Chapter 27

BASIC DESIGN CONTROLS

BUREAU OF LOCAL ROADS AND STREETS MANUAL

Chapter 27
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Chapter 27
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" of this *Manual* applies to all local public agency (LPA) projects funded with Federal, State, and Motor Fuel Tax (MFT) funds that are processed through the Central Bureau of Local Roads and Streets (CBLRS).

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 terms are in order of hierarchy from mandatory to permissive. Depending on the term used within a design criterion, it is possible for the hierarchy to change when a specific condition is met or not met as noted in a footnote or elsewhere.

Shall, require, will must. A mandatory condition. Designers are obligated to adhere to the criteria and applications presented in this context or to perform the evaluation indicated. A design exception is required if the criteria and applications cannot be met. See Section 27-7 for Level of approval.

Limits (minimum, maximum, lower, upper). Provides a range of values generally accepted within the design community with the understanding these limits are not necessarily inviolable. However, when the criteria presented in this context are not met, a design exception is typically required. See Section 27-7 for the Level of approval.

Should, recommend. An advisory condition. Designers are strongly encouraged to follow the criteria and guidance presented in this context unless there is reasonable documented justification not to do so. A design exception is not required if the criteria or guidance is not followed.

Desirable, preferred. An advisory condition. An indication that the designer should make every reasonable effort to meet the criteria and that the designer should only use a "lesser" design after due consideration of the "better" design. A design exception is not required if the criteria or guidance is not followed.

May, could, can, suggest, consider. A permissive condition. Designers are allowed to apply individual judgment and discretion to the criteria when presented in this context. The decision is based on a case-by-case assessment. A design exception is not required.

The remaining terms are strictly in alphabetically order.

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

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.

Exception. Approval from the Illinois Department of Transportation (IDOT) for using design criteria which do not conform to the minimum criteria as set forth in this *Manual*.

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

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

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.

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.

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

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.

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.

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

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.

Transportation Facility / Facility. A transportation facility / facility may include but not limited to roads or streets, structures, shared-use lanes, shared-use paths, sidewalks, railroad crossings, and their respective appurtenances.

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.

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.

27-2 PROJECT SCOPE OF WORK

The project scope of work reflects the basic intent of the LPA 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 references the applicable chapters in Part IV "Project Design" of this *Manual*.

27-2.01 New Construction

Generally, new construction is the construction of a transportation facility 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. IDOT's criteria for new construction by LPA's on local facilities are presented in Chapters 27 – 32, Chapters 34 – 42, and 44.

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;
- adding bicycle accommodations;
- implementing improvements to meet the *Americans with Disabilities Act* (*ADA*) / *Public Rights of Way Access Guidelines* (*PROWAG*) 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, and/or 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.

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 existing 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 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. Rural Areas. All areas outside of urbanized and small urban areas are rural areas.
3. Urban Areas. These are areas identified by the U.S. Bureau of Census and further defined by the Federal Highway Administration (FHWA) as having a contiguous population of 50,000 or more (urbanized areas) or 5,000 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 (MPOs) and other appropriate local officials and approved by the FHWA.

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 *Illinois Highway Information System – Roadway Information and Procedure Manual (IRIS)* 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.

Description	IRIS Code
Principal Arterial System	
Interstates	1
Other Freeways and Expressways	2
Other Principal Arterials (OPA)	3
Minor Arterials	4
Collector	
Major Collector	5
Minor Collector	6
Local (Roads & Streets)	7

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. For proposed roads on new alignment, classification will occur once construction has been completed.

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. For roads within a Metropolitan Planning Area (MPA), the LPA must present proposed changes to the functional classifications first to the MPO for approval. Additional information on MPO's can be found in Section 17-2.

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 data for the proposed project from *IRIS*, the *Geographical Information System (GIS)*, *Illinois Roadway Analysis Database System (IROADS)*, or *Getting Around Illinois*.

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 (LOS).
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 of this *Manual*, 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 *IRIS*.

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

27-3.03 Functional Classification Categories

27-3.03(a) Principal Arterial System

In general, the principal arterial system carries the highest traffic volumes and accommodates the greatest trip lengths. These are subdivided into routes functionally classified as Interstates, other freeways and expressways, and OPAs.

In urban areas, 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 minor arterial routes in the rural area, and may be connecting links;
- serve generally as an extension of minor arterial routes in the rural area, and may 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 spacing 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 5,000 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 LOS; and
- provide for an integrated network serving the entire urban area.

The rural system criteria are 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. The principal arterial system in a rural area provides connections between the major urban areas and OPAs and provides a LOS suitable for Statewide or Interstate travel.

27-3.03(b) Minor Arterials

When compared to the principal arterial system, 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 principal arterial system by forming an integrated network of routes connecting to the OPAs and should provide inter-regional or inter-county service. Stub sections are seldom justified;
- 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 major collectors, minor collectors, or local routes; and
- provide a design with relatively high overall travel speeds with minimum interference to through movements.
- may carry local bus routes and provide intra-community continuity (but will not, for example, penetrate neighborhoods);
- may be urban extensions of major collector routes from the rural area;
- may be partial access control; and
- considered together with all arterial routes in an urban area, are located from 2 - 3 miles (3 - 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 – 2,500 ft (200 - 800 m) is typical.

27-3.03(c) Major Collectors

The major 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. These routes have the following general characteristics:

- provide service to any county seat not on an arterial route;
- serve the more important intra-county or intra-regional travel corridors not served by higher route classifications;
- serve larger towns not directly served by higher route classifications nor other traffic generators of equivalent intra-county 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.
- 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 routes 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 2,500 ft (800 m) between routes and, within the central business district, provide a spacing of 650 ft to 2,500 ft (200 m to 800 m); and
- may be urban extensions of minor collector routes in the rural area.

27-3.03(d) 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 routes and to connect all developed areas within a reasonable distance from a major 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.

27-3.03(e) Local

The routes functionally classified as local roads or streets generally have the following characteristics:

- constitute mileage not designated as part of higher classifications;
- serve primarily to provide access to abutting property and connections to higher classified routes;
- typically will have a lower Average Daily Traffic (ADT);
- reflect minimal design criteria with primary consideration to access needs.
- 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 routes with a local 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 5,000. 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. Pedestrian and bicycle activity is often a design factor. Right-of-way may be more readily 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. 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 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. Design speed does not necessarily have to equal posted speed.
2. 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.
3. High Speed. For geometric design purposes, high speed is defined as greater than 45 mph (70 km/h).
4. Low Speed. For geometric design purposes, low speed is defined as 45 mph (70 km/h) or less.
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.

Avoid artificially selecting a design speed low enough to eliminate any design exceptions. 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, consider requesting design exceptions for the 45 mph (70 km/h) geometric features.

27-6 CAPACITY METHODOLOGY

27-6.01 Terminology

1. Actuated Control. A defined phase sequence in which the presentation of each phase is on recall or the associated traffic movement has submitted a call for service through a detector.
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. Back of Queue. The maximum backward extent of queued vehicles during a typical cycle, as measured from the stop line to the last queued vehicle.
5. Capacity. The maximum number of vehicles that can reasonably be expected to traverse a point or uniform section of a lane or roadway 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 a LOS E.
6. Cycle. A complete sequence of signal indications.
7. D-Factor. The portion of traffic moving in the peak direction of travel on a given roadway during the peak hour.
8. Delay. Additional travel time experienced by a driver, passenger, bicyclist, or pedestrian beyond that required to travel at the desired speed. The primary performance measure on interrupted flow facilities.
9. Demand Flow Rate. The count of vehicles arriving at the system element during the analysis period, converted to an hourly rate. This manual uses the term design hourly volume (defined below) in a similar manner as demand flow rate.
10. Density. The number of vehicles occupying a given length of lane, averaged over time. It is usually expressed as vehicles per mile per lane.
11. 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. The term DHV is not used in the *Highway Capacity Manual (HCM)*, but its utility is similar to how demand flow rate (defined above) is used.
12. Directional Design Hourly Volume (DDHV). The traffic volume in peak direction of flow during the design hour.
13. Directional Distribution (D). A characteristic of traffic that volume may be greater in one direction than in the other during any particular hour on a highway.

14. 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.

15. Flow Rate. The equivalent hourly rate at which vehicles or other roadway users pass over a given point or section of a lane or roadway during a given time interval of less than one hour, usually 15 minutes.

16. Free Flow. A flow of traffic unaffected by upstream or downstream conditions.

17. Green Time (g/c) Ratio. The ratio of the effective green time of a phase to the cycle length.

18. Heavy Vehicles. A vehicle with more than four wheels touching the pavement during normal operation.

19. K-factor. The portion of AADT that occurs during the peak hour (DHV/AADT).

20. Lane Group. A lane or set of lanes designated for separate analysis.

21. Level of Service (LOS). A quantitative stratification of a performance measure or measures that represent quality of service, measured on an A to F scale, with LOS A representing the best operating conditions from the traveler's perspective and LOS F the worse.

22. Passenger–Car Equivalent. The number of passenger cars that will result in the same operational conditions as a single heavy vehicle of a particular type under specified roadway, traffic, and control conditions.

23. Peak Hour. The hour of the day in which the maximum volume occurs.

24. 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).

25. Pedestrian. An individual traveling on foot.

26. Permitted Turn. A left or right turn at a signalized intersection that is made by a vehicle during a time in the cycle in which the vehicle does not have the right-of-way.

27. Phase. The part of the signal cycle allocated to any combination of traffic movements receiving the right-of-way simultaneously during one or more intervals. A phase includes the green, yellow, and red clearance intervals.

28. Progression. The act of various controllers providing specific green indications in accordance with a time schedule to permit continuous operation of groups of vehicles along the street at a planned speed.

29. Protected Turn. The left or right turns at a signalized intersection are made by a vehicle during a time in the cycle when the vehicle has the right-of-way.

30. Queue Storage Ratio. The maximum back of queue as a proportion of the available storage on the subject lane or link.

31. Red Clearance Interval. A brief period of time following the yellow indication during which the signal heads associated with the ending phase and all conflicting phases display a red indication.

32. Saturation Flow Rate. The equivalent hourly rate at which previously queued vehicles can traverse an intersection approach under prevailing conditions, assuming that the green signal is available at all times and no lost times are experienced.

33. Semi-Actuated Control. A signal control in which some approaches (typically on the minor street) have detectors and some approaches (typically on the major street) have no detectors.

34. Service Flow Rate. The maximum directional rate of flow that can be sustained in a given segment under prevailing roadway, traffic, and control conditions without violating the criteria for LOS *i*.

35. Service Measure. A performance measure used to define LOS for a transportation system element.

36. Volume-to-Capacity (v/c) Ratio. The ratio of flow rate to capacity for a system element.

37. Weaving. The crossing of two or more traffic streams traveling in the same direction along a significant length of highway, without the aid of traffic control devices (except for guide signs).

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 involves 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 ADTs of 400 or less, current traffic volumes may be used. However, if there is known development planned which may increase traffic to an ADT greater than 400, the traffic should be projected out based on the design period. 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 selected terminal pavement serviceability. Chapter 44 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 *Illinois Manual of Uniform Traffic Control Devices (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 ADT or the 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) ADT 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) DHV Selection

The peaking characteristics are significant for most geometric design elements on arterials and multilane collectors in the urban area and for intersections. The local facility should be able to accommodate the DHV (adjusted for the peak-hour factor) at the selected LOS. 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. The *HCM* uses the term demand flow rate similarly as DHV.

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 LPA 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. Because the design of the project is significantly dependent upon the projected DHV, carefully examine these projections before using them for design purposes.

27-6.04 Level of Service (LOS)

LOS describes a quantitative stratification of a performance measure or measures that represents quality of service, measured on an A to F scale. A designated LOS is described in terms of service measures such as speed, density, delay, or percent time-spent-following.

Because drivers will accept different driving operational conditions, including lower travel speeds on different facilities, it is not practical to establish one LOS for application to every type of highway. Therefore, various levels of service have been established for the different types of highways facilities, location (i.e., rural or urban) and the scope of the improvement.

The *HCM* has established service measures used to define LOS for transportation system elements on various types of facilities. These are presented in Figure 27-6A for those elements on local roads and streets. For each service measure, the *HCM* provides the analytical tools to calculate the numerical value. Note that highway capacity service measures 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.

Type of Facility	Service Measures
Vehicular	
Interrupted Flow	
Urban Street Segments	Travel Speed, Base of Free Flow Speed
Signalized Intersection	Delay
Two-way Stop Intersection	Delay
All-way Stop Intersection	Delay
Roundabouts	Delay
Uninterrupted Flow	
Two-lane Highway	Percent Time-Spent-Following, Average Travel Speed, Percent of Free Flow Speed
Multilane Highway	Density
Other Highway Users	
Pedestrian	Space, Delay, LOS Score
Bicycle	LOS Score
Transit	LOS Score
Off-Street Pedestrian or Bicycle Facility	
Pedestrian	Space, Events
Bicycle	LOS Score

SERVICE MEASURES FOR LOS

Figure 27-6A

The *HCM* provides the LOS (A to F) criteria for the capacity analysis for each highway element, including:

- multilane rural highways
- two-lane, two-way 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 DHV at the selected LOS. The methodologies in the HCM uses the DHV, or demand flow rate, and the various highway factors which affect capacity to determine the LOS. The service flow rate should be accommodated by adjusting the various highway factors which affect capacity until a suitable 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" of this *Manual* 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 LPA 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 exceptions 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;
- LOS 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 individuals with disabilities;
- pedestrian and bicycle accommodations;
- roadside clear zones;
- LOS for intersection(s);
- warrants for stop signs and signals;

- guardrail; and
- angle parking.

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 (LOS 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;
- pavement design; and
- other items deemed important.

27-7.02 Identification of Design Criteria and Design Exceptions

The following procedure identifies project design criteria and design exceptions 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. Initial Documentation of Design Exceptions (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 any design exceptions being considered are evaluated appropriately. The LPA must fully document its evaluation of the project's design and clearly demonstrate that a design exception is justified. The designer should include a statement that:

   a. identifies the design element,

   b. identifies BLRS design criteria,

   c. discusses the proposed design, and

d. provides justification for the design exception.

2. 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.

   a. When requesting a design exception, the following will apply:

   b. Federal Funded Projects. Complete Form BLR 22120 in its entirety.

   c. MFT and State Funded Projects. For LPAs 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 LPA's staff, the designer only needs to complete the sections for the criteria on Form BLR 22120 for which there is an exception.

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

3. District Coordination Meetings. Any contemplated design exceptions should be coordinated with the district early on in the project development phase. Many districts will discuss design exceptions at the district coordination meetings with attendance by representatives from the FHWA, CBLRS, and the LPAs and their consultants. The minutes of the coordination meeting may serve as documentation of the approval. These meetings are usually scheduled bi-monthly and monthly in Districts One and Eight,

   When evaluating exceptions 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.

4. Approval. Exceptions from Level One design criteria must receive approval from CBLRS. Exceptions from Level Two design criteria will receive approval from the districts. LPAs operating under an Agreement of Understanding (Section 5-1) will be allowed to determine the acceptability of Level Two design exceptions without district approval. Exceptions which are denied should be returned to the LPA with reasons for the denial in writing. Exceptions denied by CBLRS will be sent to the district.

5. Final Documentation. For Federal funded projects, include Form BLR 22120, the approval or denial, and copy of the minutes from the coordination meeting in the Project Development Report (PDR). For all other projects, include Form BLR 22120, the approval, and a copy of the minutes from the coordination meeting in the LPA's project file.

For LPA projects which require improvements on facilities under the jurisdiction of the State and a design exception is being contemplated, it follows a similar process as on the local facilities except:

1. Policy and Procedure. Section 31-8 of the *Bureau of Design & Environment (BDE) Manual* must be followed.
2. Documentation / Submission. Form BDE 3100 must be submitted to the district for review, who will forward the form and the district's recommendation to BDE.
3. District Coordination Meetings. The LPA project may need to be brought to the state-side of the district coordination meeting for discussion among FHWA, BDE, various district staff, the LPA and their consultants.
4. Approval. The approval of Form BDE 3100 is by BDE and in rare cases may require FHWA's approval.
5. Final Documentation. For Federal funded projects, include Form BDE 3100, the approval, and copy of the minutes from the coordination meeting in the PDR. For all other projects, include Form BDE 3100, the approval, and a copy of the minutes from the coordination meeting in the LPA's project file

27-7.03 Accessibility Standards for Individuals with Disabilities

Section 41-6 presents the IDOT application of the Federal standards for accessibility for individuals with disabilities as promulgated in *ADA / PROWAG*. The following applies when accessibility standards cannot be met, but they are designed to the maximum extent practicable (MEP) within the scope of the project (non-compliant element):

1. Procedure. Where site conditions and/or topography creates a non-compliant element, an in-depth evaluation with documentation is required. However, approval of funding for projects with non-compliant elements are extraordinarily rare and, therefore, a LPA should pursue this option only as a last resort.

   If the non-compliant element is on facilities under the jurisdiction of the State, the LPA shall follow the procedure in Section 31-8 of the *BDE Manual* and document it on Form BDE 3101.

2. Documentation / Submission. The LPA must fully document its evaluation of the project site conditions and must clearly demonstrate that the standards cannot be met and the design is to the MEP within the scope of the project. The content of the submission will vary on a case-by-case basis. Include the following information as appropriate:

   - location of the affected property,
   - a set of plans showing the location and the proposed deficient element, location of the affected property,

- photographs of the non-compliant element,
- what work is required to achieve the *ADA / PROWAG* standard, and
- the cost of achieving the *ADA / PROWAG* standards.

If the district concurs the LPA has properly documented the non-compliant element and cannot meet the standards and will be designed to the MEP, the district will submit the LPA's documentation to CBLRS with a request to concur the LPA has documented the MEP properly. If the request is on facilities under the jurisdiction of the State, the LPA's documentation shall be submitted to BDE.

3. District Coordination Meetings. Any contemplated non-compliant element shall be discussed at the district coordination meetings, if federal funds are included in the project. It is recommended an onsite field visit be scheduled to evaluate non-compliant elements.

4. Concurrence. IDOT concurrence is whether or not the LPA has properly documented that the non-compliant element is designed to the MEP and will be by CBLRS with concurrence from FHWA for requests on facilities under the LPA's jurisdiction. Facilities under the jurisdiction of the State shall follow the procedure in Section 31-8 of the *BDE Manual*.

5. Final Documentation. For Federal funded projects, include the LPA's documentation, IDOT's concurrence in the LPA's documentation, and copy of the minutes from the coordination meeting in the Project Development Report. For all other projects, include the LPA's documentation and IDOT's concurrence in the documentation in the LPA's project file.

27-8 ACRONYMS

This is a summary of the acronyms used within this chapter.

3R	Rehabilitation, Restoration, and/or Resurfacing
AADT	Annual Average Daily Traffic
AASHTO	American Association of State Highway and Transportation Officials
ADA	*Americans with Disabilities Act*
ADT	Average Daily Traffic
BDE	Bureau of Design and Environment
BLRS	Bureau of Local Roads and Streets
CBD	Central Business Districts
CBLRS	Central Bureau of Local Roads and Streets
DDHV	Directional Design Hourly Volume
DHV	Design Hourly Volume
GIS	Geographical Information System
FHWA	Federal Highway Administration
FRNG/OBD	Fringe Area/Outlying Business District
HCM	*Highway Capacity Manual*
IDOT	Illinois Department of Transportation
I-ROADS	*Illinois Roadway Analysis Database System*
ILMUTCD	*Illinois Supplement to the Manual of Uniform Traffic Control Devices*
IRIS	*Illinois Highway Information System – Roadway Information and Procedure Manual*
ISTEA	*Intermodal Surface Transportation Efficiency Act*
LPA	Local Public Agency
MEP	Maximum Extent Practicable
MFT	Motor Fuel Tax
MPA	Metropolitan Planning Area
MPO	Metropolitan Planning Organization
NHS	National Highway System
OPA	Other Principal Arterials
PHF	Peak-Hour Factor
PROWAG	*Public Rights of Way Access Guidelines*
STP	Surface Transportation Program
TWLTL	Two-Way Left-Turn Lane

27-9 REFERENCES

1. *A Policy on Geometric Design of Highways and Streets*, AASHTO, 2011.
2. Chapter 31 "Basic Design Controls," *BDE 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. *HCM2010 Highway Capacity Manual*, TRB, 2010.