# Chapter Twenty-seven

# BASIC DESIGN CONTROLS

BUREAU OF LOCAL ROADS AND STREETS MANUAL

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# Chapter Twenty-seven
# BASIC DESIGN CONTROLS

Road and street design is predicated on many basic controls that establish the overall objective of the facility and identify the basic purpose of the project. Chapter 27 presents the basic controls that impact road design. The design criteria in Part IV "Project Design" applies to all local agency projects funded with Federal, State, and Motor Fuel Tax funds that are processed through Central BLRS.

## 27-1 TERMINOLOGY

Many qualifying words are used in road and street design and in this *Manual*. For consistency and uniformity in the application of various design criteria, the following definitions apply:

1. Standard. Indicating a design value that cannot be violated without severe consequences. This suggestion is generally inconsistent with geometric design criteria. Therefore, "standard" will not be used in this *Manual* to apply to geometric design criteria.

2. Policy. Indicating practice that IDOT generally expects the designer to follow, unless otherwise justified.

3. Guideline. Indicating a design value that establishes an approximate threshold that should be met if considered practical.

4. Criteria. A term typically used to apply to design values, usually with no suggestion on the criticality of the design value. Because of its basically neutral implication, this *Manual* frequently uses "criteria" to refer to the design values presented.

5. Variance. Approval from IDOT for using design criteria that does not meet the criteria set forth in this *Manual*.

6. Minimum, maximum, upper, lower (limits). Representative of generally accepted limits within the design community but not necessarily suggesting that these limits are inviolable. However, where the criteria presented in this context will not be met, the designer will in many cases need approval.

7. Warranted. Indicating that some well-accepted threshold or set of conditions has been met. Note that, once the warranting threshold has been met, this is an indication that the design treatment should be considered and evaluated — not that the design treatment is automatically required.

8. Justified. Indicating that some set of conditions has been shown to be valid, sound, or conforming to fact or reason. This may be applied to either objective or subjective evaluations.

9. Ideal. Indicating a standard of perfection (e.g., traffic capacity under "ideal" conditions).

10. Practical, feasible, cost-effective, reasonable. Advising the designer that the decision to apply the design criteria should be based on a subjective analysis of the anticipated benefits and costs associated with the impacts of the decision. No formal analysis is intended, unless otherwise stated.

11. Typical. Indicating a design practice that is most often used in application and which is likely to be the "best" treatment at a given site.

12. Acceptable. Design criteria that may not meet desirable values, but yet is considered to be reasonable and safe for design purposes.

13. Possible. Indicating that which can be accomplished. Because of its connotation, this word will rarely be used in this *Manual* for the application of design criteria.

14. Significant, major. Indicating that the consequences from a given action are obvious to most observers and, in many cases, can be readily measured.

15. Insignificant, minor. Indicating that the consequences from a given action are relatively small and not an important factor in the decision-making for road and street design.

16. Shall, require, must. Designers are obligated to adhere to the criteria and applications presented in this context unless a variance is approved or to perform the evaluation indicated.

17. Should, recommend, desirable, preferred. Designers are strongly encouraged to follow the criteria and guidance presented in this context, unless there is reasonable justification not to do so. A variance is not required if the criteria or guidance is not followed.

18. May, could, can, suggest, consider. Designers are allowed to apply individual judgment and discretion to the criteria when presented in this context. The decision will be based on a case-by-case assessment.

## 27-2 PROJECT SCOPE OF WORK

The project scope of work reflects the basic intent of the local agency and determines the overall level of improvement. This scope, in combination with the roadway functional classification (see Section 27-3), determines which criteria in the *Manual* apply to the geometric design of the project. The following Sections provide the general scopes of work for the different types of construction. Each of the following Sections also reference the applicable chapters in Part IV "Project Design."

### 27-2.01 New Construction

Generally, new construction is the construction of a road or street on new location. The project is usually based on at least a 20-year design period. Typically, the project will have a significant length and should connect logical termini. New construction also includes any intersection or interchange that falls within the project limits of a new facility. Chapters 28 – 32 and Chapters 34 – 42 present IDOT criteria for new construction by local agencies on local facilities.

### 27-2.02 Reconstruction

Reconstruction of an existing local facility will typically include the addition of travel lanes and/or reconstruction of the existing horizontal and/or vertical alignment, but the road or street will remain essentially within the existing corridor. These projects usually require some right-of-way acquisitions. The primary reasons for reconstruction of an existing facility are because:

- the facility cannot accommodate its current or future traffic demands,
- the existing alignment or cross section is significantly deficient, and/or
- the service life of the pavement has been exceeded.

Any intersection that falls within the limits of a reconstruction project will be reconstructed as needed.

Because of the significant level of work for reconstruction, the design of the project is generally determined by the criteria for new construction based on a 20 year design period. Chapters 28 – 32 and Chapters 34 – 42 apply to reconstruction projects.

### 27-2.03 3R Projects

3R projects (rehabilitation, restoration, and/or resurfacing) are primarily intended to extend the service life of the existing facility and to enhance safety. In addition, 3R projects should make cost-effective improvements to the existing geometrics, where practical. Typically, 3R work on the mainline or at an intersection is within the general constraints of the existing right-of-way and existing alignment. Right-of-way acquisition is occasionally included for:

- flattening slopes,
- changes in horizontal alignment,
- changes in vertical profile, and
- safety enhancements.

The overall objective of a 3R project is to perform the work necessary to return the facility to a condition of acceptable structural and/or functional adequacy. 3R projects may include any number of the following types of improvements:

- providing pavement resurfacing, and/or rehabilitation (full-depth pavement replacement may be justified in some instances);
- providing lane and shoulder widening (without adding through lanes);
- providing intersection improvements (e.g., adding turn lanes, flattening turning radii, corner sight distance improvements);
- rehabilitating or replacing existing structures;
- adding a Two-Way Left-Turn Lane (TWLTL);
- adding pavement markings;
- converting an existing uncurbed urban street into a curbed street;
- replacing existing curb and gutter;
- flattening an occasional horizontal or vertical curve;
- adjusting the roadside clear zone;
- flattening side slopes;
- providing landscaping;
- revising the location, spacing, or design of existing driveways along the mainline;
- adding, widening, or resurfacing parking lanes;
- adding or replacing sidewalks;
- implementing improvements to meet the ADA accessibility criteria (e.g., sidewalk curb ramps);
- adjusting utility facilities;
- upgrading guardrail and other roadside safety appurtenances to meet current criteria;
- implementing drainage improvements; and/or
- upgrading highway/railroad grade crossings.

Chapter 33 presents IDOT criteria for the design of 3R projects on local roads and streets.

## 27-2.04 Full-Depth Pavement Replacement

The extent of pavement replacement on an existing facility is one significant factor in determining if the project scope of work is "reconstruction" or "3R." The more extensive the pavement work, the greater the opportunity to incorporate geometric improvements (e.g., lane and shoulder widening). However, the practical level of geometric improvements is dependent on many other factors (e.g., available right-of-way, environmental impacts, construction costs).

Therefore, if a proposed project includes pavement replacement for a significant portion of the project length, the project scope of work is determined on a case-by-case basis. The Central BLRS will have final approval on the scope of work determination when full-depth pavement replacement is performed.

## 27-2.05 Pavement Preservation Projects

These projects consist of repairing and resurfacing existing paved roadways on local facilities, both urban and rural. The purpose of pavement preservation projects is to extend the life of exiting pavements. Pavements with significant and extensive structural distress are not eligible for these projects. A successful pavement preservation project improves the ride quality and reduces the life-cycle costs of pavement rehabilitation.

Because the project's purpose is primarily to improve pavement serviceability, roadway design improvements are extremely limited for the project scope of work. These projects shall use the Local Agency Pavement Preservation (LAPP) policy as discussed in Chapter 45.

## 27-3 FUNCTIONAL CLASSIFICATION SYSTEM

### 27-3.01 General

#### 27-3.01(a) Terminology

1. Functional Classification. The classification of a road or street based on the character of service it is intended to provide.

2. Urban Areas. These are areas identified by the U.S. Bureau of Census as having a contiguous population of 50,000 or more (urbanized areas) or 5000 or more but less than 50,000 (small urban areas). The urban area boundaries are established by the State, in cooperation with the Metropolitan Planning Organizations (MPO's) and other appropriate local officials and approved by the FHWA.

3. Rural Areas. All areas outside of urbanized and small urban areas are rural areas.

#### 27-3.01(b) Background

The *Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991* required that every State functionally reclassify its public roads and streets. The database is used to identify routes for the National Highway System (NHS), for administering the Federal-aid programs, and for assessing the extent, conditions, and performance of the highway system. Figure 27-3A presents IDOT's functional classification terminology.

| RURAL | URBAN |
|---|---|
| Principal Arterial System<br>• Interstates<br>• Other Principal Arterials (OPA) | Principal Arterial System<br>• Interstates<br>• (Non-Interstate) Freeways and Expressways<br>• Other Principal Arterials (OPA) |
| Minor Arterials* | Minor Arterials |
| Collector Roads<br>• Major Collectors*<br>• Minor Collectors | Collector Streets |
| Local Roads | Local Streets |

** Upgrade rural Minor Arterial to Urban OPA and upgrade rural Major Collector to urban Minor Arterial when these routes enter an urbanized area.*

**IDOT FUNCTIONAL CLASSIFICATION TERMINOLOGY**

**Figure 27-3A**

In order to maintain a 5 year anticipated functional usage of the street/highway network, the district, in cooperation with the appropriate local officials, is responsible for continually monitoring the need for functional classification revisions. These revisions must be based on changes in travel characteristics, new growth and development of an area (i.e., commercial, industrial, residential), new roadways, and/or significant roadway realignments.

The Bureau of Statewide Program Planning in the Central Office of Planning and Programming is responsible for the final review and processing of all changes to the functional classification system. Once the appropriate local officials approve the change, the Bureau of Statewide Program Planning will process the district's request and will make the formal written request for approval for all revisions Statewide to the FHWA.

### 27-3.01(c) Relationship to Roadway Design

The functional classification concept is one of the most important determining factors in roadway design. The concept recognizes that the public highway network in Illinois provides two basic and often conflicting functions — access to property and travel mobility. Each road or street provides varying levels of access and mobility, depending upon its intended service. The overall objective of the functional classification system, when viewed in its entirety, is to yield an optimum balance between its access and mobility functions. When this balance is achieved, the benefits to the traveling public are maximized.

The functional classification system provides the foundation for highway planning functions and the framework for determining the geometric design of individual roads and streets. Once the function of the facility is defined, the designer can select an appropriate design speed, roadway width, roadside safety elements, amenities, and other design values. All of Part IV of this *Manual* is based upon this systematic concept to determine roadway design.

Before initiating project work, the designer should review the most recent highway functional classification maps for the proposed project. These maps are available from the district or from the Central Office of Planning and Programming.

### 27-3.02 General Functional Classification Categories

The following identifies the basic characteristics of the three general categories within the functional classification system:

1. Arterial. Arterial highways are generally characterized by their ability to quickly move relatively large volumes of traffic, but often with restricted accessibility to abutting properties. The arterial system typically provides for high travel speeds and the longest trip movements. The rural and urban arterial systems are connected to provide continuous through movements at approximately the same level of service.

2. Collector. Collector routes are characterized by a relatively even distribution of access and mobility functions. Traffic volumes and speeds are typically lower than those of arterials.

3. Local. All public roads and streets not classified as arterials or collectors are classified as local roads and streets. The many points of direct access to adjacent properties characterize local roads and streets. Speeds and volumes are usually low and trip distances short.

The users of this *Manual* must understand that the term "local roads and streets" within the functional classification system differs from the term "local roads and streets" when referring to the jurisdiction for the facility. Many "local" facilities not on the State highway system are functionally classified as collectors, and a few are functionally classified as arterials. When applying the criteria in Part IV, base the design on the facility's functional classification.

The percent of mileage allocated nationally in each category is documented in the US DOT/FHWA's Manual, *Highway Functional Classification — Concepts, Criteria and Procedures*. Roadway information is collected on all public highways and is in the Illinois Roadway Information System (IRIS).

The following Sections more explicitly describe the characteristics of these three general categories for rural and urban areas.

## 27-3.03 Rural Functional Classification Categories

The rural system criteria is expressed primarily in qualitative, rather than quantitative terms. Because of varying geographic conditions (e.g., population density, spacing and size of cities, density and pattern of roadway network) it is not feasible to define uniform criteria of size of population centers, on length of trip and traffic volume, or on spacing of routes that would apply to all systems in all counties.

### 27-3.03(a) Principal Arterial System

The rural principal arterial system provides connections between the major urban areas and OPAs and provides a level of service suitable for Statewide or Interstate travel. For local facilities (i.e., those off the State highway system), there are currently no facilities classified as rural principal arterials.

### 27-3.03(b) Minor Arterials

Rural minor arterials should form a network having the following characteristics:

- form an integrated network of routes connecting to the OPAs and should provide interregional or intercounty service. Stub sections are seldom justified;
- interconnect and serve areas of the State not served by the principal arterial system;
- connect with routes of the same function in adjacent States;
- be spaced at intervals consistent with population density, so that all developed areas of the State are within a reasonable distance of an arterial route;
- provide service to corridors with trip lengths and travel density greater than those predominantly served by rural collectors or local systems; and
- provide a design with relatively high overall travel speeds with minimum interference to through movements. Partial access control should be considered and investigated on these routes as they approach urbanized areas.

There are very few minor rural arterials on the local system.

### 27-3.03(c) Collector Roads

The rural collector road system generally includes those routes where the predominant travel distances are shorter than trips on arterial routes but greater than the shorter trips characteristic of the local road functional system. Consequently, more moderate speeds may be typical on the average. To more clearly define the characteristics of rural collector roads, these facilities have been subdivided into two separate functional classifications:

1. Major Collectors. These are characterized as follows:

    - provide service to any county seat not on an arterial route;
    - serve the more important intracounty or intraregional travel corridors not served by higher route classifications;
    - serve larger towns not directly served by higher route classifications nor other traffic generators of equivalent intracounty importance. These routes link nearby larger cities or other routes of higher classification;
    - form an integrated network; however, stub sections are not uncommon. Consolidated school districts, shipping points, recreational areas, important mining and agricultural areas, or other equivalent traffic generators can be used to justify the inclusion of these stubs in this classification; and
    - provide all-weather service for reliable and safe travel that considers both access and mobility.

    1.

2. Minor Collectors. These are characterized as follows:

    - provide service to any remaining small communities;

- are located at intervals, consistent with population density, to collect traffic from local roads and to connect all developed areas within a reasonable distance from a collector route;
- include more stub sections than the major collector classification; and
- are designed for relatively reliable and year-around safe travel, with more emphasis on property access than mobility.

Up to 15% of Surface Transportation Program (STP) funds can be spent for projects on rural roads classified as rural minor collectors.

### 27-3.03(d) Local Roads

The roads functionally classified as rural local roads generally have the following characteristics:

- constitute the rural mileage not designated as part of higher classifications;
- serve primarily to provide access to abutting property and connections to higher classified routes;
- provide service to motorists who travel relatively short distances as compared to collectors or other higher classified routes;
- commonly include stub sections; and
- reflect minimal design criteria with primary consideration to access needs.

Except for the replacement or rehabilitation of existing structures greater than 20 ft (6 m) in length, projects for improvements on roads with a rural local road functional classification are not eligible for Surface Transportation Program (STP) funds.

## 27-3.04 Urban Functional Classification Categories

### 27-3.04(a) Principal Arterial System

In general, the urban principal arterial system carries the highest traffic volumes and accommodates the greatest trip lengths. These are subdivided into Interstates, non-Interstate freeways and expressways, and other principal arterials (OPAs). The few urban principal arterials on the local system are OPAs. These routes consist of a connected urban network of continuous routes having the following designations and characteristics:

- provide service to, through, or around urban areas from rural minor arterial routes, and may be connecting links;
- serve generally as an extension of a rural minor arterial highway, and could be a major two-way city street or a one-way couple system;

- may warrant management of access to the highway;
- serve long-distance traffic within a city by connecting major regional activity centers not served by connecting links;
- in urbanized areas (50,000 population or greater), provide for significant urban and suburban travel demands. These trips would be between central business districts and outlying residential areas, between major inner city communities, or between major suburban centers;
- in urbanized areas, are located at spacings that are closely related to the trip-end density characteristics of specific portions of the urban area. The spacing may vary from 1 mile (1.5 km) between routes in the densely developed central business district areas to 5 miles (10 km) or more in the sparsely developed urban fringes;
- in smaller urban areas (under 50,000 but greater than 5000 population), may be limited in the number and extent of routes. The importance of these routes is primarily to serve the central business district and to accommodate through travel at an appropriate level of service; and
- provide for an integrated network serving the entire urban area.

### 27-3.04(b) Minor Arterials

When compared to the principal arterial system, urban minor arterials may provide lower travel speeds and accommodate shorter trip lengths and lower traffic volumes, but they provide more access to property. These routes have the following general characteristics:

- interconnect and supplement the urban principal arterial system;
- provide service for trips of moderate length and at a somewhat lower level of mobility than urban principal arterial routes;
- may carry local bus routes and provide intracommunity continuity (but will not, for example, penetrate neighborhoods);
- may be urban extensions of rural major collector routes; and
- considered together with all urban arterial routes, are located from 2 miles to 3 miles (3 km to 5 km) between routes in suburban fringes, but should not be more than 1 mile (1.5 km) apart in fully developed areas. Within the central business district, a spacing of 650 ft to 2500 ft (200 m to 800 m) is typical.

### 27-3.04(c) Collector Streets

In urban areas, collector streets serve as intermediate links between the arterial system and points of origin and destination. These facilities typically have the following characteristics:

- provide both access and traffic circulation within residential neighborhoods and commercial and industrial areas;
- may penetrate residential neighborhoods or commercial/industrial areas to collect and distribute trips to and from the arterial system;
- in the central business district, may include the streets that are not classified as arterials;
- have spacing of routes dependent on the density of development. In fully developed areas, spacing together with higher classifications should provide approximately 2500 ft (800 m) between routes and, within the central business district, provide a spacing of 650 ft to 2500 ft (200 m to 800 m); and
- may be urban extensions of rural minor collector routes.

### 27-3.04(d) Local Streets

The streets functionally classified as urban local streets generally have the following characteristics:

- constitute the urban mileage not designated as part of a higher classification;
- serve primarily to provide direct access to abutting land and higher order systems;
- offer the lowest level of mobility and usually contain no bus routes; and
- discourage through traffic movements.

Except for the replacement or rehabilitation of existing structures greater than 20 ft (6 m) in length, projects for improvements on streets with an urban local street functional classification are not eligible for Surface Transportation Program (STP) funds.

## 27-4 TYPES OF DEVELOPMENT AREAS

The functional classification system is based in part on the urban or rural designation. In many cases, this is not sufficient to determine the appropriate roadway design criteria. Therefore, the type of area where the project is located further divides the criteria in this *Manual*. The refinement to the roadway design process allows the designer to better tailor the project to the constraints of the surrounding environment.

The following Sections briefly discuss the types of areas for rural and urban locations. Select the type of area that is most appropriate for the project under design.

### 27-4.01 Rural Highways and Roads

Many roads in Illinois are classified as rural but frequently pass through relatively developed areas. Therefore, Chapters 32 and 33 present design criteria based on the extent of roadside development. The tables in the chapters provide criteria for the average number of access points per mile (kilometer) per side. These criteria provide some guidance, but they should not be considered rigid. In addition, consider the following narrative descriptions of roadside development:

1. Open. This fits the traditional concept of a rural area. The driver has almost total freedom of movement and is generally not affected by occasional access points along the road. For the purpose of determining the open classification, access points will average less than 15 per mile (10 per kilometer) per side. Right-of-way is usually available.

2. Low/Moderate Density. The roadside development has increased to a level where prudent drivers will instinctively reduce their speed as compared to an open roadway. Drivers must be more alert to the possibility of entering and exiting vehicles, but they are still able to maintain a relatively high travel speed. The estimated number of access points will average between 15 and 30 per mile (10 and 20 per kilometer) per side. Right-of-way may be difficult to obtain.

3. Moderate/High Density. The roadside development has increased to a level that is comparable to a suburban area within the urban limits or may be an incorporated municipality with a population less than 5000. The extent of the development will have a significant impact on the selected travel speed of a prudent driver. Exiting and entering vehicles are frequent, and traffic signals are typical at major intersections. The estimated number of access points will average greater than 30 per mile (20 per kilometer) per side. Right-of-way is usually quite difficult to obtain.

## 27-4.02 Urban Roads and Streets

### 27-4.02(a) Suburban Roads and Streets

Suburban areas are within urban areas as defined in Section 27-3.01(a); however, they suggest a degree of development greater than that of an open rural area but less than that of a high-density urban area. The predominant character of the surrounding environment is usually residential, but it may also include a considerable number of commercial establishments and a few industrial parks. On suburban roads and streets, drivers usually have some freedom of maneuverability; nonetheless, they must devote some of their attention to entering and exiting vehicles. Roadside development is characterized by low to moderate density. Typically, there are less than 30 to 40 access points per mile (20 to 25 per km). Pedestrian and bicycle activity is often a design factor. Right-of-way may be available for roadway improvements.

Local and collector streets in suburban areas are typically located in residential areas but may also serve a commercial area. Posted speed limits typically range between 30 mph and 45 mph. The majority of intersections will have stop or yield control, but there will be an occasional traffic signal.

A typical suburban arterial will have strip commercial development and perhaps a few residential properties. Posted speed limits usually range between 35 mph and 50 mph, and there will be a few signalized intersections along the arterial.

### 27-4.02(b) Urban Streets

For design purposes, urban areas (not including those considered suburban) are characterized by moderate/high density. Typically, there are greater than 30 to 40 access points per mile (20 to 25 per km). These facilities are subdivided as follows:

1. Central Business Districts (CBD). On streets in the CBD or downtown area, abutting building development often prohibits space for off-street parking and entrances for individual businesses. Right-of-way is usually very limited. The streets may include high-density commercial or residential development (e.g., apartment complexes, row houses). Access to property is the primary function of the street network in CBDs. The designer often must select the cross-sectional criteria that will fit into the existing right-of-way. Pedestrian and bicycle considerations may be as important as vehicular considerations, especially at intersections.

   Because of the high density of development in CBD areas, the primary distinction among the three functional classes is often the relative traffic volumes and, therefore, the number of lanes needed. As many as half of the intersections may be signalized, and posted speed limits typically range between 25 mph and 30 mph.

2. Fringe Area/Outlying Business District (FRNG/OBD). These areas generally have off-street parking and driveway entrances which usually are quite numerous. Right-of-way

may be restricted and will typically limit the practical options for roadway improvements. The extent of roadside development will have a significant impact on the selected speeds of drivers. Pedestrian and bicycle activity is common and warrants significant consideration in design.

Local and collector streets in FRNG/OBD areas typically have posted speed limits between 30 mph and 45 mph. The frequency of signalized intersections is substantially higher than in suburban areas. An arterial in FRNG/OBD areas will often have strip commercial development along its roadside, and posted speed limits will range between 35 mph and 45 mph.

## 27-5 SPEED

### 27-5.01 Terminology

1. Design Speed. Design speed is the selected speed that is used to determine the various geometric design features of the roadway.

2. Low Speed. For geometric design purposes, low speed is defined as 45 mph (70 km/h) or less.

3. High Speed. For geometric design purposes, high speed is defined as greater than 45 mph (70 km/h).

4. 85th-Percentile Speed. The 85th-percentile speed is the speed below which 85% of vehicles travel on a given facility. The most common application of the value is its use as one of the factors for determining the posted, legal speed limit of a roadway section. In most cases, field measurements for the 85th-percentile speed will be conducted during off-peak hours when drivers are free to select their desired speed. Legal posted speed limits are discussed in Section 3-2.01.

5. Pace Speed. Pace speed is the specified increment of spot speed that includes the greatest number of speed measurements.

### 27-5.02 Design Speed

#### 27-5.02(a) Range/Increments

Design speeds for local projects typically range between 20 mph and 60 mph (30 km/h and 100 km/h), and they are selected in 5 mph (10 km/h) increments.

#### 27-5.02(b) Selection

Each project will have a design speed selected that establishes criteria for several geometric design elements including horizontal and vertical curvature, superelevation, cross sectional features, and sight distance. Chapter 32 presents the design speed criteria for new construction and reconstruction projects. Chapter 33 presents the design speed criteria for 3R non-freeway projects. In general, the selected design speed is based on the following road design elements:

1. Functional Classification. The higher-class facilities (i.e., arterials) are designed with a higher design speed than the lower class facilities (i.e., collectors and locals).

2. Urban/Rural. Design speeds in rural areas are generally higher than those in urban areas. This is consistent with the typically fewer constraints in rural areas (e.g., less development).

3. Terrain. The flatter the terrain, the higher the selected design speed can be. This is consistent with the typically higher construction costs associated with more rolling terrain.

4. Traffic Volumes. On some facilities (e.g., rural collectors), the design speed varies by traffic volumes (e.g., as traffic volumes increase, higher design speeds are used).

For geometric design application, the relationship between these road design elements and the selected design speed reflects general cost-effective considerations. For example, the higher the traffic volumes, the more benefits to the traveling public from a higher design speed. In addition, the anticipated posted/regulatory speed limit should be one factor when selecting the design speed. However, it is not necessary for the design speed to equal or exceed the anticipated posted speed limit.

Avoid artificially selecting a design speed low enough to eliminate any design variances. For example, if BLRS criteria dictates a design speed of 50 mph (80 km/h) and one or more geometric features are adequate only for 45 mph (70 km/h), the project design speed should be 50 mph (80 km/h) and not 45 mph (70 km/h). In this case, request design variances for the 45 mph (70 km/h) geometric features.

## 27-6 TRAFFIC VOLUME CONTROLS

### 27-6.01 Terminology

1. AM/PM Peak Volumes. The one-hour volumes for each movement at an intersection in the morning and evening.

2. Annual Average Daily Traffic (AADT). The total yearly volume in both directions of travel divided by the number of days in a year.

3. Average Daily Traffic (ADT). The calculation of average traffic volumes in both directions of travel in a time period greater than one day and less than one year and divided by the number of days in that time period. Although not precisely correct, ADT is often used interchangeably with AADT. The use of an ADT could produce a bias because of seasonal peaks and, therefore, the user should be aware of this.

4. Capacity. The maximum number of vehicles that can reasonably be expected to traverse a point or uniform section of a road during a given time period under prevailing roadway, traffic, and traffic control conditions. The time period most often used for analysis is 15 minutes. "Capacity" corresponds to Level of Service E.

5. Current ADT. Average Daily Volume of traffic expected at the time the improvement has been completed.

6. Delay. The primary performance measure on interrupted flow facilities, especially at signalized intersections. For this element, average stopped-time delay is measured, which is expressed in seconds per vehicle.

7. Density. The number of vehicles occupying a given length of lane, averaged over time. It is usually expressed as vehicles per mile per lane.

8. Design Hourly Volume (DHV). The one-hour volume in both directions of travel in the design year selected for determining the dimensions and configuration of the roadway design elements. For capacity analyses, the DHV is typically converted to an hourly flow rate based on the maximum 15-minute flow rate during the DHV.

9. Design Year. The year used to determine the traffic volumes to be used to design the facility.

10. Directional Design Hourly Volume (DDHV). The one-hour volume in one direction of travel during the DHV.

11. Directional Distribution (D). The division, by percent, of the traffic in each direction of travel, which is usually provided for the DHV. In some cases, D may be provided for the ADT and/or AADT.

12. K-factor. The ratio of DHV to AADT. K-factor will vary based on the hour selected for design and the characteristics of the specific highway facility.

13. Level of Service (LOS). A qualitative concept which has been developed to characterize acceptable degrees of congestion as perceived by motorists.

14. Peak-Hour Factor (PHF). A ratio of the volume occurring during the peak hour to the maximum rate of flow during a given time period within the peak hour (typically 15 minutes).

15. Service Flow Rate. The maximum hourly vehicular volume which can pass through a roadway element under prevailing roadway traffic and control conditions while maintaining a designated level of service.

16. Truck Factor (T). A factor that reflects the percentage of heavy vehicles (trucks, buses, and recreational vehicles) in the traffic stream during the DHV, ADT, and/or AADT. For geometric design and capacity analyses, trucks are defined as vehicles with 6 or more tires.

## 27-6.02 Design Year Selection

### 27-6.02(a) Roadway Design

The geometric design of a highway should be developed to accommodate expected traffic volumes during the life of the facility assuming reasonable maintenance. This necessitates projecting the traffic volumes to a selected future year. For new construction/reconstruction projects, 20 years is the usual design period. For current low volume roadways with ADT's of 400 or less, current traffic volumes can be used. For 3R projects, current traffic volumes for the year of construction are typically used, but the design period may be 10 years or longer. In all cases, the design year is measured from the expected construction completion date.

### 27-6.02(b) Other Highway Elements

The following presents the recommended criteria for selection of a design year for highway elements other than road design:

1. Bridges. The structural life of a bridge may be 75 years or more (e.g., substructure, superstructure). For new bridges (including bridge replacements), the clear roadway width of the bridge is based on the 20 year traffic volume projection beyond the construction completion date. For low volume roadways (i.e., ADT of 400 or less), the design criteria may be based on current traffic volumes. For bridges within the limits of 3R projects, see Chapter 33.

2. Underpasses. The design year used for the geometric design of underpasses is determined on a case-by-case basis.

3. Drainage Design. Drainage appurtenances are designed to accommodate a flow rate based on a specific frequency of occurrence. The selected frequency is based on the functional class of the facility, the ADT, and the specific drainage appurtenance (e.g., culvert). See Chapter 36 for more detailed information on drainage design.

4. Pavement Design. The pavement structure is designed to withstand the vehicular loads during the design analysis period without falling below a selected terminal pavement serviceability. Chapter 37 presents the criteria for selecting a design year for pavements.

5. Intersections. Use both AM/PM peak volumes for intersection analyses in suburban and urban areas where traffic volumes are high.

6. Traffic Signals. Use current traffic volumes for traffic signal analyses in suburban and urban areas where traffic volumes are high. Base the analyses on the criteria for warrants presented in the *ILMUTCD*.

## 27-6.03 Design Traffic Volumes

Most geometric elements are determined by traffic volumes projected for the design year. The traffic volumes may be either the Average Daily Traffic (ADT) or the Design Hourly Volume (DHV) depending on whether the road or street is located in a rural or an urban area, the functional classification, and the geometric criteria. Obtain projected traffic volumes from the district or from regional transportation studies.

### 27-6.03(a) Average Daily Traffic Selection

On two-lane urban collectors and local streets and on rural roads, ADT is used to determine most geometric design items including design speed and lane and shoulder width.

### 27-6.03(b) Design Hourly Volume Selection

For most geometric design elements on urban arterials and multilane collectors and for intersections, the peaking characteristics are significant. The local facility should be able to accommodate the DHV (adjusted for the peak-hour factor) at the selected level of service. This DHV will affect many design elements including the number of through travel lanes, lane widths, and intersection geometrics. Analyze the proposed design using the AM and PM DHVs separately. This could have an impact on the geometric design of the facility.

Traditionally, the 30th highest hourly volume in the selected design year has been used to determine the DHV for design purposes. However, at the discretion of the district and local highway agency for urban facilities, it may be more appropriate to base the DHV on the 10th to 20th highest hourly volume in the selected design year. See the *Highway Capacity Manual* for more detailed discussion on selecting the DHV. Because the design of the project is significantly dependent upon the projected design hourly volumes, carefully examine these projections before using them for design purposes.

## 27-6.04 Level of Service

Level of service (LOS) describes a qualitative measure of operational conditions within a traffic stream as perceived by motorists. The *Highway Capacity Manual* (HCM) has established measures of effectiveness (MOE) for the level of service definition for each highway element on various types of facilities. These are presented in Figure 27-6A for those elements on local roads and streets. For each MOE, the *HCM* provides the analytical tools to calculate the numerical value. Note that highway capacity MOEs may be segregated into two broad categories: (1) uninterrupted flow, or open highway conditions, and (2) interrupted flow, as at stop-controlled or signalized intersections. Uninterrupted flow occurs on facilities where the influence of intersections and abutting property development is not significant, and the design volume can be determined by an hourly rate of flow. A designated LOS is described in terms of average travel speed, density, traffic interruptions, comfort, convenience, and safety.

Because drivers will accept different driving operational conditions, including lower travel speeds on some facilities, it is not practical to establish one LOS for application to every type of highway. Therefore, several levels have been established for the various classes and types of roads and streets. The values of speed and design hourly volume used in each case to identify a LOS are the lowest acceptable speed and highest obtainable volume for that specific level.

| TYPE OF FACILITY | MEASURE OF EFFECTIVENESS |
|---|---|
| Two-Lane, Two-Way Highways | Percent time spent following<br>Average travel speed (mph) |
| Multilane Highways | Density |
| Signalized Intersections | Average individual stopped delay (seconds/vehicle) |
| Unsignalized Intersections | Delay |
| Urban Streets | Average travel speed (mph) |

**MEASURES OF EFFECTIVENESS FOR LEVEL OF SERVICE**

**Figure 27-6A**

In the *Highway Capacity Manual*, the qualitative descriptions of each LOS (A to F) have been converted into quantitative measures for the capacity analysis for each highway element, including:

- two-lane, two-way rural highways;
- multilane rural highways;
- signalized intersections;
- unsignalized intersections; and
- urban and suburban arterials.

Chapters 32 and 33 present LOS criteria for each facility type based on the project scope of work.

## 27-6.05 Capacity Analyses

Design the roadway mainline or intersection to accommodate the selected design hourly volume (DHV) at the selected level of service (LOS). This may involve adjusting the various roadway factors that affect capacity until an appropriate design is determined. The detailed calculations, factors, and methodologies are presented in the *HCM*.

The *HCM* provides the analytical techniques to determine the LOS for all highway elements (e.g., for basic roadway segments, intersections) for a given set of traffic and roadway conditions. For a major highway segment, for example, the capacity analysis will determine if an existing roadway will accommodate future traffic demands at the desired LOS or if roadway improvements are necessary (e.g., the addition of travel lanes).

Capacity analyses are normally required only at intersections. An analysis for uninterrupted flow may be required in urban areas to determine the number of through traffic lanes needed.

## 27-7 ADHERENCE TO DESIGN CRITERIA

Part IV "Project Design" presents geometric design criteria for application to individual projects. In general, the designer is responsible for making a reasonable effort to meet these criteria in the project design for local agency projects. This will ensure that a local road and street system meets the transportation needs of the public and provides a reasonable level of safety, comfort, and convenience for the traveling public. However, recognizing that this is neither always practical nor cost effective, the following process evaluates and approves variances to the geometric design criteria.

### 27-7.01 Hierarchy of Design Criteria

The design criteria presented in the *BLRS Manual* have varying levels of importance. Therefore, IDOT has established Level One and Level Two design criteria for designers. These two levels of design criteria are intended to assist the designers in summarizing compliance and providing documentation for the proposed project design.

### 27-7.01(a) Level One Design Criteria

Level One design criteria are judged to be those design elements that are the most critical indicators of a highway's safety and its overall serviceability. Level One design criteria elements include:

- design speed;
- level of service for the mainline;
- lane widths (through lanes, turn lanes, parking lanes, bike lanes);
- traveled way cross slopes;
- shoulder widths;
- horizontal curvature (minimum radius);
- superelevation rates;
- maximum grades;
- intersection sight distance;
- stopping sight distance (vertical curvature (K values), horizontal clearances);
- clear roadway bridge widths;
- freeboard above design high water;
- vertical clearances;
- accessibility for disabled persons;

- roadside clear zones;
- level of service for intersection(s);
- warrants for stop signs and signals; and
- pavement design.

### 27-7.01(b) Level Two Design Criteria

Level Two design criteria include additional important indicators of a facility's safety and serviceability but are not considered as critical as the Level One criteria. Level Two design criteria elements include:

- design period (design year);
- horizontal alignment (superelevation transition lengths, superelevation distribution);
- vertical alignment (minimum grades, minimum length of vertical curves, maximum K values);
- cross section elements (parking lane cross slopes; sidewalk widths, cross slope, and grades; median type and width; shoulder cross slopes, rollover factors, curb and gutter types, side slopes);
- drainage (flood frequency),
- intersections (level of service for individual movements, skew angle, approach gradients, design vehicle, turning radius, minimum island size, turn lane lengths and tapers, entrances);
- railroad crossing protection and widths;
- highway lighting; and
- other items deemed important.

### 27-7.02 Identification of Design Criteria and Design Variances

The following procedure identifies project design criteria and design variances that will apply to all Federal, State, and MFT funded projects on local facilities for new construction, reconstruction, and 3R projects. Pavement preservation projects are not covered. The determination of whether or not the proposed project design meets the controlling design criteria is dependent upon the project scope of work (e.g., for a 3R project, the criteria in Chapter 33 will apply). The following will apply:

1. Approval of Design Variances (Form BLR 22120). Form BLR 22120 assists the designer in determining if any design element meets the design criteria presented in this *Manual*. Completing Form BLR 22120 will ensure that the design variance is considered and evaluated appropriately. The following will apply:

a. Federal-Funded Projects. Complete Form BLR 22120 in its entirety.

b. MFT- and State-Funded Projects. For local agencies that do not have an Illinois licensed professional engineer on its staff, complete Form BLR 22120 in its entirety. This includes projects that are designed by a consultant even if there is a professional engineer on the consultant's staff. For projects where there is an Illinois licensed professional engineer on the local agency's staff, the designer only needs to complete the sections for the criteria on Form BLR 22120 for which there is a variance.

c. Pavement Preservation Projects. Completion of Form BLR 22120 is not required for these projects; however, the design variance process as described in this Section still applies.

2. Documentation. The local agency must fully document its evaluation of the project's design and must clearly demonstrate that a design variance is justified. The designer should prepare a statement for use at the district coordination meeting that:

- identifies the design element,
- identifies BLRS design criteria,
- discusses the proposed design, and
- provides justification for the design variance.

3. Submission. Submit Form BLR 22120 and all justification to the district as early as possible in the project's development. For Federal-funded projects, submit the Form prior to submission of the Project Development Report; see Chapter 22. For MFT- and State-funded projects, complete the Form prior to submitting the plans to the district.

4. District Coordination Meetings. Any contemplated design variances should be discussed at the district coordination meetings. These meetings are usually scheduled bi-monthly, monthly in District One, and are attended by representatives from the FHWA, Central BLRS, and the local agencies and their consultants. The minutes of the coordination meeting will serve as documentation of the approval.

Requests for variances may also be submitted in writing to the district. IDOT will send the written approval to the local agency.

When evaluating variances to design criteria, the primary considerations are:

- safety,
- capacity,
- compatibility with adjacent sections,

- time to construction of ultimate improvement,
- construction costs, and
- impacts to the natural and built environment.

5. Approval. Variances from Level One design criteria must receive approval from the Central BLRS. Variances from Level Two design criteria will receive approval from the districts. Local agencies operating under an Agreement of Understanding will be allowed to determine the acceptability of Level Two design variances without district approval.

6. Documentation. For all projects, include Form BLR 22120, the approval, and a copy of the minutes from the coordination meeting in the local agency's project file. For Federal-funded projects, include Form BLR 22120, the approval, and copy of the minutes from the coordination meeting in the Project Development Report

### 27-7.03 Accessibility Standards for the Disabled

Section 41-6 presents the IDOT application of the Federal standards for accessibility for disabled individuals as promulgated in the *Americans with Disabilities Act* (ADA). The following procedure applies to a request for a waiver to the accessibility standards:

1. Procedure. ADA provides a waiver procedure that can be used where site conditions and/or topography preclude the use of the ADA standards. However, granting waivers are extraordinarily rare and, therefore, a local agency should pursue this option only as a last resort.

2. District Coordination Meetings. Any contemplated exceptions to ADA standards should be discussed at the district coordination meetings.

3. Documentation. The local agency must fully document its evaluation of the project site conditions and must clearly demonstrate that a waiver is justified. The content of the waiver request will vary on a case-by-case basis. Include the following information as appropriate:

   - a set of plans showing the location and the proposed deficient element,
   - location of the affected property,
   - what work is required to achieve the ADA standard, and
   - the cost of achieving the ADA standards.

4. Submission. If in agreement, the district will submit the local agency documentation to the Central BLRS with a request for the waiver to ADA standards.

## 27-8 REFERENCES

1. *A Policy on Geometric Design of Highways and Str*eets, AASHTO, 2004.

2. Chapter 31 “Basic Design Controls,” *Bureau of Design and Environment Manual*, IDOT.

3. *Highway Functional Classification — Concepts, Criteria, and Procedures*, FHWA.

4. *Roadway Information and Procedure Manual*, IDOT.

5. *Policy on Establishing and Posting Speed Limits*, Bureau of Operations.

6. *Highway Capacity Manual 2000*, TRB, 2000.