shown within the dashed lines and shaded areas on Figure V-3. For projects located within these mapped limits, a special pavement analysis shall be performed. If adverse soil conditions are confirmed to exist at the recommended subgrade elevation, a recommended pavement design shall be provided.

Recommended paving designs should include the following:

- Consideration of the standard paving design for the street as given in Table V-1.
- Equivalent substitution for any required subgrade treatment. Acceptable substitutions include 4 inch thick cement treated base or asphaltic concrete coarse graded surface coarse.
- A waterproof barrier at the subgrade level to seal off the subgrade from potential infiltrating water.
- Removal of any unsuitable subgrade soil, proof rolling, and compaction to required densities. Details for proof rolling, removal of unsuitable material



AVAILABLE GEOLOGIC MAPPING OF POSSIBLE EAGLE FORD SHALE OUTCROPS

CHAPTER V - ALTERNATE PAVING DESIGN

CITY OF DALLAS

DE95-057

FIGURE V-3

and subgrade preparation are given in the Public Works Addendum to the Standard Specifications.

- Drainage catchment facilities such as french drains when potential surface and subsurface water sources are present which can infiltrate the subgrade. Catchment facilities shall capture the intruding water outside of the proposed subgrade area and seal off the water from the subgrade.
  In general, drainage catchment facilities should provide the following.

  1. A horizontal alignment outside of the subgrade zone plus one foot. The edge of trench for catchment facilities shall be at least one foot behind the back of curb line;
  2. The typical section of the catchment facility shall provide at least a two foot wide trench with a sturdy plastic type waterproof barrier lining in the trench bottom and up the trench sides to the top of collection pipe;
  3. The trench shall have a crushed rock embedment of thickness not less than 4 inches and a perforated PVC collection pipe having a diameter no less than 4 inches;
  4. The trench bottom, sides and top shall be lined with a nonwoven reinforcing fabric suitable for drainage applications and shall totally encapsulate the embedment, pipe and rock backfill material providing at least a 12 inch overlap;
  5. The trench shall be backfilled with crushed rock up to the grade necessary to capture the drainage;
  6. A clay cap of at least 8-inch thickness shall be provided over the trench and the top of ground shall be graded as required for the paving sections;
  7. The flowline of the collection and main pipes shall be no less than 30 inches below the top of proposed curb at any location;
  8. The drainage catchment facility shall be designed to gravity drain and shall tie into existing storm drainage conduits, inlets or structures; mainlines may cross under the subgrade from one side of the street to the other only when a suitable outfall structure is not available. In such cases the trench requirements above shall apply except that the main pipe shall be nonperforated PVC pipe and at least one foot of clay cap shall be provided below the proposed bottom of prepared subgrade and over the trench.

5.03.03 Pavement Widening

Pavement widening projects may require a special pavement analysis and alternate pavement subgrade design. If the subgrade soil P.I. exceeds 20, a special pavement analysis shall be performed by the designer and, if warranted, the designer shall perform a special pavement subgrade design.

Clay soils overlain by existing deteriorated pavement are usually very moist and at or near optimum moisture levels with low swell potentials (low potential vertical rise (PVR) value). On the other hand, clay soils in unpaved areas (such as interior medians where widened pavement sections are to be constructed) are usually much drier and potentially expansive (high PVR value). Therefore, when existing pavement sections are widened or when old pavement is removed and replaced with a widened section, differential upward pavement deflections can occur over short distances in a transverse direction (across the width) due to non-uniformity of subgrade moisture conditions. Longitudinal cracks and separations can develop as a result of large differential movements if the ground movements exceed flexural capacity of the reinforced pavement sections.

Due to varying conditions described above, sample borings shall be drilled along the proposed alignment to determine the differential PVR between the existing paved and unpaved areas as part of the project soils investigation. Sample borings shall be drilled on 1000 foot spacings along the existing pavement and on 500 foot spacings along the proposed (unpaved) area for pavement widening. Moisture content tests, hand penetrometer tests and swell tests shall be performed to determine the differential soil PVR along the proposed alignment. If the differential PVR exceeds two (2) inches, the designer shall propose an alternate pavement subgrade design that shall reduce the differential PVR to less than two (2) inches. Additional borings shall be made at the time of construction to confirm the differential PVR and validate the proposed pavement subgrade design.

VI - CONSTRUCTION PLAN PREPARATION

6.01 GENERAL

All paving plans for construction of street and thoroughfare improvements in the City of Dallas, except those prepared for subdivisions shall be prepared in accordance with Department of Public Works and Transportation procedures. The work required to prepare construction plans is normally divided into three phases: Conceptual Design Phase, Preliminary Design Phase, and Final Design Phase. The Conceptual Design phase is normally performed by the City; however, on certain projects, the consultant designer may be required to perform the Conceptual Design Phase as part of the design contract.

Plans for subdivision construction shall be adequate to allow for review and construction inspection.

6.02 CONCEPTUAL DESIGN PHASE

The conceptual design phase is generally completed only on thoroughfare projects which require the acquisition of street right-of-way. The horizontal roadway layout or alignment is extremely important and is the basis of the conceptual design.

In the conceptual design phase, horizontal control shall be established in accordance with the procedures of Appendix B and property line surveys performed as required to establish the existing right-of-way of the thoroughfare. An alignment study shall be completed which consists of developing, reviewing, and comparing alternate alignments which meet the requirements of the proposed roadway. Areas to be reviewed and compared include:

1. Right-of-way requirements
2. Thoroughfare functional classification
3. Access requirements
4. Right-of-way costs
5. Neighborhood service impacts
6. Environmental impacts (floodplain, wetlands, noise, and aesthetics)
7. Park services impacts (if adjoining or in Park property)
8. Utility impacts

9. School impacts
10. Thoroughfare and Bike Plan requirements.

Upon approval by Public Works and Transportation of a tentative alignment, proposed and existing right-of-way alignment maps showing existing and proposed pavement, curb lines and other significant topographic features shall be prepared and colored as required by the Chief City Surveyor for the proposed roadway alignment. These maps shall be prepared for use in neighborhood meetings and for presentation to the City Council.

Final approval rests with the City Council. Upon receiving approval by City Council, legal descriptions and parcel council agenda maps for all parcels of street right-of-way to be acquired shall be prepared and shall be in accordance with the Public Works and Transportation Department, Survey section "Field Note Guidelines". After the legal descriptions and parcel maps have been prepared and after the horizontal alignment map has been finalized, the designer shall submit the approved field notes, parcel maps, and two plan copies of the final alignment to the City for approval. Upon approval by the City, the designer shall proceed with the preliminary design phase.

6.03 PRELIMINARY DESIGN PHASE

The preliminary design phase is the development of the project in sufficient detail to allow review by the Department of Public Works and Transportation for design compliance with standards and for establishment of final criteria and details. To commence this phase, unless otherwise provided for during the concept phase, the project horizontal and vertical control shall be established according to the procedures in Appendix B. All topographic surveys shall be furnished to allow establishment of horizontal alignment and geometrics, vertical alignment, and right-of-way requirements. These may be accomplished by on-the-ground field surveys, by aerial photogrametric methods, or may be furnished by the Department of Public Works and Transportation when available. Copies of all survey field notes shall be furnished to the City at the completion of all projects which the survey work was not preformed by the City. Field notes and documentation for establishing the horizontal and vertical control shall be submitted to the project engineer as provided in Appendix B.

If the paving project includes storm drainage improvements, the hydraulic design of the proposed storm drain shall be accomplished based on procedures and criteria outlined in the Public Works and Transportation "Drainage Design Manual."

The design engineer shall establish the scope, schedule and coordinate all geotechnical investigations required to establish the project design. Unless otherwise provided for in the design contract, the City will provide the geotechnical laboratory and will be responsible for authorizing and paying for work done on the project.

6.03.01 Preliminary Plans

Preliminary construction plans shall include a cover sheet, quantity summary sheet, horizontal control sheet, typical paving section and detail sheet including general notes, paving plan-profile sheets, paving cross sections, drainage area map, drainage plan-profile sheets, drainage cross sections if required, and a storm water pollution prevention plan. Other items which may be required include a sequence of construction, traffic control plan, street lighting plans, and traffic signals, signs, and marking plans. If bridge, box culvert, or other structures are involved, preliminary plans shall include structure plan-profile sheets and typical section/detail sheets.

6.03.02 Paving Plan-Profile Sheets

Paving plan-profile sheets shall be prepared with a horizontal scale of one-inch equals twenty feet and a vertical scale of one-inch equals six feet. In the plan view the centerline of the street shall be drawn and stationed at one hundred foot intervals, and each sheet shall begin and end with even or fifty foot stations. The centerline length on each sheet shall not exceed 600 feet.

The horizontal control sheet shall provide the alignment/horizontal control drawing as specified in Appendix "B". Sufficient data including monuments and other survey controls shall be shown on the horizontal control sheet as well as on the paving plan to permit establishment and staking of the project right-of-way and centerline of the pavement from the construction plans. If a survey line or transit line is required to establish the right-of-way, it shall be properly identified and dimensioned from the pavement centerline and shown on the horizontal control sheet. See Appendix B for details on horizontal and vertical control requirements.

Also shown on the plan view shall be the horizontal geometrics and dimensions of the proposed paving improvements including curb and gutter, median, pavement edges, driveways, sidewalks, alley approaches, street approaches, street headers, temporary pavement, etc. Where the cut or fill exceeds 0.5 foot vertically from existing ground at the property line, the top of the cut slope or the toe of the fill slope shall be shown on the plan.

Right-of-way information shall include dimensions of existing and proposed property lines and easements and shall be shown on the proposed street and intersecting streets. All lots fronting on the proposed street shall be dimensioned and shall be identified by the lot and block number, house number, and ownership.

The proposed paving improvements shall be shaded as necessary to clarify the intent of the plans. Pavement dimensions, unless otherwise noted, shall be to the face of the curbs. City of Dallas standard symbols which are shown in Figure VI-1, shall be used in preparing the plans. See Table VI-2 for drafting standards. All plans prepared for the City shall be prepared using Computer Aided Drafting and Design Methods (C.A.D.D.) unless authorized otherwise by the City.

The design engineer shall coordinate with the Transportation Engineering Section for planned locations of traffic control facilities, median lighting, and other appurtenances which should be included or coordinated with the paving plans. The design engineer shall be responsible for the design, layout, and inclusion into the plans of such items when they are required for the project.

Proposed storm drainage systems and inlets shall be shown on the paving plan indicating the paving station at the centerline of the inlet, inlet size, inlet type, top of curb elevation, and inlet flow line. The throat elevation shall be given for all proposed "Y" type inlets. Existing storm drainage systems and utilities shall be properly shown and identified.

Other data to be shown on each plan sheet shall include two City of Dallas benchmarks which will remain after construction of the improvements, flow arrows

FIGURE VI – 1 DEPARTMENT OF PUBLIC WORKS AND TRANSPORTATION STANDARD DRAFTING SYMBOLS AND PEN SIZES ( )

EXIST. PROPERTY LINE OR DRAINAGE EASEMENT (0)

PROP. PROPERTY LINE OR DRAINAGE EASEMENT (2)

CENTER LINE OF CONSTRUCTION
PAVING (2) 2
DRAINAGE (0) 2

TRANSIT LINE (00)
(NOT SHOWN IF PLANS INCLUDE SEPARATE HORIZONTAL CONTROL SHEET.) 243' F60d

FENCE (00) 4' C.L.

ANCHOR (00)

EXIST. CURB (00)

PROP. CURB. (3)

PROP. HEADER (1)

FUTURE CURB (00)

RAIL ROAD TRACK (0)

EDGE EXIST. GRAVEL

EXIST. ASPHALT LIMITS

ROCK IN PROFILE

PROP. GRAVEL SURFACE

ASPH. CONC. IN TRANSITIONS ETC. 504 5" THK.

EXIST. CONC. (STIPPLE ONLY SELECT AREAS TO CLARIFY PLANS)

CONC. REMOVAL

CROSS IN CONCRETE CUT "x"

IRON PIPE OR IRON ROD IR 24.98'

BUILDING (TO SCALE) (000) #3707

EXISTING WALL (0)

LIGHT, POWER, & TELE. POLES (0) PP

WATER METER (0) WM

GAS METER (0) GM

PROP. WATER SERVICES

FIRE HYDRANT FH

TEXAS DEPT. OF HIGHWAYS & PUBLIC TRANSPORTATION THD MON.

MANHOLE TU MH

CLEAN OUT (00) CO

PROP. STREET LIGHT

EXIST. STREET LIGHT

GAS OR WATER VALVE (00)

SPRINKLER HEAD

SURVEY NAILS (SET OR FOUND) (00) SET60d

TRAFFIC SIGNAL (00)
EXISTING
PROPOSED W / ITEM NO. 707

MAIL BOX

RAIL ROAD SIGN

STREET SIGN

TREE (TO SCALE) 10" OAK

HEDGE

BUSH

STORM DRAINAGE SYSTEM (TO SCALE)
ON PAVING PLANS
EXISTING (1) 36" SD
PROPOSED (0) 36" SD

ON STORM DRAINAGE PLANS
EXISTING (0) EXIST. 24" RCP
PROPOSED (1)
FUTURE (00) 24" RCP

UNDERGROUND UTILITIES (00)
EXISTING
SWBT CABLE
TU CONDUIT
6" LSG
8" W
10" SS
WU

PROPOSED
SAME WITH DASHED LINES

TABLE VI-2
DRAFTING STANDARDS

Computer Aided Drafting and Design Methods (C.A.D.D.)

Design files should be produced on MicroStation version 4.0 or later.

Design files Working Units shall be set to the following formats:

- Master File = feet
- Sub Units = inch
- Sub Units / Master Unit = 12
- Position Units / Sub Unit = 1600

The following MicroStation Settings shall be applied to all design files:

Level	Color	Line Style	Weight	Text Size	Font	Used For
1-5	AS REQUIRED					Raw Survey Data
6-9	AS REQUIRED					Unassigned for use as needed
10	2	0	0	6	86	Block No. & Street Name
10	0	0	1	2.5	83	Lot Dimensions
10	4	0	1	3	83	Property Owners & Lot Number
10	2	3	2	3	43	Property Lines & Text
11-12	4	0	0	2	1	Existing Topo Features (Survey) - Final Form
12	3	6	1	2	41	Survey Lines & Text
12	3	0	1	2	41	Rods or Pipes & Measurements
13	4	4	1	2	41	Center Line & Text
14	0	0	1	2	73	Benchmark Description & Coordinate Info.
15	2	0	2	2.5	83	Existing Ground @ R.O.W.
20	4	0	1	2	41	Existing Topo Features
21	0	0	1	2	1	Existing Utilities (plan view)
22	3	2	1	2.5	1	Existing Storm Drain
24	6	0	2		81	Proposed Sidewalk
25	6	0	4			Proposed Curbs (plan view)
26	6	0	2			Proposed Drive Approaches
27	2	0	1	2.5	81	Proposed Paving Text (plan view)
28	6	0	4	2.5	83	Proposed Top of Curbs (profile)
29	10	0	3	2.5	86	Profile Grid Text
30	0	0	2	2.5		Proposed Storm Drain (plan view)
31	3	0	4	2.5	83	Proposed Storm Drain (profile)
37	7	0	1	2.5	81	Proposed Drainage Text

TABLE VI-2 (continued)

LEGEND

FONT		COLOR	
No.	**Description**	**No.**	**Description**
1	P. Leroy	0	White
23	S. Leroy	1	Blue
41	Freehand	2	Green
43	Vertical	3	Red
73	Text	4	Yellow
81	Swiss 721	5	Purple
83	S. Swiss 721	6	Orange
86	Csb702il		

Consultants using other CADD software systems shall provide conversions of their system compatible with Figure VI-1 "DEPARTMENT OF PUBLIC WORKS AND TRANSPORTATION STANDARD DRAFTING SYMBOLS AND PEN SIZES ( )". Additional information may be obtained from the Chief City Surveyor of Public Works and Transportation Department if necessary. All files submitted to the City for review and approval must be compatible with and submitted in the City's version of Microstation.

TABLE VI-2 (continued)

Manual Methods (When Authorized by the City)

1. Ink all drawing and notes pertaining to new work. Existing topography may be shown in pencil for contrast, but must print legibly. Avoid inks and pencils which produce a shine.

2. All lettering must be a minimum of 1/8" high or Leroy scribe No. 120. Do not crowd letters. Space equally. Avoid embellishments. Do not underline.

3. Use single stroke plain Gothic lettering, upper case without serifs. "Microfont" is also recommended if available.

4. When writing fractions use horizontal dividing line between numerator and denominator. Maintain 1/8" minimum height for numbers.

5. Keep drawing clear of useless dimension lines and item numbers. Use explanatory notes to clarify intentions and construction details.

6. Erase cleanly to avoid ghosts. Backing up the tracing on a hard surface, preferably metal, will give cleaner erasures and also avoid buckling. Use an erasing shield to help dissipate heat. Heat can cause a chemical reaction in some material.

7. Colored shading will not xerox acceptably. If shading is considered necessary, use pattern or shading film on the back side such as dotted 60 line, 40% graduated tones with Mylar and 60 line, 10% for linen.

8. Shading or lines must be on the back of linen, tracing paper and paper sepia. Drafting must be clear and prints legible if these materials are used.

9. Contrasting lines widths are essential for clarity. Suggested pen sizes for various lines are as follows:

Centerline of Paving Construction	#2
Centerline of Storm Drainage Construction	#1
Existing Property Lines	#00 (long dashes, 2" - 3")
Proposed Property Lines	#2 (short dashes, 1")
Proposed Curb Lines	#3
Ground Profiles	#0
Proposed Top of Curb Grades	#2

10. Existing concrete paving should be stippled as necessary for clarity. Areas of concrete to be removed as pay items should have hatch lines throughout.

11. Show a legend or key to symbols used if not standard.

indicating direction of storm water flow, street names, match lines, scale, north arrow, item numbers, etc. The item numbers shall identify items of work to be completed and shall be taken from the City item list.

The profile section shall show the existing ground profile at each right-of-way line and the proposed top of curb profile on each side of the street. The existing ground profiles shall agree with the ground line shown on the cross sections. If the street has a median, the profiles of the median curbs shall also be shown with the existing ground profile at the pavement centerline. On the profile section street intersections, the top of curb elevations at the horizontal curb P.I.'s together with the paving stations shall be shown along with the name of the intersecting street. Street grades should be determined according to the procedure in Appendix "A". Of utmost importance in determining street grades is the safety of all persons and vehicles using the street. The convenience and comfort of through traffic must be balanced against the necessity to serve the abutting property, keeping in mind that the property owners will be assessed for a portion of the cost of paving.

The proposed street grade shall be indicated to the nearest one hundredth percent. Vertical curve data shall be shown including length of vertical curve, midordinate distance (M), and station and elevation at point of vertical intersection (PVI), point of vertical curvature (PVC), and point of vertical tangency (PVT) (see figure IV-17).

Elevations of the proposed top of curb shall be shown at each one hundred-foot station and fifty-foot station including elevations on vertical curves at these stations. Low points on sag vertical curves and high points on crest vertical curves shall also be shown.

At some convenient location (preferably on a separate detail sheet), one or more typical paving sections shall be presented which shall include: proposed type and dimensions of pavement, base (if required), subgrade treatment, curb, driveway grades, location of walks, pavement crown, parkway requirements, ties to existing ground, limiting grade for cross slopes, existing typical ground line and features, etc. Typical sections shall address existing facility removal limits, construction and pay limits, and provide typical pay items with clear descriptions.

6.03.03 Cross Sections

Cross sections shall be taken at the locations and in the manner described in Appendix "B". Cross sections must be adequate for use in engineering design, calculation of excavation and fill quantities, and showing the affect the proposed construction will have on abutting property.

The usual scale for plotting cross sections will be 1"= 2' vertical and 1"= 5' horizontal. Abnormal conditions may require variations in the scale used. Prior approval for variations in scale will be required and should be so noted on the first sheet. Cross sections shall be plotted on standard size paper sheets 24"x 36". Drafting must permit reduction to half size by copying while maintaining legibility.

Each section shall be clearly defined by station and elevation. A clear description shall be added to the section if other than 100' or 50' station. Cut and fill areas shall be recorded for each section, quantities calculated, and quantities summarized corresponding to paving plan sheets.

Each sheet shall have a title block in the same relative position as the paving plan sheets giving the project name and limits, scale, file number and sheet number.

6.03.04 Storm Drainage Plans

Storm drainage plans to accompany the paving project shall be prepared in accordance with Section 3.0, Construction Plan Preparation, of the "Drainage Design Manual," Department of Public Works and Transportation. Storm drainage plans accompanying paving plans must have a separate drainage file number, and all sheets shall be numbered separately from the paving plans.

6.03.05 Storm Water Pollution Prevention Plans

A storm water pollution prevention plan (SWPPP) with the associated items and quantities shall be included in the design of all projects. The SWPPP shall consist of an erosion control and toxic waste management plan and a narrative defining site parameters and techniques to be employed to reduce the release of sediment and pollution from the construction site. The design shall provide at least 70% effectiveness for entrapment of project sedimentation and pollution. Projects which have a disturbed area of 5 acres or more shall require a complete SWPPP meeting all EPA regulations and all submittal and reporting requirements. Projects which have a disturbed area of less than 5 acres do not require a complete SWPPP meeting all EPA regulations; however, standard types of erosion and pollution prevention controls and associated locations shall be included by the designer.

6.02.06 Review of Preliminary Plans

Prior to submittal of preliminary plans, the engineer responsible for the project shall have walked the project and thoroughly reviewed it on site to insure accuracy and completeness of the design. Upon submittal of the plans, a review will be completed and comments provided outlining areas of concern or items which need to be addressed.

After the preliminary plans have been reviewed and modified as needed, and before preparation of final plans, reproducible drawings shall be submitted in order that copies may be distributed to other City departments and utility companies for their review and comment. Comments received which may be resolved by redesign shall be addressed in the final design phase.

6.04 <u>FINAL DESIGN PHASE</u>

6.04.01 General

During the final design phase, the construction plans shall be placed in final form. All sheets shall be plotted or drawn in ink on 24-inch by 36-inch linen or mylar drafting film and shall be clearly legible when sheets are reduced to half scale. Lettering shall be sufficiently sized to be easily read when the plans are reduced and placed on microfilm. Special provisions for nonstandard work or materials shall be submitted to the City for review and approval.

6.04.02 Preparation of Final Plans

a. <u>Final Design and Drafting</u>

Review comments shall be considered, additional data incorporated, and the final design and drafting of the plans completed. All geometrics of paving improvements, pavement removals, storm drains, paving grades, elevations, storm drain sizes and grades, utility locations, special notes, items, and quantities shall be completed and checked by the design engineer, and each plan-profile sheet shall have two benchmarks shown. General notes (provided by the City) shall be added to the plans. A quantity summary plan sheet providing a sheet by sheet breakdown of item numbers, estimated quantities, and bid quantities shall be prepared. Each tracing of the plans shall be sealed and signed in the lower right hand corner by a licensed professional engineer in the State of Texas.

b. <u>Correlation between Paving Plans, Drainage Plans, Storm Water Pollution Prevention Plans, Cross Sections and Structural Plans</u>

In preparing the final plans, the engineer shall insure that paving, storm drain, and inlet stations and elevations are correctly shown on storm drainage plans, structural plans, and paving plans if applicable. Inlet locations on storm drainage plans shall conform with inlet locations as shown on the drainage area map. Proposed pavement location shall agree horizontally and vertically between paving plans, storm drainage plans, structural plans, and cross sections. Existing and proposed walls, pavement, drive approaches, and proposed grading shall be shown on the cross sections and shall coincide with the locations and extent specified on the paving and structural plan.

c. <u>Standard Construction Details</u>

Standard Construction Details, File 251D-1, have been prepared by the Department of Public Works and Transportation. These standard details shall be used in all designs whenever practical.

d. Special Details and Specifications

Any special details required for the project and not shown on the Standard Construction Details, File 251D-1 shall be prepared by the engineer and included in the plans. Structural details for bridges, special retaining walls, headwalls, junction boxes, culverts, special inlets, etc. shall be provided as well as bridge railings, hand railings, special barricades (permanent and temporary), and warning signs. Material and construction specifications which are not a part of the standard specifications as currently amended by the Public Works and Transportation Department shall be submitted in writing as a part of the Special Provisions. A sequence of construction and traffic control plan shall be prepared which will provide for maintenance of traffic as required by the Public Works and Transportation Department Transportation Division and will allow the maximum use of on-site cut in proposed fill areas. Access requirements, use of existing paving, traffic requirements, public convenience and safety, and minimizing cost and schedule shall also be considered when determining the sequence of construction. The sequence of construction shall be general in nature in addressing the above concerns yet at the same time providing for sound construction practices and flexibility to the contractor. The traffic control plan shall be in compliance with the Texas Manual on Uniform Traffic Control Devices, as currently amended. Structural analysis computations shall be provided in a legible form for any existing structure which will act as a support or supplement to the designed facility. Items on the plans requiring special provisions and special construction techniques shall be clearly delineated on the plans and specifically called to the City's attention by letter prior to final plan submission.

6.04.03 Preparation of Field Notes

Field notes shall be prepared in accordance with the Public Works and Transportation Department Survey Section "Field Note Guidelines", for all remaining street right-of-way, drainage easements, slope easements, temporary working area easements, and all other easements required for the construction of the project together with legal descriptions and parcel council agenda maps. Upon approval of the City, the field notes and related paperwork shall be submitted to the City project engineer.

6.04.04 Submission of Final Plans

Before submission of final plans, the engineer shall carefully review plans against the check list in Appendix "C". The completed check list shall be submitted with the final plans. After completion of final plans for City improvement projects, the engineer shall prepare a final construction cost estimate for the paving project. The estimate shall include the subtotal costs for paving, storm drainage, traffic, and bridge or major structure. Unit prices for items of work included in the project shall be obtained from the most recent listing of Public Works and Transportation Department currently stored average prices. The final documents shall be delivered to the Department of Public Works and Transportation and shall include:

(1) Tracings of final plans and cross sections

(2) One (1) set of prints of final plans and cross sections.

(3) Computer disk of final design (CADD file) which shall include alignment/horizontal control drawing

(4) Final construction cost estimate

(5) Field survey notes

(6) Hydraulic calculations used for drainage design

(7) Structural design notes and calculations

(8) Approved Special Provisions for non-standard work or materials

(9) Right-of-way and easement field notes, legal descriptions, and parcel maps (if required)

APPENDIX "A"
Recommended Procedure for Setting Street Grades

1. Plot left and right ground line profiles along the property lines on plan sheets. Check for the following:

   a. Show drives, intersections, ditches, etc. Profiles must give realistic picture of conditions grades must meet.

   b. If additional right-of-way is to be acquired, confirm profiles have been plotted along the proposed property line, not existing property line.

   c. If property line falls in a ditch, show a second profile at normal ground elevation also.

   d. Check any sharp breaks in the profile which might identify plotting errors.

   e. Confirm that the profiles plotted agree with the cross-section information.

2. Spot critical points in profile which will control top of curb elevation. Calculate maximum curb elevation permissible at these points.

3. Lay tentative grade for low side of street. Minimum grade = 0.40% Desirable minimum = 0.50%.

4. Lay matching grade on high side of street. Watch the following:

   a. On streets with parabolic crown, avoid all crossfall unless conditions require it, and then crossfall must not exceed 0.5 foot. Remember that a few tenths of a foot crossfall seldom benefits enough to justify the reduced water carrying capacity of the street.

   b. On divided streets the cross slope of traffic lanes should not be less than 0.5 foot between curbs nor more than ½ inch per foot any place in the roadway.

   c. Avoid fill if at all possible. If absolutely necessary to fill, try to limit height so access to abutting property will not be restricted.

   d. In extreme cases the street may cross slope the same direction for the full width of the street. Special permission is required for this.

   e. Occasionally the centerline of the proposed pavement can be offset from the centerline of right-of-way to aid in matching improvements on the high side.

f. In flat areas try to keep top of curb 0.5' below ground at property line. This will assure good drainage from the abutting property.
g. If street is in the flood plain, the minimum curb elevation must be at least one foot above the design surface elevation (100-year flood water surface elevation or elevation of design flood of record, whichever is higher), provided by the Flood Plain Management section of Public Works and Transportation. Streets crossing creeks require higher minimum curb elevations (see manual Section 4.02.04 Drainage).

5. Use standard design criteria for vertical curves. Safe sight distances must not be compromised.

6. Check safe speed of all curves. Superelevation may be necessary on short radius curves to maintain safe design speed.

7. Avoid changing shape of crown since this requires hand work by the contractor and increases cost.

8. Plot proposed tops of curbs on cross sections. Check for proper slope in parkway at every location. Look for places grade may be improved to serve property better. Numerous breaks in grade to enhance value of abutting property are preferable to long straight grades which may be detrimental to property.

9. Check every intersection carefully. Give special attention to:

   a. Drainage. Make sure ditches and gutters drain.

   b. Riding quality. This is very important at the intersection of two thoroughfares. Severe grade breaks must be avoided in both directions.

   c. Approach grades should not be over 4%. Steeper grades require special consideration. Motorists should be able to see approaching traffic clearly in both directions.

10. Check both ends of project as to drainage and riding quality. Avoid such solutions as "Grade to Drain." If necessary to drain into existing ditches show ditch profiles and proposed grades in profile. Show spot ditch elevations in plan view.

11. Sags in grade should fall at locations where inlets will cause least inconvenience to abutting property owners.

12. Outside curb and median curb grades on arterial thoroughfares follow the curbline of the through traffic lane, usually 7.5 from centerline for median curbs. Therefore it is necessary to show spot top of curb elevations at critical points on right and left turn lanes. Show these in the plan view. Slope of right and left turn lane should match slope of adjacent through lanes if possible.

13. In general, street grades must meet the needs and safety requirements of the traveling public, but must also serve the abutting property. Do not neglect the property owner who will be assessed for a portion of the cost of paving.

APPENDIX "B"
Recommended Procedure for Establishing Horizontal and Vertical Controls and for Cross Sectioning

A. GENERAL

1. Alignment/Horizontal Control Drawing

   a. An electronic drawing (CAD) on separate levels or layers shall be prepared accurately and oriented according to the coordinate system approved by the Chief City Surveyor. This drawing shall be furnished both in a hard copy (linen or mylar) and electronic copy (disk).

   b. The drawing hard copy shall include a certification statement signed and sealed by the Texas Registered Professional Land Surveyor (R.P.L.S.) that all boundaries, monuments and benchmarks shown on the project plans were established or verified under his or her direct supervision.

   c. The drawing shall be prepared in a format compatible with the City of Dallas' CAD system and shall allow the extraction of coordinate points. (.DGN, .DXF, or .DWG format is acceptable as of 10/1/95).

   d. The Alignment/Horizontal Control Drawing shall have point numbers and coordinates shown at the locations of all horizontal control points, reference monuments, and for any additional points necessary to delineate the design. Horizontal control points shall be as defined in Section B.3, Procedures for Establishing Horizontal Control, of this Appendix "B". The drawing whall reference monuments set as provided in Section B of this appendix "B". The coordinates of all of these points shall be stored on level 9 in the electronic file.

   e. A table showing Point Numbers, Northings, Eastings, and Description shall be shown on the Alignment/Horizontal Control Drawing.

   f. The drawing shall show, define and provide sufficient information to establish City right-of-way and easements necessary to support the construction work.

   g. The centerline pavement stationing shall be given on the Alignment/Horizontal Control Drawing at the beginning and end of the project.

   h. Curve data including radius, curve length, tangent and delta angle shall be given for all curves.

i. The Alignment/Horizontal Control Drawing shall be prepared to accurately locate all the shown features and to construct the proposed improvements. Additional points necessary for construction may be extracted from this drawing. These points may include but are not limited to the following:

Streets - Alleys

(1) Centerline - Coordinates at the radius points, PC's, PT's, and angle points on the centerline and on the back of the curb;

(2) Intersections - Coordinates at the median noses and radius points, curb returns, and terminus points;

(3) Coordinate points locating retaining walls (beginning, angle points, P.V.I.'s, ending)

(4) Other - Coordinate points at transition areas, non-concentric curves, and limits of cut and fill areas that require staking;

Storm Drainage

(1) Centerline - Coordinates at the radius points , PC's, PT's, and angle points on the centerline of facility;

(2) Pipes - Points at pipe size changes, manholes, and pipe to pipe or wye connections;

(3) Structures - Points locating headwalls, wingwalls, approach aprons, gabions, culverts, inlets, junction boxes, retaining walls (beginning, angle points, PVI's , ending), channels, slope protection, flumes, and all points defining major design elements;

Bridges

(1) Centerline - coordinates at the radius points, PC's, PT's, and angle points on the centerline of pavement and bridge;

(2) Structures - coordinate points at centerline of bridge abutment caps and bent caps, beginning of approach slabs, beginning and end of wing walls and all points defining major design elements.

2. Engineering Design

Sections are needed at every location which may affect street grades, surface drainage, or structures. See section D, Procedure for Cross-Sectioning,for details.

3. Earthwork Calculations

   Complete and accurate sections shall be provided which show all grade breaks both transverse and longitudinal. These sections shall be used not only for estimating but may be used for actual payment to the Contractor. See Section D for details.

B. PROCEDURE FOR ESTABLISHING HORIZONTAL CONTROL

1. The consultant shall use a coordinate system approved by the Chief City Surveyor.

2. Reference monumentation shall be set for the centerline points at the beginning and end of the project and at all intersecting streets. A minimum of two reference monuments shall be required for each of these centerline points and shall be located sufficiently away from the construction areas so as not to be disturbed by the contractors or utilities. These reference points shall be set so that the paving and right-of-way centerline may be reestablished during and after construction.

3. Points shall be set at 100 foot stations along the project pavement centerline. Points shall also be set at all PC's, PT's, and angle points. All monumentation and points set shall be appropriately described, (i.e. PK Nail, 60d, Fnd or Set IR, etc.).

4. Complete field notes and calculations documenting the location and description of all reference monumentation and centerline points set and documenting centerline traverse closure shall be submitted to the project engineer with the initial preliminary plan submittal.

C. PROCEDURE FOR ESTABLISHING VERTICAL CONTROL

1. Vertical Control for projects shall be determined from an established bench mark datum. This datum shall include at least two (2) Standard Water Dept. Bench Marks. A closed loop shall be required to verify existing bench marks. Complete field notes documenting the location and description of the bench marks to be used for the project and documenting the closed loop shall be turned in to the project engineer with the submission of the initial preliminary plans.

2. Loops are to be established using level and level rod and must have an accuracy of plus or minus 0.05 foot times the square root of the distance in miles looped.

3. Bench marks are to be established at each end of the project, with intermediate locations spaced about every 500 feet, at a sufficient distance outside the limits of construction so as not to be disturbed. A minimum of two bench marks are to be provided on each paving plan/profile sheet with the description and location including distance from the centerline given on the plans with the elevation M.S.L.

4. When running the benchmark loop, additional bench marks used on other projects in the immediate area should be turned through to provide a check. **NEVER ASSUME THAT BENCHMARKS FROM DIFFERENT JOBS ARE ON THE SAME DATUM**.

5. Turning points should be sufficiently stable to maintain desired accuracy. Backsights and foresights should be balanced in distance and shots should not exceed 300 feet. Care should be taken to ensure level rod is properly extended and "waved or rocked" to ensure lowest reading.

6. Bench marks shall be referred to as found or set. Set B.M.'s shall also include the date set in the description. Found bench marks shall include record elevation and refer to source of B.M., such as D.W.U.B.M. Book number, or plan number such as 411Q1321, sh. 21; etc.

7. Bench marks established shall be reasonably permanent and substantial (avoid using R/R spikes, 60d nails, crosses on top of fire hydrants, etc). They shall be easily identified and afforded reasonable protection against damage or destruction. A description of the B.M. shall be written in a clear and concise manner so that it can be easily recovered (specify distance to nearest cross street when applicable).

D. PROCEDURE FOR CROSS-SECTIONING

1. Cross sections and/or elevations taken must be from Bench Marks established in accordance with section C, Procedure for Establishing Vertical Control. Bench marks must be read at the beginning and end of each instrument set-up. Two (2) bench marks should be used for each set-up. **NO SHOTS SHALL BE TAKEN IN EXCESS OF 400 FEET FROM THE INSTRUMENT.**

2. Stationing for center line shall be from south to north, or west to east, with station 10+00 at the beginning center of intersection on street surveys and at the intersection of street R.O.W. and center line of alley for alley surveys. Cross sections shall begin two hundred (200) feet before the starting limit of the project and extend two hundred (200) feet past the limits of the project. The limits of the project are defined as the points where the proposed grading or pavement transitions tie to the existing pavement or ground.

3. Orientation for all cross sections shall be looking up station.

4. Cross sections shall be taken at a maximum of fifty (50) feet intervals along the centerline of the proposed pavement, at any intermediate breaks in grade, and at locations outlined in section D.5 of this appendix "B". In the transverse direction, cross sections shall include, but shall not be limited to the following shots both right and left of centerline: existing and proposed pavement centerlines, quarter points, edges of road, edges of pavement, gutters and top of curbs, edges of existing sidewalks, property lines, any intermediate breaks in slope, and shots twenty-five (25) feet past the street right-of-way lines. Shots shall also be taken at high banks, low banks, center of ditches, toe of banks, flow line of ditches, etc. Shots will be taken no greater than fifteen (15) feet apart in the transverse direction.

5. Sections must also be taken at every location which may affect design. These include:

    a. Driveway centerlines, or each edge of the driveway, depending on width of driveway and grade of street;

    b. Lead walks and steps, edge of parking lots, beginning and end of walls;

    c. Grade breaks between sections, such as low areas, terraces or walls perpendicular to street, drain ditches, roof drains, etc.

    d. Alleys. Take shots for at least 200 feet from the street centerline up alleys. Sometimes property line shots will be needed in addition to the usual centerline information if the alley is not paved.

    e. Existing drainage pipes and structures for at least 200 feet from street centerline both upstream and downstream, always including flow lines of the structure.

    f. Beginning and end of existing walls, buildings or other structures close to or on the right-of-way line. Label each special cross section with an exact description so it is clear as to the location of the section. The special cross sections shall also be labeled using centerline paving station, left or right.

6. Cross sections shall be taken at intersecting streets along property lines, high bank and toe of bank of ditches, edge of pavement, top of curbs, gutters, quarter points and centerline for at least two hundred (200) feet past the centerline of the principal street being surveyed. Actual distance shall be dictated by design requirements.

7. Shots must be taken to locate utility elevations in manholes, inlets, culverts, water valves, etc. Shots in manholes should include elevations, size, and direction of all lines coming in and for the line going out and elevation to the top of the operating nut on water valves.

8. All cross sections shall extend at least 25 feet behind the proposed street right-of-way lines and shall extend farther as necessary to define the point that the proposed grades tie to the existing grade and to define cross drainage to this point. Deep cut and fill areas also require wider cross sections than are normally required.

9. All cross sections shall be labeled using the centerline paving station at the section.

APPENDIX "C"
Check List for Paving Plans

A. GENERAL

1. North arrow provided

   a. Each sheet

   b. Clearly visible

   c. Preferably in upper right corner

2. Bench marks provided

   a. Two provided on each paving plan/profile sheet with description and location

   b. Spotted in plan view

   c. Conveniently spaced (500' ±)

   d. Located outside construction limits

   e. On permanent structure

3. Private property identified

   a. Block numbers

   b. Lot numbers and lot lines

   c. Dimensions

   d. Owners

   e. Right-of-way, easement, and slope easement lines and temporary work areas (by permission) with dimensions shown

   f. Street addresses

4. Title blocks completed

    a. Completely filled out according to standard

    b. Title agrees with cover sheet

    c. Sheets numbered

    d. Engineer's seal (adjacent to title block)

5. Street names provided

    a. Street under design identified

    b. Intersecting streets identfied

6. Plan notes

    a. Provide complete and applicable set of General Notes (Standard General Notes to be obtained from City Project Engineer)

    b. Provide special notes on plan sheets controlling construction (including pertinent R.O.W considerations, if any)

7. Typical paving and grading sections

    a. Centerline shown and dimensioned to proposed curbs and right-of-way lines.

    b. Existing structures and grade shown including type of material and thickness.

    c. Proposed structures and grade shown, including cut and fill slopes.

    d. Proposed pavement cross slopes or crown specified

    e. Give type and depth of proposed pavements using type thoroughfare or street designation for the street as given in the City Thoroughfare Plan, as currently amended, (6-inch concrete for local streets, 8-inch concrete for residential collectors, 9-inch concrete for normal community collector, minor and principal arterial thoroughfares, 10-inch concrete for heavy duty community collectors and 11-inch concrete for heavy duty minor and principal arterial thoroughfares; for CBD streets, 10-inch concrete section on 4" thick, 650 psi CTB or alternate 10-inch concrete section on 8-inch cement stabilized subgrade (10% by dry weight).

f. Give required base and subgrade stabilization: local streets - 6- inch lime treatment (give % lime required), normal thoroughfares - 8- inch lime treatment (give % of lime required), heavy duty thoroughfares - 8- inch cement stabilized subgrade (give % of cement required), CBD streets - 4- inch thick, 650 psi cement treated base, on compacted subgrade, 98% proctor density at ± 2% of optimum moisture or alternate 8- inch cement stabilized subgrade (give % cement required).

g. Show proposed sidewalks

h. Cross slope limitations provided for parkway area (maximum and minimum when applicable) or proposed cross slope specified.

i. Driveway grades specified from gutter to right-of-way line and behind property line, if applicable.

j. Special driveway cross sections provided showing proposed grades from street gutter to existing grade for driveways in deep cuts, on fill areas or in steep graded adjoining property areas. High point of driveway above gutter shown on cross sections.

k. Complete dimensions provided

l. Construction and pay limits clear.

m. Pay items given and described clearly

n. Adequate number of typical sections provided

8. Special sections and details

a. Provided for all non-standard work

b. Existing and proposed features clearly shown

c. Complete dimensions provided

d. Removal, construction and pay limits clear

e. Pay items given and described clearly

B. COVER SHEET

1. Standard format as currently required by PW&T Department
2. Project job number(s) provided
3. Official project title for project and each street paved
4. Plan revision summary block
5. Signed and sealed by professional engineer registered in Texas
6. Plan index block listing file numbers, plan descriptions and sheet numbers for all plans approved for this project
7. Specify length in feet for each street to be paved
8. Project location map
9. Plan sheets keyed on location map or detailed plan description in plan index block
10. Appropriate signature block
11. Show CADD file name with complete path at lower right corner of cover.

C. SURVEY INFORMATION

1. Provide Alignment/Horizontal Control Drawing as outlined in Appendix "B", Recommended Procedure for Establishing Horizontal and Vertical Controls and for Cross Sectioning, Section A - GENERAL.
2. Provide notes documenting establishment of horizontal and vertical control as outlined in Appendix "B", Sections B and C.
3. Plans shall include complete survey data for construction of the project, and all survey control points required to stake the proposed work must be set on the ground. Check for floating dimensions not tied to centerline.
4. Critical survey control points clearly shown, described, identified and referenced. State whether found or set.
5. Property lines adequately tied and dimensioned. Both existing and proposed right-of-way lines and all easements and temporary working areas (by permission) and sloping

easements must be shown on paving and drainage plan view sheets.

6. Iron pins or monuments located by station and distance.

7. Centerline stationing shown and related to profile.

8. Stationing shall be shown on the centerline, measured distances on transit line. Transit line shall be shown on the Alignment/Horizontal Control Drawing.

9. Certain topographical features must be tied by centerline station and distance and shown on plans: walls, fence corners and other improvements near property line or construction limits; inlets and headwalls which will stay in place; utility poles, traffic signal poles, and utility appurtenances near proposed curbs; and other features of concern to contractors when bidding and constructing the job.

D. TOPOGRAPHY

1. Show and describe all existing features clearly in close proximity to the construction including utilities, roadways, railroads, landscaping, creeks, driveways, buildings, signs, etc. using standard drafting symbols.

2. Show all buildings adjoining project with address numbers.

3. Existing driveways shown and described including width and type of paving.

4. Show and describe existing fences including type and height. If encroaching, address removal/relocation and temporary fencing needs.

5. Show and describe trees. Give caliper, actual location, and kind. If close to property line or otherwise questionable status, can tree be saved? Specify save or remove.

6. Show and describe signs. If commercial and in right-of-way, who will remove? State if electrical service is involved.

7. Show intersecting streets. Give type, thickness and width of pavement and sidewalks. Show spot elevations in ditches or gutters sufficient distance to clarify drainage and transitions.

8. Show existing concrete paving clearly using standard symbols and with accurate dimensions. Curbs and gutters must be dimensioned.

9. Show existing storm drains and inlets using standard symbols.

10. Show existing travelways and identify as to type, depth, etc.

11. Show walls. Specify preserve or remove. Address material to be salvaged for property owner.

12. Show mail boxes, rural type; address relocation (pay item)

13. Design roof drain connections to storm drain.

14. Show lawn sprinklers and irrigation systems. Address relocation.

15. Show existing landscaping. Address adjustment or relocation.

E. UTILITIES

1. Show all existing and proposed facilities

2. Existing underground facilities must match visible appurtenances such as manholes, valve covers, etc.

3. Underground facilities close or in conflict with proposed construction must be located by excavating and obtaining actual ties and elevations.

4. Clarify status of existing facilities whether to remain in service, abandon or remove and by whom.

5. Show design location of proposed facilities. Reference file number of plans. Give time table if known.

6. Add caution notes when construction operations will come close to any facility, giving telephone number of utility company to call for assistance in locating.

7. Check for adequate clearance for any work under overhead high voltage wires. Provide caution notes to contractor where appropriate.

F. STORM DRAINS

1. Locate inlets so as to give least inconvenience to property owners.

2. Check street cross fall at inlet locations. Provide at least 1/4" per foot cross fall into inlet. Provide adequate inlet capacity on low side of street.

3. Proposed storm drains shall be shown by standard symbols. Drainage pattern shall be

clear without having to refer to storm drainage plans.

4. Inlets and pipes shall be drawn to scale.

5. For each inlet show size, paving station at center, top and flowline elevations and pay item number. Also show throat elevations for "Y" inlets.

6. Locate manholes for inlets directly above the adjoining lateral pipe entrance.

7. Verify that inlet data on paving plans matches drainage plans.

8. Show gutter drainage flow arrows in paving plan view at inlets, crests and sags.

9. Complete items on the "Checklist For Storm Drainage Plans", Drainage Design Manual.

G. PLAN

1. Provide proposed pavement grades low enough to drain adjoining properties and provide adequate access with minimum encroachment on private properties.

2. Clearly show all proposed features, grading and improvements and provide clear descriptions and dimensions including limits of proposed construction using standard drafting symbols.

3. All work on private property will require either a letter of permission or an official easement. Show any required conditions affecting the construction on the plans

4. All work on Park property will require Park Board approval. Show any required conditions affecting the construction on the plans.

5. Clearly show all removal items including limits and pay item number for each.

6. Properly dimension all proposed pavement, sidewalk, driveways, etc. including length and width.

7. Provide all property frontage dimensions.

8. Clearly define limits of new paving, adjustments to intersecting streets and driveways by stations and dimensions as necessary.

9. Provide special detail sections for ties to existing driveways which are nonstandard or which go beyond street right-of-way and for ties to existing streets which go beyond the proposed street turnout.

10. Provide proper pavement transitions for ties to all intersecting streets, alleys, parking lots and private property, including cross section and structure for all proposed transition pavements.

11. Provide special details to clarify congested or difficult to read construction problems.

12. Clarify drainage patterns by flow arrows, spot elevations in ditches and gutters, and other notations. Especially address intersections, ties to adjoining properties and all ends of the project.

13. Design all traffic control work and provide work items as required by Transportation Division. Show all required signal and facility foundation removals.

14. Provide for street and traffic control signs and markings as required by Transportation Division.

15. Design street light structures on divided thoroughfares as required by Transportation Division, using City provided spacing and standard details.

16. Provide barrier free ramps on all sidewalks at street and driveway intersections.

17. Show toe of slope and top of cut limit lines where grade differences are 0.5' or more. Provide field notes for all slope easements meeting approval of the Chief City Surveyor.

18. Show dimensional temporary work areas provided by property owner permission.

19. Draw steps to scale and show number of risers. Clearly show on plans what is existing and what is proposed.

20. Specify proposed wall types, beginning and end paving stations and top of wall elevations. Address drainage behind walls. Show walls in profile. Provide designs for modified or non-standard retaining walls.

21. Check existing and proposed retaining walls, fences, guard rails, utility poles, trees, etc. for adequate sight distance.

22. Check all drives, intersections, median openings and other locations involving retaining walls or steep grades and cross traffic for possible hazardous situations. Design for unobstructed sight distances, eliminate hindrances to safe operation at design speed, danger to pedestrians, etc.

23. Turn lanes and Median Openings

   a. Check median opening for compliance with minimum distance standards from street intersections and other median openings.

   b. Center median openings on streets and driveways.

   c. Provide traffic buttons and stripping per standards in 251D-1

   d. Show proposed top of 6 inch median curb at P.C.'s, P.R.C.'s, P.T.'s, median nose (6" theoretical curb) and intermediate points for left turn lanes and existing top of median curb elevations for portions to remain.

   e. Check median and street cross fall for compliance with standards.

   f. Provide median pavement and monolithic median nose per standards.

   g. Provide typical paving section for left and right turn lanes.

   h. Show existing driveways and inlets in proximity to turning lanes and on both sides of the street at all proposed median openings.

   i. Show required street lighting and traffic control improvements as required by the Transportation Division.

   j. Provide curve and reverse curve geometry for curbs transitioning to turning lanes in conformance with Public Works and Transportation Standards

24. Check transitions at ends of project and at intersections for safety, complete design addressing tie to existing features, drainage, etc. Show complete topography and design information adjoining limits of all transition work.

25. Look beyond the limits of the project and address adverse impacts on traffic flow, safe conditions and use of developed property.

26. Provide shading and coding where needed for clarification.

27. Lettering and drafting shall be clear when reduced to half scale.

28. Provide pay item numbers for all proposed work unless otherwise clearly noted in the plans. Provide clear, concise definitions and pay limits to eliminate confusion.

29. Provide "No Separate Pay" or "Work Incidental to Pay Items Provided" notes for each specified work items not covered under a specific pay item.

30. Provide estimated pay items and work quantities on separate quantity summary sheet. Check for obvious errors. Provide space for City to add contingency pay items. Provide column for bid quantities. Confirm quantities reflect all revisions made to the plans during the plan review process.

H. PROFILES AND GRADES

1. Show in profile existing ground elevation at proposed property lines and street centerline. Have drives, street intersections, lead walks, walls, etc., been plotted to show realistic ground line?

2. Design top of curb grades should be below existing ground profiles at right-of-way line to provide at least 1/4" per foot of parkway crossfall between right-of-way line and the top of curb unless embankment section is required or street is in 100-year floodplain. Check fill areas for encroachment or damage to adjoining properties.

3. Design driveway and intersecting street adjustments and transitions compatible with grades and profiles. Deeper cuts or fills require longer adjustments.

4. Check street crossfalls with minimum and maximum standards. Check inlet locations in plan in relation to cross fall to insure design drainage interception.

5. Check gutter capacity, grade and cross fall of all streets and design inlets to insure street capacity is not exceeded and required drainage is intercepted.

6. Design grades to provide smooth intersections. Provide vertical curves when grade breaks on the proposed street pavement exceed 1%.

7. Confirm that no abutting property is in danger of being damaged due to poor vehicular access or loss of improvements. <u>Double Check!</u>

8. Complete vertical curves information. Confirm that proposed vertical curves meet minimum sight distance requirements for street design speed.

9. Show in profile proposed top of 6" curb profiles including median curbs if applicable.

10. For each profile provide top of curb elevations at 50 foot stations and at beginning and ending match lines, at vertical curve P.V.I.'s, at beginning and ending of approach or structural slabs, at intersecting street point of curb intersection points (outside curb profiles only) and at beginning and ending of street curb points. Provide centerline paving

stations for all points of elevation which are not at 50 foot stations.

11. Provide curb grade slope in percent to nearest one hundredth percent for each profile.

12. Provide smooth riding grades for pavement transitions. Grade breaks exceeding 1% require vertical curves. Use same grade design standards as for proposed pavement design.

13. Provide appropriate profiles for pavement transitions showing centerline and edge of pavement grades at 50 foot stations and at beginning and ending match lines or ties to proposed and existing pavement and at vertical curve P.V.I.'s, P.C.'s and P.T.'s. Provide centerline paving stations for all points of elevation which are not at 50 foot stations.

14. Provide proposed top of wall elevations at beginning, ending and P.V.I.'s with centerline street stations given.

15. Show existing or proposed drainage, utility or structure facilities which are in close proximity to the construction.

16. Check paving grades, cross sections and plan view carefully; eliminate any place water might pond by revising design grades and plan view picture as required. Locate inlets at sag points of vertical curves.

17. Confirm grades, crossfall, slopes, etc., are consistent with information shown on typical sections.

18. Check all horizontal curves for safe operation at design speed. Provide superelevation as required to comply with standards. Revise profile grade and plan view as required.

19. Confirm that proposed paving grades do not pond drainage on adjoining properties.

20. Check ends of project for drainage. If gutters drain to ditches or field type inlets, provide proposed grades and profiles for required grading. Show required grading and transition to existing features in plan view. Provide grading typical sections.

I. ADDITIONAL REQUIREMENTS

1. All required landscaping and irrigation designs shall be completed in conformance with City standards with pay items and established quantities provided on the plans and quantity sheet.

2. Storm Water Pollution Prevention Plans shall be prepared with pay items and estimated quantities provided on the plans and quantity sheet. Design shall provide 70% sediment trap effectiveness.

3. All required hydraulic backwater analysis shall be prepared and run as required for streets encroaching in the 100 - year flood plain. Design shall conform with approved City flood plain management plans and/or flood plain ordinance.

4. Plans shall be consistent with all Dallas Water Utilities joint water and wastewater design plans for this Project.

5. Provide sequence of construction details and traffic control plan as required by the City to protect the public interest and comply with Texas Manual on Uniform Traffic Control Devices, as currently amended.

6. Provide specifications for all nonstandard materials and designs proposed for this project.

7. Related Submittals

    a. Review plans shall be submitted to City Survey section for stakeability review; all comments must be addressed.

    b. Review plans shall be submitted to the City Construction Inspection section for constructability review; all comments must be addressed.

    c. Review Plans shall be submitted to City Transportation Division for street lighting and traffic control review; all comments must be addressed.

    d. Approved preliminary plans shall be submitted to City for Utility clearance review; all comments must be addressed.

    e. Review plans shall be submitted to City Street, Sanitation and Code Enforcement Services for review; all comments must be addressed.

    f. Review plans shall be submitted to TXDOT(State)/County (if involved) for review; all comments must be addressed.

APPENDIX "D"

STREET CENTERLINE AND CORNER CURB RETURN RADII DETERMINATIONS-EXAMPLES

EXAMPLE 1. To determine the minimum centerline radius allowed for a Principal Arterial class thoroughfare with an M-6-D(A) section and a super elevation of 1/4 inch per foot sloping from median curb (high side) down to outside curb (low side) on both sides of the median.

a) What is the minimum centerline radius for the thoroughfare without intersection sight distance requirements?

There are intersecting streets and alleys in the curved section.

b) What is the desirable minimum and safety minimum centerline radii for both sides for intersecting streets and alleys?

c) Which controls the required minimum centerline radius?

d) Will dedication of sight easements in the curve reduce the required minimum centerline radius?

SOLUTION TO EXAMPLE 1

a) The minimum centerline radii for thoroughfares for various cases of design speed and super elevation without consideration of sight distance requirements is given in Table IV-11A "MINIMUM CENTERLINE RADIUS FOR THOROUGHFARES".

- Step 1 Determine the design speed. Referring to Table IV-5 "DESIGN SPEED AND SIDE FRICTION FACTORS FOR THOROUGHFARES", the design speed for a Principal Arterial class thoroughfare with a M-6-D (A) section is 50 miles per hour (MPH).

- Step 2 Determine the minimum centerline radii for both sides of the thoroughfare using the super elevation given. For the half of the street on the inside of the curve, the pavement slopes up from the outside curb line to the median curb line at a rate of 1/4 inch per foot. This is equal to +1/4 inch per foot in relation to the center of the horizontal curve of the street. Referring to Table IV-11A, the minimum centerline radius for this half of the roadway is 1,040 feet for a design speed of 50 MPH. For the half of the street on the outside of the curve, the pavement slopes down from the median curb line to the outside curb line at a rate of 1/4 inch per foot. This is equal to -1/4 inch per foot in relation to the center of the horizontal curve of the street. Referring to Table IV-11A, the minimum centerline radius for this half of the roadway is 1,400 feet for a design speed of 50 M.P.H.

. Step 3 The larger of the two minimum radii governs the street minimum centerline radius.

ANSWER to 1a): **1400 feet**

b) The desirable minimum and safety minimum centerline radii due to sight distance requirements for intersecting streets, alleys and driveways are given in Table IV-11B "HORIZONTAL CURVE RESTRICTIONS DUE TO INTERSECTION SIGHT DISTANCES".

. Step 1 Determine the design speed as shown in the solution to Example 1a)step 1.

. Step 2 Using Table IV-11B, determine the left side desirable minimum and safety minimum radii using a Principal Arterial class thoroughfare with a M-6-D(A) section and a design speed of 50 M.P.H. Desirable Minimum Radius is 6,040 feet and the Safety Minimum Radius is 1420 feet for the left side.

. Step 3 Similarly for the right side using Table 6 IV-11B, the Desirable Minimum Radius is 2,850 feet and the Safety Minimum Radius is 880 feet.

ANSWER to 1b):

- **For the Left Side: Desirable Minimum Radius is 6,040 feet;**
  Safety Minimum Radius is 1420 feet.

- **For the Right Side: Desirable Minimum Radius is 2,850 feet;**
  Safety Minimum Radius is 880 feet.

c) The larger of the three radii: the Minimum Centerline Radius answer to part a), the left side Safety Minimum Radius answer to part b), and the right side Safety Minimum Radius answer to part b) will control.

- Step 1 The Minimum Centerline Radius as given by the answer to Example 1a) is 1400 feet.

- Step 2 The left side Safety Minimum Radius as given by the answer to Example 1b) is 1420 feet.

- Step 3 The right side Safety Minimum Radius as given by the answer to Example 1b) is 880 feet.

- Step 4 The larger of the three radii is 1420 feet.

ANSWER to 1c): **1420 feet. The left side Safety Minimum Radius for intersection sight distance requirements controls.**

d) The effect of dedication of sight easements on the required minimum centerline radius, where intersection sight distance is a factor, is given in Table IV-11C "SIGHT EASEMENT REQUIREMENTS DUE TO INTERSECTION SIGHT DISTANCES".

- Step 1 Using a Principal Arterial class thoroughfare with a M-6-D(A) section, read from Table IV-11C the minimum radius with the given sight easement widths:
  - No easement allows 1420 foot radius
  - One foot easement along the inside street right-of-way curve allows 1260 foot radius
  - Two foot easement along the inside street right-of-way curve allows 1140 foot radius
  - Three foot easement along the inside street right-of-way curve allows 1050 foot radius
  - Four foot easement along the inside street right-of-way curve allows 965 foot radius

. <u>Step 2</u> Compare the table of radius for the various easement widths with the controlling minimum centerline radius determined in Example 1c) which is 1420 feet.

. <u>Step 3</u> Find an easement width that allows a smaller minimum centerline radius. For example, an easement width of one foot along the inside street right-of-way curve allows a minimum centerline radius of 1260 feet.

. <u>Step 4</u> Compare the reduced minimum centerline radius with the minimum centerline radii for thoroughfares given in Table IV-11A. Example 1a) determined this radius as 1400 feet. <u>THE REDUCED REQUIRED MINIMUM CENTERLINE RADIUS MUST NOT BE LESS THAN THE TABLE IV-11A RADIUS.</u>

<u>ANSWER to 1d)</u>: **Yes, the required minimum centerline radius determined in Example 1c) can be reduced if a one foot wide sight easement is provided along the inside street right-of-way curve but the required radius can only be reduced to 1400 feet since the radius can not be lower than the radius determined from Table IV-11A.**

<u>EXAMPLE 2.</u> In Example 1, a Principal Arterial class thoroughfare, section M-6-D(A) and a Minor Arterial class thoroughfare, section S-4-U intersect the given thoroughfare.

a) What are the minimum required corner curb return radii and estimated corner clips at the four corners of the M-6-D(A) thoroughfare to M-6-D(A) thoroughfare intersection?

b) What are the minimum required corner curb return radii and estimated corner clips at the four corners of the M-6-D(A) thoroughfare to S-4-U thoroughfare intersection?

<u>SOLUTION TO EXAMPLE 2</u>

a) The minimum required corner curb return radii and estimated corner clips at the four corners of the intersection of two divided streets are given in Plate IV-13 TABLE "TYPE II INTERSECTION SUMMARY STREET WITH A MEDIAN INTERSECTING STREET WITH MEDIAN".

. <u>Step 1</u> Determine the Initial Street and the Destination Street to provide orientation and the possible right turn traffic movements. A plan picture of the intersection should be used to clarify. The Initial Street is the street on which the turning movement begins and the Destination Street is the street onto which the traffic is turning. In this example, the four curb returns can be described by one movement:

- *Movement A: Going from the Principal Arterial class thoroughfare M-6-D(A) section to a Principal Arterial class thoroughfare M-6-D(A) section.*

Symmetry allows us to determine the corner curb return radius and estimated corner clip required for this right turn movement and use this radius and corner clip at all four corners of the intersection.

. <u>Step 2</u> Determine the required corner curb return radius and estimated corner clip for each right turn traffic movement determined in Step 1 using Plate IV-13 TABLE "TYPE II INTERSECTION SUMMARY..." Reading from Plate IV-13 TABLE, the Typical Corner Curb Return Radius "R" is 30 feet and the Typical Corner Clip "CxC" is 11'x 11'.

<u>ANSWER to 2a)</u>: **Corner curb return radius of 30' and estimated corner clip of 11'x 11' at all four corners of the intersection.**

b) The minimum required corner curb return radii and estimated corner clips at the four corners of the intersection of a divided street and an undivided street are given in Plate IV-14 TABLE "TYPE III INTERSECTION SUMMARY...".

. <u>Step 1</u> As in Example 2a) the possible right turn traffic movements must be determined. For the Principal Arterial class thoroughfare M-6-D(A) section intersection with a Minor Arterial class thoroughfare S-4-U section, there are two possible movements with the diagonal corners being symmetrical:

- *Movement A: Going from the Principal Arterial M-6-D(A) section to the Minor Arterial S-4-U section*

- *Movement B: Going from the Minor Arterial S-4-U section to the Principal Arterial M-6-D(A) section.*

Symmetry allows us to determine the corner curb return radius and estimated corner clip required for each movement and use this radius and corner clip at the diagonal intersection corners also.

. <u>Step 2</u> Determine the required corner curb return radius and estimated corner clip for each right turn traffic movement determined in Step 1 using Plate IV-14 TABLE "TYPE III INTERSECTION SUMMARY..." Reading from Plate IV-14 TABLE, the Typical Corner Curb Return Radius "R" and the Typical Corner Clip "CxC" for each movement given in Step 1 is as follows:

- *Movement A: (M-6-D(A) to S-4-U)*
  R is 40'
  CxC is 19'x 19'

- *Movement B: (S-4-U to M-6-D(A))*
  R is 35'
  CxC is 15'x 15'

<u>ANSWER to 2b)</u>: **Corner curb return radii of 40' is required at the two diagonal corners with traffic turning from the Principal Arterial M-6-D(A) section to the Minor Arterial S-4-U section with estimated corner clips of 19'x 19'.**

Corner curb return radii of 35' is required at the two diagonal corners with traffic turning from the Minor Arterial S-4-U section to the Principal Arterial M-6-D(A) section with estimated corner clips of 15'x 15'.

<u>EXAMPLE 3.</u> Determine the minimum centerline radius allowed for a Minor Arterial class thoroughfare with an S-4-U section and a super elevation of 1/4" per foot across the full street section from the curb on the outside of the curve (high side) down to the curb on the inside of the curve (low side).

a) What is the minimum centerline radius for the thoroughfare without intersection sight distance requirements?

There are intersecting driveways and streets in the curved section.

b) What is the desirable minimum and safety minimum centerline radii for both sides for intersecting driveways and streets?

c) Which controls the required minimum centerline radius?

d) How will dedication of sight easements in the curve affect the required minimum centerline radius?

<u>SOLUTION TO EXAMPLE 3</u>

a) The minimum centerline radii for thoroughfares for various cases of design speed and super elevation without consideration of sight distance requirements is given in Table IV-11A "MINIMUM CENTERLINE RADIUS FOR THOROUGHFARES".

- <u>Step 1</u> Determine the design speed. Referring to Table IV-5 "DESIGN SPEED AND SIDE FRICTION FACTORS FOR THOROUGHFARES", the design speed for a Minor Arterial class thoroughfare with a S-4-U section is 45 miles per hour (MPH).

- <u>Step 2</u> Determine the minimum centerline radii for both sides of the thoroughfare using the super elevation given. For the half of the street on the inside of the curve, the pavement slopes up from the outside curb line to the street centerline at a rate of 1/4 inch per foot. This is equal to +1/4 inch per foot in relation to the center of the horizontal curve of the street. Referring to Table IV-11A, <u>the minimum centerline radius for this half of the roadway is 740 feet for a design speed of 45 M.P.H.</u> For the half of the street on the outside of the curve, the pavement slopes up from the street centerline to the outside curb line at a rate of 1/4 inch per foot. This is equal to +1/4 inch per foot in relation to the center of the horizontal curve of the street. Referring to Table IV-11A, <u>the minimum centerline radius for this half of the roadway is 740 feet for a design speed of 45 M.P.H.</u>

- <u>Step 3</u> The larger of the two minimum radii governs the street minimum centerline radius.

<u>ANSWER to 3a):</u> 740 feet

b) The desirable minimum and safety minimum centerline radii due to sight distance requirements for intersecting streets, alleys and driveways are given in Table IV-11B "HORIZONTAL CURVE RESTRICTIONS DUE TO INTERSECTION SIGHT DISTANCES".

. Step 1 Determine the design speed as shown in the solution to Example 3a)step 1.

. Step 2 Using Table IV-11B, determine the left side desirable minimum and safety minimum radii using a Minor Arterial class thoroughfare with a S-4-U section and a design speed of 45 M.P.H. Desirable Minimum Radius is 5,450 feet and the Safety Minimum Radius is 1,210 feet for the left side.

. Step 3 Similarly for the right side using Table 6 IV-11B, the Desirable Minimum Radius is 4,320 feet and the Safety Minimum Radius is 1,350 feet.

ANSWER to 3b):

- **For the Left Side: Desirable Minimum Radius is 5,450 feet; Safety Minimum Radius is 1,210 feet.**

- **For the Right Side: Desirable Minimum Radius is 4,320 feet; Safety Minimum Radius is 1,350 feet.**

c) The larger of the three radii: the Minimum Centerline Radius answer to part a), the left side Safety Minimum Radius answer to part b), and the right side Safety Minimum Radius answer to part b) will control.

. Step 1 The Minimum Centerline Radius as given by the answer to Example 3a) is 740 feet.

. Step 2 The left side Safety Minimum Radius as given by the answer to Example 3b) is 1,210 feet.

. Step 3 The right side Safety Minimum Radius as given by the answer to Example 3b) is 1,350 feet.

. Step 4 The larger of the three radii is 1,350 feet.

ANSWER to 3c): **1,350 feet. The left side Safety Minimum Radius for intersection sight distance requirements controls.**

d) The effect of dedication of sight easements on the required minimum centerline radius, where intersection sight distance is a factor, is given in Table IV-11C "SIGHT EASEMENT REQUIREMENTS DUE TO INTERSECTION SIGHT DISTANCES".

. Step 1 Using a Minor Arterial class thoroughfare with a S-4-U section, read from Table IV-11C the minimum radius with the given sight easement widths:
- No easement allows 1,350 foot radius
- One foot easements on both sides of the street right-of-way allows 1,040 foot radius
- Two foot easements on both sides of the street right-of-way allows 915 foot radius
- Three foot easements on both sides of the street right-of-way allows 820 foot radius
- Four foot easements on both sides of the street right-of-way allows 750 foot radius

. Step 2 Compare the table of radius for the various easement widths with the controlling minimum centerline radius determined in Example 3c) which is 1,350 feet.

. Step 3 Find an easement width that allows a smaller minimum centerline radius. For example, an easement width of four feet allows a minimum centerline radius of 750 feet.

. Step 4 Compare the reduced minimum centerline radius with the minimum centerline radii for thoroughfares given in Table IV-11A. Example 3a) determined this radius as 740 feet. THE REDUCED REQUIRED MINIMUM CENTERLINE RADIUS MUST NOT BE LESS THAN THE TABLE IV-11A RADIUS.

ANSWER to 3d): **The required minimum centerline radius determined in Example 3c) can be reduced to 750 feet if 4 foot wide sight easements are** provided in the curved section along both sides of the street right-of-way. This radius is not lower than the radius determined from Table IV-11A.

<u>EXAMPLE 4.</u> In Example 3, a Community Collector class thoroughfare, section S-2-U and a Local Street, section L-2-U(B) intersect the given thoroughfare.

a) What are the minimum required corner curb return radii and estimated corner clips at the four corners of the S-4-U thoroughfare to S-2-U Collector thoroughfare intersection?

b) What are the minimum required corner curb return radii and estimated corner clips at the four corners of the S-4-U thoroughfare to L-2-U(B) Local Street intersection?

<u>SOLUTION TO EXAMPLE 4</u>

a) The minimum required corner curb return radii and estimated corner clips at the four corners of the intersection of two undivided streets are given in Plate IV-12 TABLE "TYPE I INTERSECTION SUMMARY STREET WITHOUT A MEDIAN INTERSECTING STREET WITHOUT MEDIAN".

. <u>Step 1</u> Determine the Initial Street and the Destination Street to provide orientation and the possible right turn traffic movements. A plan picture of the intersection should be used to clarify. The Initial Street is the street on which the turning movement begins and the Destination Street is the street onto which the traffic is turning. In this example, the four curb returns can be described by two movements with the diagonal corners being symmetrical:

- *Movement A: Going from the Minor Arterial class thoroughfare S-4-U section to a Community Collector class thoroughfare S-2-U section.*

- *Movement B: Going from the Community Collector class thoroughfare S-2-U section to the Minor Arterial class thoroughfare S-4-U section.*

Symmetry allows us to determine the corner curb return radius and estimated corner clip required for each right turn movement and use this radius and corner clip at the diagonal intersection corners also.

. <u>Step 2</u> Determine the required corner curb return radius and estimated corner clip for each right turn traffic movement determined in Step 1 using Plate IV-12 TABLE "TYPE I INTERSECTION SUMMARY..." Reading from Plate IV-12 TABLE, the Typical Corner Curb Return Radius "R" and the Typical Corner Clip "CxC" for each movement given in Step 1 is as follows:

- *Movement A: (S-4-U to S-2-U)*
  R is 30'
  CxC is 10'x 10'

- *Movement B: (S-2-U to S-4-U)*
  R is 20'
  CxC is 5'x 5'

<u>ANSWER to 4b)</u>: **Corner curb return radii of 30' are required at the two diagonal corners with traffic turning from the Minor Arterial S-4-U section to the Community Collector S-2-U section with estimated corner clips of 10'x 10'.**

Corner curb return radii of 20' are required at the two diagonal corners with traffic turning from the Community Collector S-2-U section to the Minor Arterial S-4-U section with estimated corner clips of 5'x 5'.

b) The minimum required corner curb return radii and estimated corner clips at the four corners of two undivided streets are given in Plate IV-12 TABLE "TYPE I INTERSECTION SUMMARY...".

. <u>Step 1</u> As in Example 4a) the possible right turn traffic movements must be determined. For the Minor Arterial class thoroughfare S-4-U section intersection with a Local Street L-2-U(B) section, there are two possible movements with the diagonal corners being symmetrical:

- *Movement A: Going from the Minor Arterial S-4-U section to the Local Street L-2-U(B) section*

- *Movement B: Going from the Local Street L-2-U(B) section to the Minor Arterial S-4-U section.*

Symmetry allows us to determine the corner curb return radius and estimated corner clip required for each movement and use this radius and corner clip at the diagonal intersection corners also.

. Step 2 — Determine the required corner curb return radius and estimated corner clip for each right turn traffic movement determined in Step 1 using Plate IV-12 TABLE "TYPE I INTERSECTION SUMMARY..." Reading from Plate IV-12 TABLE, the Typical Corner Curb Return Radius "R" and the Typical Corner Clip "CxC" for each movement given in Step 1 is as follows:

- *Movement A: (S-4-U to L-2-U(B)*
  R is 30'
  CxC is 10'x 10'

- *Movement B: (L-2-U(B) to S-4-U)*
  R is 20'
  CxC is 5'x 5'

ANSWER to 4b): Corner curb return radii of 30' is required at the two diagonal corners with traffic turning from the Minor Arterial S-4-U section to the Local Street L-2-U(B) section with estimated corner clips of 10'x 10'.

Corner curb return radii of 20' is required at the two diagonal corners with traffic turning from the Local Street L-2-U(B) section to the Minor Arterial S-4-U section with estimated corner clips of 5'x 5'.