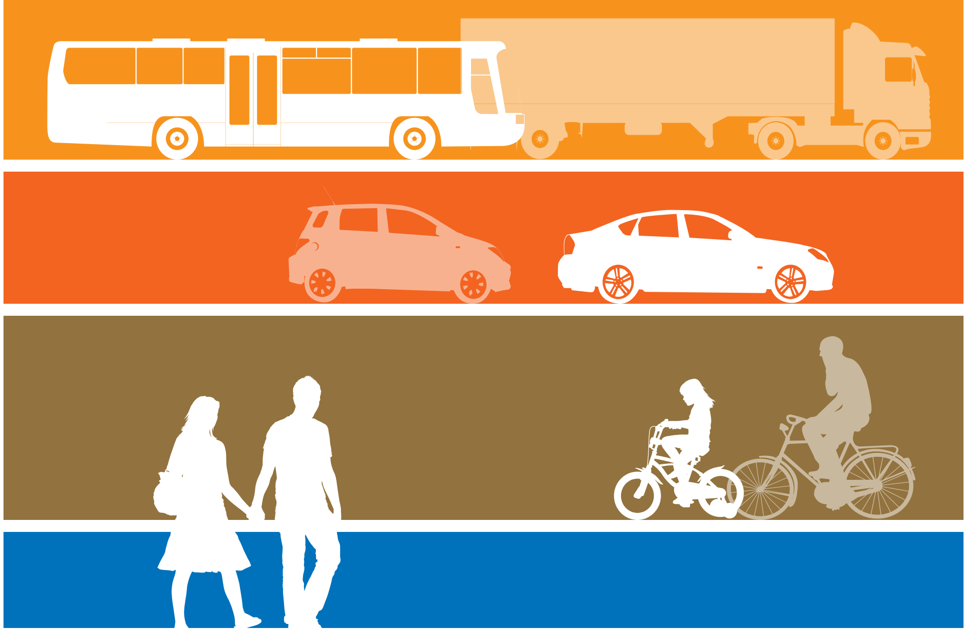
2013 QUALITY/ LEVEL OF SERVICE HANDBOOK



STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION

2013

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1 EXECUTIVE SUMMARY

This Quality/Level of Service Handbook and its accompanying software are intended to be used by engineers, planners, and decision-makers in the development and review of roadway users' quality/level of service (Q/LOS) and capacity at generalized and conceptual planning levels. This Q/LOS Handbook provides tools to quantify multimodal transportation service inside the roadway environment (essentially inside the right-of-way).

This edition of the Q/LOS Handbook is updated and reorganized, still providing a foundation for high quality, consistent capacity and LOS analyses and review in the State of Florida. It includes new analytical techniques from the Transportation Research Board's 2010 Highway Capacity Manual and updated Generalized Service Volume Tables. With these professionally accepted techniques, analysts can easily evaluate roadways from a multimodal perspective, which results in better multimodal decisions for projects in generalized and conceptual planning phases.

Two levels of analysis are included in this Q/LOS Handbook: (1) generalized planning and (2) conceptual planning. Generalized planning makes extensive use of statewide default values and is intended for broad applications such as regional analyses, initial problem identification, and future year analyses. Conceptual planning is more detailed than generalized planning but does not involve comprehensive operational analyses.

Generalized planning is most appropriate when a quick review of capacity or LOS is needed or for future long-range estimates. Florida's Generalized Service Volume Tables found at the end of this Q/LOS Handbook are the primary tools for conducting this type of planning analysis.

Conceptual planning is best suited for obtaining a more precise determination of the LOS of a facility. Examples of conceptual planning applications are determining the design concept and scope for a facility (e.g., four through lanes with a raised median and bicycle lane), conducting alternatives analyses (e.g., four through lanes undivided versus two through lanes with a two-way left turn lane), and determining needs when a generalized planning approach provides insufficient detail. Florida's LOS planning software (LOSPLAN), which includes ARTPLAN, FREEPLAN, and HIGHPLAN, is the easy to use tool for conducting these types of evaluations.

The techniques contained in this Q/LOS Handbook and the accompanying software are to be implemented immediately. Analysis that began prior to the release of this Q/LOS Handbook may continue to use the previous version. After June 30, 2013, FDOT will not accept analyses using methods, techniques, volumes, or Generalized Service Volume Tables from previous versions of this Q/LOS Handbook unless a project has a previously agreed upon methodology.

See www.dot.state.fl.us/planning/systems/sm/los/default.shtm to download the software and documentation, as well as provide your comments and suggestions.

2 Q/LOS HANDBOOK PURPOSE AND SCOPE

This Q/LOS Handbook and its accompanying software are intended to be used by engineers, planners, and decision-makers in the development and review of roadway users' quality/level of service (Q/LOS) and capacity at generalized and conceptual planning levels. The Q/LOS Handbook provides a discussion of basic transportation concepts. It provides direction for defining roadway, traffic, and control variables as these inputs greatly affect the Q/LOS along transportation facilities. It also provides guidance for using specific transportation planning tools, including LOS planning software (LOSPLAN) developed by the Florida Department of Transportation (FDOT), to assess Q/LOS.

Quality of service (QOS) is a traveler-based perception of how well a transportation service or facility operates. **Level of service** (LOS) is a quantitative stratification of quality of service into six letter grades. LOS provides a generalized and conceptual planning measure that assesses multimodal service inside the roadway environment (essentially inside the right-of-way). **Capacity** conceptually relates to the maximum number of vehicles or persons that can pass a point on a roadway or sidewalk in a given amount of time under normal conditions. The Generalized Service Volume Tables, found at the end of the Q/LOS Handbook, present maximum **service volumes**, or the highest numbers of vehicles for a given LOS.

Quality of service (QOS) is a traveler based perception of how well a service or facility is operating.

Level of service (LOS) is a quantitative stratification of the quality of service into six letter grade levels.

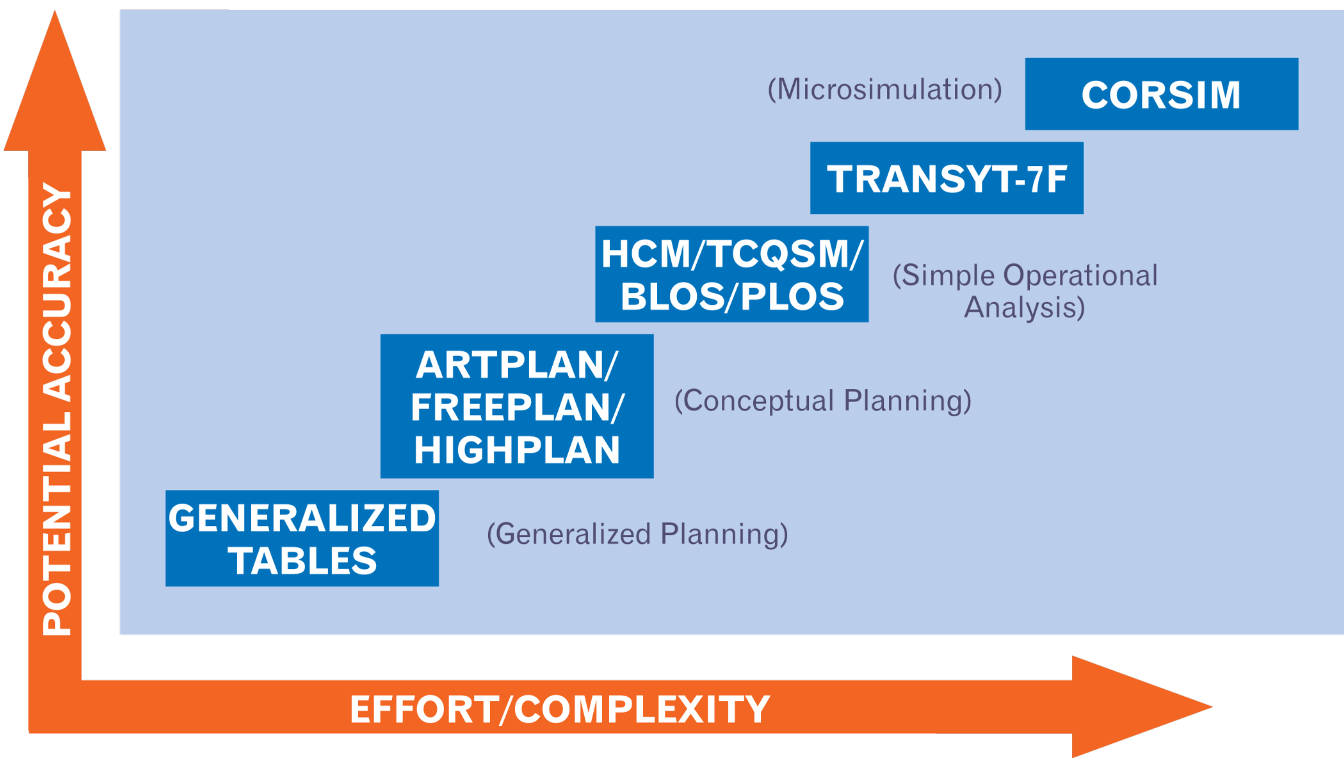
Capacity is the maximum sustainable flow rate at which persons or vehicles reasonably can be expected to traverse a point or a uniform section of roadway during a given time period under prevailing conditions.

Direction found within the Q/LOS Handbook provides assistance in selecting the most appropriate tools for Q/LOS analysis. There is specific instruction within the handbook on how to use the LOSPLAN software and Generalized Service Volume Tables. The Generalized Service Volume Tables and software guidance prioritizes inputs; defines roadway, traffic, and control variables; and illustrates how to capture pertinent data.

2.1. Levels of Analysis

There are many methods for computing capacity and LOS, which form a hierarchy ranging from Generalized Service Volume Tables (the simplest to use but potentially least accurate) to complex operational analysis tools (very precise, but time-intensive and costly). **Figure 2-1** provides an overview of analysis levels and evaluation tools for each level. In selecting the appropriate tools, tradeoffs among study purposes (e.g., generalized planning application, signal timing application), accuracy and precision of results (e.g., variability in data for current year analyses, variability in future year analyses), and data preparation effort (e.g., use of existing statewide traffic data, use of direct field measurements) should be considered. No one tool is appropriate for all applications.

Figure 2-1
Evaluation Tools



Two levels of analysis are included in this Q/LOS Handbook: (1) **generalized planning** and (2) **conceptual planning**. A third analysis level, (3) **operational analysis**, is covered within the 2010 Highway Capacity Manual (HCM) and is not discussed in detail in this Q/LOS Handbook.

Generalized planning makes extensive use of statewide default values and is intended for broad applications such as initial problem identification (e.g., deficiency and needs analyses, geographic influence areas), statewide analyses (e.g., statewide calculation of delay), and future year analyses (e.g., ten-year planning horizon). Conceptual planning is more detailed than generalized planning, but does not involve comprehensive operational analysis.

Generalized planning is a broad type of planning application that includes statewide analyses, initial problem identification, and future year analyses.

Conceptual planning is analysis performed to support decisions related to design concept and scope.

Operational analysis is a detailed analysis of a roadway's present or future level of service.

2.1.1. Generalized Planning

Generalized planning is most appropriate when a quick review of capacity or LOS is needed. Florida's Generalized Service Volume Tables found in this Q/LOS Handbook are the primary tools for conducting this type of planning analysis. The tables are the most extensively researched in the nation and provide the most representative statewide service volumes and capacities for the State of Florida.

2.1.2. Conceptual Planning

Conceptual planning is best suited for obtaining a more precise determination of the capacity and LOS of a facility. Conceptual planning analyses are performed to support decisions related to design concept and scope (e.g., four through lanes with a raised median and bicycle lane), conducting alternatives analyses (e.g., four through lanes undivided versus two through lanes with a two-way left turn lane), assessing development impacts, and determining needs when a generalized planning approach provides insufficient detail. LOSPLAN, the software suite that includes ARTPLAN, FREEPLAN, and HIGHPLAN, is the appropriate tool for this type of planning analysis. The software is specifically developed to address conceptual planning issues in Florida, is intended to be easy to use, and is based on the nation's leading operational tools, which are the 2010 HCM and the Transit Capacity and Quality of Service Manual (TCQSM).

2.1.3. Operational Analysis

Operational tools range from macroscopic to microscopic. The analytical methods found in the HCM methodology chapters and the Highway Capacity Software (HCS), which replicates the HCM methodologies, are representative of macroscopic operational tools. Macroscopic tools address vehicles as a group rather than individually, are deterministic (i.e., provide a single, consistent answer), and typically require less computational effort. They provide a cost-effective method of comparing multiple scenarios within a standard undersaturated operating environment.

Microscopic simulation tools (e.g., CORSIM) address vehicles individually, are stochastic (i.e., introduce random variations), and typically require more computational effort. Microscopic analysis is particularly useful when analyzing statistical ranges of operational characteristics, and provides added flexibility over macroscopic tools within oversaturated or relatively uncommon operating environments (diverging diamond interchanges, transit signal priority, etc.).

While operational analyses, such as intersection signal timing and interchange justification reports, are sometimes conducted at the planning level, the Q/LOS Handbook does not contain the necessary tools for these types of detailed evaluations. As a planning document, the precision of operational, design, or pavement documents such as the AASHTO Policy on Geometric Design for Highways and Streets or FDOT's Plans Preparation Manual is not included. For example, this Q/LOS Handbook's simplified planning level assumptions are applied to vehicle turning movements, lane widths, bicycle striping, sidewalk widths, bus stop amenities, and many other transportation characteristics. Therefore, it must not be used for actual design or operation of facilities or services where more appropriate resource documents and/or analysis methods are available.

2.1.4. Selecting an Appropriate Analysis Tool

The intermixing of generalized planning tools, conceptual planning tools, and operational tools should be avoided whether developing and implementing a concurrency management system, applying them to other planning applications, or conducting a traffic operations analysis. Using very precise data appropriate for a more detailed analysis as input to a less detailed analysis does not necessarily make the less detailed analysis more accurate. The precision of the inputs should be appropriate for the precision of the output. Similarly, the precision of the output is usually no better than the worst of the inputs. For example, the Generalized Service Volume Tables were structured to yield reasonable service volumes for typical roadways in the state. Typical roadway, traffic, control (signalization), and multimodal inputs from the State of Florida were used. Inserting specific traffic inputs for a conceptual planning analysis (e.g., K and D factors) without simultaneously addressing key roadway and control inputs (e.g., effective green time ratios) is inappropriate, and also potentially leads to misuse of the tools as analysts can choose particular variables to alter for a desired result.

More precision is not always necessary, and the costs required to collect data, build the model, and validate the results should be carefully considered when selecting an appropriate analysis tool.

2.2. Travel Modes

The HCM defines four major travel modes: automobile, bicycle, pedestrian, and transit. Each mode includes a unique set of characteristics that define a traveler's experience during a trip, and it is important to consider each perspective when analyzing a multimodal facility.

2.2.1. Automobile

Three major elements affect the operation of a motor vehicle: the vehicle, the driver, and the roadway environment.

Motor vehicles include passenger cars, trucks, vans, buses, recreational vehicles, and motorcycles.

Motor vehicles include passenger cars, trucks, vans, buses, recreational vehicles, and motorcycles. Each vehicle type has a unique set of operational characteristics, and the percentage makeup of each vehicle type within a traffic stream affects the capacity of a facility due to these differences. Trucks, buses, and recreational vehicles, for example, have lower acceleration and deceleration rates than standard passenger cars.

Environmental factors, such as surface type and condition, time of day, and weather, affect both the operational characteristics of vehicles as well as driver behavior. Additional factors such as fatigue, health, and driving under the influence of drugs and alcohol also affect driver behavior. However, unless otherwise specified, this Q/LOS Handbook assumes base conditions that include typical drivers on dry pavement during daylight hours.

2.2.2. Pedestrian

Many trips include at least one part where the traveler is a pedestrian. This is particularly important for transit trips, where the pedestrian section of the trip may have an impact on future mode choice.

Many trips include at least one part where the traveler is a pedestrian.

Analyzing the pedestrian experience can be summarized by two primary types of analysis: individual delay and facility attributes. Delay at intersections can be easily quantified and analyzed. The factors that describe a facility and therefore contribute to the overall walking experience are less easily quantified, including safety, security, lighting, grades, surface conditions, and even street activity levels. Automobile and heavy vehicle traffic volumes, and the extent to which pedestrians are separated from vehicular traffic, also influence pedestrians' perception of quality of service while using a sidewalk. The Q/LOS Handbook accounts for these user perception and facility attributes when determining pedestrian LOS.

2.2.3. Bicycle

Bicycles are used to make a variety of trips, including trips for recreation, commuting, and errands. Since bicycle travel is typically five times faster than travel on foot, bicycles can help extend the market area of transit service.

Bicycle travel is typically five times faster than travel on foot.

Similar to the pedestrian experience, bicycling can be summarized by delay encountered at intersections as well as the attributes of the facility itself. As with the pedestrian analysis, the Q/LOS Handbook focuses on facility attributes when determining bicycle LOS. These attributes include the volume and speed of adjacent vehicles, heavy vehicle presence, the presence of on-street parking, and pavement quality. Because of the severe deterioration of perceived service quality at flow levels well below the theoretical capacity of a bike path, the concept of capacity has little utility in the design and analysis of bicycle paths.

Choice transit riders are transit riders who choose to take transit over other readily available transportation options.

Captive riders are transit riders who are limited by circumstances to use transit as a primary source of transportation.

2.2.4. Transit

Transit riders can be grouped into two primary categories: choice and captive riders. **Choice transit riders** typically have other means of transportation readily available, but choose transit to avoid congestion, save money on fuel and parking, use their travel time productively for other activities, and/or reduce their impact on the environment. **Captive riders**, however, are unable to drive because of age, physical, mental, or financial reasons, and depend on transit or other modes for their daily transportation needs.

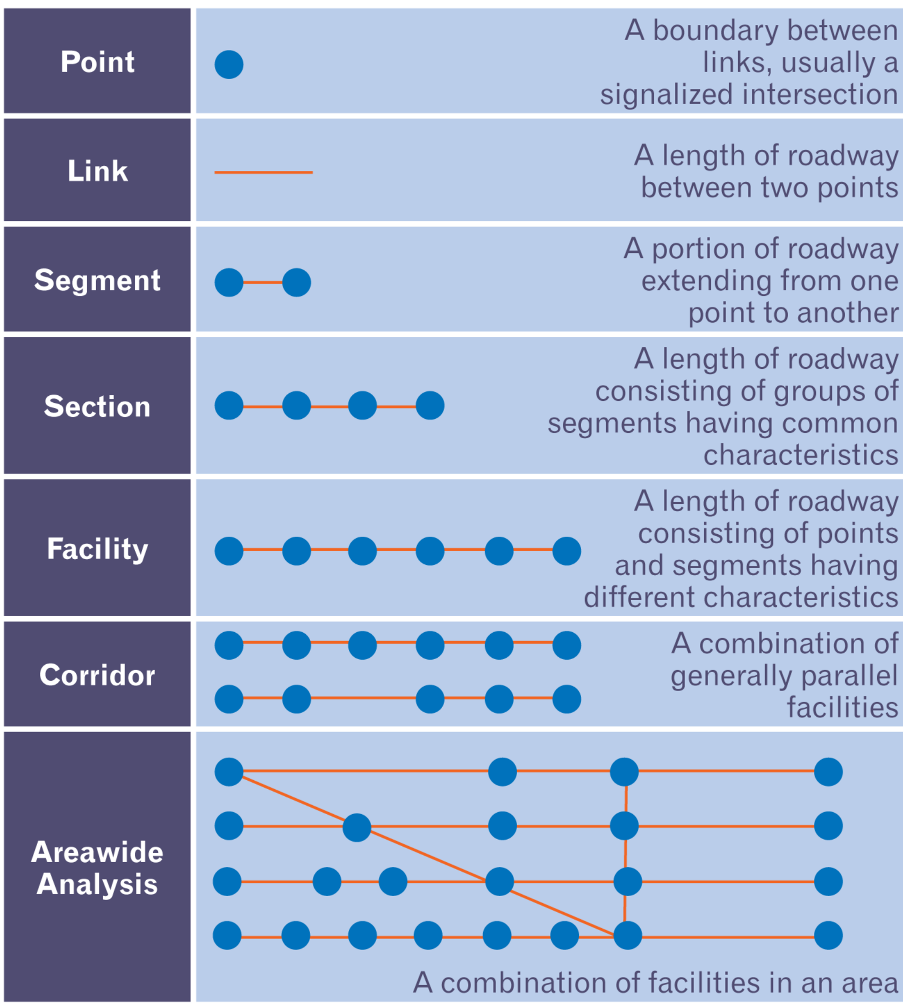
Unlike other modes, transit is primarily focused on service levels rather than facility characteristics. Infrastructure for driving, biking, or walking is available at all times, once constructed; transit service is only available during certain times along designated routes. Additionally, transit passengers are not in direct control of their travel, and service frequency and reliability are therefore important factors that impact the quality and utility of transit service. Service frequencies at levels high enough to eliminate the need for passengers to consult schedules (headways of approximately 10 minutes or less) are particularly desirable, as these nearly continuous levels allow transit users the freedom to treat the system as they would other modes. Service frequencies that require passengers to plan their trips around a limited transit schedule offer much less utility, and deter choice riders.

Because transit passengers typically must walk to and from transit stops on either end of their trip, the quality of the walking experience at the beginning or end of a trip may be just as important to the transit passenger as the actual transit experience.

2.3. Transportation System Structure

FDOT's Q/LOS techniques generally incorporate the primary highway system structure of the HCM, consisting of points, links, segments, sections, facilities, corridors, areas, and systems, although the HCM occasionally includes other structural units (e.g., subsegment). A generalized characterization of the HCM structure is shown in **Figure 2-2**.

Figure 2-2
Generalized HCM Highway System Structure



The analysis techniques contained in this Q/LOS Handbook and accompanying software are focused at the HCM facility level. In some cases, however, it may be more appropriate to analyze specific roadways at the point (intersection), subsegment, or section level. Although future editions may include corridor, areawide, and system-level analysis methods, they are currently beyond the scope of this Q/LOS Handbook. Points, links, segments, subsegments, sections, and facilities are discussed further below.

The primary purpose of this Q/LOS Handbook is to compute the LOS for State facilities. Nevertheless, the analysis techniques contained in this Q/LOS Handbook are applicable to nearly all roadways in Florida. The two exceptions are unsignalized local streets and unpaved roads.

2.3.1. Point

A point is a boundary between links—typically a signalized intersection or other place where modal users enter, leave, or cross a facility.

A **point** is a boundary between links. In broad terms, points are where modal users enter, leave, or cross a facility, or where roadway characteristics change. In most applications of this Q/LOS Handbook, points are signalized intersections. Other points may include freeway gores, unsignalized intersections, area boundaries, bicycle lane terminals, sidewalk terminals, pedestrian mid-block crossings, and bus stops.

Point analyses are typically operational in nature and not appropriate at a planning level. At the conceptual planning level, the usual intent of point analyses is to determine the g/C ratio necessary to move traffic through the point so the roadway as a whole operates adequately. Therefore, in some cases, in order for the roadway as a whole to work effectively, specific bottlenecks may need to be addressed. Usually operational tools are needed to analyze these critical points. In the case of arterials, a further analytical complication arises because the facility LOS service measure, average speed, changes to control delay at a signalized intersection. Although there is typically a direct relationship between the two, it is possible to have acceptable LOS at signalized intersections along a poorly operating facility, or vice versa.

For conceptual planning studies of a specific roadway, basic capacity and LOS analyses should be conducted at the point level over the roadway's length. FDOT's ARTPLAN and HIGHPLAN software feature some point highway capacity and LOS features; however, they do not provide detailed operational results. The HCS software or another HCM-based analysis tool should therefore be considered if an operational tool is needed to supplement the LOSPLAN analysis.

2.3.2. Link

A **link** represents a length of roadway between two points. Link-level analysis is independent from point analysis, and does not include influencing factors such as queuing from downstream intersections or upstream metering effects. For automobile and transit analysis, it is therefore beneficial to consider the link and its points together in a segment-level analysis. However, for pedestrian and bicycle analysis, where the performance of the adjacent intersections has limited impact on the characteristics and performance of the link itself, links are often analyzed independently.

A link is a length of roadway between two points.

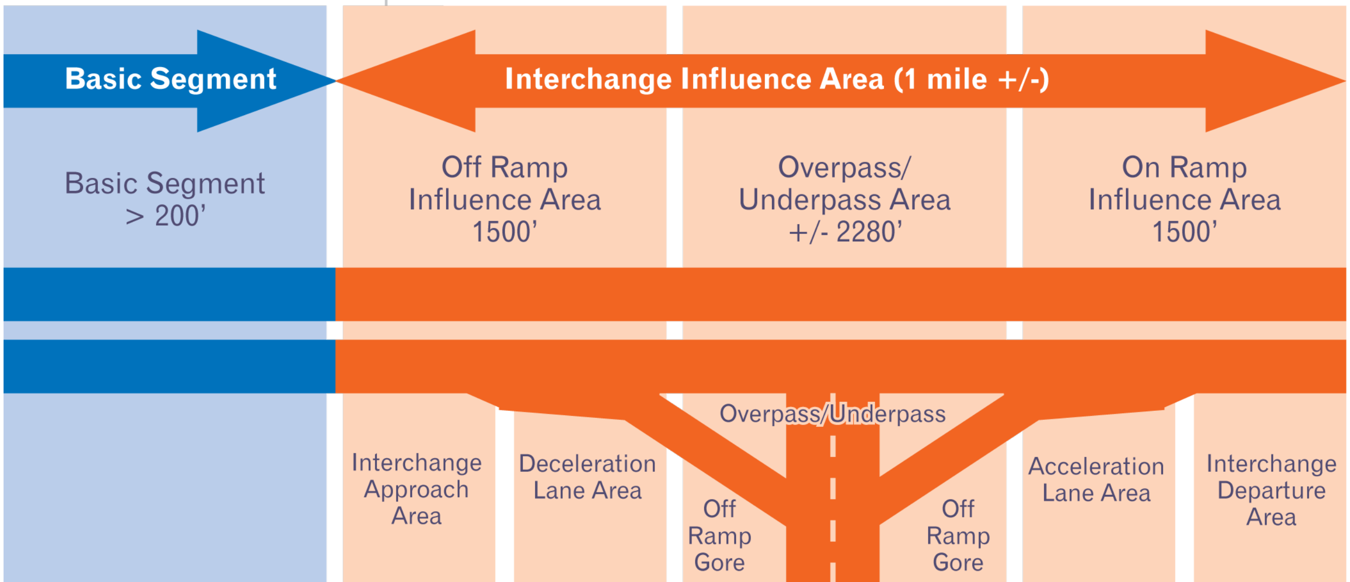
2.3.3. Segment

A link and its boundary points are referred to as a **segment**. Segments are the primary building blocks of facility analyses. For arterials and other signalized roadways, segments generally extend from one signalized intersection to the next signalized intersection. However, for bicycle, pedestrian, and bus analyses, other segmentation may also be appropriate. For example, if buses leave a roadway before a signalized intersection, it may be desirable to make a segment break reflecting where the buses leave the arterial. For freeways, segments are generally either a basic segment in which operations are not affected by interchanges, or one of the building blocks of interchanges, which include on-ramp influence areas, off-ramp influence areas, or weaving segments.

A segment is a portion of a facility defined by two boundary points.

A typical interchange, made up of an off-ramp influence area, a basic segment, and an on-ramp influence area segment, is illustrated in **Figure 2-3**.

Figure 2-3
Typical Freeway Interchange



Subsegment

A subsegment is a further breakdown of segments.

A **subsegment** is a further breakdown of a segment. Although segments are the primary building blocks of facility analyses, at times it is desirable to subdivide them into smaller units. For example, pedestrian conditions frequently vary between signalized intersections (e.g., discontinuous sidewalks, sidewalk proximity to roadways) and it is desirable to analyze these conditions. However, the entire roadway analysis for other modes should not be based on these special conditions.

2.3.4. Section

A **section** is a group of consecutive segments that have similar roadway, traffic, and, as appropriate, control characteristics for a mode of travel. When determining roadway LOS and implementing FDOT's LOS standards, most FDOT districts partition roadways at points were volumes significantly change or the number of through lanes changes. For LOS analysis purposes, individual segments are usually grouped together as long as traffic and roadway characteristics do not vary appreciably. Because of typically shorter travel distances by the bus, pedestrian, and bicycle modes on individual roadways, a section level analysis is more appropriate for those modes than a facility-level analysis.

A section is a group of consecutive segments that have similar roadway, traffic, and control characteristics for a mode of travel.

Typical Section Lengths

- Freeways: interchange to interchange
- Arterials: 0.5 to 2 miles
- Highways: highly variable in length and may include
  - uninterrupted flow two-lane segments
  - uninterrupted flow multilane segments
  - isolated intersection influence areas

Typical Section Termini

- Changes in the number of through lanes
- Significantly varying traffic volumes
- Freeway interchanges
- Intersecting functionally classified principal arterials
- A signalized intersection no more than 2 miles away from the following area boundaries (see section below on signalized intersection as termini for arterial analyses):
  - Urbanized area boundaries
  - Transitioning area boundaries
- Area boundaries if no nearby signalized intersection exists:
  - Urbanized area boundaries
  - Transitioning area boundaries.

A facility is a length of roadway composed of points and segments having different characteristics.

2.3.5. Facility

A **facility** is a group of consecutive segments or sections that form logical roadway lengths based on driver perspective or the overall network system structure. Three primary types of facilities are identified in the HCM, this Q/LOS Handbook, and their accompanying implementation software:

- **Freeways** (multilane, divided roadways with at least two lanes for exclusive use of traffic in each direction and full control of ingress and egress),
- **Highways** (generally uninterrupted flow roadways which may be further categorized as two-lane or multilane), and
- **Arterials** (signalized roadways that primarily serve through traffic).

Facility analysis is the focus of this Q/LOS Handbook, the Generalized Service Volume Tables, and the LOSPLAN software.

Typical Freeway Facility Lengths and Termini

APPROPRIATE LENGTHS

- 4 - 15 miles in urbanized and transitioning areas
- 10 - 50 miles in rural areas

TYPICAL TERMINI

- Intersecting Strategic Intermodal System (SIS) routes
- Urbanized area boundaries
- Transitioning area boundaries

Typical Highway Facility Lengths and Termini

APPROPRIATE LENGTHS

- At least 3 miles

TYPICAL TERMINI

- Large urbanized areas – intersecting freeways and arterials that connect to at least two freeways
- Other areas – intersecting functionally classified principal arterials
- Urbanized area boundaries for nearby jurisdictions
- Transitioning area boundaries
- Urban boundaries
- City boundary to city boundary in cities under 5,000 population

Typical Arterial Facility Lengths and Termini

APPROPRIATE LENGTHS

- 0.75 - 2 miles in urbanized downtown areas
    - Typically 1 mile
- 1.5 - 5 miles in other areas
    - Typically 3 miles

TYPICAL TERMINI

- Large urbanized areas – intersecting freeways and arterials that connect to at least two freeways
- Other areas – intersecting freeways and intersecting functionally classified principal arterials
- A signalized intersection less than 2 miles away from an area boundary
- City boundary to city boundary in cities under 5,000 population

Corridors are sets of essentially parallel transportation facilities for moving people and goods between two points.

Areas consist of an interconnected set of transportation facilities serving movements within a specified geographic space.

Systems are composed of all the transportation facilities and modes within a region.

2.3.6. Corridors, Areas, and Systems

Generally, **corridors** are a combination of parallel facilities. **Areawide analyses** involve a combination of interconnected transportation facilities. **System analyses** involve a combination of facilities and modes within a region. These levels of analysis are typically used in travel demand models and other network-wide analyses, and are therefore not covered within this Q/LOS Handbook.

2.3.7. Integrated Approach

Because the system structure is different for each mode, an integrated multimodal approach becomes more difficult. The transit system structure of the Transit Capacity and Quality of Service Manual (TCQSM) consists of transit stops, route segments, and systems. The two national document system structures (HCM, TCQSM) are conceptually equivalent when comparing points and transit stops as well as areawide and system analyses. Route segments are portions of a transit route where, in general, bus service is provided at constant headways. The bicycle and pedestrian LOS models within the HCM are based on point-level and link-level analysis in which roadway characteristics are the same between the upstream and downstream intersections. In some cases, additional detail between intersections is needed to capture the changes in the pedestrian and bicycle environments.

Even within the HCM highway system structure, occasional inconsistencies can arise when determining the LOS of a roadway because of different service measures being applied. For example, if percent time spent following another vehicle is used as the service measure to evaluate the LOS on an uninterrupted flow two-lane highway, the reported LOS may improve when adding a traffic signal (or even multiple signals), contrary to expectations. This improvement occurs because the service measure for a signalized intersection is based on control delay and the service measure for roadways with multiple signals is average travel speed. Thus, anomalies are possible when changing from one facility type to another.

As shown in **Figure 2-4**, the vehicular volume and number of lanes significantly affect the automobile, bicycle, and pedestrian levels of service. Other roadway and traffic variables, plus control (signalization) variables, determine the automobile LOS. The motorized vehicle running speed (calculated as part of the automobile LOS) is also an important determinant of bicycle and pedestrian LOS. Together with the presence of bicycle lanes and sidewalks, motorized vehicle volumes and speeds are the main determinants of bicycle and pedestrian LOS. Bus LOS is primarily determined by bus frequency, but is also affected by pedestrian LOS. In summary, all the roadway modes are linked together.

Figure 2-4
Relationship of Inputs to Quality of Service Measures

<table>
<tr><th>Mode</th><th>Automobile</th><th>Bicycle</th><th>Pedestrian</th><th>Bus</th></tr>
<tr><td rowspan="7">Major Inputs</td><td>Volume and Lanes</td><td>Bicycle Lane</td><td>Sidewalk</td><td>Bus Frequency</td></tr>
<tr><td colspan="3">Volume and Lanes</td><td></td></tr>
<tr><td colspan="3">Other Traffic and Roadway Characteristics</td><td></td></tr>
<tr><td colspan="3">Arterial Running Speed</td><td></td></tr>
<tr><td>Arterial Running Time</td><td></td><td colspan="2">Sidewalk</td></tr>
<tr><td>Control Characteristics</td><td></td><td></td><td></td></tr>
<tr><td>Control Delay</td><td></td><td></td><td></td></tr>
<tr><td>Service Measure</td><td>Average Travel Speed</td><td>Bicycle LOS Score</td><td>Pedestrian LOS Score</td><td>Adjusted Bus Frequency</td></tr>
<tr><td>LOS Determinator</td><td>HCM LOS Criteria</td><td>HCM LOS Criteria</td><td>HCM LOS Criteria</td><td>TCQSM LOS Crteria</td></tr>
</table>

FDOT does not recommend combining the LOS for each of the modes into one overall LOS for a roadway.

For several reasons, FDOT does not recommend combining the LOS for each of the modes into one overall LOS for a roadway.

- There is no professionally accepted or scientifically valid technique for combining the LOS for the various modes.
- The issue of applying a weight to each of the modes. Various scenarios exist of weighting the modes equally, by relative importance, policy goals, or other criteria. For example, it would be inappropriate to average the LOS for bicycles and pedestrians equally with that of automobiles and trucks on freeways. However, simply weighting each of the modes by the number of users would, in most cases, result in using the LOS for the automobile.
- The functional classification/purposes of roadways. For example, pedestrian considerations should have greater importance on local streets serving schools than on highways serving freight transfer facilities.
- The purpose and travel patterns of each of the modes are generally distinct, rendering any combination effectively meaningless.

2.4. What's New in the 2013 Q/LOS Handbook

In general, this edition of the Q/LOS Handbook primarily reflects an update of the 2009 edition, using HCM 2010 methodology. The Q/LOS Handbook and accompanying LOSPLAN software maintain their roles as the primary generalized and conceptual planning applications of the HCM and the premier tools for multimodal analyses. User input indicated a general satisfaction with the 2009 Q/LOS Handbook, its maximum service volume tables, and the LOSPLAN software.

Significant revisions have been made to this Q/LOS Handbook, Generalized Level of Service Volume Tables, and LOSPLAN software compared to the 2009 editions due to:

- FDOT adopting Standard K factors
- FDOT adopting a new policy on Level of Service Standards for the State Highway System (Topic No.: 000-525-006-a) and a new procedure Level of Service Standards and Highway Capacity Analysis for the State Highway System (Topic No.: 525-000-006-a)
- Publication of the 2010 HCM

There are two FDOT supported and statewide acceptable highway capacity and LOS analysis tools for generalized and conceptual planning: FDOT's Generalized Service Volume Tables and FDOT's LOSPLAN software. In order to provide clarification on previous versions of the Q/LOS Handbook and software, and to achieve greater consistency across the state, the Q/LOS Handbook and software now:

- Provide more guidance on section and facility lengths and typical termini
- Include multimodal intersection LOS analyses
- Have an improved user interface within the LOSPLAN software
- Provide warnings to software users when inputs or outputs are beyond normally acceptable ranges
- Incorporate recent analytical research efforts
- Address future year analyses
- Include updated traffic data

Specific analytical improvements or changes to the LOSPLAN software and Q/LOS Handbook include:

- Traffic Characteristics
  - FDOT implementation of Standard K factors
  - Updated directional distribution (D) factors
  - Making the default value for the peak hour factor (PHF) equal to 1.0
- Changes in Analytic Models
  - Implementation of updated 2010 HCM equations (unless specifically noted)
  - Use of a two class arterial system rather than the 2000 HCM which used a four class arterial system and the 2010 HCM which did not use arterial class (see **Section 3.5**)
  - Treatment of left turn protected plus permitted phasing
  - New level of service thresholds for rural freeway facilities
  - Treatment of two-lane interrupted flow highways
  - An improved bicycle LOS link model
  - Treatment of bicycle sidepaths and shared use paths
  - Ability to assess bicycle and pedestrian LOS at signalized intersections
  - Inclusion of the effects of on-street parking
  - An updated bus level of service model
  - Improved two-lane highway analyses and compatibility with the updated chapter of the 2010 HCM
  - Better accounting for the effects of passing lanes on two-lane highways
  - Inclusion of Florida research on heavy vehicles effects on cyclist
  - Improved analyses of the effects of turning movements on arterials
  - Greater emphasis on the effects of area type as a variable
  - Inclusion of new segment types for freeway segmentation
  - Updated LOS density threshold criteria for freeways, reflecting the effects of interchanges

- Incorporation of the capacity and LOS effects of tolled lanes, weaving segments, toll booths, and ramp overlap areas
- Additional off-ramp and toll outputs
- Inclusion of recent national research on freeway weaving analysis

Changes to the Generalized Service Volume Tables include:

- Service volume changes at most relevant service levels due to changes in peak hour, K, and D factors, as well as methodological changes
- New category of service volumes for urban core freeways
- Elimination of LOS B service volumes on arterials
- Modifications to the treatment of non-state signalized roadways

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3 QUALITY AND LEVEL OF SERVICE PRINCIPLES

Providing mobility for people and goods remains transportation's most essential function. There are four dimensions of mobility:

- **Quality of travel** – traveler satisfaction with a facility or service
- **Quantity of travel** – magnitude of use of a facility or service
- **Accessibility** – ease in which travelers can engage in desired activities
- **Capacity utilization** – quantity of operations relative to capacity

Of the four dimensions of mobility, this Q/LOS Handbook focuses primarily on quality, followed by capacity utilization. The quantity and accessibility dimensions are not addressed in this Q/LOS Handbook.

Quality of service (QOS) is based on a user's perception of how well a transportation service or facility operates. In other words, how do travelers perceive the overall quality of service?

Level of service (LOS) is a quantitative stratification of quality of service. Beginning in 1965, the HCM divided highway quality of service into six letter grades, A through F, with A being the best and F being the worst. With the A through F LOS scheme, traffic engineers were able to more easily explain operating and design concepts to the general public and elected officials. Despite its widespread use as an independent measurement, it is important to note that LOS is simply a quantitative breakdown from transportation users' perspectives of transportation QOS. LOS reflects the quality of service as measured by a scale of user satisfaction and is applicable to each of the following modes that use roadways: automobiles, trucks, bicycles, pedestrians, and buses.

Because this handbook deals with the overall quality of user satisfaction and its quantitative breakdown, it is labeled as the Quality/Level of Service Handbook. The measurement techniques, however, are frequently simply referred to as LOS analysis. This Q/LOS Handbook deals with both the quality of service and the level of service roadways provide to roadway users (i.e., motorists, bicyclists, pedestrians, and transit passengers) and provides planning tools to assist transportation planners and engineers with addressing these issues. This Q/LOS Handbook does not deal with the overall quality of the entire trip experience, which depends on a variety of factors including aesthetics, safety, and other social measures.

Trucks, recreational vehicles, and motorcycles are all considered part of the automobile mode.

In this Q/LOS Handbook, the automobile mode includes all motor vehicle traffic using a roadway, except for buses. Thus, trucks, recreational vehicles, and motorcycles are all considered part of the automobile mode. Certain vehicle types, (e.g., trucks) have different operating characteristics than private automobiles; these characteristics are taken into account by the analytical methodologies where needed. The LOS thresholds for the automobile mode are based on the perspective of the automobile drivers. Therefore, the automobile LOS measures may not necessarily reflect the perspectives of drivers of other types of motorized vehicles, particularly trucks.

3.1 Common Q/LOS Misconceptions

HCM Capacity is the maximum sustainable flow rate at which persons or vehicles reasonably can be expected to traverse a point or a uniform section of a lane or roadway during a given time period under prevailing roadway, environmental, traffic, and control conditions.

LOS relates to the stratification of quality provided to travelers.

Although frequently considered to be the same, highway capacity analysis and LOS analysis are two distinct, although closely related, analyses. The HCM defines capacity as the "maximum sustainable flow rate at which persons or vehicles reasonably can be expected to traverse a point or a uniform section of a lane or roadway during a given time period under prevailing roadway, environmental, traffic, and control conditions." As used in Florida, motorized vehicle capacity may be thought of as the maximum hourly volume that can reasonably be expected to pass a point under prevailing conditions. LOS, on the other hand, relates to the stratification of quality provided to travelers. For most generalized and conceptual planning applications associated with motorized vehicles, the maximum service volumes for LOS E shown in this Q/LOS Handbook and accompanying software is approximately equivalent to the capacity of the roadway.

Three common misconceptions about Q/LOS often arise.

- Misconception 1: QOS is directly related to all other dimensions of mobility. Truth: QOS is frequently related to the other dimensions of mobility but not in all cases.
- Misconception 2: LOS is applicable only to automobile analysis, while QOS is related to the non-automobile modes. Truth: Bicycle, pedestrian, and transit analyses are as quantitative and rigorously developed as those for automobiles.
- Misconception 3: LOS letter A-F grades are comparable to American school letter grades. Truth: Unlike school grades, LOS A is not necessarily a desirable goal and the meaning of A-F is not entirely consistent across modes.

The first common misconception is related to the relationship between quality and other dimensions of mobility. They are frequently related, but not directly in all cases. Q/LOS for automobile drivers is usually closely linked to how many other motorized vehicles are on the road. However, the relationship is not always perfect.

For example, arterial speeds are more closely tied to signalization conditions than the number of other motorized vehicles on the roadway. A higher quality LOS grade may exist on a four-lane arterial with twice the volume of another arterial due to efficient signal progression. For transit users, pedestrians, and bicyclists, there is often an even weaker relationship between total demand and Q/LOS. In fact, in most situations in Florida, the total number of bicyclists and pedestrians on a facility has very little impact on Q/LOS; other factors are much more important. Similarly, in most of Florida, bus frequency is typically much more important to transit users than how many people are actually on a bus.

In some cases, particularly for the non-automobile modes, an analysis of total potential demand is a more important component of the decision making process than quality of service. This Q/LOS Handbook only addresses Q/LOS, not methods of determining overall demand or mode splits. Other tools, such as logit models, are more appropriate for these types of analyses.

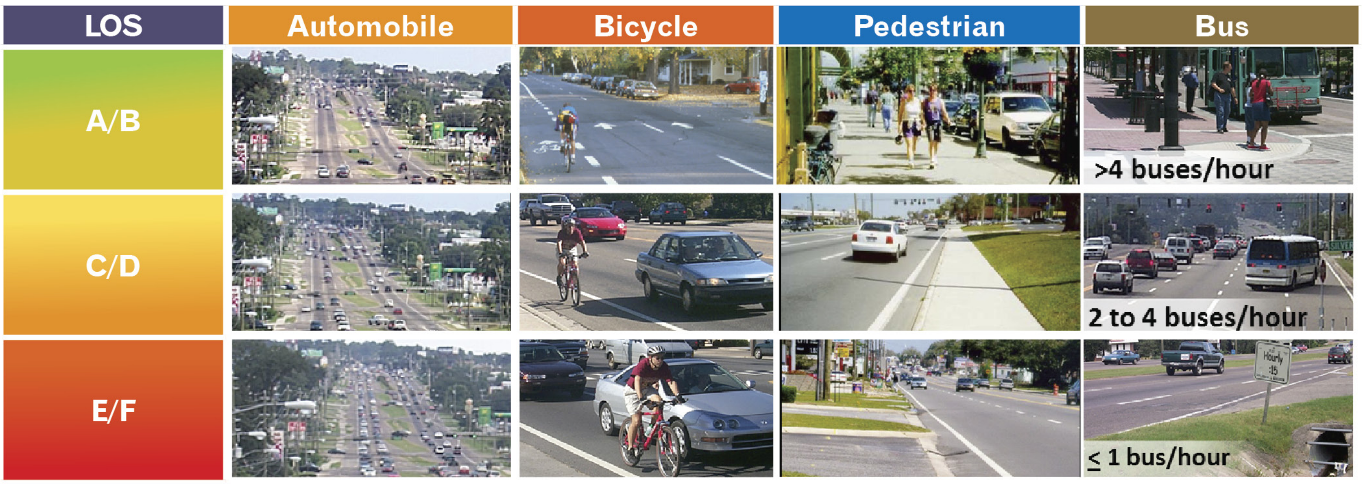
The second common misconception is that LOS applies only to automobiles and QOS applies to the other modes. It is often assumed that while automobile analyses are highly quantitative, the bicycle, pedestrian, and transit analyses are more qualitative. However, the bicycle, pedestrian, and transit techniques are as quantitative and rigorously developed and tested as those for automobiles. The LOS for each mode for urban roadways is illustrated in **Figure 3-1**.

For bicycle and pedestrian analysis, the total number of users typcically has very little impact on Q/LOS.

Bus frequency is typically much more important to transit users than how many people are actually on a bus.

Bicycle, pedestrian, and transit techniques are as quantitative and rigorously developed and tested as those for automobiles.

Figure 3-1
Examples of LOS By Mode for Urban Roadways



Although it is true that A is best and F is worst, LOS A is not necessarily a desirable goal.

A third and perhaps most common misconception about LOS letter grades A-F is that they are comparable to school grades A-F. Although they share some basic similarities, there are some very important distinctions to make at a planning level. Although it is true that A is best and F is worst, this is strictly from a traveler perspective. LOS A is not necessarily a desirable goal to achieve from an overall transportation or societal perspective. In fact, LOS A in a peak travel hour could be an indicator of an inefficient use of limited funding. It is simply not cost effective to design the state's roadways to operate at LOS A during the peak hour. FDOT's LOS standards appearing in **Chapter 10** should therefore typically be considered a desirable condition during the peak hour, with significant variance from those standards in either direction an undesirable condition.

Although both LOS and letter grades use 'F' to represent a failing condition, there are more factors to consider when LOS reaches F. Essentially, LOS F either means travel demand exceeds capacity and the roadway is operating in oversaturated conditions, or another undesirable condition exists. However, oversaturated condition may only arise for a 15-minute or 1-hour period. Depending on the type and function of the facility, the condition may not necessarily warrant improvements for relatively short periods of congestion.

Although each of the methodologies for automobiles/trucks, bicycles, pedestrians, and buses make use of the LOS A-F scales, the meaning of A-F is not entirely consistent across the modes. Transportation professionals widely consider LOS D for the automobile mode an acceptable condition, and this threshold is often used as a design condition in urbanized areas. Both the bus and automobile LOS scales, however, were developed by transportation professionals, with the objective of classifying various levels of congestion in undersaturated conditions. It was members of the general public, however, who determined the derivation of the bicycle and pedestrian LOS thresholds, thus incorporating a general perception of LOS D as a largely undesirable condition. Because of this, LOS D likely represents a worse condition from the user perspective for the bicycle and pedestrian modes than the automobile and bus modes. FDOT and its research team evaluated and considered various methods to make the LOS thresholds more consistent across modes, but found no scientific basis to adjust the scales. Users should therefore simply be cautious about comparing the same LOS letter grade across modes.

The meaning of A-F is not entirely consistent across the modes.

3.2. Highway Capacity Manual

For capacity and automobile, pedestrian, and bicycle quality/level of service analysis, the Highway Capacity Manual (HCM) is the foremost recognized and accepted analysis tool. Furthermore, FDOT's Q/LOS Handbook and software are nationally recognized as the leading planning application of HCM for the evaluation of automobile, bicycle, and pedestrian LOS.

3.2.1. Traffic Flow and Capacity Concepts

The HCM defines two primary facility types: uninterrupted and interrupted flow facilities. The terms refer to the type of facility and therefore the analysis type, not the quality of traffic flow at any given time.

Uninterrupted flow facilities are roadways that have no fixed causes of periodic delay or interruption to the traffic stream, such as signals or STOP signs.

Uninterrupted flow facilities have no fixed causes of delay or interruption external to the traffic stream. Freeways represent the purest form of uninterrupted flow, as there are no fixed interruptions to traffic flow and access to the facilities are limited to ramp locations. Multilane and two-lane highways operate under uninterrupted flow in long segments between points of fixed interruption (e.g., traffic signals), but it is often necessary to examine the points of fixed interruption using interrupted flow methodologies.

Interrupted flow facilities are roadways that have fixed causes of periodic delay or interruption to the traffic stream—such as signals or STOP signs—with average spacing less than or equal to 2.0 miles.

Interrupted flow facilities have fixed causes of periodic delay or interruption to the traffic stream, such as traffic signals or STOP signs. Traffic flow patterns on interrupted flow facilities are the result not only of vehicle interactions and the facility's geometric characteristics, but also of the traffic control used at intersections and frequency of access points to the facility. Traffic signals, for example, allow designated movements to occur only during portions of the signal cycle, and therefore affect both flow and capacity as the facility is not available for continuous use. Traffic signals also create platoons of vehicles that travel along the facility as a group. By contrast, all-way STOP controlled intersections and roundabouts discharge vehicles more randomly, creating periodic but sometimes small gaps in traffic at downstream locations.

Person flow is capacity on uninterrupted and interrupted flow facilities defined in terms of persons per hour.

Capacity on uninterrupted and interrupted flow facilities can be defined in terms of persons per hour, passenger cars per hour, or vehicles per hour depending on the type of analysis or system element. **Person flow** is often an important concept in making strategic decisions regarding transportation modes in heavily traveled corridors and in defining the role of transit and high-occupancy-vehicle priority treatments.

Reasonable expectancy is the basis for defining capacity. Capacity is therefore not the absolute maximum flow rate observed on a facility, but rather a flow rate that can be achieved repeatedly for peak periods of sufficient demand.

Prevailing roadway, traffic, and control conditions define capacity.

Prevailing roadway, traffic, and control conditions define capacity; these conditions should be relatively uniform for any segment of a facility that is analyzed. Base conditions, by comparison, assume optimum conditions, including good weather, dry pavement conditions, users who are familiar with the system, and no impediments to traffic flow. In most cases, prevailing conditions differ from base conditions (e.g. there are trucks in the traffic stream, rolling terrain, etc.). As a result, computations of capacity, service flow rate, and LOS must include adjustments to capacity under base conditions.

3.2.2. Bicycle LOS

Bicycle LOS is based on bicyclists' perceptions of the roadway environment. Bicycle LOS is based on five variables with relative importance (T statistic) ordered in the following list:

- average effective width of the outside through lane
- motorized vehicle volumes
- motorized vehicle speeds
- heavy vehicle (truck) volumes
- pavement condition

Average effective width is largely determined by the width of the outside travel lane and striping for bicyclists, but also includes other factors such as the effects of street parking and drainage grates. Each of the variables is weighted by coefficients derived by stepwise regression modeling importance. A numerical LOS score, generally ranging from 0.5 to 6.5, is determined and stratified to a LOS letter grade. Thus, unlike the determination of automobile LOS in which there is typically only one service measure (e.g., average travel speed), bicycle LOS is determined based on multiple factors.

Bicycle LOS is based on bicyclists' perceptions of the roadway environment.

3.2.3. Pedestrian LOS

Like bicycle LOS, pedestrian LOS is based on the pedestrians' perceptions of the roadway or nearby roadside environment. Pedestrian LOS is based on four variables with relative importance (T statistic) ordered in the following list:

- existence of a sidewalk
- lateral separation of pedestrians from motorized vehicles
- motorized vehicle volumes
- motorized vehicle speeds

The weighting of each variable is determined by stepwise regression modeling. A numerical LOS score, generally ranging from 0.5 to 6.5, is determined along with the corresponding LOS letter grade. Thus, like the bicycle LOS approach (but unlike the automobile approach), pedestrian LOS is determined based on multiple factors.

Because the pedestrian LOS model applies to the roadway or nearby roadside environment, applying the model to pedestrian facilities significantly greater than 100 feet from a roadway may exceed the validated range of the model.

Pedestrian LOS is based on the pedestrians' perceptions of the roadway or nearby roadside environment.

3.3. Transit Capacity and QOS

The Transit Capacity and Quality of Service Manual (TCQSM) is the nation's leading document for transit and quality/level of service analysis. Part 5 of the TCQSM deals specifically with QOS and includes LOS thresholds. Transit related text in the HCM comes from applicable text in the TCQSM dealing with transit operating on roadways. As used in this Q/LOS Handbook, transit or bus is limited to scheduled fixed route bus transit. The TCQSM techniques, supplemented by FDOT's Transit Level of Service (TLOS) software, should be used to evaluate bus Q/LOS at an operational level.

One significant exhibit in the TCQSM is a table for urban scheduled transit service based on service frequency. In essence, **Table 3-1** replicates this TCQSM table, but includes Florida-specific modifications to the adjusted service frequency.

Table 3-1
Service Frequency LOS Thresholds

Level of Service	Adjusted Service Frequency (Vehicles/hour)	Headway (minutes)	Comments
A	>6	<10	Passengers don't need schedules
B	>4	<15	Frequent service, passengers consult schedules
C	≥3	≤20	Maximum desirable time to wait if transit vehicle missed
D	≥2	≤30	Service unattractive to choice riders
E	≥1	≤60	Service available during hour
F	<1	>60	Service unattractive to all riders

3.4. Simplifying Assumptions

Planning level analyses make extensive use of default values and simplifying assumptions to the operational models on which they are based. As such, there are multiple simplifying assumptions used in this Q/LOS Handbook and accompanying software.

3.4.1. Averages

This Q/LOS Handbook makes extensive use of averages. For generalized planning (Generalized Service Volume Tables), most of the default input variables represent statewide averages. Similarly, for generalized planning, **simple averages** are recommended. For example, if an arterial facility has daily volumes of 20,000, 25,000, and 24,000, it would be reasonable to use the average (23,000) of the three. However, users should be cautious of outlying values and use some judgment when applying simple averages. In the above example, if the first value were only 10,000, the user may want to disregard that value or use the median value (i.e., 24,000). For facility analyses at the conceptual planning level for automobiles and buses, LOS determinations use an average, typically weighted by segment lengths (**weighted average**). For example, in determining average travel speed of automobiles on arterials or freeways, the length of the segments is included within the calculation of the average. The same is true for bus analyses. For example, if two buses serve 1 mile of a facility, and one bus serves 3 miles of the facility, the weighted average for bus frequency for the entire 4-mile facility would be 1.25 ([2x1 + 1x3]/4).

Two explicit exceptions exist to the simple average or weighted average by distance: (1) treatment of the effective green ratio (g/C) in the Generalized Service Volume Tables and (2) evaluation of bicycle and pedestrian LOS accounting for segments providing poor service.

A simple average is an average that gives equal weight to each component.

For generalized planning, simple averages are recommended.

A weighted average is an average that results from multiplying each component by a factor reflecting its length or importance.

For facility analyses at the conceptual planning level, weighted averages are recommended.

The weighted effective green ratio is the average of the critical intersection's through g/C and the average of all the other signalized intersections' through g/Cs along the arterial facility.

The amount of green time that traffic movements receive at signalized intersections is one of the most significant variables in automobile Q/LOS and capacity analyses. A major simplifying assumption essential to the development of the Generalized Service Volume Tables is the selection of a single effective green ratio (g/C) for all the intersections along the arterial. A fundamental question arises as to what green time value to assume, given that intersections frequently have widely varying green times. The average green time for through movements along the entire arterial, the green time at a critical intersection where the greatest delay is likely to occur, or some other value could potentially be used. FDOT has determined that for generalized planning analyses, the **weighted effective green ratio** yields the closest results to actual conditions. The weighted effective g/C of an arterial is the average of the critical intersection through g/C and the average of all other through g/Cs. In other words, the worst intersection is given equal weight to all other intersections combined. For conceptual planning analyses, there is rarely a need to use weighted effective green ratios. The weighted g/C approach is probably only needed when it is desired to develop a generalized service volume table.

Bicyclists and pedestrians do not simply evaluate a roadway by its average conditions. Rather they put extra weight on poor conditions.

To determine bicycle and pedestrian LOS for a facility, FDOT uses a weighted average approach in which each segment is weighted by its distance and the severity of the scores. Essentially, FDOT is taking the position that bicyclists and pedestrians do not simply evaluate a roadway by its average conditions. Rather they put extra weight on poor conditions.

3.4.2. Turning Movements

One of the most significant planning assumptions is that mainline turning movements are adequately accommodated. Within this Q/LOS Handbook, the through movement is defined as the traffic stream with the greatest number of vehicles passing directly through a point. While this movement is typically straight ahead, occasionally the through movement is a right or left turn, with the straight ahead movement considered a turning movement.

Most analyses of through movements in the HCM are relatively straightforward. Complications arise with the treatment of turning/merging movements, especially for signalized intersections and arterials. By handling turning arterial movements (i.e., turns from the arterial, side street movements) in a general way, Q/LOS and capacity analyses are greatly simplified. This is also true for some two-lane uninterrupted flow highways in which mid-block turning movements may affect capacity. Off and on-ramp movements along freeways are also handled in a general way and are assumed to be adequately accommodated. Most importantly, it is assumed that movements at off-ramps do not back up into the through lanes of the freeway.

Where turning movements are not adequately accommodated, the planning techniques found in this Q/LOS Handbook and accompanying software are not appropriate. Although the arterial analysis in this Q/LOS Handbook includes all vehicles on the arterial, it focuses on the through movement. For example, only the green time for the through movement is included and penalties are assigned if there are no left turn lanes at signalized intersections and no medians exist mid-block.

3.4.3. Queue Spillback

Another major assumption is that turning movements do not back up into adjacent through lanes. Essentially, adequate storage is assumed to be available for left turning vehicles on arterials and for vehicles exiting freeways. FDOT's conceptual planning programs have been enhanced to perform basic capacity checks to see if **queue spillback** is likely to occur; if so, the software provides a warning to the user. However, the results of the analysis would not include any of these potential queue spillback effects. Therefore, where mainline turning movements are not adequately accommodated, the planning techniques found in this Q/LOS Handbook and accompanying software are not appropriate.

Queue spillback is when a link's queue of vehicles extends on to upstream links.

3.4.4. Capacity

For HCM analyses of uninterrupted flow facilities, capacity is set in terms of passenger cars per hour per lane. Free flow speed is estimated based on other variables such as percent heavy vehicles, driver population, median type, and lateral clearance. In the HCM, those variables affect free flow speed, not capacity.

Free flow speed is the average speed of vehicles under low flow traffic conditions and not under the influence of signals, STOP signs, or other fixed causes of interruption.

Free flow speed is generally assumed to be 5 mph over the posted speed limit for planning purposes.

For HCM analyses of interrupted flow facilities, capacity represents the maximum number of vehicles that can pass a point during a specified time period under prevailing roadway, traffic, and control conditions. Variables affect capacity, not free flow speed. This capacity approach is common in traffic engineering literature. Largely for consistency across both uninterrupted flow facilities and interrupted flow facilities, this Q/LOS Handbook and accompanying software primarily rely on and report capacity values based on the interrupted flow concept of capacity, with free flow speed being considered a roadway variable input. For planning purposes, the assumed **free flow speed** is 5 mph over the posted speed limit (although in the software analysts may override this planning assumption). Regardless, ARTPLAN, FREEPLAN, and HIGHPLAN software all follow the HCM calculation processes.

3.4.5. Bus Frequency

Bus frequency is the number of buses per hour serving one direction of a roadway facility.

Bus frequency is the single most important factor in determining the Q/LOS to transit users.

For transit analysis planning purposes, the most significant assumption is that **bus frequency** is the single most important factor in determining the Q/LOS to transit users along a transit route segment or roadway facility. FDOT, in cooperation with the TCQSM authors and others, has incorporated that concept. Certainly, LOS varies for individual transit users along a facility, but in the determination of bus LOS along a transit route segment or roadway facility, the availability of buses is usually the more relevant performance measure.

3.5. Planning Extensions

Although the methodologies used in this Q/LOS Handbook are consistent with those found in the 2010 HCM and the TCQSM, in some circumstances, it is necessary to deviate from these methodologies. Both the HCM and the TCQSM outline detailed operational models that are not appropriate in all cases for planning applications. Thus, FDOT needed to develop some planning applications of the methodologies (LOSPLAN). In all cases, the extensions or variations were coordinated with leaders of the source documents to be as consistent as possible with the methodologies.

A more detailed description of the generalized planning approach that includes these extensions is provided in **Chapter 11**.

3.5.1. FREEPLAN

Features

Major features of FREEPLAN are:

- Use of the HCM as the primary resource document for the methodology such that the FREEPLAN methodology should not be inconsistent with the HCM, but, as appropriate, extend the HCM for generalized and conceptual planning purposes
- Concentration on the through vehicle, while being sensitive to the analysis of other vehicles on the freeway and on segments of the freeway
- The approach is structured towards combining segments (e.g., interchange areas, toll plaza influence areas), rather than combining point analyses (e.g., ramps)
- LOS thresholds based on density
- Capacity reductions in interchange areas
- Capacity considerations associated with auxiliary lanes, ramp metering, length of acceleration and deceleration lanes, and ramp terminals
- Use of a local adjustment factor or driver population factor based primarily on area type

- Use of the most recent national research on weaving areas from the 2010 HCM
- Resulting volumes matching reasonably well with actual Florida traffic counts

Interchange Influence Areas

Within interchange influence areas, the base saturation flow rate for the two outside lanes are reduced by:

- 200 passenger cars per hour per lane for off-ramp influence areas; and
- 100 passenger cars per hour per lane for on-ramp influence areas.

Auxiliary Lanes

Auxiliary lane adjustments are handled completely within the weaving segment analysis.

Auxiliary lanes are additional lanes on freeways that connect on-ramps and off-ramps of adjacent interchanges. Consistent with the HCM 2010 methodology, auxiliary lane adjustments are handled completely within the weaving segment analysis, and no capacity reductions are made for auxiliary lanes within segments too long for weaving analysis to be performed.

Ramp Metering

Freeway ramp metering has the positive benefit of smoothing out traffic demand on to a freeway during the peak period.

Freeway ramp metering has the positive benefit of smoothing out traffic demand on to a freeway during the peak period. This positive benefit is reflected by increasing the volumes shown on the Generalized Service Volume Tables by 5 percent.

Measured Freeway Volumes

Actual Florida freeway volumes seldom exceed an average of 2,100 vehicles per lane per hour in urbanized areas and 1,800 vehicles per hour per lane in rural areas. By applying the interchange capacity reductions and statewide defaults for the peak hour factor, heavy vehicle percentage, and local adjustment factor, the calculated volumes match very well with actual volumes.

3.5.2. HIGHPLAN

Passing Lanes

The HCM does not adequately address the effectiveness of passing lanes when taking into account the length of facility. After discussions with key members of the committee overseeing the HCM, FDOT has established their effectiveness based on the proportion of passing lane coverage.

3.5.3. ARTPLAN

Adjusted Saturation Flow Rate

Research in Florida indicates that an area's population size, number of lanes, and speed limit have effects on adjusted saturation flow rates. Furthermore, as traffic queues get longer, traffic pressure affects capacity. Although not currently in the HCM, these effects are included in FDOT's generalized and conceptual planning software program ARTPLAN.

Add-On/Drop-Off Lanes

The HCM does not directly address the situation where lanes that carry through traffic are added before a signalized intersection and dropped after the intersection. The **add-on/drop-off lane** (or expanded intersection) will contribute to intersection capacity, but likely not to the extent of a full through lane. The add-on/drop-off lane contains up to half the capacity of a full through lane.

An add-on/drop-off lane is a roadway lane added before an intersection and dropped after the intersection.

For any capacity benefit to be considered two conditions should be met:

- both the add lane and drop lane must each be at least 800 feet in length, and
- the add-on/drop-off pair combined must be at least 1,760 feet in length

For additional discussion, see **Section 4.3.1**.

One-way pairs are assumed to have 20 percent higher service volumes than corresponding two-way roadways with the same number of lanes.

FDOT has adopted different control delay criteria for urban and rural areas.

One-Way Streets

For the evaluation of one-way streets, the Generalized Service Volume Tables include a factor that has been approved by the LOS Task Team, but not contained within the HCM. Essentially, one-way pairs are assumed to have a 20 percent higher service volumes than corresponding two-way roadways with the same number of lanes.

Rural LOS Criteria

The LOS service thresholds found in the HCM are primarily determined by urbanized area conditions. For example, the maximum control delay at a signalized intersection for LOS D is 55 seconds. While that value may be reasonable based on user perception in an urbanized area, in a small town or at an isolated intersection on a rural highway, that delay would certainly be considered F. To overcome this difference in user perception, FDOT has adopted different control delay criteria in rural undeveloped and rural developed areas. The criteria are one-half, rounded up, of the urbanized area criteria. For arterials in rural developed areas, arterial Class I LOS thresholds apply. These revised LOS criteria are directly imbedded in FDOT's rural undeveloped and rural developed Generalized Service Volume Tables and software. The LOS criteria appear on the back of the tables.

3.5.4. Bicycle LOS Model

Facility LOS

The HCM's Bicycle LOS Model was developed and calibrated at a roadway segment level. However, from the beginning of FDOT's planning LOS program, facilities (e.g., 4 miles of an arterial or freeway) not segments or points (e.g., signalized intersections) have been emphasized. For example, the Generalized Service Volume Tables are applicable for automobile LOS at a facility level, not for a given segment or intersection/interchange along those facilities.

For consistency, a method was needed to aggregate the individual segment bicycle analyses into a facility analysis. The aggregation method is especially important when one considers the continuity of a paved shoulder/bicycle lane existence over some segments, but not over the entire facility. Portions of a facility may offer reasonably good quality of service, but other portions may be so poor that many bicyclists are discouraged from riding on the facility altogether.

Each segment is weighted by its distance and LOS score to determine the facility LOS for bicyclists. Specifically, the bicycle LOS for a facility is given by the following equation:

$$\text{BLOS}_f = \sum d_1\,(b_1)^2 + \;...\; d_n\,(b_n)^2 / \sum d_1\,(b_1) + \;...\; d_n\,(b_n)$$

Where:

BLOS_f	=	Bicycle level of service for the facility
d_1	=	Length of the first segment
b_1	=	Bicycle level of service score for the first segment
d_n	=	Length of the last segment
b_n	=	Bicycle level of service score for the last segment

Heavy Vehicles

Bicyclists are affected by the windblast effect of heavy vehicles. To bicyclists, it is primarily the number of heavy vehicles that is important, not the percentage of heavy vehicles. In developing the HCM's Bicycle LOS Model, the percent of heavy vehicles proved to be a useful factor largely because traffic and heavy vehicle volumes were in typical ranges. When traffic or heavy vehicle volumes are extremely low or high, distortions in the results from using the percent of heavy vehicles may occur. Working with the developers of the Bicycle LOS Model, FDOT developed some calculation techniques in ARTPLAN to better account for the number of heavy vehicles, as opposed to strictly the percent of heavy vehicles.

To bicyclists, the number of heavy vehicles is more important than the percentage of heavy vehicles.

3.5.5. Pedestrian LOS Model

Much like the bicycle LOS model, the HCM's Pedestrian LOS Model was developed and calibrated at a roadway segment level. However, for consistency, a method was needed to aggregate the individual segment pedestrian analyses into a facility analysis. The aggregation method is especially important when the sidewalk coverage is not continuous over the entire facility. Portions of the facility may offer reasonably good quality of service, but other portions may be so poor that many pedestrians are discouraged from walking along the facility altogether.

Each segment is weighted by its distance and the severity of its pedestrian LOS score to determine the facility LOS for pedestrians. Specifically, the pedestrian LOS for a facility is given by the following equation:

$$\text{PLOS}_f = \sum d_1\,(p_1)^2 + \ \dots\ d_n\,(p_n)^2 / \sum d_1\,(p_1) + \ \dots\ d_n\,(p_n)$$

Where:

PLOS_f	=	Pedestrian level of service for the facility
d_1	=	Length of the first segment
p_1	=	Pedestrian level of service score for the first segment
d_n	=	Length of the last segment
p_n	=	Pedestrian level of service score for the last segment

3.5.6. TCQSM

Pedestrian considerations are the second most important determinant of bus LOS.

Although pedestrian access to transit is recognized as important in the TCQSM, it did not provide guidance on how to incorporate pedestrian factors. The methodology in this Q/LOS Handbook makes use of pedestrian considerations as the second most important determinant of bus LOS along a transit route segment or facility. The Generalized Service Volume Tables use sidewalk coverage along a facility as the factor for pedestrian access to transit. Within ARTPLAN, several important pedestrian considerations are included to determine an adjusted bus frequency and bus LOS. These considerations include pedestrian LOS, roadway crossing difficulty, passenger load factor, and bus stop amenities. Favorable conditions have multiplicative factors greater than 1.0 and unfavorable conditions have values less than 1.0 and are applied to bus frequency to determine the adjusted bus frequency.

Pedestrian LOS

Pedestrian LOS is determined by the methodology contained in this Handbook and accompanying software (ARTPLAN). The Pedestrian LOS factors as they relate to bus LOS are shown in **Table 2-3**.

Table 3-2
Pedestrian LOS Adjustment Factors on Bus LOS

Pedestrian Level of Service (LOS)	Adjustment Factor
Pedestrian LOS A	1.15
Pedestrian LOS B	1.10
Pedestrian LOS C	1.05
Pedestrian LOS D	1.00
Pedestrian LOS E	0.80
Pedestrian LOS F	0.55

Roadway Crossing Difficulty

When catching a bus, transit users frequently have to cross a road. Crossing difficulty is typically influenced by three broad factors: traffic signal density, crossing length, and motorized vehicle volume. It is more difficult to cross roadways with low signal densities than roadways with closely spaced signalized intersections. Mid-block crossing difficulty increases with road width and lack of pedestrian refuges (i.e., restrictive, or raised, medians). Mid-block crossing difficulty also increases as the number of motorized vehicles increase, which results in fewer gaps. These three broad factors and others, such as motorized vehicle speed, are interrelated. To account for crossing difficulty in a general way, FDOT's conceptual planning approach includes a set of **roadway crossing adjustment factors** which are applied to help determine an adjusted bus frequency.

Crossing difficulty is typically influenced by three broad factors: traffic signal density, crossing length, and motorized vehicle volume.

Roadway crossing adjustment factors are used to determine the adjusted bus frequency by applying a factor that captures crossing difficulty.

Passenger load factors are used to determine the adjusted bus frequency value by applying a factor commensurate to the level of passenger crowding.

Bus stop amenity factors are used to determine the adjusted bus frequency value by applying a factor commensurate to the quality of bus stop amenities.

Bus stop type adjustment factors adjust travel times along bus routes by adding 15 to 35 seconds of delay per route for typical and major bus stops, respectively.

Passenger Load Factor

Bus crowding plays a role in the user's perception of quality of service, particularly on overcrowded buses when no seating is available. FDOT's approach includes a set of **passenger load factors**, which are applied to help determine the adjusted bus frequency value. These factors can be found in Chapter 7 of this Q/LOS Handbook.

Bus Stop Amenities

Passenger comfort and safety within the passenger waiting areas play a role in user perception of quality of service and the desirability of a transit system. FDOT's approach includes a set of **bus stop amenity factors**, which are used to help determine the adjusted bus frequency value. The factors can also be found in **Chapter 7** of this Q/LOS Handbook.

Bus Stop Type

Delay time at bus stops plays a role in travel times along routes, and thus impacts overall average travel speed. FDOT includes a **bus stop type adjustment factor**, which is used to add 15 to 35 seconds of delay per route for typical and major bus stops, respectively.

Bus Facility Analysis

The TCQSM structure for Q/LOS analysis consists of points (e.g., bus stops), route segments, and systems. It does not include a facility analysis. Nevertheless, to maintain consistency, a method of aggregating segment-level bus frequency to a facility-level was needed. At the conceptual level, ARTPLAN shows the LOS for each roadway segment and for the facility as a whole, based on bus frequency weighted by the distance of the segment lengths. At the generalized level, a simple average is acceptable. For example, if on a 3-mile facility, four buses serve the first 2 miles and two buses serve the last mile, then using a value of three buses [(4 + 2)/2] is acceptable for a generalized level analysis. For conceptual planning analyses, however, a weighted average of 3.3 buses [(4 × 2 + 2 × 1)/3] should be used.

3.6. Florida Specific Techniques

The technical foundation of FDOT's highway capacity and LOS program is the HCM. The previous sections have described simplifying assumptions and planning extensions FDOT has made to the HCM. As such, the guidance presented in this Q/LOS Handbook and the LOSPLAN software may be considered approximately 95 percent consistent with the HCM operational techniques. Nevertheless, in Florida, six analysis techniques are to be used in lieu of the HCM or other operational techniques.

3.6.1. Generalized Service Volume Tables

FDOT's Generalized Service Volume Tables were specifically generated for Florida and based on Florida-specific roadway, traffic, control, and multimodal data. The HCM's service volume tables are more general in nature and were not meant to supersede more specific state or local tables.

3.6.2. Freeway Facility Capacities

At a facility level the HCM/HCS will routinely provide capacity levels higher than seen on Florida's freeways. Freeway capacities should be based on what can reasonably be expected in Florida, not rare occurrences.

For freeway facilities and sections, the maximum generally acceptable volumes are as follows in vehicles per hour per lane (vphpl). See **Section 4.2** for discussion of area types.

- Large urbanized – 2,100 vphpl
- Other urbanized – 2,000 vphpl
- Transitioning – 1,900 vphpl
- Urban – 1,800 vphpl
- Rural – 1,800 vphpl

In general, a well-calibrated microsimulation software package is the preferred analytical approach at the freeway facility level. It is important to select the most appropriate tool when a new or modified access to limited access facilities is considered, as access changes will affect facility operations. The HCM remains the primary analytical tool at the point and segment levels. Results from a microsimulation analysis must still comply with the freeway facility capacity values provided above.

All LOS analyses of rural freeway facilities in Florida, including any microsimulation programs, must use the rural threshold criteria.

3.6.3. Rural Freeway LOS Criteria

The HCM's freeway LOS thresholds were developed with urban freeways in mind, not rural freeways. Whereas, the thresholds appear reasonable for urban travelers, they are not for rural freeway travelers. An FDOT/UF research project *[Rural Freeway Level of Service Based Upon Traveler Perceptions by Rural Freeway Travelers, Washburn, et. al., 2006]* conducted in Florida developed rural thresholds based on traveler perceptions. FDOT recommends the use of this research over the HCM, which has no LOS research for rural freeways. All LOS analyses of rural freeway facilities in Florida, including any microsimulation programs, must use the rural threshold criteria. The rural criteria are imbedded in FREEPLAN.

3.6.4. Arterial Facility LOS Criteria for Automobiles

In 1985, the HCM introduced the concept of arterial classes for interrupted flow facilities. Arterial classes have been a major feature of Florida's Generalized Service Volume Tables since their inception in 1987. Arterial class was essentially a categorization of arterials involving signalized intersection spacing, free flow speed, and location. LOS for arterials was based on average travel speed thresholds.

Percent of free flow speed is the percentage of vehicle average travel speed to free flow speed.

In developing the 2010 HCM, one of the last technical decisions made by the HCM committee was to do away with the concept of arterial class and introduce a new service measure, **percent of free flow speed**, to set LOS thresholds. Minimal testing of the new approach occurred.

Class 1 arterials are roadways that have posted speeds of 40 mph or higher.

Class 2 arterials are roadways that have posted speeds of 35 mph or less.

FDOT expressed some concern about the new approach in which LOS for all interrupted flow facilities ranging from low speed downtown streets to high speed suburban arterials could be fairly treated using the percent of base free flow speed criterion and thresholds. Research conducted by FDOT and the University of Florida indicated that relatively low speed arterials with short signal spacing (e.g., those in central business districts) would have lower LOS than with the previous versions of the HCM. FDOT did not consider this an acceptable practice. FDOT has therefore implemented a two-class system with new average travel speed thresholds. **Class 1 arterials** have posted speeds of 40 mph and higher. **Class 2 arterials** have posted speeds 35 mph and less.

The accepted practice in Florida for all highway capacity and LOS analyses of arterial facilities is to use this two-class system and LOS thresholds.

FDOT intends to conduct further research on this class system and determine acceptable free flow speeds before the next update of this Q/LOS Handbook.

3.6.5. Arterial Free Flow Speed

The 2010 HCM includes a process to calculate free flow speed on arterial segments and facilities. In general, for higher speed arterials (i.e., posted 45 mph and greater) the calculated free flow speed is less than the posted speed. Such an approach is not applicable in Florida where the vast majority of free flow speeds are higher than posted speeds. The accepted practice in Florida is to use 5 mph over the posted speed limit as the free flow speed. However, a roadway specific free flow speed study may be conducted and used.

3.6.6. Passing Lanes on Two-Lane Highways

The HCM does not adequately address the effectiveness of passing lanes when taking into account the length of facility being analyzed. After discussions with key members of the committee overseeing the HCM, FDOT has established passing lane effectiveness based on the proportion of passing lane coverage. The approach is incorporated into HIGHPLAN.

3.6.7. Exception Process

Under specific circumstances, any of these six cases could be approved through an exception process. As an example, from FDOT's permanent count stations, two known cases exist where freeway facility volumes approximate high volumes similar to what would be derived from an HCM analysis. An exception process would exist where these unusually high volumes would be used for an analysis of interchange access along those facilities.

3.7. Statewide Acceptable Tools

There are two FDOT supported and statewide acceptable highway capacity and LOS analysis tools for generalized and conceptual planning: FDOT's Generalized Service Volume Tables and FDOT's LOSPLAN software which includes ARTPLAN, FREEPLAN, and HIGHPLAN. These two tools form the core for all FDOT's highway capacity and LOS analyses and reviews in planning stages. Through detailed research and review, these generalized and conceptual planning tools can frequently result in more accurate analyses than more detailed unadjusted national operational tools. Each may be supplemented by other analyses, but they form the basis for all highway capacity and LOS analyses and determinations in Florida. To ensure that an analysis is consistent with Florida conditions and research, the inputs and volumes must be within the ranges specified in **Chapters 4 through 7** of this Q/LOS Handbook.

If there is conflicting guidance on the application of highway capacity or LOS analyses in other FDOT planning handbooks (e.g., Transportation Impact Handbook), the guidance above takes precedence while these other handbooks are being updated.

For the State Highway System and all proposed developments directly impacting the State Highway System, LOS analyses must be based on the HCM methodologies or a methodology determined by FDOT as having comparable reliability.

The misuse of level of analysis tools and the intermixing of level of analysis tools, especially at a conceptual planning level, is common in Florida. For the State Highway System and all proposed developments directly impacting the State Highway System, LOS analyses must be based on the HCM methodologies or a methodology determined by FDOT as having comparable reliability. Outside of the State Highway System, if an operational tool is needed to supplement an LOSPLAN analysis, FDOT recommends using the HCM/HCS. There are numerous reasons for this position including:

- State and national recognition of the HCM as the nation's leading resource on highway capacity and LOS analysis
- HCS is a faithful replication of the HCM methodology chapters and is the leading software implementing the HCM in Florida and the nation
- FDOT staff cannot be responsible for acquiring and reviewing all of the currently available software programs in the market
- Although other methodologies may be more accurate than the HCM in specific applications, they have not received the international acceptance based on national research conducted through the National Academies of Science Transportation Research Board

- Operational analysis based on the HCM/HCS offers statewide consistency in approach for the benefit of both the reviewers and analysts submitting analyses

Regardless of adoption or use by non-FDOT entities, FDOT will use the LOS Standards for the review of actions directly affecting the State Highway System for all planning and permitting processes.

The methodologies in this Q/LOS Handbook are generalized and conceptual planning applications from the following primary resource documents and analytical techniques using actual Florida roadway, traffic, and signalization data:

- 2010 HCM methodologies for automobiles, trucks, bicycles, and pedestrians
- 2003 Transit Capacity and Quality of Service Manual (TCQSM) for buses

Extensions of these operational techniques are presented in the previous sections.

3.8. Alternative Analysis Tools

While the Generalized Service Volume Tables and FDOT's LOSPLAN software are the preferred analysis tools for generalized and conceptual planning, alternative tools may be necessary depending on the scale of the analysis and the level of detail required.

The Federal Highway Administration's Traffic Analysis Toolbox defines seven categories of analysis tools:

- Sketch-planning tools produce general order of magnitude estimates of travel demand and traffic operations in response to transportation improvements.
    - QuickZone, STEAM, SPASM, IDAS
- Travel demand models forecast future travel demand based on current conditions and future projections of household and employment characteristics.
    - CUBE, TransCAD, VISUM

- Analytical/deterministic tools (HCM-based) quickly predict capacity, density, speed, delay, and queuing on a variety of transportation facilities.
    - LOSPLAN, Synchro, aaSIDRA
- Traffic signal optimization tools are primarily designed to develop optimal signal-phasing and timing plans for isolated signal intersections, arterial streets, or signal networks.
    - Synchro, TRANSYT-7F
- Macroscopic simulation models are based on the deterministic relationships of the flow, speed, and density of the traffic stream. The simulation in a macroscopic model takes place on a section-by-section basis rather than by tracking individual vehicles.
    - TRANSYT-7F, BTS, CORFLO
- Mesoscopic simulation models models combine the properties of both microscopic and macroscopic simulation models. As in microscopic models, the mesoscopic models' unit of traffic flow is the individual vehicle.
    - DYNASMART-P, DynusT
- Microscopic simulation models simulate the movement of individual vehicles based on car-following and lane-changing theories.
    - VISSIM, CORSIM, SimTraffic, Paramics
- Hybrid Models employ microscopic and mesoscopic models simultaneously. These tools are intended to be applied to very large networks containing critical subnetworks connected by several miles of essentially rural facilities.
    - Aimsun, TransModeler

One additional tool not described by FHWA is the Quick Estimate Method (QEM), which is a simple method for determining the critical intersection volume-to-capacity ratio, signal timing, and delay for a signalized intersection. The method is discussed in Chapter 31 of the HCM. Although the method is computationally intensive, it requires fewer inputs than is typically required for a full intersection analysis within the HCS software. At a minimum, the analyst must provide traffic volumes and the approach lane configuration for the subject intersection. Default or actual values for additional variables may also be used, including the phasing plan, presence of on-street parking, signal coordination plans, and area type. The method produces approach delay and intersection delay, which can be used to estimate LOS with limited data requirements.

Florida's LOSPLAN software, other HCM-based tools, and travel demand models are typically **deterministic**, or not subject to randomness. Each model run of a deterministic model will produce the same outcome. All analysts will obtain the same results shown in the Generalized Service Volume Tables using the LOSPLAN software along with the inputs provided. Most simulation models, on the other hand, are **stochastic**, and incorporate variability and uncertainty into the analysis using random number sequences.

Deterministic models are not subject to randomness.

Stochastic models incorporate variability and uncertainty into analysis.

These alternative analysis tools may be considered when one or more of the following conditions apply:

- The facility includes non-standard elements not included within the LOSPLAN software capabilities
- The evaluation of alternatives requires the application of additional performance measures not included within the LOSPLAN software
- Routing is an essential part of the problem being addressed
- Detailed vehicle interaction measures are necessary for the analysis, such as turn lane spillback impacts
- Demand levels predict oversaturated conditions over a substantial part of the peak hour

While not applicable under all circumstances, the LOSPLAN software is based on peer-reviewed methodologies that have been determined to adequately model traffic flow under most conditions without the need to rely on more time-intensive analysis methods. When alternative tools produce similar performance measures to those provided by LOSPLAN using more detailed analysis methods, the time needed to set up and calibrate the model, generate output, and validate results should always be considered alongside the benefits associated with the use of the alternative analysis tool.

4 ROADWAY VARIABLES

Florida's Generalized Service Volume Tables and the conceptual planning software that produces them are based on the 2010 HCM, Transit Capacity and Quality Service Manual (TCQSM), and Florida roadway, traffic, control (signalization), and multimodal data. The resulting tables and programs are valid in Florida, and their use for generalized and conceptual planning applications is encouraged by FDOT. Recognizing varying characteristics with the state and differing roadway, traffic, control, and multimodal characteristics, the Generalized Service Volume Tables are not adequate for all analysis needs. **Chapters 4 through 7** therefore provide a description of input variables needed to use the LOS software in order to allow the user to recognize these variations and analyze specific roadways.

Roadway variables describe the geometric and functional characteristics of a facility. Not all roadway variables are applicable to all roadway types, and the following list provides an indication of the roadway type the variable is used to describe (Arterial = A, Highway = H, Freeway = F):

- **Roadway Type** (A, H, F)
- Roadway Class (A)
- **Area Type** (A, H, F)
- **Number of Through Lanes** (A, H, F)
- Posted Speed (A, H, F)
- Free Flow Speed (A, H, F)
- Acceleration/Deceleration Lanes (F)
- Median Type (A, H)
- Terrain (H, F)
- Percent No Passing Zone (H)
- **Exclusive Left Turn Lanes** (A, H)
- Exclusive Right Turn Lanes (A)
- Roadway Lengths (A, H, F)
- Freeway Segments (F)
- Exclusive Left Turn Storage Length (A)
- Passing Lanes (H)
- Passing Lane Spacing (H)

Default values should not be used as part of a conceptual planning analysis for bolded values.

Table 4-1 provides an overview of the roadway variable input requirements within the Generalized Service Volume Tables and the LOSPLAN software.

Table 4-1
Roadway Input Requirements

Input Variable	Generalized Service Volume Tables	ART PLAN	FREE PLAN	HIGHPLAN	
				2-Lane	Multilane
Roadway Type	R	F	F	F	F
Roadway Class	R	F	-	-	-
Area Type	R	F	F	F	F
Number of Through Lanes	R	S	S	F	F
Posted Speed	D	S	F	F	F
Free Flow Speed	D	S	S	F	F
Acceleration/Deceleration Lanes at least 1,500 feet	D	-	S	-	-
Median Type	R	S	-	-	F
Terrain	D	D	S	F	F
Percent No Passing Zones	D	-	-	F	-
Exclusive Left Turn lanes	R	S	-	S	-
Exclusive Right Turn Lanes	R	S	-	-	-
Roadway Lengths	D	S	S	F	F
Freeway Segments	D	-	F	-	-
Exclusive Left Turn Lane Storage Length	D	S	-	-	-
Passing Lanes	R	-	-	F	-
Passing Lane Spacing	D	-	-	F	-

Legend:
R Required Table Input
S Segment/Point Specific
D Default Cannot be Altered
F Facility Specific
– Not Applicable

Additionally, the effects that individual variables have on the computational process vary. **Table 4-2** indicates the sensitivity of the variables on highway capacity and LOS. Variables that have a high degree of sensitivity on service volumes (shown in **bold** on the first page of this chapter) should not be defaulted when a conceptual planning analysis is being conducted. The LOSPLAN programs highlight these variables and require analysts to provide specific values before the programs calculate capacity and LOS.

Table 4-2
Sensitivity of Roadway Variables on Service Volumes

Roadway Variables	Sensitivity on Service Volumes
Roadway Type	high
Roadway Class	medium
Area Type	high
Number of Through Lanes	high
Posted Speed	medium
Free Flow Speed	medium
Acceleration/Deceleration Lanes at least 1,500 feet	low
Median Type	low
Terrain	low
Percent No Passing Zones	low
Exclusive Left Turn Lanes	high
Exclusive Right Turn Lanes	medium
Roadway Lengths	low
Freeway Segments	medium
Exclusive Left Turn Lane Storage Length	medium
Passing Lanes	low
Passing Lane Spacing	low

4.1. Roadway Type

Compatible with the terminology of the HCM, this Q/LOS Handbook and accompanying software are based on three major roadway types:

- Freeways
- Uninterrupted flow highways
- Interrupted flow roadways

4.1.1. Freeways

Freeways are divided highways with at least two lanes in each direction and full access control.

Freeways are multilane, divided highways with at least two lanes for exclusive use of traffic in each direction and full control of ingress and egress.

4.1.2. Highways

Uninterrupted flow highways are non-freeway roadways that generally have uninterrupted flow, with average signalized intersection spacing greater than 2.0 miles.

Uninterrupted flow highways are roadways with a combination of roadway segments, which have average signalized intersection spacing greater than 2 miles and are not freeways. Because of the significantly different operating characteristics, these types of roadways are frequently also distinguished as two-lane highways and multilane highways.

4.1.3. Arterials

Interrupted flow roadways are roadways with fixed causes of periodic delay or interruption and average signalized intersection spacing less than or equal to 2.0 miles.

Interrupted flow roadways are characterized by signals with average signalized intersection spacing less than or equal to 2 miles. In this Q/LOS Handbook and accompanying software, signalized arterials are the predominant type of interrupted flow roadway. They primarily are operated by the state and serve through traffic. Also included in this category are signalized non-state roadways, but not local streets. As used here, signalized intersections refer to all fixed causes of interruption to the traffic stream, and may occasionally include STOP signs or other control types.

Arterials are further classified based on posted speed. There are two arterial classes:

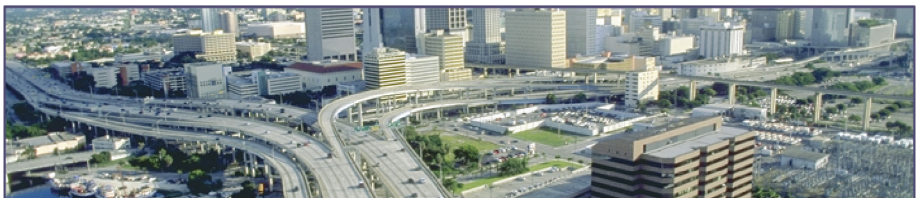
- **Class I** – Arterials with a posted speed of 40 mph or greater
- **Class II** – Arterials with a posted speed of 35 mph or less

4.2. Area Type

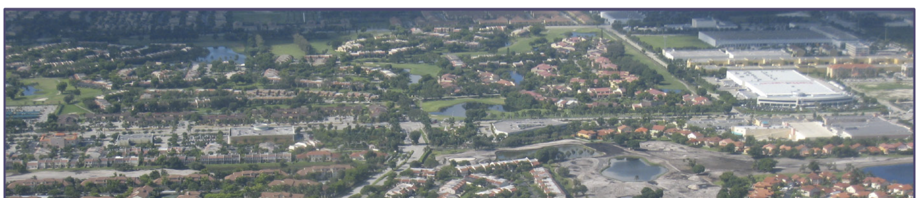
Three broad area type groupings are used in this Q/LOS Handbook and accompanying software, as shown in **Figure 4-1**:

- Urbanized areas
- Transitioning/urban areas (transitioning into urbanized/urban areas or areas over 5,000 population not in urbanized areas)
- Rural areas (rural undeveloped areas and cities or developed areas less than 5,000 population)

Figure 4-1
Area Types

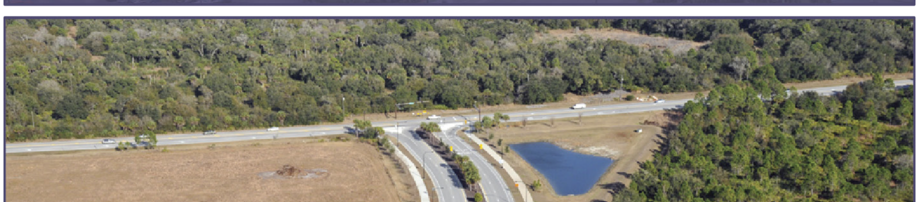


Urbanized Area



Transitioning Area

Urban Area



Rural Area

The area types in the Generalized Service Volume Tables and software match well with FDOT's LOS standards; however, there are a few special cases. FDOT District LOS Coordinators (**Chapter 13**) should be consulted for applicable boundaries within their districts.

There may be small lengths of roadways (e.g., approximately 6 miles for freeways, 3 miles for non-freeways) between area types or adjacent to an area type which from a logical and analytical sense should be combined into one area type or another.

These situations typically occur with adjacent interchanges or in transitioning areas, but may also occur elsewhere. FDOT districts have the flexibility to adjust the area type boundaries or designate a roadway with a certain area type under these circumstances.

As Florida's population grows, area types may change for a specific location or roadway in future years. FDOT's district offices (contact information available online at http://www.dot.state.fl.us/publicinformationoffice/moreDOT/districts/district.shtm) should be consulted if analysts believe different area types are appropriate for a future study period.

4.2.1. Urbanized Areas

The minimum population for an urbanized area is 50,000.

Large urbanized refers to an MPO urbanized area greater than 1,000,000 in population.

Other urbanized refers to an MPO urbanized area less than 1,000,000 in population.

Urbanized areas are defined by the Federal Highway Administration (FHWA) approved boundary, which encompasses the entire Census Urbanized Area, as well as a surrounding geographic area as agreed upon by FDOT, FHWA, and the Metropolitan Planning Organization (MPO). The minimum population for an urbanized area is 50,000.

All urbanized areas are combined in Tables 4 and 7 of the Generalized Service Volume Tables, regardless of size. However, in both Table 1 as well as the software, urbanized area types are distinguished by whether the population of an area is greater than or less than 1,000,000. Currently, the over 1,000,000 grouping applies to the MPO areas that include central cities: Ft. Lauderdale, Jacksonville, Miami, Orlando, St. Petersburg, Tampa, and West Palm Beach. In the software, these are referred to as **Large Urbanized**. The Large Urbanized category does not extend to adjacent MPO areas. The urbanized areas less than 1,000,000 population are referred to as **Other Urbanized**. Florida research has shown driver aggressiveness increases with area population. This increases the saturation flow rate, yielding higher service volumes.

4.2.2. Transitioning Areas

Transitioning areas are fringe areas that exhibit characteristics between rural and urbanized/urban. Transitioning areas are intended to include areas that, based on their growth characteristics, are anticipated to become urbanized or urban in the next 20 years.

Frequently the Metropolitan Planning Area is used for the transitioning area adjacent to an FHWA Urbanized Area (Adjusted Census Urbanized Area Boundary). The definition of Metropolitan Planning Area specifically mentions the "contiguous area expected to become urbanized with the 20-year forecast period." It is the contiguous area that should be considered the transitioning area. However, in practice, most MPOs have not specifically delineated those contiguous or transitioning areas and many of the Metropolitan Planning Areas extend to remote rural areas of counties. In situations where the MPO does not identify these transitioning areas, or areas adjacent to urban (but not urbanized) areas, FDOT Districts, in cooperation with local governments, may delineate transitioning areas for LOS purposes.

There is no established statewide process for designating transitioning areas. For example, some districts may prefer having signatures of approval for the boundaries while other districts may designate the areas less formally. For understanding by all potential parties involved, keeping the boundaries relatively consistent over time is desirable. The transitioning boundary should be reviewed and adjusted as a part of the census cycle update consistent with the setting of the FHWA Urbanized Area boundaries. It may also be appropriate to review the transitioning boundary in conjunction with a Long Range Transportation Plan update. Regardless, short time frame updates to respond to individual development projects or political desires should be avoided. For these reasons FDOT District LOS Coordinators should be consulted for transitioning boundaries within their districts. It is recommended that boundaries for transitioning areas be based on the location of major roadways or at interchanges. This avoids portions of a freeway changing from transitioning to urbanized or rural between interchanges. It is desirable for an arterial to have the same designation between major roadways and not change mid-block. In cases where aligning the boundary with major roads is impractical, see the text below on treatment of small lengths of roadways.

Transitioning areas are areas that exhibit characteristics between rural and urbanized/ urban areas.

Based on their growth characteristics, transitioning areas include areas that are anticipated to become urbanized or urban in the next 20 years.

4.2.3. Urban Areas

Urban areas are located outside of urbanized areas and have populations between 5,000 and 50,000.

An **urban area** has a population between 5,000 and 50,000 and is not within an urbanized area. Boundaries for cities over 5,000 population and not within urbanized areas are primarily set by existing city limits and must be agreed upon by FDOT, the local government, and FHWA. However, the 5,000 population threshold is primarily a surrogate for areas that exhibit urban traffic characteristics. In situations where a city has less than 5,000 population (e.g., 3,000), but the surrounding area has more than 5,000 population (e.g., 10,000), and the city has an urban character, then it is reasonable to use the over 5,000 population classification in the Generalized Service Volume Tables and urban classification in the software.

Other situations exist where an area has over 5,000 population and yet, the area is more characteristic of a rural developed area. In this situation, it is reasonable to use the developed area less than 5,000 population sections of Generalized Service Volume Tables 3, 6, and 9, and the rural developed classification in the software. In both of these situations, FDOT district planning offices, after consultation with the central office, should make a determination as to the appropriate area type designation to use.

4.2.4. Rural Areas

Rural areas consist of two types:

Rural undeveloped refers to portions of rural areas with no or minimal population or development.

- **Rural undeveloped** – areas in which there is no or minimal population or development
- **Rural developed** – areas consisting of cities and other population areas with less than 5,000 population or along coastal roadways.

Rural developed refers to portions of rural areas that are along coastal roadways or in generally populated areas with a population less than 5,000.

Generally, the cities or developed areas portion of the Generalized Service Volume Tables should be applied to areas with a population between 500 and 5,000, and not immediately adjacent to urbanized, urban, or transitioning areas. This portion of the tables also should be generally applied to coastal roads not in urbanized, urban, or transitioning areas.

4.3. Number of Through Lanes

The number of through lanes is one of the most important variables to analyze a roadway's capacity and LOS. Emphasis is placed on through lanes, or lanes that directly accommodate through traffic. The number includes shared lanes (e.g., through/right), but does not include exclusive turn lanes or two-way left turn lanes on arterials, auxiliary lanes on freeways, or passing lanes on two-lane highways. Arterials are often described as having an odd number of lanes when two-way left turn lanes are present. However, for highway capacity and LOS analyses that is not appropriate. The two-way left turn lane does not accommodate through vehicles, and the facility is more appropriately characterized as having an even number of lanes with a non-restrictive median.

Usually the total number of through lanes in both directions is used to describe roadways. However, this Q/LOS Handbook bases analyses upon a single direction. As an example, a LOS analysis for a six-lane freeway is based upon three lanes, using the higher directional traffic volume. Similarly, a LOS analysis for a four-lane arterial would be based upon two directional lanes. When using FDOT's software, the sum of the directional number of through lanes should be entered to describe the roadway facility. When calculating LOS, the software will automatically take one-half of the total number of through lanes, unless overridden by the analyst.

Throughout this Q/LOS Handbook, it is assumed that the predominant traffic movement is straight ahead. Occasionally, however, more vehicles turn in a certain direction than go straight ahead. Under those circumstances the turning lanes accommodating the predominant movement should be considered the through lanes. As an example, consider this illustration: if 55 percent of the vehicles are turning left from two lanes, 20 percent are going straight ahead from one lane, and 25 percent are turning right from one lane, then the two lanes accommodating the left turning movement should be considered the through lanes. Further discussion of special use of through lanes and turning movements are covered under the discussion of percent turns from exclusive turn lanes.

4.3.1. Arterials

An important aspect of this Q/LOS Handbook is the methodology for determining an arterial's number of through lanes. Since the ultimate result of the LOS analysis is a facility estimation of LOS, and it is widely recognized that signalized intersections are the arterial's primary capacity constraint, it is appropriate to place more emphasis on the intersections' characteristics than mid-block characteristics. Generally, mid-block segments have capacities far exceeding those of major intersections and it is rare for significant delays to occur mid-block. By weighting the effects of intersections more heavily, a more accurate aggregate estimation is possible.

Site-specific characteristics (e.g., intensity and type of land use, driver behavior, speed, etc.) can dramatically affect the viability of add-on/drop-off pairs as through lanes; therefore, each application should be examined on a case-by-case basis. Analysts are strongly cautioned to review all pertinent characteristics prior to adjusting the number of through lanes used. The reviews should be conducted during peak travel conditions. Analysts are encouraged to consult with FDOT District LOS Coordinators prior to application of this concept. The following guidelines are offered as a capacity estimating tool only. This process should never be used for the design or redesign of an expanded intersection.

For any capacity benefit to be considered two conditions should be met:

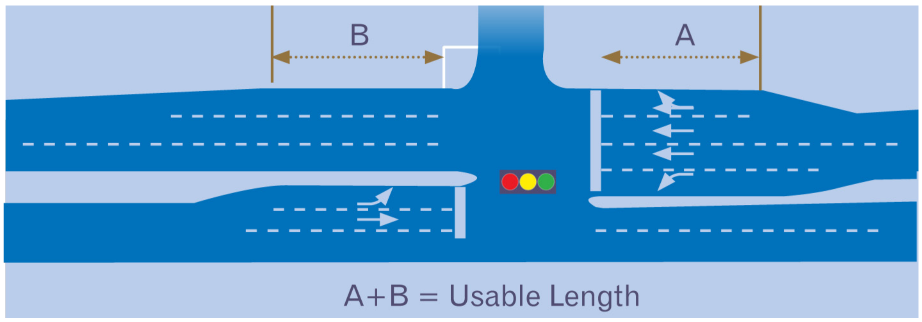
- both the add lane and drop lane must each be at least 800 feet in length, and
- the add-on/drop-off pair combined must be at least 1,760 feet in length

If either of these conditions is not met, then no additional capacity is assumed.

If the add-on/drop-off pair is at least one-third of a mile in length (roughly divided equally between approach and departure and exclusive of tapers and cross-street width, as represented by A + B in the accompanying diagram), it may be reasonable to consider an additional one-half lane for capacity purposes. For example, in the accompanying diagram if A = 1,000' and B = 1,000', then it would be reasonable to consider that the intersection approach has 2.5 effective through lanes.

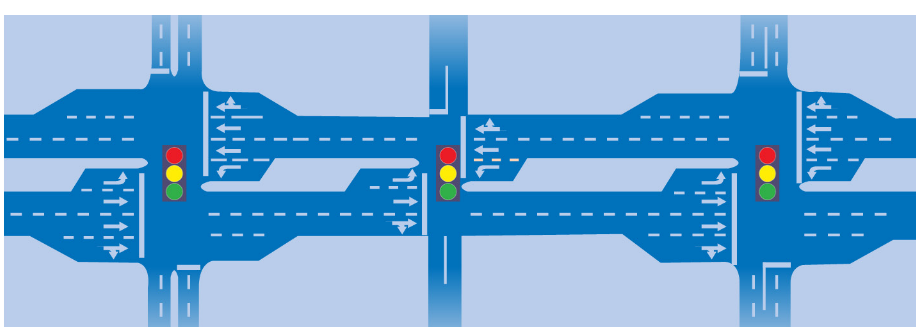
With a length of at least one-half mile (roughly divided equally between add lane and drop lane), it may be reasonable to consider the add-on/drop-off pair as adding up to one full through lane.

Figure 4-2
Usable Length



When using the Generalized Service Volume Tables, the number of through lanes on a facility is typically determined by the through and shared through/right lanes at major intersections rather than mid-block. In the illustration below, the mid-block segments have four lanes, with two lanes in each direction. The major intersections each have six lanes, with two through and one shared through/right add-on/drop-off lane with tapers adequate for safe merging. In this illustration, as in many cases, minor signalized intersections have green times so heavily weighted to the arterial that they do not cause significant delays to through traffic. When this is the case, it is sometimes acceptable to disregard the number of lanes at these minor intersections; instead, the determination should be based on the lanes at major intersections. So in terms of LOS, this particular facility has six lanes, as shown in **Figure 4-3**.

Figure 4-3
Example Six-Lane Roadway



At a conceptual planning level it is appropriate to evaluate in more detail the effects of add-on/drop-off lanes. When lanes carrying through traffic are added before the intersection and dropped after the intersection, the add-on/drop-off lane, or expanded intersection, will contribute to intersection capacity, but likely not to the extent of a full through lane. To accommodate this consideration, ARTPLAN allows the analyst to enter a fractional number of directional lanes (e.g., 2.5) at the signalized intersection. Under this situation, the number of lanes should more appropriately be considered the number of directional effective lanes.

4.3.2. Highways

For uninterrupted flow highway facilities, the number of lanes is the basic segment or mid-block laneage. For example, a two-lane highway, which is widened to four lanes at major intersections, should be considered a two-lane highway.

4.4. Speed

Posted Speed

Posted speed is the posted speed limit.

Free Flow Speed

Free flow speed is the average speed of vehicles under low flow traffic conditions and not under the influence of signals, STOP signs, or other fixed causes of interruption.

For generalized planning purposes, free flow speed is generally assumed to be 5 mph over the posted speed limit.

Free flow speed is the average speed of vehicles not operating under the influence of speed reduction conditions. In general, free flow is the speed under low flow conditions and not influenced by control conditions, such as signalized intersections. The assumption used in this Q/LOS Handbook is that the free flow speed is 5 mph above the posted speed. As an example, if an arterial is posted 40 mph, the default free flow speed used in this Q/LOS Handbook and accompanying software is 45 mph; however, if a more accurate free flow speed is available, it should be used.

4.5. Acceleration/Deceleration Lanes

4.5.1. Freeways

As used in this Q/LOS Handbook and accompanying software, acceleration and deceleration lanes are included in the capacity of a freeway. An acceleration lane extends from the on-ramp gore to the end of the taper. A deceleration lane extends from the beginning of the taper to the off-ramp gore. Vehicular turbulence occurs as vehicles enter and exit freeways. On- and off-ramp influence areas extend 1,500 feet from the interchange gores. In Florida, acceleration and deceleration lanes are typically 1,000 feet and 450 feet, respectively. In FREEPLAN, some additional capacity can usually be obtained by extending these types of lanes to 1,500 feet.

4.6. Median Type

4.6.1. Arterials/Highways

As used in this document, medians may be classified in one of three ways:

- restrictive median (r)
- non-restrictive median (nr)
- no median (n)

A **restrictive median** is a raised or grassed area normally at least 10 feet in width separating opposing mid-block traffic lanes and includes left turn lanes.

A restrictive median is a raised or grassed area that restricts crossing movements.

A **non-restrictive median** is a painted at-grade area normally at least 10 feet in width separating opposing mid-block traffic lanes, and for arterials, accommodates mid-block left-turning vehicles to exit from through lanes. Continuous two-way left turn lanes are considered as a non-restrictive median under this definition. Situations in which restrictive or non-restrictive medians are less than 10 feet wide are considered as having no median.

A non-restrictive median is a painted, at-grade area separating opposing mid-block traffic lanes.

Although a median factor does not exist in the HCM, FDOT included it to account for a lowering of mid-block average travel speeds when no median is present. From the aspect of getting left-turning vehicles out of the traffic stream, the difference between a restrictive and a non-restrictive median is relatively inconsequential. Thus, in determining automobile LOS, restrictive and non-restrictive medians are treated the same.

A non-restrictive median provides no pedestrian refuge.

From a pedestrian point of view, there is a significant difference between non-restrictive medians and restrictive medians. Restrictive medians give pedestrians a much safer mid-block crossing. Thus, this type of median is a consideration in determining the pedestrian crossing factor that enters the bus LOS analysis.

A pedestrian refuge is a raised or grassed area at least 5 feet but less than 10 feet in width that separates opposing mid-block traffic lanes and allows pedestrians to cross a roadway.

A **pedestrian refuge** is a raised or grassed area at least 5 feet but less than 10 feet in width (not a full raised median) separating opposing mid-block traffic lanes, and allowing pedestrians to cross the roadway more safely and comfortably. From a pedestrian point of view, a pedestrian refuge has nearly the same benefit as a restrictive median. In terms of pedestrian crossing difficulty, the difference between a restrictive median and pedestrian refuge is relatively small; therefore, in determining pedestrian crossing difficulty, the two may be treated the same. Pedestrian refuges are occasionally seen along beach roads or other roads where development is almost exclusively on one side of the road.

Because pedestrian refuges are not common in Florida, FDOT's LOS software does not include them as a distinct category. If an analyst needs to evaluate the effects of a pedestrian refuge, it should be treated as a restricted median for transit analysis, but as no median for automobile analysis.

4.7. Terrain

4.7.1. Highways/Freeways

Terrain is a general classification used for analyses in lieu of specific grades.

Terrain is a general classification used for analyses in lieu of specific grades. Level terrain is a combination of horizontal and vertical alignments that permits heavy vehicles to maintain approximately the same speed as passenger cars, usually short grades of no more than 1 to 2 percent. Level terrain is assumed throughout Florida.

Level terrain is assumed throughout Florida.

4.8. Exclusive Turn Lanes

4.8.1. Arterials

Left Turn Lanes

Exclusive left turn lanes are storage areas designated to exclusively accommodate left turning vehicles. The length of these lanes must be able to accommodate turning demand such that left turn traffic (1) is able to enter the turn lanes behind through queues, or (2) can be stored in the turn lane to ensure the through lane traffic is not blocked. When left turn lanes are not present, a shared lane exists.

When analyzing arterials without left turn lanes, the use of the Generalized Service Volume Tables and ARTPLAN is discouraged in all but the most basic analyses. If used, the Generalized Service Volume Tables include adjustment factors for the lack of left turn lanes that have been approved by the LOS Task Team. However, they are not contained within the HCM. To account for the absence of left turns lanes, adjustment factors must be manually applied to the service volumes contained in the table. Likewise, if an ARTPLAN analysis is performed, the resulting service volume is internally reduced by the same factor. However, the user is cautioned that research indicates that the true value of the reduction is highly dependent on the distribution of traffic volumes among all the various movements, and a constant reduction factor, as used in the tables and ARTPLAN, is not accurate.

Storage length refers to the total amount of storage available for left turning vehicles, in feet. The default value is 235 feet. For new turn lanes, FDOT design standards should be consulted (found at http://www.dot.state.fl.us/rddesign/DS/10/IDx/300grp.pdf).

Storage length is the total amount of storage available for left turning vehicles, in feet.

Right Turn Lanes

Exclusive right turn lanes are storage areas designated to exclusively accommodate right turning vehicles.

The length of these lanes must be able to accommodate turning demand to allow for the free flow of the through movement.

Exclusive right turn lanes are storage areas designated to exclusively accommodate right turning vehicles.

4.9. Roadway Lengths

In order to properly apply the Generalized Service Volume Tables or the LOSPLAN software, it is necessary to partition roadways into appropriate lengths for analysis. Setting lengths too short may not adequately capture traffic flow characteristics. Vehicles will not achieve the same average running speed on a segment as over a longer facility length. Short lengths would also be subject to bias caused by signal control delay.

Furthermore, analysis results would not conform to the concept of LOS that is based on driver perception of the operation of roadways and may not show where the most significant impact of proposed development traffic will occur. Conversely, setting lengths too long may dilute the impact of hot spots by averaging them into other portions that operate better.

FDOT District LOS Coordinators have primary responsibility for segmentation of the State Highway System for LOS purposes.

FDOT District LOS Coordinators have primary responsibility for segmentation of the State Highway System for LOS purposes. FDOT Central Office may combine smaller segmentation lengths of a facility for statewide reporting and other purposes.

In general, the partitioning of roadways for facility analyses should be based on the following considerations, ranked in order:

- highway system structure
- area type boundaries
- lengths

At times, section termini may also aid in the delineation of facility termini and lengths. In all cases, the beginning and ending points for a facility analysis should coincide with the beginning and ending points of sections that make up the facility. For freeways, the termini are interchanges.

At the local level, government agencies frequently make highway capacity and LOS termini at their own jurisdictional boundaries, regardless of the appropriate facility length and termini considerations described above. Jurisdictional boundaries by themselves are usually not appropriate termini for capacity and LOS analyses. Local governments are encouraged to consult with FDOT District LOS Coordinators for applicable segmentation within their jurisdictional boundaries.

4.9.1. Arterials

For an arterial facility analysis, the general recommendation is that the facility be at least 2 miles in length in order to use the service measure of average travel speed. Major intersecting arterials frequently serve as logical breaks in segmenting the arterial facility. In downtown areas, the general recommended length is at least 1 mile.

When evaluating arterial section or facility LOS at a conceptual planning level, the roadway should begin and end at a signalized intersection. The following guidance is provided for some special cases:

(1) **Interchanges along an arterial** – Although at a generalized planning level it is typically appropriate to make a break at an interchange (highway system structure criterion) that does not include a signalized intersection, at a conceptual planning level it is appropriate to extend the analysis to the next signalized intersection if within 2 miles of the interchange.

(2) **Boundaries**, especially urbanized area boundaries – When a signalized intersection lies just outside the **boundary,** it is proper to extend an analysis to the next signalized intersection if within 2 miles of a boundary for a conceptual planning analysis. For example, if a signalized intersection lies 1 mile beyond the existing urbanized boundary in a transitioning area, it is appropriate to include that signalized intersection and the 1 mile of transitioning area as part of an urbanized area analysis.

Boundaries refer to the geographical limits associated with FDOT's Level of Service Standards for the State Highway System *or its MPO Administrative Manual.*

4.9.2. Highways

The analysis length of uninterrupted flow two-lane and multilane highways varies considerably (e.g., 2 to 60 miles), and may or may not include interrupted flow conditions (e.g., signalized intersections, STOP signs). Any given uninterrupted segment should be greater than 2 miles. Segments with greater than 3.5 miles between interrupted flow conditions should be considered uninterrupted. For segments between 2- and 3.5-miles, analysts have the discretion to group the segment into an uninterrupted facility or into an interrupted facility.

Any given uninterrupted segment should be greater than 2 miles.

Segments with greater than 3.5 miles between interrupted flow conditions should be considered uninterrupted.

The HCM does not contain a facility level analysis for generally uninterrupted flow facilities (highways). The HCM two-lane and multilane highway chapters are segment chapters. They deal

An off-ramp influence area refers to the geographic limits affecting the capacity of a freeway associated with traffic exiting a freeway.

A basic freeway segment is the length of a freeway in which operations are unaffected by interchanges.

An on-ramp influence area refers to the geographic limits affecting the capacity of a freeway associated with traffic entering a freeway.

A ramp overlap segment is the length for which the upstream on-ramp influence area and the downstream off-ramp influence area overlap.

A weaving segment is the length of freeway over which traffic streams cross paths through lane changing maneuvers.

with uninterrupted flow segments, but there is no guidance on how to combine segments or how to deal with isolated signalized intersections or a combination of two-lane and multilane segments.

For two-lane highways, FDOT has developed a methodology *[Improvement of Planning Level Analysis Procedures for Two-Lane Highways, University of Florida, 2005]* for grouping segments into a single facility for LOS analysis, and this methodology has been incorporated into the LOSPLAN software. The analysis relies on the calculation of percent time-delayed over the length of the facility, which is made up of:

- **Basic two-lane highway segments**
- **Intersection influence areas**, which include deceleration and acceleration distances
- **Affected downstream highway segments**, which includes the area outside of the intersection influence area that is still affected by the platooning of vehicles from the upstream signal

While the user must enter the total length of the highway segments between intersections, the software calculates the length of each of these segment types based on signal speed, volume, and signal timing parameters.

4.9.3. Freeways

For urbanized freeway facility analyses, the general recommendation is that the freeway facility length be between 4 and 15 miles. For rural freeway analyses, the length is expected to be considerably longer. For example, I-75 across the Everglades extends for 87 miles.

The generalized and conceptual planning analysis facility method makes use of six freeway segment types: basic segments, off-ramp influence areas, on-ramp influence areas, weaving segments, ramp overlap segments, and toll plaza segments. A typical interchange area is around 1 mile in length and consists of an **off-ramp influence area** 1,500 feet long, a **basic freeway segment** 2,280 feet in length, and an **on-ramp influence area** 1,500 feet long. The actual length of the interchange area may vary from this value, depending upon ramp geometry and the distance between ramps. When two interchanges are closely spaced (within about 3,000 feet), a **ramp overlap segment** is needed to define the region where the upstream on-ramp influence area and the downstream off-ramp influence area overlap. For interchanges where the on-ramp precedes the off-ramp, a **weaving segment** is needed to define the area. Parts of freeways outside these influence areas are basic freeway segments.

Their lengths vary significantly based on interchange locations, but should be at least 200 feet in length.

The facility method also includes the ability to analyze toll facilities, consisting of traditional payment station or ETC tolling, open road tolling (ORT) stations where drivers are not required to slow significantly, or a combination of the two. For combination tolling facilities, the traditional plaza is typically accessed by exiting the mainline, paying the toll, and then merging back on the mainline.

4.10. Segments

4.10.1. Freeways

As used in this document and in FREEPLAN, freeway segments are either basic, on-ramps, off-ramps, weaving segments, ramp overlaps, or toll plazas. For a freeway facility analysis using FREEPLAN, the number of segments is an input.

4.11. Passing Lanes

4.11.1. Highways

A passing lane is a short lane (approximately 1 mile) added to provide passing opportunities in one direction of travel on a two-lane highway. Continuous two-way left turn lanes are not considered passing lanes.

Passing lanes have not been shown to affect the capacity of a two-lane highway. However, the operation of two-lane highways is improved with the addition of passing lanes. In the rural undeveloped portions of the Generalized Service Volume Tables, the benefit of passing lanes is handled as an adjustment to the service volumes for LOS B through D and varies by the proportion of coverage of the lanes (i.e., total length of passing lanes relative to the total length of the analysis segment). When analyzing two-lane highways in rural undeveloped areas, HIGHPLAN adjusts the percent time spent following and average travel speed by the same proportion as the proportion of passing lane coverage. For example, *Percent no passing zone is the percentage of a two-lane highway along which passing is prohibited in the analysis direction.*

Passing lane spacing is the distance in miles between passing lanes on two-lane highways.

if there are 2 miles of passing lanes within a 10-mile segment, the percent time spent following will be decreased by 20 percent and the average travel speed will be increased by 20 percent relative to their values without any passing lanes present. When analyzing the potential of passing lanes, analysts should routinely alter the percent no passing zone value as well, because passing lanes generally result in higher percentages of no passing zones.

Percent No Passing Zone

Percent no passing zone refers to the percent of a two-lane highway where passing is prohibited in the analysis direction.

Passing Lane Spacing

As used in HIGHPLAN, **passing lane spacing** is the distance in miles between passing lanes on two-lane highways.

5 TRAFFIC VARIABLES

The following Chapter provides an overview of each traffic variable used within the LOSPLAN software in order to allow the user to recognize these variations and analyze specific roadways. Where applicable, default and maximum values are provided.

Traffic variables describe overall traffic demand and the characteristics of the traffic stream. As with the roadway variables, not all traffic variables are applicable to all roadway types, and the following list provides an indication of the roadway type the variable is used to describe (Arterial = A, Highway = H, Freeway = F):

- **Annual Average Daily Traffic** (A, H, F)
- Planning Analysis Hour Factor (A, H, F)
- **Directional Distribution Factor** (A, H, F)
- Peak Hour Factor (A, H, F)
- Base Saturation Flow Rate (A, H, F)
- Percent Heavy Vehicles (A, H, F)
- Local Adjustment Factor (H, F)
- **Percent Left Turns** (A)
- Percent Right Turns (A)

Default values should not be used as part of a conceptual planning analysis for bolded values.

Table 5-1 provides an overview of the traffic variable input requirements within the Generalized Service Volume Tables and the LOSPLAN software.

Table 5-1
Traffic Variable Input Requirements

Input Variable	Generalized Service Volume Tables	ART PLAN	FREE PLAN	HIGHPLAN	
				2-Lane	Multilane
Annual Average Daily Traffic (AADT)	R	S	S	F	F
Planning Analysis Hour Factor (K)	D	F	F	F	F
Directional Distribution Factor (D)	D	F	F	F	F
Peak Hour Factor (PHF)	D	F	F	F	F
Base Saturation Flow Rate/ Base Capacity	D	F	F	F	F
Percent Heavy Vehicles	D	F	F	F	F
Local Adjustment Factor	D	-	F	F	F
Percent Left Turns	D	S	-	S	-
Percent Right Turns	D	S	-	S	-

Legend:
- R Required Table Input
- S Segment/Point Specific
- D Default Cannot be Altered
- F Facility Specific
- – Not Applicable

Additionally, the effects that individual variables have on the computational process vary. **Table 5-2** indicates the sensitivity of the traffic variables on highway capacity and LOS. With the exception of using Standard K, traffic variables that have a high degree of sensitivity on service volumes (shown in **bold** on the first page of this chapter) should not be defaulted when a conceptual planning analysis is being conducted. The LOSPLAN programs highlight these variables and require analysts to provide specific values before the programs calculate capacity and LOS.

Table 5-2
Sensitivity of Traffic Variables on Service Volumes

Traffic Variables	Sensitivity on Service Volumes
Annual Average Daily Traffic (AADT)	high
Planning Analysis Hour Factor (K)	high
Directional Distribution Factor (D)	high
Peak Hour Factor (PHF)	medium
Base Saturation Flow Rate/ Base Capacity	medium
Percent Heavy Vehicles	low
Local Adjustment Factor	medium
Percent Left Turns	high
Percent Right Turns	medium

5.1. Volume and Demand

Traffic volume is the number of vehicles passing a point on a highway during a specified time period.

Traffic volume is the most basic of all traffic parameters and is generally defined as the number of vehicles passing a point on a highway during a specified time period. Traffic volumes typically are developed separately from capacity/LOS analyses and provide input to those analyses. Various sources include:

- FDOT's Florida Traffic Online
- FDOT's Project Traffic Forecasting Handbook
- Extrapolation of historical growth trends
- FDOT's travel demand forecasting models
- ITE's Trip Generation Handbook

Traffic demand is the number of vehicles that desire to traverse a particular highway during a specified time period.

While traffic demand expresses a desire, volume typically represents actual measurement.

Volume is the parameter most often used to quantify traffic demand. **Traffic demand** is the number of vehicles that desire to traverse a particular highway during a specified time period. While traffic demand expresses a desire, volume typically represents actual measurement.

Misuse of measured volumes often occurs in capacity/LOS analyses. Traffic studies result in the observation and measurement of conditions as they presently exist. Current observations do not reflect constraints in the existing highway system that may prevent vehicles from accessing a desired segment of the system at any given point in time. Observed volumes on congested facilities are more a reflection of capacity constraints than of true demand.

Traffic volume cannot theoretically exceed roadway capacity, but traffic demand can. An example of a common misinterpretation of these two distinct terms typically occurs while collecting traffic data at an oversaturated intersection. The traffic volume that can physically be processed through a traffic signal is a measure of the capacity (or supply). When traffic volumes approach roadway capacity, the transportation system may experience abnormally long vehicle queues and excess vehicular delay. The length of the vehicle queue upstream of a traffic signal is a more accurate measure of the traffic demand that cannot be processed in the one-hour analysis period.

The impact of bottlenecks, alternative routes, latent demand, and future growth further complicates the relationship between measured traffic volume and traffic demand. If questions arise as to the appropriateness of using measured volumes or demand volumes for capacity and LOS analyses, it is clear demand volumes should be used.

5.2. Annual Average Daily Traffic (AADT)

Annual average daily traffic (**AADT**) is the total volume on a highway segment/section for one year divided by the number of days in the year. Most generalized and conceptual planning applications begin with AADT volumes. Determining AADT values is a separate process and distinct from capacity/LOS analyses. FDOT routinely provides AADT values for state roads.

Average annual daily traffic (AADT) is the volume passing a point or segment of a roadway in both directions for 1 year divided by the number of days in the year.

AADT values are easy to confuse with two other traffic count numbers that are used to estimate AADT. The average daily traffic (**ADT**) is the total traffic volume during a given time period, more than a day and less than a year, divided by the number of days in that time period. ADT is generated from a short-term traffic count and can be used to estimate AADT. Ensuring that ADT counts are reflective of the normal average traffic is an important consideration when using them to estimate the annual traffic (AADT) on the roadways. Traffic taken during a four-day holiday, long weekend, or Saturday night when 50,000 or more football fans gather is not a normal occurrence.

Average daily traffic (ADT) is the total traffic volume during a given time period divided by the number of days in that time period.

Peak Season Weekday Average Daily Traffic (**PSWADT**) numbers are normally generated by travel demand forecasting planning models, such as FSUTMS. Like ADT, they can be converted to AADT by an adjustment factor.

Peak Season Weekday Average Daily Traffic (PSWADT) is the average weekday traffic during the peak season.

Telemetry traffic monitoring sites (TTMS), or permanent traffic recorders (PTR), refer to permanent counters that continuously monitor traffic.

Portable traffic monitoring site (PTMS) are coverage counters at temporary sites.

Axle correction factors are adjustment factors used to calculate AADT by compensating for an axle counter's tendency to count more vehicles than are actually present.

A seasonal adjustment factor is a factor used to adjust for the variation in traffic over the course of a year.

FDOT operates two types of traffic monitoring programs: (1) continuous monitoring at selected locations using permanently installed equipment, and (2) coverage counts at many temporary sites using portable equipment. Permanent counters that continuously monitor traffic are referred to as telemetry traffic monitoring sites (**TTMS**), and are sometimes called permanent traffic recorders (**PTR**). They are permanently placed at specific locations throughout the state to record the distribution and variation of traffic flow by hour of the day, day of the week, and month of the year, from year to year. Coverage counters at temporary sites are called portable traffic monitoring site (**PTMS**) counters. Short-term traffic surveys, usually 24-48 hours in duration, are collected using portable equipment at 5,000-6,000 locations, from one to four times a year. These PTMS surveys are used to provide the volume estimates for each segment of highway on the State Highway System.

Two count adjustment factors are used to calculate AADT. The first, **axle correction factors**, are used to compensate for an axle counter's tendency to count more vehicles than are actually present. An axle counter, for example, would show a count of two when a four-axle truck runs over the sensor, even though only one vehicle is present. The second, **seasonal adjustment factors**, have been developed to adjust for the variation in traffic over the course of a year. The peak season is the 13 consecutive weeks with the highest volumes. The weekly seasonal factors for those weeks will be the lowest and the factors will be the highest for the weeks with the lowest volumes. The seasonal factor is used as follows:

AADT = short-term traffic count X seasonal factor

Although for generalized and conceptual planning purposes AADT is usually used, actual capacity and LOS analyses are conducted on an hourly or subhourly directional basis. For example, all FDOT's Generalized Service Volume Tables are based on peak hour directional roadway, traffic, control, and multimodal characteristics. FDOT's daily tables are possibly the most widely used in the U.S. Nevertheless, it should be recognized that they are based on hourly directional analyses. FDOT's hourly directional tables may be viewed as the most fundamental of the tables because the daily tables are created by dividing the peak hour directional values by the directional distribution factor (D) and the planning analysis hour factor (K). Although determination of AADTs is outside the capacity/LOS analyses, determination of K and D is a fundamental part of capacity/LOS analyses in generalized and conceptual planning stages because of the need to convert AADT to peak hour directional volumes.

5.3. Planning Analysis Hour Factor (K)

The Planning Analysis Hour Factor, or **K Factor**, is the ratio of the traffic volume in the study hour to the annual average daily traffic (AADT). Historically, FDOT has used a variety of study hours and K factors depending upon the application. Frequently used K factors included the 30th highest volume hour of the year (K_{30}), 100th highest volume hour of the year (K_{100}), highest hourly volume to daily volume ($K_{p/d}$), 5-6 p.m. weekday volume to AADT ($K_{5\text{-}6pm}$), average p.m. weekday peak volume to AADT (K_{pm}), average a.m. peak weekday volume to AADT (K_{am}), and noon weekday volume to AADT (K_{noon}). In general, K factors are used for peak hour traffic analyses, but analyses can also be based on low volume conditions, such as the analysis of truck travel in early morning hours. Roadway, traffic, and control conditions vary considerably during the day, potentially affecting capacity values and service volume thresholds.

The K factor is the ratio of the traffic volume in the study hour to the annual average daily traffic (AADT).

Standard K is the primary planning analysis hour factor used in Florida, and the value is set based on the area type and facility type. The use of Standard K represents a design approach in which the K factor for a roadway is established from planning through design. Rather than being a variable, Standard K values are a fixed, cost-effective parameter, much like the use of 12-foot through lanes on a major high-speed roadways. Unless otherwise noted, all references in this Q/LOS Handbook and accompanying LOSPLAN software to an hour or K factor refer to Standard K.

Standard K is FDOT's standard peak hour to annual average daily traffic ratio (K), based on a roadway's characteristics (facility type) and location (area type).

The Standard K factor is used to convert a peak hour volume to an AADT and vice-versa. The Standard K factors used in the Generalized Service Volume Tables were obtained through a methodical process to obtain accurate, representative Standard K factors. On the freeways in the seven largest urbanized areas in Florida, Standard K represents a peak study period. For all other facilities, Standard K represents a peak hour not within the peak season.

The K factor generally drops as an area becomes more urbanized and high traffic volumes are spread out over longer time periods. If adequate documentation is provided, FDOT would consider deviations from the Standard K table for special facility types or multimodal transportation districts (MMTD).

The K factor generally drops as an area becomes more urbanized and high traffic volumes are spread out over longer time periods.

With the release of the 2012 LOSPLAN programs, FDOT has shifted away from demand-based K values to a more cost-effective analysis structure based on Standard K values by area and facility type. Although FDOT has established an exemption process, exemptions will be limited to special cases such as emergency evacuation routes and managed lanes. The updated LOSPLAN software automatically enters the correct Standard K value based on the selected area and facility type, using the following values:

- Urbanized and transitioning areas (all facility types) – 0.090
- Large urbanized – 0.080-0.090
- Urban
  - Freeways – 0.105
  - Highways – 0.090
  - Arterials – 0.090
- Rural developed and rural undeveloped
  - Freeways – 0.105
  - Highways – 0.095
  - Arterials – 0.095

For major, non-toll freeways going through the urbanized core areas of the largest metropolitan areas, such as I-4 in Orlando, FDOT has adopted lower K values. Standard K values on freeways in large urbanized areas range from 8.0 to 9.0 percent, while Standard K values on these “core freeways” in large urbanized areas are typically lower within this range. The lower K values signify a peak period as opposed to a peak hour, a common observation in these areas is a rush “hour” that lasts from 4:00 to 6:00 p.m. The urban core freeway K values in large urbanized areas are available on Florida Traffic Online.

Multimodal Transportation Districts (MMTD)

The purpose of MMTDs is to encourage desirable transportation environments for all users, including transit passengers, pedestrians, cyclists, and motorists. The designation of such districts recognizes the inherent, integral relationship between transportation, land use, and urban design and the degree to which each of these elements impact the others. Local governments opting to designate an MMTD assign secondary priority to vehicle mobility and primary priority to assuring a safe, comfortable, and attractive pedestrian environment, with convenient connections to transit. FDOT supports local governments who are committed to such efforts. Implementation of MMTDs should help foster the use of multiple modes of transportation, leading to a reduction in automobile use while maintaining high mobility characteristics in the area.

The primary way FDOT will support these designated areas is through its LOS standards, which have been developed using a lower Standard K. FDOT will promote lower acceptable automobile travel speeds for longer durations in the planning, design, and operations of its facilities. Conceptually, in urban and urbanized areas, FDOT's LOS standards for state arterials are based on typical weekday peak hour speeds. For relatively low speed arterials (35 mph posted speed or less) in urbanized areas, FDOT's LOS standard is "D" for autos, which corresponds to a speed of 13 mph during the peak hour. In an MMTD, FDOT's LOS standard would apply the 13 mph criterion not to just the one peak hour but to the average over the 3-hour peak period. FDOT believes that in these areas, although auto speeds are quite low from drivers' perspectives, they are tolerable. Such low speeds for an extended time would improve pedestrian and bicyclist LOS and safety. Lowering the acceptable operating auto speed on arterials and improving pedestrian and bicycle conditions should also help lower vehicle miles traveled. By adopting a multi-hour peak period approach within MMTD, based on a K factor as low as 7.5, FDOT will break from the historical tradition of basing LOS criteria on the 30th or 100th highest travel hour of the year for the planning and design of facilities. FDOT believes that this approach achieves a reasonable balance among all users of a facility.

5.4. Directional Distribution Factor (D)

The Directional Distribution Factor, or D, is the proportion of an hour's total volume occurring in the higher volume direction.

The Directional Distribution Factor, or **D**, is used to convert AADT to directional peak traffic. The peak hour D factor is the proportion of an hour's total volume occurring in the higher volume direction.

FDOT recommends the use of demand D_{200} values. The preferred approach to obtain D_{200} data is from Florida Traffic Online. It provides a Demand D_{200} for all state roads. The process incorporated in Florida Traffic Online is to take the average of measured D values around the 200th highest hour from nearby and comparable roadway sites and report those. The statewide minimum acceptable D_{200} is 0.51 (the minimum D_{200} factor is not the default value; this should only be used in an LOS analysis if adequate justification is provided for the specific roadway). If the calculated value is less than that value then 0.51 is shown. Using such an approach provides statewide consistency and reasonable accuracy in the values indicated and at a minimum cost.

Minimum acceptable D input value:

- D (all area and facility types) – 0.51

5.5. Peak Hour Factor (PHF)

Peak hour factor (PHF) is the ratio of the hourly volume to the peak 15-minute flow rate for that hour.

The Peak Hour Factor (**PHF**) is the hourly volume divided by the peak 15-minute rate of flow within the peak hour; specifically

PHF = hourly volume ÷ (4 x peak 15-minute volume).

Although consideration of subhour traffic peak may be important for detailed analysis, a planning-level approach has been adopted within this handbook. As such, all service volumes in this Q/LOS Handbook are for an entire hour; that is to say, no sub-hour analysis procedures are documented. A peak hour factor of 1.0 should be used for all analyses, which assumes no variations in demand over an hour.

5.6. Base Saturation Flow Rate

The HCM uses the term **base saturation flow rate** for interrupted flow roadways and capacity, or base capacity, for uninterrupted flow roadways to describe the maximum steady flow. These are not the same as capacity as normally used to define how many vehicles a roadway can reasonably accommodate. These rates are expressed in passenger cars per hour per lane (pcphpl). The base saturation flow rates/capacities for Florida's roadway facilities are shown below.

- Arterials and other interrupted flow facilities – 1,950 pcphpl (assuming 100 percent green time)
- Basic freeway segment (70 mph posted speed) – 2,400 pcphpl
- Freeway interchange influence areas (70 mph posted speed) –
    - 2,200 pcphpl for the two outside lanes for the off-ramp influence area
    - 2,300 pcphpl for the two outside lanes for the on-ramp influence area
    - 2,400 pcphpl for additional inside lanes
- Uninterrupted flow multilane highway segments – 2,200 pcphpl
- Uninterrupted flow two-lane highway segments – 1,700 pcphpl

Previous editions of this Q/LOS Handbook made use of the term adjusted saturation flow rate as an input value instead of base saturation flow rate. Essentially, it accounted for the effects of the driver population factor, heavy vehicles, and other adjustment factors on the base saturation flow rate. However, primarily related to the greater emphasis on truck movements, those factors are now broken into two broad categories: (1) **heavy vehicle percent** and (2) **local adjustment factor**. To aid users understanding the impacts of many of the roadway and traffic variables, the terms adjusted saturation flow rate and adjusted capacity appear in the current conceptual planning software for freeways and multilane highways as outputs.

Base saturation flow rate is the maximum steady flow rate, expressed in passenger cars per hour per lane (pcphpl), at which passenger cars can cross a point on interrupted flow roadways.

Heavy vehicle percent is the percentage of heavy vehicles in the traffic stream.

The local adjustment factor is an adjustment factor FDOT uses to adjust base saturation flow rates or base capacities to better match actual Florida traffic volumes.

Class Group	Axle Weight
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	Any 7 or more axle

FHWA Scheme F

The heavy vehicle percentage typically has a relatively minor role in determining capacity and LOS.

5.7. Heavy Vehicle Percent

FHWA has a vehicle classification scheme in which vehicles larger than a pick-up truck are considered heavy vehicles. This includes vehicles with more than four wheels or classification group four or higher. The percentage of these heavy vehicles in a given hour is frequently referred to as a truck factor (T). However, to be more consistent with HCM terminology and to overcome some definitional problems with the common understanding of the meaning of a truck, this Q/LOS Handbook uses the term heavy vehicle and makes use of the percent of heavy vehicles in a given hour.

The heavy vehicle percentage varies dramatically by time of day, day of week, roadway type, and adjacent land uses. Operational characteristics of heavy vehicles also vary dramatically by type of heavy vehicle (e.g., a relatively small delivery truck compared to a fully loaded 18-wheel semi-truck) and whether they are operating on an uncongested freeway or on signalized roadways. The blast effect of heavy vehicles on bicyclists also varies significantly based on the type and speed of heavy vehicles.

FDOT recommends using the HCM heavy vehicle factors and statewide average percentages that appear on the back of the Generalized Service Volume Tables for capacity/LOS analyses. Use of the T factor in FDOT's Florida Traffic Online is not recommended. That factor is properly used for roadway pavement design. Rules of thumb have been applied to that factor to convert to a design hour; however, the factors appearing on the back of the tables are more applicable for the peak traffic hour.

The heavy vehicle percentage typically has a relatively minor role in determining capacity and LOS. Consistent with previous guidance in this Q/LOS Handbook, a more refined value for this factor is usually not needed. If it is deemed desirable to use a roadway specific heavy vehicle percentage, it should be based on a peak hour field study and not Florida Traffic Online.

5.8. Local Adjustment Factor

The local adjustment factor may be thought of as a driver population factor that accounts for driver characteristics and their effects on traffic. The factor takes into consideration driver aggression, hurriedness, and familiarity with the facility. It is used in FREEPLAN and HIGHPLAN to reflect lower capacities by different area types. It is not used as a separate input in ARTPLAN, as the concept is directly incorporated by the selection of the area type.

5.9. Percent Turns From Exclusive Turn Lanes

5.9.1. Arterials

Percent turns from exclusive turn lanes is the percent of vehicles approaching an intersection served by an exclusive turn lane(s). More specifically, the percent left turns is the percentage of vehicles performing a left-turning movement at a signalized intersection, and the percent right turns is the percentage of vehicles performing a right-turning movement at a signalized intersection. Typically, the percent turns from an exclusive lane is the percent using an exclusive left turn lane with the predominant traffic movement being straight ahead.

Some of the most complicated calculations within the HCM chapter on signalized intersections deal with accommodating left turn movements. The Generalized Service Volume Tables and ARTPLAN assume that left turn lanes adequately serve left turning vehicles. In other words, the base condition assumes there is no queue spillback from the left turn lane into the adjacent through lanes. If this assumption cannot be made, results obtained from the planning analysis tools are possibly inaccurate. ARTPLAN also loses some accuracy when the percentage of turning vehicles is very high. For these reasons and more, the tables and programs should not be used for intersection design or detailed traffic operations analysis.

The Generalized Service Volume Tables and ARTPLAN assume that left turn lanes adequately serve left turning vehicles.

The automobile LOS methodology described in this Q/LOS Handbook applies the HCM procedures to through traffic at each signalized intersection. Turning movement adjustments are made internally, based on the user-specified value of percent turns from exclusive lanes. Turning volumes are added to the through volumes to determine the overall service volumes shown in the Generalized Service Volume Tables and computed by ARTPLAN. Conversely, the turning volumes must be subtracted from the overall demand volumes for purposes of computing arterial through-traffic delay by ARTPLAN.

The accuracy of LOS calculations is highly dependent on the percent turns from exclusive turn lanes.

The accuracy of LOS calculations is highly dependent on the percent turns from exclusive turn lanes. Although it is typically of moderate importance, at some key intersections it may be one of the most significant variables. While FDOT does not routinely suggest acquiring percent turns from exclusive turn lanes, data collection should be considered at key intersections. Furthermore, some FDOT districts may require specific counts. If the percent turns at key intersections are obtained in the field, a value of 10 percent value may be assumed for the other intersections, assuming an exclusive left turn lane and no exclusive right turn lane. If the percentage of turns from exclusive turn lanes is acquired, the turning movement count should be conducted during the peak hour, as illustrated in **Table 5-3**.

Table 5-3
Calculation of Percent Turns from Exclusive Turn Lanes

Measured Day	Peak Hour	Signalized Intersection	Total Peak Hour Predominant Approach Volume	Exclusive Lane Volume	% Turns from Exclusive Turn Lanes	
					A	B
22-Jan	4-5 PM	A	884	130	14.7%	16.7%
		B	900	150		
23-Jan	5-6 PM	A	1,152	150	13.0%	13.0%
		B	1,150	150		
24-Jan	5-6 PM	A	1,102	150	13.6%	14.7%
		B	1,090	160		
Totals	–	A	3,138	430	13.7%	14.6%
		B	3,140	460		

Special Turning Movement Cases

Two special cases exist when dealing with turns from exclusive lanes. First is the case where the predominant movement is a turn movement instead of the straight-ahead movement. Second is the case of T intersections.

In **Figure 5-1**, the predominant movement is the left turning movement, and the 550 vehicles turning left should be considered the through movement. In ARTPLAN, the 200 vehicles going straight ahead should be treated as left turning vehicles with 20 percent left turns ((200/(550 + 200 + 250)) from an exclusive left turn lane. The 250 vehicles turning right should be treated normally, with 25 percent right turns ((250/(550 + 200 + 250)) from an exclusive right turn lane.

In **Figure 5-2**, all vehicles are turning from exclusive turn lanes at a T intersection. The 600 vehicles turning right is the predominant movement and should be considered through vehicles. The 400 vehicles turning left should be treated normally, which is to say there are 40 percent left turns (400/(400 + 600)) from an exclusive left turn lane.

In **Figure 5-3**, another T intersection is shown, featuring a shared left/through lane in addition to the predominant movement being served by the exclusive right lane. Normally a shared left/through lane does not have the same capacity as a through lane because of the effect of opposing vehicles blocking permitted left turns for the main movement. However, in this case, there is no opposing movement and the capacity of this shared lane is virtually the same as a typical through lane. In this situation, an analyst should enter one through lane and one shared through lane with 20 percent left turns ((200/(200 + 200 + 600)).

Figure 5-1
Predominant Turning Movement

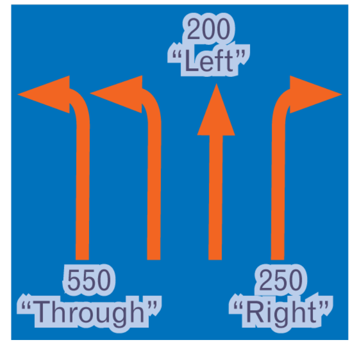


Figure 5-2
Through Movement at a T Intersection with Exclusive Lanes

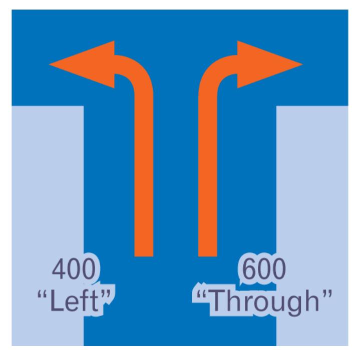
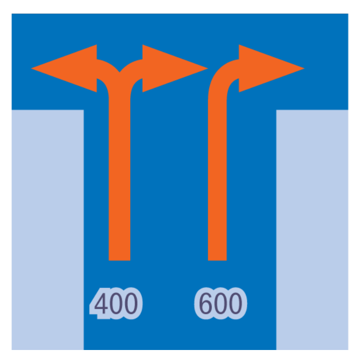


Figure 5-3
Through Movement at a T Intersection with Shared Lanes



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6 CONTROL VARIABLES

The following Chapter provides an overview of each control variable used within the LOSPLAN software in order to allow the user to recognize these variations and analyze specific roadways. Where applicable, default and maximum values are provided.

Control variables refer to roadway or area traffic controls and regulations in effect for a roadway point or segment, including the type, phasing, and timing of traffic signals, STOP signs, lane use and turn controls, and other similar measures. In this Q/LOS Handbook, control variables refer to those regularly occurring at signalized intersections, unless otherwise noted. For uninterrupted flow facilities, such as freeways and rural multilane highways, LOS can readily be derived from the volume of vehicles and roadway capacity, and control variables are not applicable. For signalized roadways, however, volume to capacity ratios (v/c) are simply not sufficient to determine LOS, and control variables must also be considered. These include:

- **Number of Signalized Intersections**
- Arrival Type
- Signal Type
- Cycle Length
- **Through Effective Green Ratio**
- Exclusive Left Effective Green Ratio

Control variables refer to the type, phasing, and timing of traffic signals, STOP signs, lane use and turn controls, and other similar measures.

Default values should not be used as a part of a conceptual planning analysis for bolded values.

Table 6-1 provides an overview of the control variable input requirements within the Generalized Service Volume Tables and the LOSPLAN software.

Table 6-1
Control Variable Input Requirements

	Input Variable	Generalized Service Volume Tables	ART PLAN	FREE PLAN	HIGHPLAN	
					2-Lane	Multilane
CONTROL	Number of Signalized Intersections	D	F	-	-	-
	Arrival Type	D	S	-	-	-
	Signal Type	D	F	-	-	-
	Cycle Length (C)	D	S	-	-	-
	Through Effective Green Ratio (g/C)	D	S	-	-	-
	Exclusive Left Effective Green Ratio	D	S	-	-	-

Legend:
- R Required table input
- S Segment/point specific
- D Default cannot be altered
- \- Not applicable
- F Facility specific

The effects that individual variables have on the computational process vary. **Table 6-2** indicates the sensitivity of the control variables on capacity and LOS. For control variables that have a high degree of sensitivity on service volumes (shown in **bold** on the first page of this chapter), default values should not be used as part of any conceptual planning analysis. ARTPLAN highlights these variables and requires analysts to provide specific values before the program calculates capacity and LOS.

Table 6-2
Sensitivity of Control Variables on Service Volumes

Control Variables	Sensitivity on Service Volumes
Number of Signalized Intersections	high
Arrival Type	medium
Signal Type	low
Cycle Length (C)	medium
Through Effective Green Ratio (g/C)	high
Exclusive Left Effective Green Ratio	medium

If FDOT's preferred processes for determining AADT, Standard K, D_{200}, and g/C values are followed, there will be no need for extensive field data collection for conceptual planning capacity/LOS analyses. Traffic variables, including AADT, Standard K, and D_{200} data should be obtained from FDOT's Florida Traffic Online. The truck or heavy vehicle factor from Florida Traffic Online should not be used for conceptual planning capacity/LOS analyses; instead, analysts should use the default values appearing on the back of the Generalized Service Volume Tables. Although turning movement counts at key intersections may be necessary, as discussed previously, FDOT does not recommend the use of travel time studies for LOS planning applications.

If FDOT's preferred processes for determining AADT, Standard K, D_{200}, and g/C values are followed, there will be no need for extensive field data collection for conceptual planning capacity/LOS analyses.

The Arterial Data Collection Worksheet (**found at the end of this handbook**) has proved helpful in FDOT sponsored LOS training courses. Analysts may find it useful to record collected traffic and control data on this sheet. Up-to-date aerial or satellite imagery may be sufficient for most of the data entry items. Signalization information is often available from the applicable traffic operations agency's signal timing plans. The applicable transit agency should be contacted for transit data.

6.1. Number of Signalized Intersections

The cumulative effect of numerous traffic signals, lack of green time, and lack of effective signal progression often have a detrimental effect on LOS on arterials. An important feature of FDOT's Generalized Service Volume Tables is the inclusion of the number of signalized intersections on the determination of LOS.

The distance between signalized intersections is required to determine specific service volumes for a roadway. FDOT's Generalized Service Volume Tables use signalized intersections per mile as an input, and assume uniform spacing. While this spacing may be acceptable for an areawide analysis, precise distances between signalized intersections should be determined when an individual roadway is being analyzed at a conceptual planning level.

For analysis purposes, 100 feet is considered the minimum distance between signalized intersections.

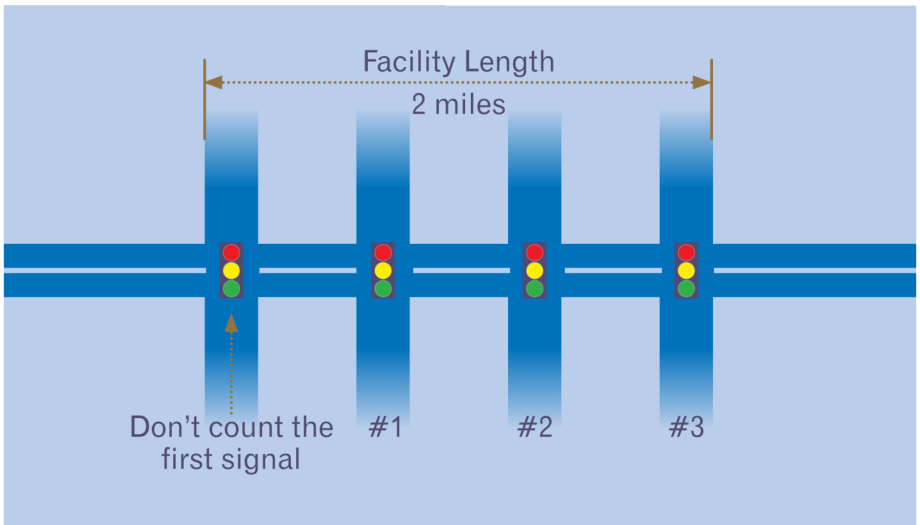
For analysis purposes, 100 feet between signalized intersections is considered the minimum distance. In situations where the actual distance is less than 100 feet (e.g., side streets with wide medians), it is reasonable to consider these together as one signalized intersection.

Roadway and traffic characteristics often change over time. The number of signalized intersections per mile is frequently the most significant change. As development takes place and an area becomes more urbanized, the number of signals per mile is likely to increase. LOS analysis of future conditions should therefore take into account changes in roadway and signalization characteristics.

To avoid double counting when determining the number of signalized intersections, only one intersection at the ends of the facility should be counted, as shown in **Figure 6-1**. In general, FDOT recommends including the last intersection within the analysis and ignoring the first, or entry, intersection. This allows the analysis to include the effects of delay, backup, and LOS from the last intersection for the facility under study.

Only one intersection at the ends of the facility should be counted.

Figure 6-1
Total Number of Signalized Intersections



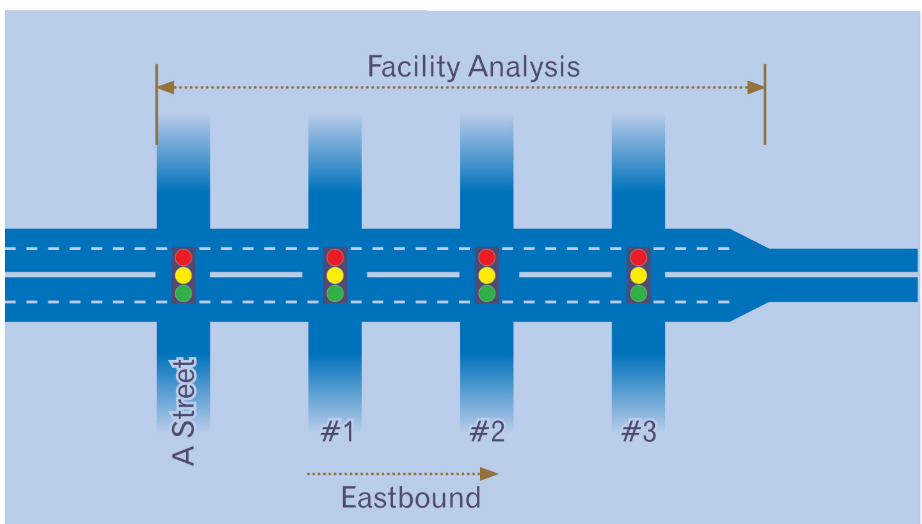
For example, in southeast Florida, principal arterials are often spaced 1 mile apart, with other signalized intersections in between. In this situation, only one of the signalized intersections at the ends of the roadway, plus the signals in between, should be counted when determining the number of signalized intersections per mile. In general, the last intersection in the peak flow direction would be counted, ignoring the first intersection.

As discussed previously, the arterial should begin and end at a signalized intersection. In unusual situations where this assumption is not applicable (e.g., lane drops, ramp junctions, etc.) the following guidance is provided:

- For the Generalized Service Volume Tables, do not count the unsignalized terminus as a signalized intersection
- For a conceptual planning analysis using ARTPLAN, treat the terminus as a signalized intersection with a g/C ratio of 1.00

As an example, consider a case where a four-lane arterial leads eastward out of an urbanized area, as shown in Figure 6-2. The western terminus is A Street. There are three signalized intersections east of A Street. However, the analysis extends 2.5 miles past the last signal as a four-lane road. At that point, the road tapers and becomes a two-lane facility. If using the Generalized Service Volume Tables, this roadway should be considered as having three signalized intersections. In ARTPLAN, however, the eastbound terminus should have a signalized intersection with a g/C of 1.00 (ARTPLAN needs to end at a signalized intersection).

Figure 6-2
Using a Taper as a Terminus for Facility Analysis



In general, only fixed, periodic interruptions should be considered in determining the number of signalized intersections. Draw bridges, at-grade railroad crossings, school zones, pedestrian crossings, and median openings should not be counted. Depending on site specific conditions or analysis desired, there may be exceptions to this general guidance.

Only fixed, periodic interruptions should be considered in determining the number of signalized intersections.

When using the Generalized Service Volume Tables, an intersection with a STOP sign for the through movement is considered a signalized intersection for a state signalized arterial. When analyzing a non-state signalized roadway the roadway must have at least one signalized intersection. When using ARTPLAN, an unsignalized intersection should be treated as a signalized intersection with a through g/C no greater than 0.40.

6.2. Arrival Type

Arrival Type is a general categorization of quality of signal progression. The HCM defines six Arrival Types, with 1 representing the worst progression quality and 6 representing the best. Uncoordinated operation, or random arrivals, is represented by 3 and is appropriate for actuated signals. Arrival Type 4 is FDOT's default for coordinated signal systems. More favorable progression (5 or 6) may be appropriate when progression design strongly favors the peak direction of travel and all the signals are coordinated for the length of the facility. One-way facilities tend to have better quality progression than two-way facilities. A higher level of progression may also be appropriate around freeway interchanges where signals are typically highly coordinated. Arrival type may vary significantly from one signal to the next, even in coordinated signal systems. Coordinated-actuated signals have varying g/C ratios, with breaks between groups of coordinated signals.

Arrival type is a general categorization of the quality of signal progression.

The assumption of very good progression in one direction does not imply efficient progression in the other direction. Even with less traffic volume, off peak direction speeds could be lower if favorable progression has been established for the peak direction only.

6.3. Signal Type

The signal type indicates the degree to which a traffic signal's cycle length, phase plan, and phase times are preset or actuated. Three main types are:

- Actuated
- Coordinated-Actuated
- Pretimed

It should be noted that modern traffic signals can handle multiple settings and can vary by time of day. Consequently, a traffic signal's operation (actuated, coordinated-actuated, or pretimed) can change by time of day to best meet traffic demands.

6.3.1. Actuated

Actuated, or fully actuated signals, use vehicle detection for all signal phases present at the intersection.

Actuated, or fully actuated signals, use vehicle detection for all signal phases on both the main and side street approaches. Each phase is subject to a minimum and maximum green time, and some phases may be skipped if there is no demand for the phase. The length of the green time observed in the field generally depends upon the amount of vehicular demand for the phase. If there is little demand, then a relatively short green time will be allocated to the phase. If there is significant demand, a relatively long green time will be allocated, subject to the maximum green time for that phase. The minimum and maximum green times for each phase can be easily changed by entering new values into the traffic signal controller.

Since phases can be skipped, and the amount of green time for each phase generally depends upon demand, the cycle length will often vary substantially from cycle to cycle. The exception occurs during periods of heavy vehicular demand, when all phases consistently reach their maximum values, making it seem as if the cycle length is fixed. Actuated signal operations are most frequently used when the signalized intersection is isolated, or when there is a desire to minimize delay without concern for progression.

6.3.2. Coordinated-Actuated

A subset of actuated control is referred to as **coordinated-actuated control**. In this type of signal operation, the cycle length is typically fixed while the amount of green time for the main street through phase varies. It consists of a minimum amount of green time plus any unused time from the minor phases. Holding the main street green in this manner at all of the signals along a facility allows platoons of vehicles to move relatively unimpeded along the main street with decent progression. Coordinated-actuated signal operations are typically used in Florida's developed areas, especially during peak travel times. This type of operation typically offers the best balance of capacity and progression for the main street through movement.

Coordinated-actuated refers to fixed-cycle signal control of an intersection in which the through movement on the designated main roadway gets the unused green time from side movements.

6.3.3. Pretimed

Pretimed signals use a preset sequence of phase times in a repetitive order and make no use of vehicle detection. Each phase is green for a fixed period of time, irrespective of vehicular demand, and none of the phases can be skipped. Thus, cycle length is fixed. This type of signal operation is most frequently used in downtown areas with high signal density, or when the desire is to maximize progression without extensive concern about maximizing capacity for the through movement.

Pretimed signals use a preset sequence of phase times in a repetitive order and make no use of vehicle detection.

6.4. Cycle Length

Cycle length (**C**) is the total time for a signal to complete a sequence of signal indications for all traffic movements. For actuated signals, the cycle length may vary depending on side street traffic, up to a maximum value. As used in the Generalized Service Volume Tables, the cycle length represents this maximum cycle length.

Cycle length (C) is the time it takes a traffic signal to go through one complete sequence of signal indications.

6.5. Effective Green Ratio (g/C)

The effective green ratio (g/C) is the ratio of the effective green time (g) for the through movement to the total cycle length (C).

One of the most significant variables used in calculating highway capacity and LOS on a signalized roadway is the through movement's effective green time to signal cycle length ratio (**g/C**). g/C is the amount of time allocated for the through movement (typically calculated as the green plus yellow plus all red indication times less the lost time) divided by the cycle length. Along with the number of through lanes, it is usually one of the two most important factors for determining the capacity of a roadway's through movement at any given intersection and for the roadway as a whole. Despite this, for generalized and conceptual planning analyses, g/C is often ignored. There may be many reasons for this:

- g/Cs typically vary from intersection to intersection along an arterial
- g/Cs typically vary by time of day
- Planning staff often ignore signal operations

Ignoring g/C undermines any arterial LOS analysis at a generalized planning or conceptual planning level. For this reason, guidance is needed to provide default g/Cs for generalized planning arterial analyses and to determine g/Cs at a conceptual planning level.

Weighted g/C is the average of the critical intersection's through g/C and the average of all the other signalized intersections' through g/Cs along the arterial facility.

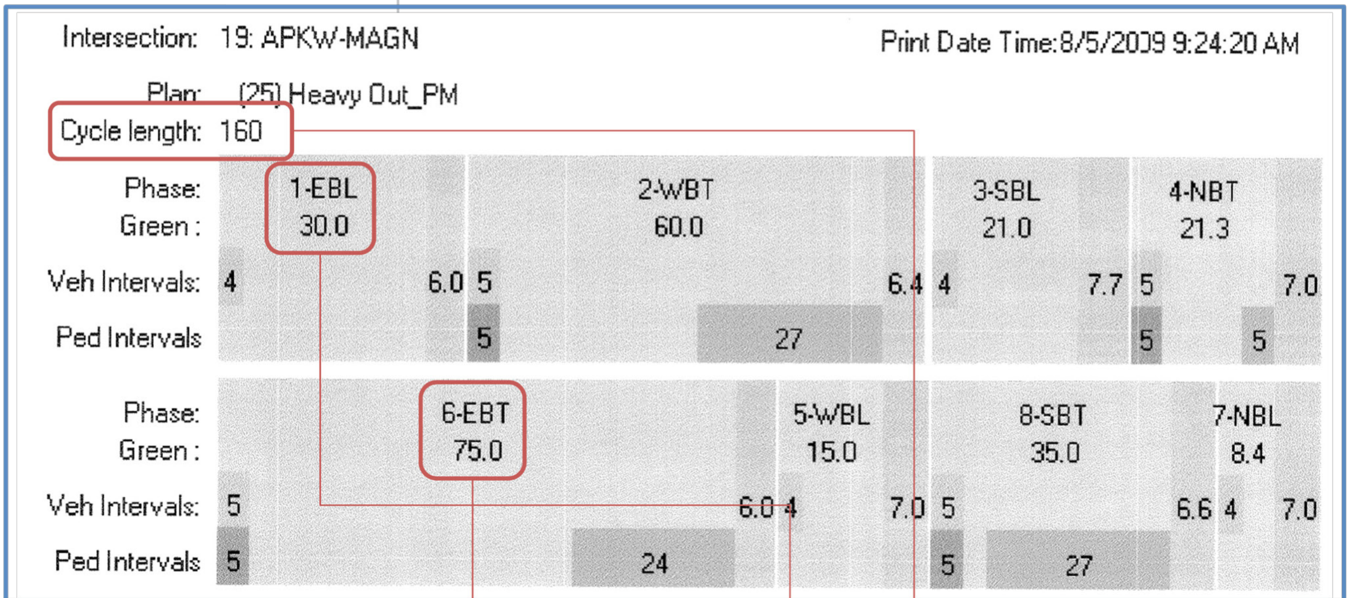
A major simplifying assumption that is essential to the development of the Generalized Service Volume Tables is the selection of a single g/C for all intersections on an arterial. FDOT has determined that for generalized planning analyses, the weighted effective green ratio yields the closest results to actual conditions. The **weighted g/C** of an arterial is the average of the sum of the critical intersection's through g/C with the average of the other intersections' through g/Cs. Essentially the worst intersection is given equal weight to all the other intersections combined. The weighted g/C approach is also used in ARTPLAN to give an analyst or reviewer a warning whether or not accurate g/Cs are being used for the arterial. A warning is issued if the weighted g/C value exceeds 0.5. In conceptual planning applications, however, signal specific g/Cs should be used, not a weighted g/C.

As an example, for the through movement phase, G is the green displayed time, Y the yellow displayed time (typically 3 or 4 seconds), R the all red indication (typically 1 or 2 seconds), and C the cycle length. The most representative situation in Florida is for cycles to consist of four phases and 12 indications: one phase each to accommodate the main road through movement, the side road left movement, the side road through movement, and the main road left movement, with G, Y, and R indications for each of the four phases. g refers to the effective green time which includes the effects of vehicular start up and clearance lost times (l1, l2).

FDOT's preferred approach for g/C determination for current year analyses is to use the actual signal timing plan from the traffic operations agency for the PM peak hour (typically 5-6 p.m.) for each signalized intersection. This approach offers a consistent and cost-effective approach while providing reasonable accuracy. If the signal is actuated, (G + 4)/C should be used for the through movement. This assumes the typical Y + R time of 4 seconds as additional time allocated to the through movement as a result of unused time from the other movements. If the signal is pretimed, the g/C for the through movement should be used.

For consistency and ease of review, FDOT recommends the use of signal timing plans from the applicable traffic operations agency. The process of determining g/C for both the through movement and the left turn movement is illustrated in **Figure 6-3**.

Figure 6-3
Example Signal Timing Plan and g/C Calculation



Example Completion of
g/C Documentation Worksheet

Intersection Name	Control Type	Primary Road Thru	Primary Road Left	Cycle Length	Primary Road Thru		Primary Road Left
	(a,s,p) *	G	G	C	(a,s) (G+4)/C	(p) G/C	G/C
Magnolia		75	30	160	0.49	N.A.	0.19

(75 + 4)/160 = 0.49

30/160 = 0.19

Analysts should be aware that signal timing plans come in a variety of forms, use many notations, and are not designed to directly address the determination of g/C. In fact, it may be necessary to coordinate with the operating agency directly in order to interpret the output values. When requesting the signal timing plan, the analyst should specify that only the 5-6 p.m. weekday time period is desired. However, even with the signal timing plan in hand, it is often necessary to confirm the actual splits in the field.

Analysts should calculate and input g/C for the through movement at all intersections. g/C for left turning movements need only be collected at any major intersections. A 10 percent value can be assumed as the left g/C for other intersections.

In previous FDOT guidance, FDOT offered two other methods for determining g/C:

- actual signal timings from the traffic operations agency
- field studies

Both approaches have some merit; however, after FDOT analyzed and tested both approaches, the preferred approach of using signal timing plans in general offers the best combination of consistency, accuracy, and cost-effectiveness. The use of field studies for g/C is discouraged unless early agreement by affected parties is reached.

The maximum acceptable facility through movement effective green ratios (g/C) during the peak hour typically should not exceed:

- State principal arterials
    - Current year – 0.50
    - Long term (≥ 10 years out) – 0.47
- Other roadways – 0.44

Under most circumstances, arterial facilities are 1.5 - 5.0 miles in length and include principal arterials as terminus points. The g/C value of 0.50 approximates FDOT's maximum allowable arterial capacity volumes of 1,000 vphpl and 950 vphpl in large urbanized areas and other urbanized areas, respectively.

Through movement g/Cs vary widely for individual intersections and different hours of the day. Therefore, ARTPLAN's acceptable g/C range for individual intersections is 0.1 to 1.0. Along principal arterials it is not unusual for the arterial to have g/C ratios in the 0.5 to 0.7 range at many intersections. However, as the analysis length increases from an individual intersection to a segment, to a section, and on to a facility, the probability that the arterial intersects other arterials increases. Furthermore, when two principal arterials intersect, the g/Cs for the through movements are in the range of about 0.40. To reflect these wide ranges in g/C values and upper limits of a facility g/C ratio, ARTPLAN allows individual intersections to have a g/C ratio of up to 1.0, but it provides warnings and messages if the facility weighted g/C exceeds a value of 0.50.

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7 MULTIMODAL VARIABLES

The following Chapter provides an overview of each multimodal variable used within the LOSPLAN software in order to allow the user to recognize these variations and analyze multimodal LOS on specific roadways. Where applicable, generally acceptable ranges are provided.

Multimodal variables describe the various geometric and demand characteristics that are needed to determine pedestrian, bicycle, and bus LOS. As with the control variables, multimodal variables are only applicable for arterial analyses:

- **Paved Shoulder/Bicycle Lane**
- Outside Lane Width
- Pavement Condition
- **Sidewalk**
- Sidewalk/Roadway Separation
- Sidewalk Protective Barrier
- **Bus Frequency**
- Bus Stop Amenities
- Bus Stop Type
- Passenger Loads

Default values should not be used as a part of a conceptual planning analysis for bolded values.

Table 7-1 provides an overview of the multimodal variable input requirements within the Generalized Service Volume Tables and the LOSPLAN software.

Table 7-1
Multimodal Variable Input Requirements

Input Variable	Generalized Service Volume Tables	ART PLAN	FREE PLAN	HIGHPLAN	
				2-Lane	Multilane
Paved Shoulder/Bicycle Lane	R	S	-	-	-
Outside Lane Width	D	S	-	-	-
Pavement Condition	D	S	-	-	-
Sidewalk	R	S	-	-	-
Sidewalk/Roadway Separation	D	S	-	-	-
Sidewalk/Roadway Protective Barrier	D	S	-	-	-
Bus Frequency	R	S	-	-	-
Bus Stop Amenities	D	S	-	-	-
Bus Stop Type	D	S	-	-	-
Passenger Loads	D	S	-	-	-

Legend:
- R Required table input
- S Segment/point specific
- D Default cannot be altered
- \- Not applicable
- F Facility specific

The effects that individual variables have on the computational process vary. **Table 7-2** indicates the sensitivity of the multimodal variables on capacity and LOS. For multimodal variables that have a high degree of sensitivity on service volumes (shown in **bold** on the first page of this chapter), default values should not be used as part of a conceptual planning analysis. ARTPLAN highlights these variables and requires analysts to provide specific values before calculating capacity and LOS.

Table 7-2
Sensitivity of Multimodal Variables on Service Volumes

Multimodal Variables	Sensitivity on Service Volumes
Paved Shoulder/Bicycle Lane	high
Outside Lane Width	low
Pavement Condition	low
Sidewalk	high
Sidewalk/Roadway Separation	medium
Sidewalk/Roadway Protective Barrier	medium
Bus Frequency	high
Bus Stop Amenities	low
Bus Stop Type	low
Passenger Loads	low

7.1. Paved Shoulder/Bicycle Lane

Within this Q/LOS Handbook, a bicycle lane is a designated or undesignated (paved shoulder) portion of a roadway for bicycles adjacent to motorized vehicle lanes. Painted lines separate paved shoulders/bicycle lanes from motorized vehicle lanes.

For planning purposes, a **designated bicycle lane** is usually 4 to 5 feet in width, and includes a bicycle logo. An **undesignated bicycle lane** is usually 4 feet in width and does not contain a bicycle logo. To be considered a paved shoulder/bicycle lane, at least 3 feet of paved shoulder must exist outside the painted line. Facilities with striped shoulders between 1 and 3 feet should be considered as having wide outside lane widths. In ARTPLAN, the assumed width of a paved shoulder/bicycle lane is 5 feet.

To be considered a paved shoulder/ bicycle lane, at least 3 feet of paved shoulder must exist outside the painted line.

A designated bicycle lane is a lane, usually 4 to 5 feet in width, that includes a bicycle logo.

An undesignated bicycle lane usually 4 feet in width and does not contain a bicycle logo.

7.2. Outside Lane Width

Outside lane width is the width, in feet, of a roadway's motorized vehicle through lane closest to the edge of pavement.

Wide curb lanes are 14-foot outside lanes.

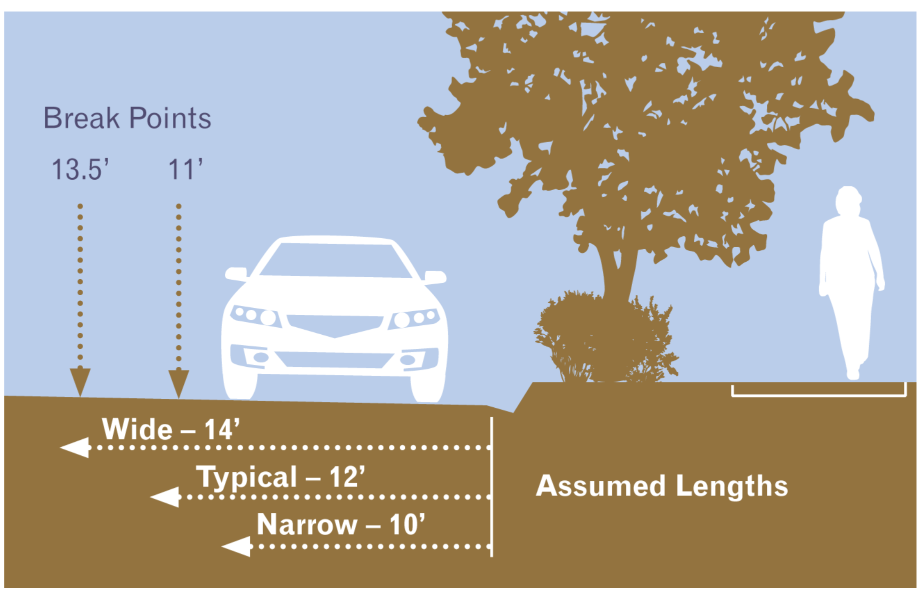
Within this Q/LOS Handbook, **outside lane width** is the width, in feet, of a roadway's outside motorized vehicle through lane, not including the gutter. This factor is usually important in the determination of a roadway's bicycle LOS. The majority of the State Highway System lane widths are 12 feet. Many local roads and some state highways have 14-foot outside lanes; these are sometimes referred to as **wide curb lanes**. Many other local roads and some state facilities have outside lane widths less than 12 feet.

The dimensions indicated below are for planning analyses only:

- Wide – greater than or equal to 13.5 feet, with 14 feet being the assumed value in ARTPLAN;
- Typical – greater than or equal to 11 feet and less than 13.5 feet, with 12 being the assumed value in ARTPLAN; and
- Narrow – less than 11 feet, with 10 feet being the assumed value in ARTPLAN.

ARTPLAN assumes that if the outside lane width is 12 feet or greater, the inside lane(s) is 12 feet. If the outside lane is less than 12 feet, the inside lane(s) should be the same as the outside lane.

Figure 7-1
Outside Lane Width



7.3. Pavement Condition

Pavement condition for bicycle LOS analysis is a general classification of the roadway surface where bicycling usually occurs, not necessarily that which drivers of motorized vehicles experience. Three general classifications are used: desirable, typical, and undesirable. These general classifications are used in lieu of detailed pavement surface grades found in the operational model on which this planning technique is based.

- **Desirable pavement condition** is new or recently resurfaced pavement. The pavement still maintains a dark black color, is free of cracks, and rides smoothly.
- **Typical pavement condition** is the most common type of pavement condition of Florida's roadways. Generally, the pavement has a light gray color, the surface appears worn, and may have some cracks; however, the ride for the bicyclist is fairly smooth.
- **Undesirable pavement condition** consists of pavement with noticeable cracks, broken pavement, or ruts. There may be existing or partially filled potholes, or drainage grates hazardous to bicycles. When the bicycle riding surface contains loose dirt, gravel, or debris, even if the roadway surface is typical or desirable, then it would be considered undesirable.

In general, FDOT recommends the use of a typical pavement condition for most analyses, especially those involving future years.

For analysts familiar with FHWA's PAVECON factors, desirable would equate to a 4.5 or 5.0 rating; typical would equate to 3.0 to 4.0 ratings, and undesirable would equate to 2.5 or less. The ARTPLAN software assumes a 4.5 rating for desirable, 3.5 for typical, and 2.5 for undesirable.

Pavement condition is the general classification of the roadway surface where bicycling generally occurs.

A sidewalk is a paved walkway for pedestrians at the side of a roadway.

Paved roadway shoulders are not considered sidewalks.

7.4. Sidewalk

Within this Q/LOS Handbook, a **sidewalk** is a paved walkway for pedestrians at the side of a roadway, typically 5 feet in width. Paved roadway shoulders are not considered sidewalks. Since LOS analyses are directional, the existence of a sidewalk is based on the directional side of the arterial being analyzed.

Sidewalk/Roadway Separation

Sidewalk/roadway separation is the lateral distance in feet from the outside edge of pavement to the inside edge of the sidewalk.

Within this Q/LOS Handbook, sidewalk/roadway separation is classified in three ways, as shown in **Figure 7-2**:

- **Adjacent** – less than or equal to 3.0 feet
- **Typical** – greater than 3.0 and less than or equal to 8.0 feet
- **Wide** – greater than 8.0 feet

In general, pedestrians tend to walk towards the outer half of sidewalks, away from traffic. ARTPLAN makes the assumption that pedestrians walk 4 feet from the inside edge of the sidewalk.

Figure 7-2
Sidewalk/Roadway Separation

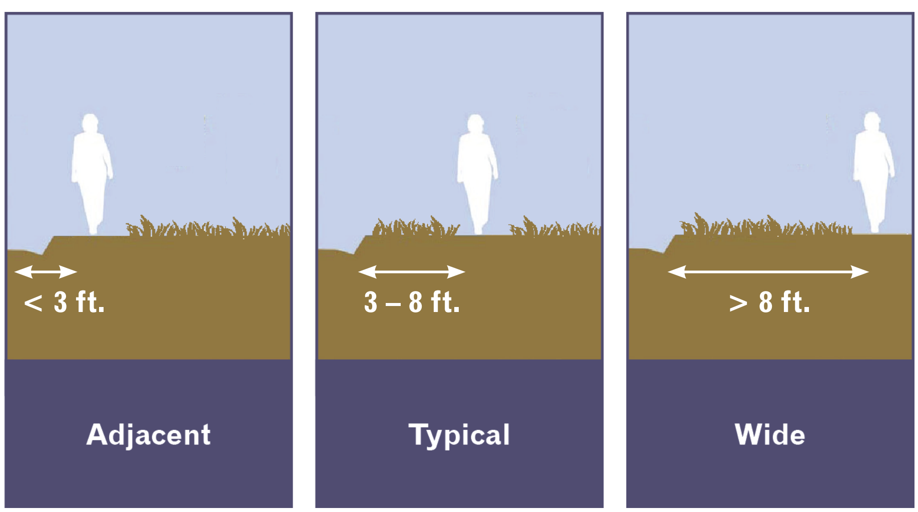


Table 7-3 provides the assumed ARTPLAN separation distances for pedestrians walking on sidewalks (pedestrian/sidewalk/roadway separation).

Table 7-3
ARTPLAN Assumed Sidewalk/Roadway Separation Distances

Pedestrian/Sidewalk/Roadway Separation Distances	Sidewalk/Roadway Separation Classification
6 feet	Adjacent
10 feet	Typical
15 feet	Wide

In downtown environments, sidewalks frequently extend at least 8 feet from the curb. In situations where there are no tree plantings or other sidewalk/roadway protective barriers, sidewalks should be classified as adjacent. When there are tree plantings or some other barrier between where people walk and the outside edge of the travel lane, sidewalks are assumed to have typical separation.

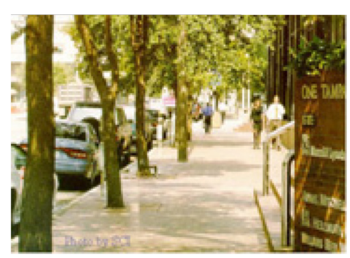
In situations where on-street parking and sidewalks both exist, the sidewalk/roadway separation should be considered wide, regardless of how close the sidewalk is to the edge of pavement. Essentially, on-street parking adds approximately 8 additional feet between pedestrians and motorized vehicles.

In situations where on-street parking and sidewalks both exist, the sidewalk/roadway separation should be considered wide, regardless of how close the sidewalk is to the edge of pavement.

7.5. Sidewalk Protective Barrier

In addition to sidewalk width, this Q/LOS Handbook also adds an overall **sidewalk protective barrier** factor to include the added benefits of trees, on-street parking, or other barriers. In ARTPLAN, the analyst simply states whether or not a barrier exists. ARTPLAN assumes that these barriers have the equivalent of a 1.5-fold impact on sidewalk/roadway separation. For example, if a row of trees exists along a roadway in which the sidewalk/roadway separation is typical (sidewalk distance from the outside edge of pavement is 6 feet), then the effect of the trees is the equivalent separation distance of 9 feet from the edge of the outside lane.

The sidewalk protective barrier factor is a factor that includes the added benefits of trees, on-street parking, or other barriers.



Bus frequency is the number of buses which have a potential to stop on a given segment in one direction of flow in a one hour time period.

Bus stop amenities are enhancements for comfort or safety that can greatly influence perceived quality of service along a route.

7.6. Bus Frequency

Bus frequency, also known as headway, refers to the number of scheduled fixed route buses which have a potential to stop on a given roadway segment in one direction of flow in a one-hour time period. Express buses with no potential of stopping along a roadway are not included.

7.7. Bus Stop Amenities

The bus stop is often the first component of any transit system that a passenger will encounter, and available amenities for comfort or safety can greatly influence perceived quality of service along a route. Rather than quantify all potential bus stop components, this Q/LOS Handbook creates four categories of **bus stop amenities**: excellent, good, fair, and poor. Having shelter from the weather and a place to sit is the most desirable condition at any bus stop, regardless of type, and is considered an excellent condition. A shelter without a bench represents a good condition, as rain, wind, and sun could otherwise deter choice riders. A bench only is less desirable than a stop with a shelter only, and is considered a fair condition. Finally, a bus stop with no bench and no shelter is considered a poor condition. Because excellent bus stops may improve a user's perception of the system, the bus stop amenity factor is used to increase the adjusted bus frequency value. Bus stops with no amenities are uninviting and discourage use, and the variable is therefore used to decrease the adjusted bus frequency value, as shown in **Table 7-4**.

Table 7-4
Bus Stop Amenity Factors

Bus Stop Amenities	Adjustment Factor
Excellent	1.1
Good	1.0
Fair	1.0
Poor	0.9

7.8. Bus Stop Type

Bus travel speed depends not only on distances and congestion along the route, but also the number of stops and the dwell time at each stop. Typical bus stops delay a bus for around 15 seconds, while major stations with numerous boardings and alightings can add around 35 seconds of delay.

7.9. Passenger Loads

Just as traffic congestion contributes to the degradation of level of service, crowding on buses can also impact quality of service. Because overcrowded buses may reduce the overall desirability of a route, a **passenger load factor** is used to modify the adjusted bus frequency value, as shown in **Table 7-5**.

The passenger load factor is a factor used to determine the adjusted bus frequency value by applying a factor commensurate to the level of passenger crowding.

Table 7-5
Passenger Load Factor

Passenger Load Factor	Adjustment Factor
< 30%	1.05
< 70%	1.00
≤ 100%	0.95
> 100%	0.85

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8 FUTURE YEAR ANALYSES

Traffic and development conditions change on roadways over time. This raises questions as to what input values, analysis tools, and LOS standards should be used for capacity/LOS analyses in future years. Analysis years and planning horizons vary appreciably in transportation planning. To aid in understanding and for simplification in this text, long term means 10 or more years from the current year, and short term means less than 10 years from the current year. However, for a specific application, FDOT District LOS Coordinators should be consulted for more detailed guidance.

Long term means 10 or more years, and short term means less than 10 years from the current year.

For development reviews, FDOT's LOS standards and area types remain effective throughout the project's planning horizon. For example, in FDOT's review of a proposed multi-phase development, the same standards and area types would be used regardless of the amount of development anticipated over time. The only time the applicable standards may change is when the development order conditions provide for a reevaluation of transportation impacts for subsequent phases of development. The change in LOS standards may result from an official change in designation (e.g., Census update, rule change, variance).

For future year analyses, it is also important to consider changes in appropriate roadway, traffic, control, and multimodal characteristics, as discussed in the following sections. For example, under existing conditions in a transitioning area, signalization may be very infrequent; however, as development occurs more signalized intersections can be anticipated and should be accounted for in future year capacity/LOS analyses.

8.1. Change in Traffic Variables

8.1.1. AADT

Historical growth trends and the state's travel demand forecasting models are typically used for long term traffic projections. Analysts and reviewers of capacity and LOS analyses need to agree on what future AADT values to use.

For site impact analyses, volumes are frequently presented in terms of trips generated by the site rather than roadway-specific AADT, K, and D values. ITE's Trip Generation Handbook is typically used for trip generation for site impact analyses; however, FDOT should be consulted about supplemental material. In all cases, care should be given to ensure final values are compatible with statewide Standard K and D_{200} factors.

8.1.2. Planning Analysis Hour Factor (K)

As areas become more developed, measured K values often drop, primarily for two reasons. The first is that more urban situations typically are not subject to highly volatile volumes like holiday traffic in rural areas. Generally, more developed areas are subject to frequent recurring volumes such as weekday commuter traffic. The second is that as congestion develops, spreading of the peak travel hour traffic also occurs. Refer to **Section 5.3** for Standard K values used in LOSPLAN by facility type.

For future year generalized planning analyses, the Standard K values for the assumed area and facility types found on the back of FDOT's Generalized Service Volume Tables are appropriate. In the longer term, it may be necessary to determine if the area is projected to transition into a different area type over the analysis period.

8.1.3. Directional Distribution Factor (D)

For future year analysis, the typical demand D value for all area and facility types is 0.55.

For future year generalized planning analyses, the typical demand D value for all area and facility types is 0.55. If a site-specific analysis is being conducted in the short term, FDOT's preferred approach is to use the Demand D_{200} from Florida Traffic Online. In the longer term, some lowering of the D_{200} factor may be appropriate. However, in no circumstance should it fall below the statewide minimum of 0.51.

8.2. Change in Control Variables

Making traffic and roadway projections into the future is well-accepted practice for generalized and conceptual planning analyses. However, control projections are rarely performed. For reasonable generalized and conceptual planning analyses of signalized roadways, control variables must be addressed both in the short term and in the long term. Typically, the two most important control variables are the through movement effective green to cycle length ratio (g/C) and signal density.

The two most important control variables are the through movement effective green to cycle length ratio (g/C) and signal density.

8.2.1. g/C

Determining current and future g/Cs for a roadway is complicated and judgments must be made.

In the short and long terms:

- For Class II arterials, continued use of existing g/Cs is appropriate
- For Class I arterials not subject to significant development pressure, continued use of existing g/Cs is appropriate
- For Class I arterials incurring significant new development pressure, it is appropriate to lower through movement g/Cs
- For new individual signals, through movement g/Cs will vary greatly; however, for planning purposes none should be assumed to be higher than 0.55

Within ARTPLAN, an acceptable way to project g/C ratios in the long term is by assuming a through g/C of 0.40 at all major intersections (typically state arterials) and 0.55 at other intersections. This is based on an assumption that each of the major arterial facilities receives an equal amount of green time for their approaches, minus the green time for accommodating left turning vehicles. Corresponding left and right turn percentages for each are 15 percent at major intersections, and 5 percent at other intersections.

Within HCS, an acceptable way to estimate future g/C ratios is by conducting intersection capacity analyses. HCS will determine the required g/C ratios to progress through traffic movements on the major street, while simultaneously minimizing delay to the minor street approaches.

8.2.2. Signal Density

As areas grow in population, additional traffic signals are frequently installed. Usually these new signals do not significantly affect the capacity of roadways unless they are in a previously undeveloped area, or are so closely spaced that queue spillback occurs. They can play a major role in the determination of LOS if stops occur more frequently and average travel speeds drop.

In both short and long term analyses, it is appropriate to consider the probability of new traffic signals, especially based on proposed new developments. In the absence of specific development plans or intersecting traffic volume cross-product signalization criteria, general guidance should be used in developed areas.

In the short term:

- For Class II arterials, continued use of existing signalized intersection locations is appropriate
- For Class I arterials not subject to significant development pressure, continued use of existing signalized intersection locations is appropriate
- For Class I arterials incurring significant new development pressure, one additional signalized intersection per mile may be assumed

In the long term:

- For Class II arterials, one additional signalized intersection per mile may be assumed
- For Class I in small towns one additional signalized intersection per mile may be assumed

Because of the wide variety of circumstances along generally uninterrupted flow highways in rural areas, no specific guidance can be given on future signal locations. However, for capacity/LOS purposes, the possibility of new signalized intersections should be considered.

Because of the importance of signal density on LOS on state roadways, for site impact applications, the number of new signals should be reviewed and approved by the FDOT district prior to use in an analysis.

Typically, other roadway, traffic, control, and multimodal variables do not have as large of an effect on capacity/LOS as the ones addressed above. If some of these other inputs (i.e., turning movement percentages) were determined in a current year analysis, they can usually be applied to future year analyses. If these other variables were not determined for a current year analysis, the statewide default values appearing on the back of the Generalized Service Volume Tables may be assumed.

8.3. Evaluation Tools

Travel demand forecasting models, the HCM and accompanying HCS software, and simulation tools are widely used for future year analyses. FDOT's LOSPLAN software programs were also developed to address LOS in future years, and are therefore appropriate for use. In Florida, concerns have arisen about the use or misuse of capacity/LOS software for planning applications in future years. In most situations, the basis for concern is not the tools themselves, but the assumptions and subsequent input values used in application of the tools.

In Florida, FDOT's Generalized Service Volume Tables are almost universally accepted for generalized planning purposes. Because of uncertainty in traffic and signal control conditions in future years they become more applicable as they do not imply a great deal of numerical precision.

FDOT's LOSPLAN software programs are specifically applicable and are typically the most appropriate tool to conduct conceptual planning capacity/LOS analyses in future years. It is imperative that appropriate assumptions and input values be used in the programs based on the guidance provided in the previous sections this Q/LOS Handbook.

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9 MAXIMUM ACCEPTABLE CAPACITY VOLUMES

Use of highway capacity and LOS tools, whether applied appropriately or not, has resulted in projected traffic volumes beyond normal capacity ranges found on Florida facilities. There are multiple reasons for this, but to aid analysts and reviewers on what capacity values will normally be acceptable, FDOT has adopted a set of general guidelines. The values provided below are based on site-specific freeway studies and counts, as well as arterial maximum acceptable g/C ratios. To aid the user, FDOT's LOSPLAN programs automatically check capacity and provide warnings and messages if acceptable capacities are exceeded. (Note: Under most circumstances, the maximum service volume for LOS E equals capacity).

Under most circumstances, the maximum service volume for LOS E equals capacity.

9.1. Arterials

For arterial facilities, the maximum generally acceptable per lane approach volumes are as follows:

- Large urbanized – 1,000 vehicles per hour per lane (vphpl)
- Other urbanized – 950 vphpl
- Transitioning – 920 vphpl
- Urban – 920 vphpl
- Rural – 850 vphpl

Note: arterial segments and sections may have higher values.

The maximum volumes shown represent a weighted g/C of approximately 0.50, which is the average of the critical g/C and the average of all other g/Cs along an arterial facility. Typically there will be at least one principal arterial intersecting an arterial being analyzed. Such intersections are usually the critical intersections (hot spots) for an arterial analysis, and g/C ratios for the through movements are in the range of about 0.40. Although these intersections are frequently flared out to achieve greater capacity, the through movement g/C ratios cannot increase appreciably if all intersection movements are included. Therefore, the use of a 0.50 g/C ratio for determining the capacity of an arterial should represent the upper bounds of what can be reasonably expected.

Arterial facility analyses typically involve intersecting principal arterials, but section analyses may not. Under these circumstances, arterial through movements during peak travel hours may feature g/C ratios in the 0.50 to 0.60 range. Such values may be appropriate for segment or section analyses; however, use of such high g/C ratios is not normally acceptable for a facility analysis and may represent inappropriate segmentation of roadways.

Another situation in which g/C ratios may be above 0.50 is in the outlying parts of urbanized areas or in transitioning areas for both arterials and generally uninterrupted flow highways. In these areas, signals have typically been recently installed, and side traffic has not yet reached the high levels that it will in future years. Therefore, although current maximum volumes per lane may be higher than those shown above, in the future, such values will likely not be sustained and should be avoided in the arterial analysis.

9.2. Freeways

For freeway facilities and sections, the maximum generally acceptable volumes are as follows:

- Large urbanized – 2,100 vphpl (1,900 vphpl if oversaturated)
- Other urbanized – 2,000 vphpl (1,900 vphpl if oversaturated)
- Transitioning – 1,900 vphpl
- Urban – 1,800 vphpl
- Rural – 1,800 vphpl

Ramp metering and extension of acceleration/deceleration lanes are two operational freeway characteristics within FREEPLAN that may result in volumes higher than those shown above.

Ramp metering and extension of acceleration/deceleration lanes will have a 5 percent or less improvement on capacity.

In general, implementation of ramp metering and extension of acceleration/deceleration lanes will have a 5 percent or less improvement on capacity. No special consideration is given to those two types of possible improvements in the maximum generally acceptable volume per lane values shown above.

9.3. Highways

For highway segments (generally uninterrupted flow highways), the maximum generally acceptable per lane approach volumes are as follows:

- Two-lane
  - Developed – 1,650 vphpl
  - Undeveloped – 1,500 vphpl
- Multilane
  - Developed – 1,850 vphpl
  - Undeveloped – 1,600 vphpl

Maximum volumes for highway segments may vary due to widely varying effective green to cycle length ratios (g/C), turning movements at intersections, and the segmentation of roadways.

9.4. Approval of Higher Capacities

Although LOSPLAN should serve as the primary analysis tool, FDOT will accept HCS operational analyses if they are appropriate to supplement LOSPLAN analyses. However, a separate check of HCS results to ensure they do not exceed the maximum volumes must be conducted. The HCS capacity results and other LOS threshold values should be adjusted to meet Florida's maximum acceptable capacity volumes. Of special note is the HCS freeway analysis methodology. Applying the HCM directly often results in higher volumes than typically seen on Florida and other U.S. freeways. If FDOT allows a different analytical tool to supplement LOSPLAN analyses, the results of those tools also should be checked to ensure they do not exceed the Florida maximum acceptable capacity volumes.

FDOT Districts and Central Office are expected to routinely reject analyses with higher facility volumes than shown above. Nevertheless, properly conducted highway capacity and LOS analyses may occasionally indicate capacities higher than the maximum acceptable capacity values.

If the facility being analyzed is not part of the SIS, FDOT District LOS Coordinators have the authority to approve higher volumes if they believe such volumes are representative of specific roadway conditions. However, they are under no obligation to do so, and may routinely submit these analyses to the FDOT's Central Office LOS Unit for review. If the analysis is for a SIS facility, FDOT districts are expected to seek concurrence with the Central Office LOS Unit before approving such high capacity volumes. Only an FDOT district may submit a request to the Central Office LOS unit for approval of higher volumes.

Demand volumes, not measured volumes, should be used to determine volume to capacity (v/c) ratios.

Additionally, demand volumes, not measured volumes, should be used to determine volume to capacity (v/c) ratios. Furthermore, capacity analysis is based on hourly time periods, such that daily volume to capacity ratios are meaningless and should not be used.

10 FLORIDA'S LOS STANDARDS FOR THE STATE

It is the Department's intent to plan, design, and operate the State Highway System at an acceptable level of service for the traveling public. Level of service standards for the State Highway System during peak travel hours are D in urbanized areas and C outside urbanized areas. For additional information, refer to FDOT's Procedure on **Level of Service Standards and Highway Capacity Analysis for the State Highway System (Topic No. 525-000-006)**.

10.1. Application of Standards

Urban State Highway System LOS Standard = LOS D

Outside Urban Areas = LOS C

The use of standard LOS is intended to promote public safety and general welfare, ensure the mobility of people and goods, and preserve the facilities on the State Highway System. The standards are to be applied to FDOT's planning activities. Unless otherwise provided by law, the minimum LOS standards for the State Highway System will be used by FDOT in review of local government comprehensive plans, assessing impacts related to developments of regional impact (DRI), and assessing other developments affecting the State Highway System.

The standards require all LOS determinations be based on the latest edition of the HCM, this FDOT Q/LOS Handbook or a methodology determined by FDOT as having comparable reliability. There are only two FDOT supported highway capacity and LOS analysis tools for generalized and conceptual planning: FDOT's Generalized Service Volume Tables and FDOT's LOSPLAN software. These two tools form the core for all FDOT's highway capacity and LOS analyses and reviews in planning stages.

10.1.1. Area Type

The area and roadway types in the LOS standards match well with FDOT's Generalized Service Volume Tables appearing at the end of this Q/LOS Handbook; however, subtleties exist on delineation of areas, as discussed in **Chapter 4**.

While the standards are applicable at the facility and section levels, there may be small lengths of roadways (e.g., 2 miles) between area types that from a logical and analytical perspective should be combined into one area type or another. This situation typically happens in transitioning areas, but may also occur elsewhere. FDOT District LOS Coordinators should be consulted for applicable boundaries within their districts.

10.1.2. Future Years

For development reviews, FDOT's LOS standards and area types remain effective throughout the project's planning horizon. For example, in FDOT's review of a proposed multi-phase development the same standards and area types would be used regardless of the amount of development anticipated over time. The only time the applicable standards may change is when the development order conditions provide for a reevaluation of transportation impacts for subsequent phases of development. The change in LOS standards may result from an official change in designation (e.g., Census update, rule change, variance).

10.1.3. Signalized Intersection Analysis

The logical extension of applying the LOS standards to point analyses is to apply the applicable standards to the through movement of the roadway. For example, for a site impact analysis, if the LOS standard for an arterial is D, then the through movement at the intersection should also be D. However, while sound in concept, it is usually possible to achieve a desired LOS for an intersection approach if the other approaches are ignored. Therefore, if an operational analysis of a signalized intersection is part of a planning study, the operational analysis should be conducted with HCS for the entire intersection with appropriate traffic volumes and other inputs for each approach. No intersection approach should fall below its established LOS standard. If there is no LOS standard, the approach should not have a volume to capacity ratio in excess of 1.0 for the full hour. The segment and the relevant intersection approaches must operate at acceptable levels of service. Other techniques exist for analyzing signalized intersections in planning studies, so District LOS Coordinators should be consulted for specific techniques and acceptable values in their districts.

If a detailed point analysis is performed, the applicant must demonstrate ample left turn storage. Any actual turning movement counts can only be used to determine the percentage of the approach turning left, not the actual number of turning vehicles as this number can be constrained and not representative of a demand volume.

10.1.4. Standard K

Standard K is the primary planning analysis hour factor used in Florida. Unless otherwise noted, all references in this Q/LOS Handbook and accompanying LOSPLAN software to a planning analysis hour or K factor refer to Standard K. The use of Standard K represents a design approach in which the K factor for a roadway is established from planning through design. The updated LOSPLAN software automatically enters the correct Standard K value based on the selected area and facility type, using the following values:

- Urbanized and transitioning areas (all facility types) – 0.090
- Large urbanized – 0.080-0.090
- Urban
  - Freeways – 0.105
  - Highways – 0.090
  - Arterials – 0.090
- Rural developed and rural undeveloped
  - Freeways – 0.105
  - Highways – 0.095
  - Arterials – 0.095

Refer to **Section 5.3** for additional information related to the use of Standard K.

All references in this Q/LOS Handbook and accompanying LOSPLAN software to a planning analysis hour or K factor refer to Standard K.

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11 GENERALIZED PLANNING ANALYSIS

11.1. Introduction

Generalized planning is a broad type of planning application that includes statewide analyses, initial problem identification, and future year analyses. Generalized planning is applicable when the desire is for a quick, "in the ballpark" estimate of LOS, and makes extensive use of default values. Florida's Generalized Service Volume Tables found at the end of this Q/LOS Handbook are the primary analysis tool in conducting this type of planning analysis.

Specific applications of the Generalized Service Volume Tables (Service Volume Tables 1 through 9) include:

- Generalized comprehensive plan amendment analyses
- Statewide highway system deficiencies and needs
- Statewide mobility performance measure (e.g., delay) reporting
- Areawide (e.g., MPO boundaries) baseline capacity and service volume values for travel demand forecasting models
- Areawide (e.g., impact areas) influence areas for major developments
- Future year analyses (e.g., 10-year planning horizon)
- Threshold evaluations for roadway concurrency management programs (e.g., 85 percent of a roadway's applicable LOS standard service volume)
- Baseline capacity and service volumes for concurrency management systems

Generalized Service Volume Tables must be appropriately applied (e.g., using the right area type and facility type designations) and interpreted (e.g., selecting the right values from the tables).

It is quite possible that no single roadway has the exact values for all the roadway, traffic, control, and multimodal variables used in the Generalized Service Volume Tables. The tables must be applied with care to roadway facilities and in the determination of the LOS grade.

Depending upon the application, such generalized analyses may be appropriately supplemented with documentation by an LOSPLAN analysis. For example, in Gainesville, for roadways where 85 percent or more of a roadway's LOS standard service volume is exceeded based on the Generalized Service Volume Tables, a supplemental LOSPLAN analysis is needed. However, to avoid cherry picking

No operational tool (e.g., HCM) should be used as part of a generalized planning analysis.

of desired input or output values, and to avoid falsely implied precision, no operational tool (e.g., HCM) should be used as part of a generalized planning analysis.

The automobile, bicycle, and pedestrian parts of the Generalized Service Volume Tables were developed based on the definitions and methodology of the HCM. Nationally, for bus analyses, the TCQSM is the comparable document to the HCM. The Generalized Service Volume Tables are believed to be the most thoroughly researched and state-of-the-art Generalized Service Volume Tables in use nationwide.

FDOT personnel conducted numerous traffic and signalization studies and developed values to reflect typical conditions in Florida. Daily and directional data were derived from FDOT's continuous traffic count stations throughout Florida. Signal timing data were obtained from analyses of traffic signal timings in Miami, Tampa, Tallahassee, Gainesville, DeLand, and Lake City. FDOT's intent has been to develop the most realistic numbers based on actual roadway, traffic, control, and multimodal data. Bicycle, pedestrian, and bus components of the tables were developed through a significant research project with the University of Florida and the developers of the TCQSM. Bicycle data collection and calibration was conducted in Tampa and pedestrian data collection and calibration was conducted in Pensacola. All roadway, traffic, control, and multimodal default values, as well as LOS thresholds, appear on the back of the Generalized Service Volume Tables.

Florida's Generalized Service Volume Tables consist of five area types grouped into three tables:

- Urbanized areas
- Areas transitioning into urbanized/urban areas, or cities over 5,000 population not in urbanized areas
- Rural undeveloped areas, or cities and developed areas less than 5,000 population

Most generalized and conceptual planning applications begin with annual average daily traffic (AADT) volumes given as an input, or end with AADT as a calculated output. Therefore, the generalized daily service volume tables shown in Tables 1 through 3 depict the AADT based on a standard peak hour. Some local and regional entities have adopted two-direction peak hour standards. Table 4 through 6 provide generalized peak hour two-way service volumes. Generalized peak hour directional tables (Tables 7 through 9) are provided because traffic engineering analyses are conducted on an hourly directional basis. These hourly directional tables may be viewed as the most fundamental of the tables because the two-way tables are simply the peak hour directional values divided by the directional distribution factor (D), and the daily tables are simply the peak hour directional values divided by both the D factor and the planning analysis hour factor (K).

All three sets of tables are internally consistent. More specifically, all of the volumes are based on the professionally acceptable Standard K factors and a PHF of 1.0. The 200th highest hour for the directional distribution variable is approximately equivalent to the typical peak hour of a day during a peak season in a developed area. Again, it is stressed that the daily, peak hour two-way, and peak hour directional tables are internally consistent, and are based on the same time period and directional flow of traffic.

The daily, peak hour two-way, and peak hour directional tables are internally consistent, and are based on the same time period and directional flow of traffic.

LOSPLAN was used to generate the Generalized Service Volume Tables, and applying the input values on the backs of Tables 1 through 9 in the LOSPLAN programs will yield the results on the front of the tables.

The Generalized Service Volume Tables present maximum service volumes, or the highest numbers of vehicles, for a given LOS. Any number greater than the value shown for a roadway with a given number of lanes would drop the LOS to the next letter grade. For example, if the volume shown in a table for a four-lane arterial at LOS C is 26,000 then 26,001 would represent LOS D. Some special aspects to the tables exist and are discussed in a later section.

The Generalized Service Volume Tables should not be referred to as capacity tables. In general, the values shown are the maximum service volumes for a given LOS based on roadway, traffic, control, and multimodal conditions during the peak hour in the peak travel direction. Whereas maximum service volume deals with the highest number of vehicles for a given LOS, capacity deals with the maximum number of vehicles or persons that can pass a point during a specified time period under prevailing roadway, traffic, and control conditions. Many of the LOS E service volumes in the hourly directional tables also represent the capacity of the roadway, but in general, most of the values do not reflect a roadway's capacity.

The Generalized Service Volume Tables should not be referred to as capacity tables.

A clear case of not representing capacity values is the daily tables. Roadway capacities for the day far exceed the volumes shown in the daily tables. All roadways are underutilized in the early morning hours and many heavily congested roads will have volumes higher

The primary criterion for LOS on arterials is average travel speed, not the capacity of the roadway.

than the highest volumes shown in the daily tables because traffic is backed up for more than a 1-hour period.

Another case of not representing capacity is the arterial LOS E service volumes. The primary criterion for LOS on arterials is average travel speed, not the capacity of the roadway. Average travel speed along arterials is made of many control variables (e.g., progression, cycle length), not just the capacity (i.e., volume to capacity ratios) of signalized intersections. Only in the special case when the capacity of signalized intersections control how many vehicles can pass through the intersections does capacity essentially dictate the lowest acceptable average travel speeds along arterials.

Florida's Generalized Service Volume Tables appear at the end of this Q/LOS Handbook.

- Daily Service Volume Tables
  - Table 1 – Urbanized Areas
  - Table 2 – Transitioning and Urban Areas
  - Table 3 – Rural Undeveloped and Rural Developed Areas
- Peak Hour Two-Way Service Volume Tables
  - Table 4 – Urbanized Areas
  - Table 5 – Transitioning and Urban Areas
  - Table 6 – Rural Undeveloped and Rural Developed Areas
- Peak Hour Directional Service Volume Tables
  - Table 7 – Urbanized Areas
  - Table 8 – Transitioning and Urban Areas
  - Table 9 – Rural Undeveloped and Rural Developed Areas

11.2. Special Cases

The volumes in the Generalized Service Volume Tables should be considered as average volumes over the facility under analysis. For example, if a 4-mile facility has AADT counts of 23,000, 22,000, 25,000, 23,000, and 27,000 for segments over its length, FDOT recommends the use of the average value 24,000 for comparison to the tables to determine the LOS. Use of the average volume works reasonably well unless there is one segment that has a widely disparate value, in which case a median value may be more appropriate.

11.2.1. Mid-Block Considerations

In general, Q/LOS analyses for interrupted flow facilities primarily focus on signalized intersections. The majority of motorist aggravation is generally attributable to delay, which primarily occurs at signalized intersections on arterials. Therefore, when using the Generalized Service Volume Tables, the number of lanes for arterials and other interrupted flow facilities should be determined at major intersections rather than mid-block.

For uninterrupted flow facilities and non-automobile modes, travelers place a greater emphasis on mid-block considerations. For example, on two-lane highways in rural undeveloped areas, LOS is largely determined by the ability to pass other vehicles. For freeways, most travelers are concerned about the operation of the whole facility and not the operation of particular interchanges. For bicycle and pedestrian movements, the Bicycle LOS and Pedestrian LOS Models are calibrated for mid-block conditions. For bus LOS, the emphasis is on the ability to travel by bus over the length of facility, with less importance placed on individual intersections. Therefore, in general, the number of lanes for these situations reflect mid-block considerations.

On two-lane highways in rural undeveloped areas, LOS is largely determined by the ability to pass other vehicles.

11.2.2. Non-State Signalized Roadways

The primary purpose of this Q/LOS Handbook is to compute the LOS for state facilities. However, because the techniques have great potential use by local governments, the Generalized Service Volume Tables and LOSPLAN software also have been structured for the needs of these agencies. The Generalized Service Volume Tables are reasonably well suited to local governments who desire to use them to evaluate roads under local jurisdiction. A feature of the urbanized and transitioning/urban Generalized Service Volume Tables is that non-state roadways are addressed. The only types of roadways not addressed in the tables are unsignalized local streets and unpaved roads.

The mere fact that roadways are operated and maintained by different governmental entities has no effect on the capacity or LOS of the roadways. ARTPLAN reflects the concept that ownership has no effect, only a facility's roadway, traffic, control, and multimodal characteristics. However, in general, non-state roadways have lower capacities and service volumes than state facilities because they have lower green times at signalized intersections. The Generalized Service Volume Tables therefore contain a -10 percent adjustment factor for non-state roadways.

In general, non-state roadways have lower capacities and service volumes than state facilities due to shorter green times at signalized intersections.

HCM LOS criteria address arterials rather than collectors or local streets. FDOT considers it appropriate for local governments to decide how to analyze collectors.

Uninterrupted flow facilities are analyzed the same, regardless of whether they are state facilities or not.

11.2.3. Variations in Levels of Service

Higher quality levels of service for the automobile, bicycle, and pedestrian modes may not be achieved, even with extremely low traffic volumes given the default values used in the Generalized Service Volume Tables. In the case of automobiles, the higher quality levels of service cannot be achieved primarily because the control characteristics simply will not allow vehicles to attain relatively high average travel speeds. In the case of bicycles and pedestrians, it is primarily caused by the lack of facilities serving those modes. The * symbol and corresponding footnote reflect this unachievable concept. The unachievable concept and * symbol also apply to service volume tables generated in ARTPLAN.

Lower quality levels of service for the automobile, bicycle, and pedestrian modes may not be applicable, even with extremely high traffic volumes given the default values used in the Generalized Service Volume Tables. In the case of automobiles, the lower quality levels of service are not applicable primarily because the control characteristics simply do not allow enough vehicles to pass through an intersection in an hour. If vehicles could get through the intersection, they could obtain the applicable LOS speed threshold, but there is not enough capacity at the intersection to let them pass through.

In the case of bicycles and pedestrians, it is primarily caused by the existence of facilities adequately serving those modes. For example, if a sidewalk exists, it is very difficult to establish a set of conditions in which the LOS to the pedestrian is F.

Essentially, once the maximum service volume is reached, the next LOS grade is F. For example, in Service Volume Table 1 for multilane Class I arterials, if demand volumes are greater than the LOS D threshold, then the LOS is F, and if the volume is at the LOS D threshold, the LOS is D; essentially LOS E does not exist. The ** symbol and corresponding footnote reflect this not applicable concept. The not applicable concept and ** symbol also apply to service volume tables generated in ARTPLAN. Alternatively, for the automobile mode it is acceptable to view the maximum service volume in a ** cell as having the same value as the previous volume appearing on the service volume table.

11.2.4. Divided/Undivided Roadways

For simplicity, the Generalized Service Volume Tables have factors that have been approved by the LOS Task Team (but not contained in the HCM) for the effects of mid-block medians and exclusive turn lanes at intersections. The cumulative effects of medians and exclusive turn lanes from common occurrences are shown in the Generalized Service Volume Tables.

A median has the effect of changing the adjusted saturation flow rate or service volume by 5 percent. In Florida, most two-lane roadways do not have a median (e.g., a two-way left turn lane), so the tables assume no median for those facilities. However, if there is a median, appropriate service volumes should be increased 5 percent. Most multilane arterials and highways in Florida have medians, so the tables are set up to assume medians for those facilities. However, if there is no median, appropriate service volumes should be decreased 5 percent.

A median has the effect of changing the adjusted saturation flow rate or service volume by 5 percent.

Most major roadways in Florida have exclusive left turn lanes at nearly all streets except those with very low volumes. If a roadway does not have left turn lanes at major intersections, its service volume drops 20-25 percent, depending upon the number of lanes, as indicated in the table. Common design practice in Florida is to use shared through/right turn lanes to accommodate right turning vehicles. However, exclusive right turn lanes have large capacity and service volume impacts for motorized vehicles at major intersections.

If a roadway does not have left turn lanes at major intersections, its service volume drops 20-25 percent depending upon the number of lanes, as indicated in the table.

11.2.5. One-Way Facility Adjustments

For simplicity, the urbanized and transitioning and urban Generalized Service Volume Tables have an intuitive factor that has been approved by the LOS Task Team (but not contained in the HCM) for the effects of one-way streets on motorized vehicles. Essentially, one-way pairs are assumed to have a 20 percent higher service volumes than corresponding two-way roadways with the same number of lanes. However, the Generalized Service Volume Tables treat each facility of a one-way pair as a separate facility. To account for that the volumes in the daily and hourly two-way Generalized Service Volume Tables (1, 2, 4, and 5) should be multiplied by 0.6, while the volumes in the hourly directional tables (Tables 7 and 8) should be multiplied by 1.2.

11.2.6. Auxiliary Lane Adjustment

Freeway auxiliary lanes (lanes connecting on-ramps and off-ramps) usually have significant capacity and LOS benefits. The values contained in the tables indicate their importance in a general way. To apply the adjustment, simply add the volume shown in the adjustment to the maximum service volume shown in the table.

11.2.7. Ramp Metering Adjustment

Freeway ramp metering has the positive benefit of smoothing out traffic demand entering a freeway during peak travel times. This positive benefit is reflected by increasing the service volumes shown on the tables by 5 percent.

11.2.8. Off-Peak Directional Volumes

Only a peak direction analysis is available in the current LOSPLAN software.

Highway capacity and LOS analyses are typically based on an hourly peak directional analysis and it is generally incorrect to apply peak direction results to the off-peak direction. This is caused by the fact that some significant off-peak inputs (e.g., signal progression, g/C) may vary from the peak direction.

11.2.9. Bicycle LOS

The volumes shown in the tables are not the number of bicyclists; rather they are the number of motorized vehicles in the outside lane.

The bicycle portions of the Generalized Service Volume Tables make primary use of the two most important factors in determining the LOS for bicyclists: the existence of paved shoulders/bicycle lanes and motorized vehicle volumes. It is important to note that the volumes shown in the tables are not the number of bicyclists; rather they are the number of motorized vehicles in the outside lane. Unlike automobile LOS, which is highly dependent on the number of other motorized vehicles on the roadway, bicycle LOS is not determined by how many other bicyclists are on road; rather, it is primarily determined by the bicycle accommodations on the roadway and volume of motorized vehicles. Default values are assumed for the other important factors such as speed of motorized vehicles, outside lane width, and pavement conditions, in establishing the bicycle LOS thresholds.

The other factor used in the Generalized Service Volume Tables is the volume of motorized vehicles in the outside lane. For analysis purposes, motorized vehicle volumes are assumed to be equally spread across the number of directional roadway lanes. Unlike the automobile entries on the table, in which the number of lanes is an entry into the tables, a step of multiplying the motorized volume by the number of lanes is needed in order to use the volume (hourly directional, hourly two-way, or daily) of motorized vehicles. For example, in Table 7, the LOS C threshold for 0 percent bicycle lane coverage is 150 vehicles for the outside lane. If the roadway has four lanes, then the 150 vehicles would be multiplied by two (number of directional lanes) in order to determine the maximum volume of motorized vehicles for bicycle LOS C in one direction of flow. The additional step was included to simplify the appearance of the tables and to save space.

11.2.10. Pedestrian LOS

The pedestrian portions of the Generalized Service Volume Tables make primary use of the two most important factors in determining the LOS for pedestrians: the existence of a sidewalk and motorized vehicle volumes. It is important to note that the volumes shown in the tables are not the number of pedestrians; rather, they are the number of motorized vehicles in the outside lane. Unlike automobile LOS, which is highly dependent on the number of other motorized vehicles on the roadway, pedestrian LOS is not determined by how many other pedestrians use the facility; rather, it is primarily determined by the presence of sidewalks and the volume of motorized vehicles. Default values are assumed for the other important factors, such as sidewalk/roadway separation, sidewalk/roadway protective barrier, and speed of motorized vehicles, in establishing the pedestrian LOS thresholds.

The volumes shown in the tables are not the number of pedestrians; rather, they are the number of motorized vehicles in the outside lane.

The other factor used in these tables is the volume of motorized vehicles in the outside lane. For analysis purposes, motorized vehicle volumes are assumed to be equally spread across the number of directional roadway lanes. Unlike the automobile entries on the table, in which the number of lanes is an entry into the tables, a step of multiplying the motorized volume by the number of lanes is needed in order to use the volume (hourly directional, hourly non-directional, or daily) of motorized vehicles. For example, in Table 7, the LOS C threshold for 100 percent sidewalk coverage is 540 vehicles for the outside lane. If the roadway has four lanes, then the 540 vehicles would be multiplied by two (number of directional lanes) in order to determine the maximum volume of motorized vehicles for pedestrian LOS C in one direction of flow. The additional step was included to simplify the appearance of the tables and to save space.

Sidewalks, whether on one side or both sides of a road, serve pedestrians in both directions.

All of the techniques contained in this Q/LOS Handbook and accompanying software are based on a directional analysis. For example, in the case of evaluating the automobile LOS on arterials, the LOS is for the peak directional flow, and the off peak direction could have a higher, lower, or the same LOS. This directional technique results in some unique perspectives when evaluating pedestrian LOS. Unlike facilities (and buses) for the other modes, sidewalks, whether on one side or both sides of a road, serve pedestrians in both directions. Furthermore, analysts should be especially careful when using the Generalized Service Volume Tables for determining pedestrian LOS when there is a sidewalk only on one side of the roadway. Because all the Generalized Service Volume Tables are based on peak hour directional analyses, pedestrian LOS based on the tables should be considered applicable only to the direction of the peak flow of traffic. When using the tables, there is typically a difference of two LOS grades if the sidewalk is, or is not, on the same side of roadway as the peak flow of traffic. Generally, having sidewalks on both sides of arterials in developed areas is considered desirable; yet, the Generalized Service Volume Tables do not adequately reflect that concept.

11.2.11. Bus LOS

The bus portions of the Generalized Service Volume Tables are primarily dependent on bus frequency, which is the number of scheduled fixed route buses that have a potential to stop in a given segment in the peak direction of flow in a 1 hour time period. That measure is supplemented by pedestrian accessibility. In the Generalized Service Volume Tables, pedestrian accessibility is represented by two broad ranges of sidewalk coverage.

There are two unique aspects of bus mode entries of the Generalized Service Volume Tables.

First, it is important to note that the volumes shown in the tables are the number of buses per hour. Unlike automobile, bicycle, and pedestrian LOS thresholds, the bus mode LOS thresholds are not related to the number of motorized vehicles on the roadway.

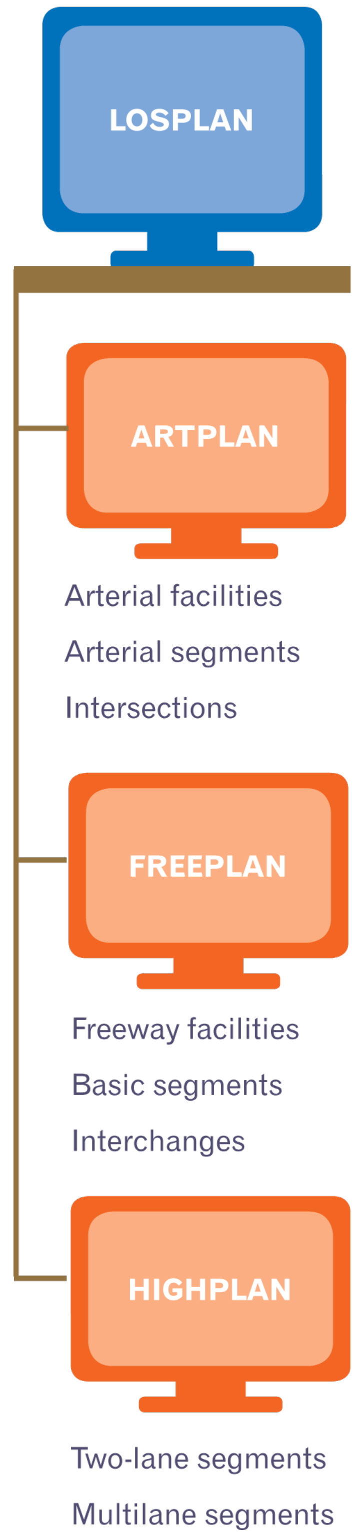
Second, regardless of the table used, all numbers are shown in terms of buses per hour for the peak hour in the peak direction. Thus, even in the daily urbanized table (Table 1), the threshold values shown are still in terms of peak hour directional buses.

12 LOSPLAN ANALYSIS

12.1. Introduction

Conceptual planning is a type of application detailed enough to reach a decision on design concept and scope (e.g., four through lanes with a raised median), conducting alternatives analyses (e.g., four through lanes undivided versus two through lanes with a two-way left turn lane), and performing other technical analyses. Conceptual planning is applicable when there is a desire for a good determination of the LOS of a facility without doing detailed, comprehensive operational analyses, and for determining needs when a generalized planning evaluation is simply not accurate enough. Florida's LOSPLAN software, which includes ARTPLAN, FREEPLAN, and HIGHPLAN, is the major tool in conducting this type of analysis. Although considered outstanding generalized and conceptual planning tools, the software programs are not detailed enough for final design or operational analysis work and should not be used for those purposes. See **Section 3.7** for a discussion of additional alternatives analysis tools.

FDOT's LOSPLAN software contains the core tools for site and project specific analyses in planning stages. Input and output documentation must be verifiable and approved by Districts and reviewing agencies. In general, the software is based on the HCM techniques and the Transit Capacity and Quality of Service Manual (TCQSM).

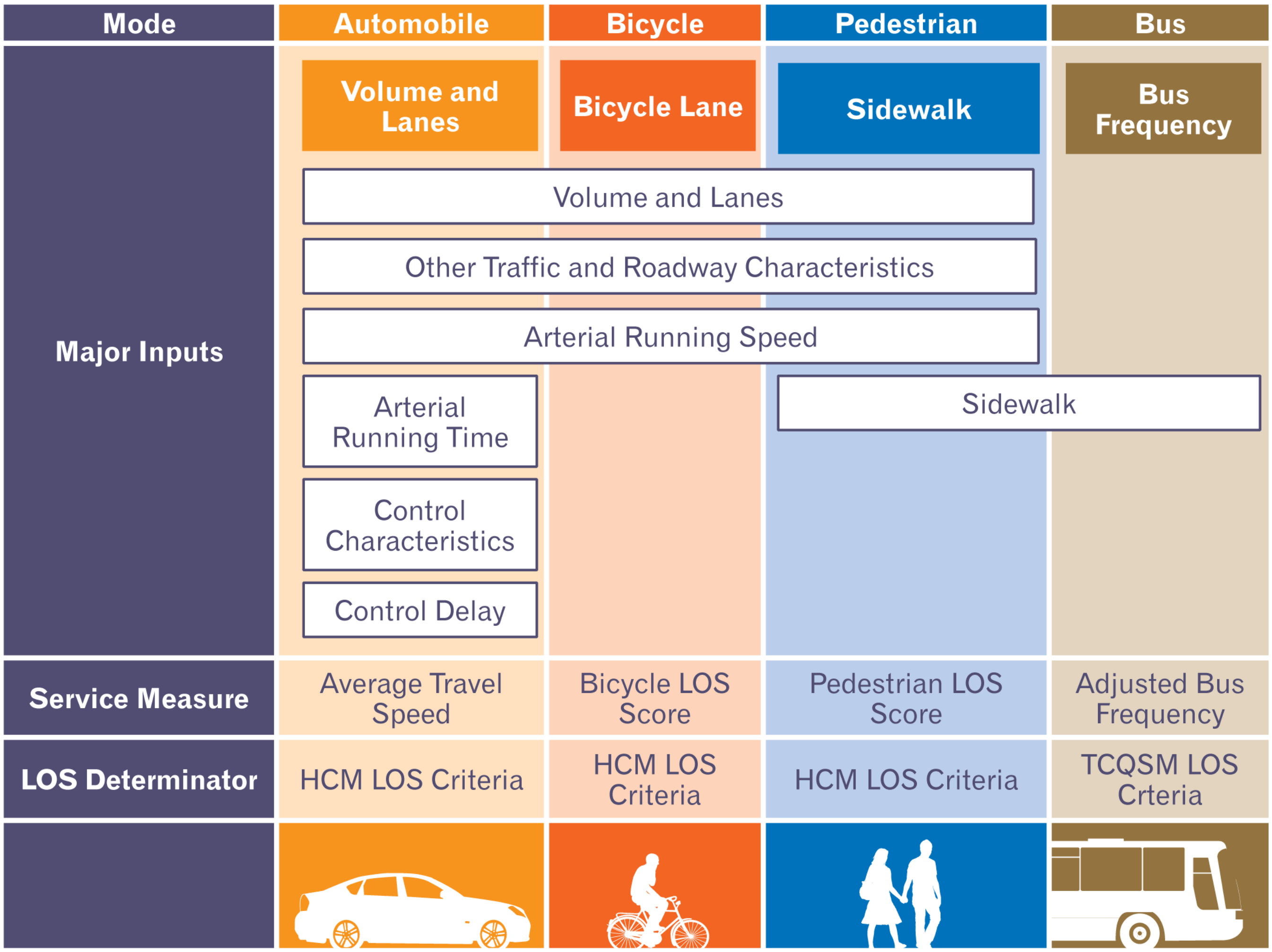


12.2. ARTPLAN

ARTPLAN is FDOT's multimodal generalized and conceptual planning software for arterial facilities. It is widely recognized as the primary planning software program implementing the HCM urban streets methodology (HCM Chapter 16). For the automobile mode, it may also be used for a simplified LOS analysis of the through movement on a segment or at a signalized intersection. The service measure for LOS differs between ARTPLAN and the HCM; ARTPLAN utilizes average travel speed solely as the service measure, whereas the HCM determines LOS based on the ratio of average travel speed to base free-flow speed. For the bicycle mode, ARTPLAN is the conceptual planning application of the Bicycle LOS methodology within Chapter 17 of the HCM. ARTPLAN determines a bicycle LOS score for side paths, roadway links, intersections, segments, and facilities. For the pedestrian mode, ARTPLAN is the conceptual planning application of the Pedestrian LOS methodology within Chapter 17 of the HCM. ARTPLAN determines a pedestrian LOS score for roadway links, intersections, segments, and facilities. For the bus mode, ARTPLAN is the conceptual planning application of the TCQSM methodology applied to bus route segments and roadway facilities.

ARTPLAN is multimodal in structure with the facility's roadway, traffic, control, and multimodal characteristics calculated simultaneously to determine the LOS for the automobile, bicycle, pedestrian, and bus modes. As quality of service of one mode improves, a positive, neutral, or negative effect on the other modes may occur. For example, as running speed of automobiles increases, the LOS may improve for automobiles and buses, but the LOS for bicyclists and pedestrians may decrease. **Figure 12-1** provides an overview of how the modes and their levels of service are linked.

Figure 12-1
Multimodal Flow Chart



As shown in the figure, the vehicular volume and number of lanes significantly affect the automobile, bicycle, and pedestrian levels of service. Other roadway, traffic, and control variables determine the automobile LOS. The motorized vehicle running speed, which is calculated as part of the automobile LOS, is also an important determinant of bicycle and pedestrian LOS. Together with the presence of bicycle lanes and sidewalks, motorized vehicle volumes and speeds are the main determinants of bicycle and pedestrian LOS. Bus LOS is primarily determined by bus frequency, but is also a major function of pedestrian LOS.

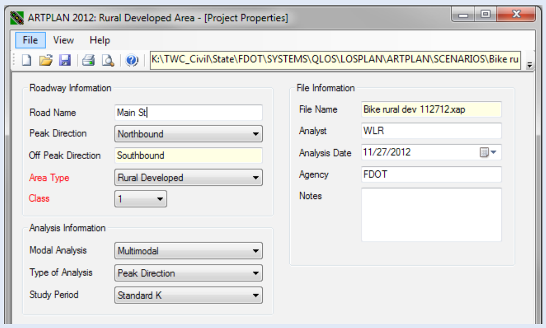
ARTPLAN does not combine the LOS for each of the modes into one overall LOS for the facility.

ARTPLAN does not combine the LOS for each of the modes into one overall LOS for the facility because there is no professionally acceptable or scientifically valid technique for combining the LOS.

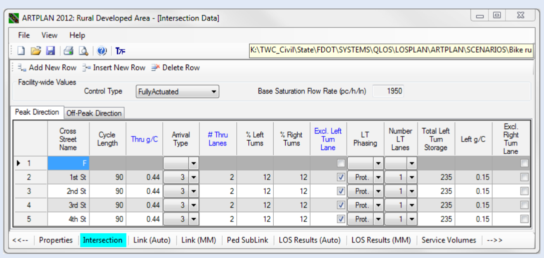
Because many sidewalks are discontinuous or vary over a roadway segment, ARTPLAN features a more detailed pedestrian subsegment analysis. Up to three pedestrian subsegments are allowed for a given roadway segment. The percent of the segment's length of each subsegment is entered. The program assumes there are no subsegments, so 100 percent appears until the analyst changes the value.

ARTPLAN input and output screens appear in **Figures 12-2** and **12-3**.

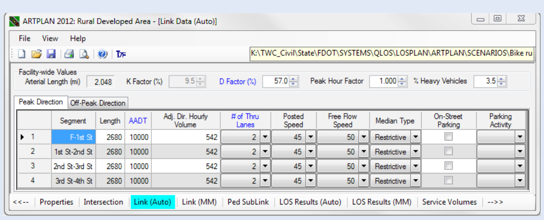
Figure 12-2
ARTPLAN Input Screens



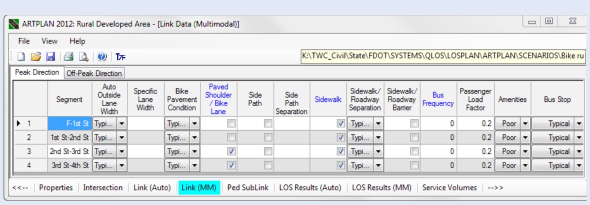
Project Properties



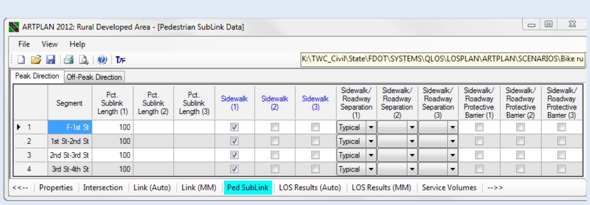
Intersection Data



Auto Segment Data

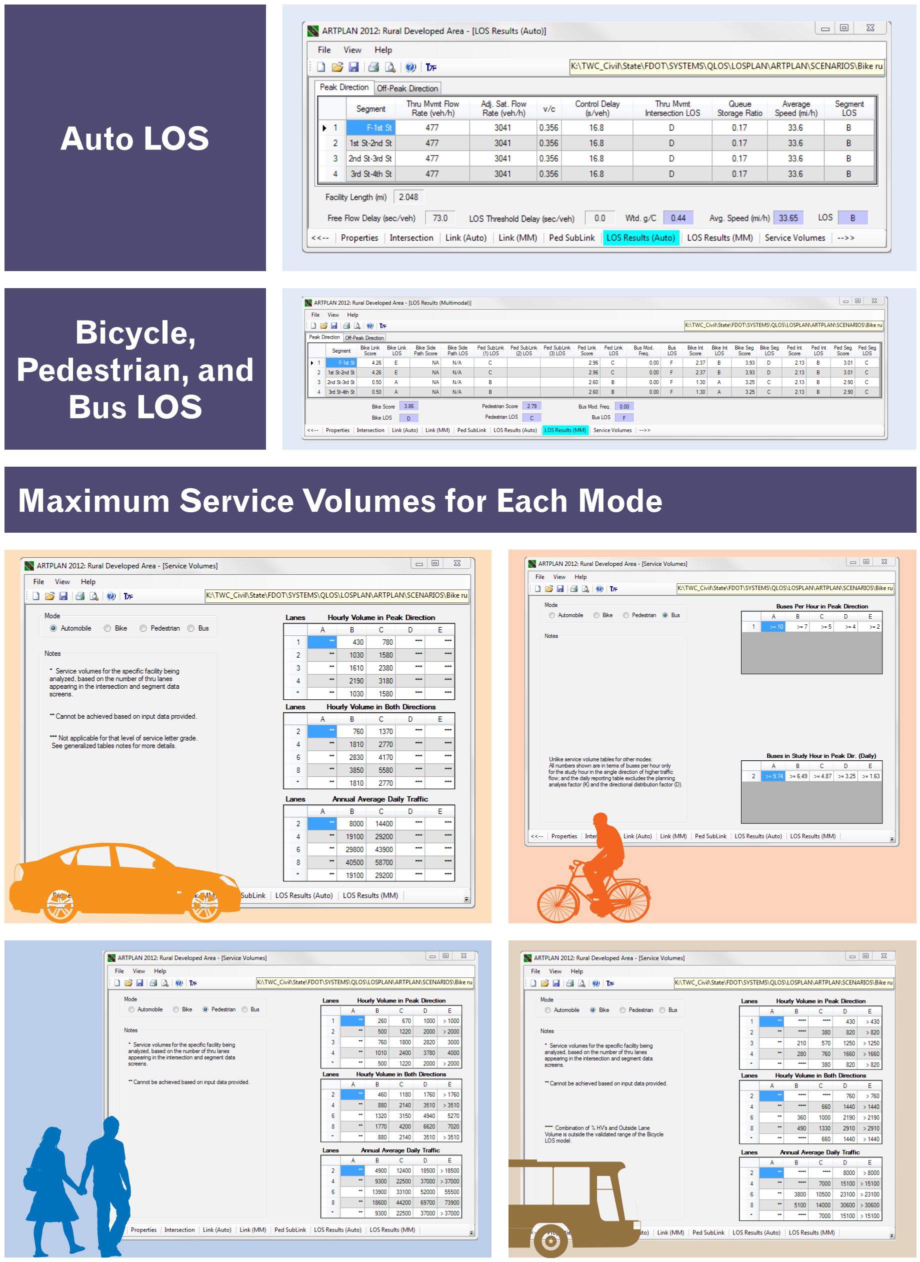


Multimodal Segment Data



Pedestrian Subsegment Data

Figure 12-3
ARTPLAN Ouput Screens



12.3. FREEPLAN

FREEPLAN is FDOT's generalized and conceptual planning software for freeways; that is, multilane divided roadways with at least two lanes for exclusive use of traffic in each direction and full control of ingress and egress.

Major features of FREEPLAN are:

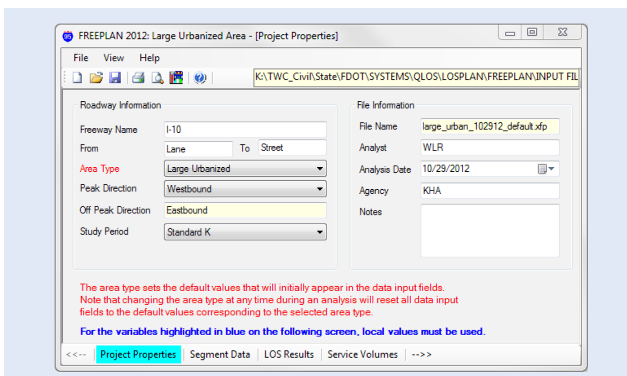
- Use of the HCM (Chapters 10, 11, 12, and 13) as the primary resource document for the methodology, such that the FREEPLAN methodology should "not be inconsistent" with the HCM, but, as appropriate, extend the HCM for generalized and conceptual planning purposes
- Concentration on the through vehicle while being sensitive to the analysis of other vehicles on the freeway and on segments of the freeway
- FREEPLAN combines point analyses (e.g., ramps), to equate a freeway facility LOS
- LOS density thresholds slightly lower than HCM basic segment criteria because of the effects of interchanges
- Capacity reductions in interchange areas
- Analysis of weaving segments using the HCM 2010 methodology
- Additional off-ramp outputs (e.g., off-ramp queue back up reports)
- An interchange ramp terminal capacity check, including off-ramp analysis
- Consideration of ramp overlap areas
- Toll plaza analysis, including open road tolling analysis
- Resulting service volumes matching reasonably well with actual Florida traffic counts

Some special aspects about operating FREEPLAN are listed below:

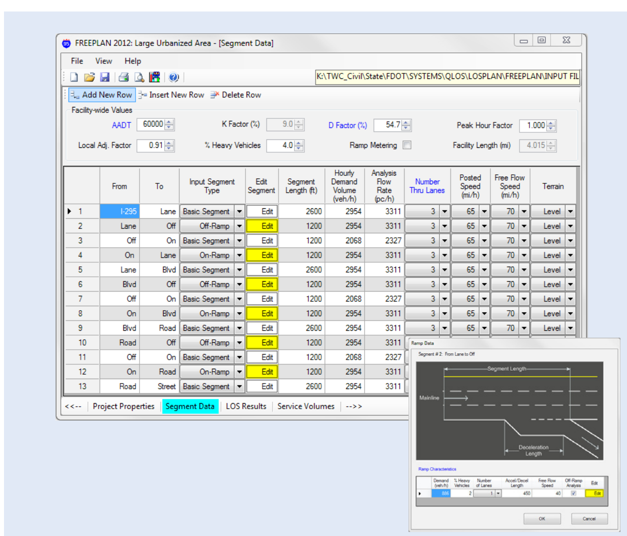
- On-ramps, off-ramps, weaving, and toll plaza segments have default characteristics that can be further edited by the analyst. The FREEPLAN operator should utilize the edit segment feature to customize ramp lengths, number of lanes, downstream signal data, weaving configuration, and toll plaza configuration.
- Basic segment influence areas are the same as the basic segment length
- AADT is entered into FREEPLAN for the first segment

FREEPLAN input and output screens appear in **Figures 12-4** and **12-5**.

Figure 12-4
FREEPLAN Input Screens

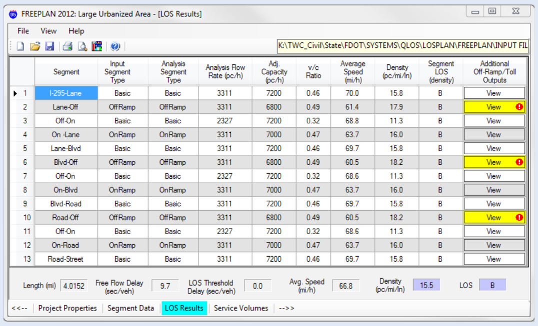


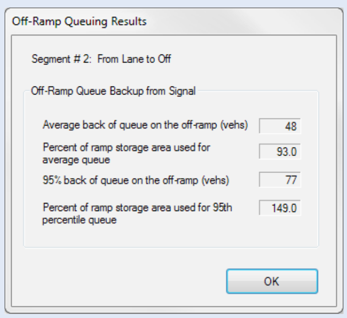
Project Properties



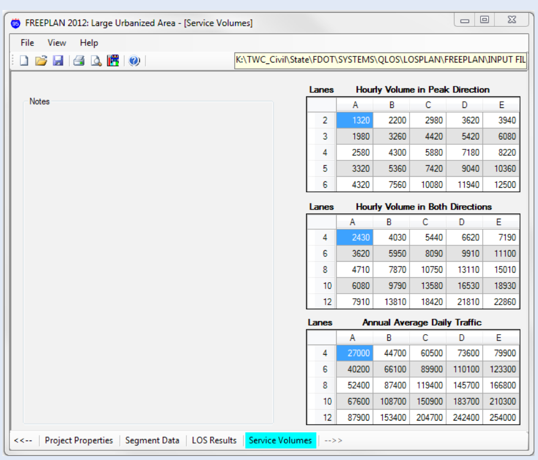
Segment Data

Figure 12-5
FREEPLAN Output Screens





Level of Service



Service Volume Tables

12.4. HIGHPLAN

HIGHPLAN is FDOT's generalized and conceptual planning software for two-lane and multilane uninterrupted flow highways with points of access not fully controlled.

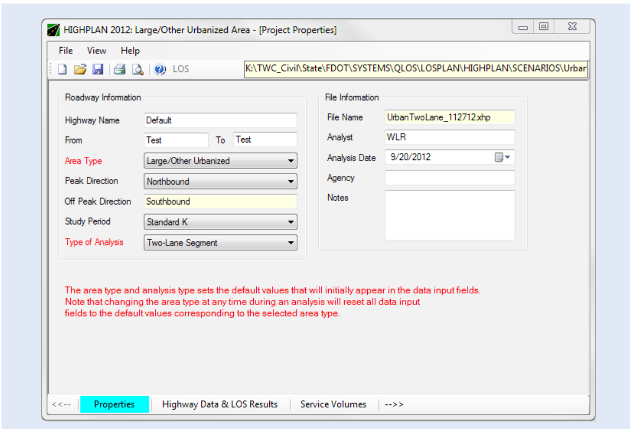
- Selection of the total number of lanes in both directions determines whether the facility will be analyzed as a two-lane or a multilane highway. The selection of either choice makes some variables irrelevant, such as percent no passing zones for multilane highways.
- Embedded in the two-lane highway portion of HIGHPLAN are two different classes of two-lane highways, one for rural undeveloped areas and one for developed areas
- In rural undeveloped areas, HIGHPLAN uses the HCM Class I LOS criteria, which is based upon percent time spent following (PTSF) and average travel speed (ATS) service measures
- In developed areas (urbanized, transitioning/urban, rural developed area types), HIGHPLAN implements the HCM Class III LOS thresholds based on percent of free flow speed
- After pressing the LOS calculation button, the results are shown with six performance measures: percent time spent following, average travel speed, percent free flow speed, free flow delay, LOS threshold delay, and v/c

When conducting a bicycle, pedestrian, or bus LOS analysis along an uninterrupted flow highway, ARTPLAN should be used instead of HIGHPLAN.

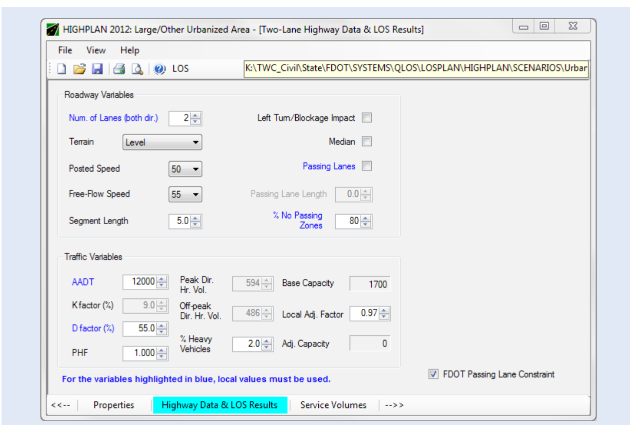
When conducting a bicycle, pedestrian, or bus LOS analysis along an uninterrupted flow highway, ARTPLAN should be used instead of HIGHPLAN. In its present form, HIGHPLAN only addresses the LOS of motorized vehicles. Primarily by using very low signal densities, ARTPLAN can approximate multimodal results as if HIGHPLAN had multimodal features. The bicycle service volumes in the rural undeveloped portions of Tables 3, 6, and 9 were generated in that manner.

HIGHPLAN input and output screens appear in **Figures 12-6** and **12-7**.

Figure 12-6
HIGHPLAN Input Screens

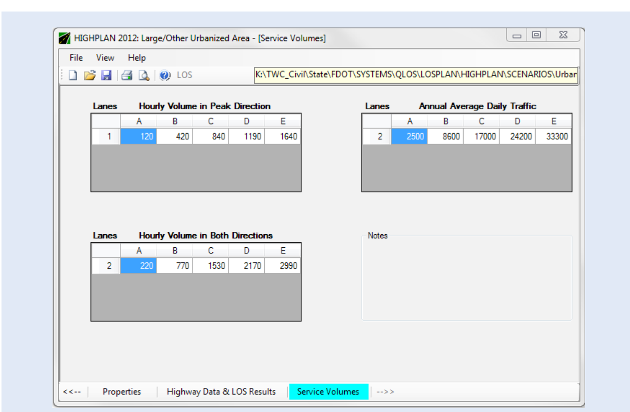


Project Properties



Highway Data and LOS Result

Figure 12-7
HIGHPLAN Output Screens



Service Volume Tables

12.5. Service Volume Calculation Process

All service volumes and resulting tables are first calculated for the peak hour in the peak direction. The peak hour two-way values are obtained by dividing the peak hour peak direction service volumes by the directional distribution factor (D). The daily volumes are obtained by dividing the peak hour two-way service volumes by the planning analysis hour factor (K).

Peak hour directional and peak hour two-way service volumes are rounded to the nearest 10 vehicles. Daily service volumes are rounded to the nearest 100 vehicles.

12.5.1. ARTPLAN

For the automobile mode, ARTPLAN starts with a volume of 10 vehicles per hour (vph) and then calculates the demand to capacity ratio (v/c) at each intersection. Then it finds the speed on each segment, which also accounts for the signal delay and the overall average speed for the facility. It then checks average speed against the average speed criterion for LOS A. If the speed is below the LOS A threshold speed, the volume is incremented by either 50 vph (if the difference in actual speed and LOS threshold speed is large) or 10 vph (if the difference in actual speed and LOS threshold speed is small). This process is repeated until the average facility speed is approximately equal to the LOS A threshold. The volume level at which this occurs is the service volume for LOS A. The volume (i.e., LOS A service volume) is then incremented by 10 vph and incrementally increased until the average facility speed is approximately equal to the LOS B threshold speed. This process repeats for LOS C, D, and E. If at any point during this process the v/c ratio exceeds 1.0 for the full hour, the calculation stops. If that condition is met, this volume becomes the service volume for whichever LOS letter grade was being evaluated at the time, as well as for the lower quality LOS grades.

For the bicycle and pedestrian modes, ARTPLAN starts with a volume of 10 motorized vph and then calculates bicycle/pedestrian LOS scores based on the Bicycle and Pedestrian LOS Models. Then it checks that score against the LOS A criterion. If the score is below the LOS A threshold value, the volume is incremented by 10 vph. This process is repeated until the facility score is approximately equal to the LOS A threshold. The volume level at which this occurs is then the service volume for LOS A. The volume (i.e., LOS A service volume) is then incremented by 10 vph and incrementally increased until the average facility score is approximately equal to the LOS B threshold volume. This process repeats for LOS C, D, and E. If at any point during this process the motorized vehicle v/c ratio exceeds 1.0 for the full hour the calculation stops. If that condition is met, this volume becomes the service volume for whichever LOS letter grade was being evaluated at the time as well as for the lower quality LOS grades.

For the bus mode, ARTPLAN uses the LOS service frequency criteria that appear in the Transit Capacity and Quality of Service Manual, modified by pedestrian LOS, relative auto speed, bus stop amenities, and passenger load factors.

12.5.2. FREEPLAN

For freeways, the automobile volume is incrementally increased until the demand flow rate to static speed ratio produces an average facility density that is approximately equal to the LOS A threshold. The volume level at which this occurs is the service volume for LOS A. The volume (i.e., LOS A service volume) is then incremented by 10 vph and incrementally increased until the average facility density is approximately equal to the LOS B threshold speed. This process repeats for LOS C, D, and E. If at any point during this process the v/c ratio exceeds 1.0 for the full hour, the calculation stops. If that condition is met, this volume becomes the service volume for whichever LOS letter grade was being evaluated at the time, as well as for the lower quality LOS grades.

12.5.3. HIGHPLAN

For multilane uninterrupted flow highways, HIGHPLAN starts with a volume of 10 vph and then calculates density. If the density is below the LOS A threshold density, the volume is incremented by 10 vph. This process is repeated until the average density is approximately equal to the LOS A threshold. The volume level at which this occurs is then the service volume for LOS A. The volume (i.e., LOS A service volume) is then incremented by 10 vph and incrementally increased until the average facility density is approximately equal to the LOS B threshold density. This process repeats for LOS C, D, and E.

For two-lane uninterrupted flow highways, HIGHPLAN uses the maximum service flow rate based on area type and free flow speed for the facility. The computations apply an iterative process in which the demand volumes are increased by increments of 10 vph and the results are compared against the thresholds that apply to the specific area type. In undeveloped areas, the service volume thresholds are determined by the percent time spent following or average travel speed for the peak 15-minute period, based on the updated chapter of the HCM. In developed areas, the thresholds are based on percent of free flow speed, subject to minimum constraints for LOS A and B. Threshold values are presented in the **Table 12-1**.

Table 12-1
LOS Thresholds for Two-Lane Uninterrupted Flow Highways in Developed Areas

LOS	Percent of Free Flow Speed	Minimum Speed (mph)
A	92	45
B	83	35
C	75	35
D	67	35
E	$v/c \geq 1.0$	35

13 REFERENCES

13.1. Contacts

FDOT welcomes questions and comments on the content and concepts of this Q/LOS Handbook and accompanying software. FDOT can provide assistance in interpretations, answering questions, providing advice, and training.

For further information also see FDOT's planning LOS website at: http://www.dot.state.fl.us/planning/systems/sm/los/default.shtm

FDOT makes extensive use of consultants for development and review of capacity and LOS analyses. In order to assure consistent application and review of capacity and LOS analyses across the state, the following guidance is provided:

Consultants working for FDOT, who perform LOSPLAN analyses or reviews for the Department, must attend a FDOT training class on the use of LOSPLAN. In extenuating circumstances, these consultants can be trained in-house on a one-to-one basis, but their work must be carefully checked to ensure that they have mastered the program. Those trained in this manner should attend a training class at the earliest possible opportunity.

If consultants are working with LOSPLAN for non-FDOT clients, it is highly recommended their firms have at least one person in each office attend an FDOT training class. They in turn can make sure that those in their office are trained in its use. These additional users can either attend a training class or be taught in house.

Training schedules can be found on the FDOT Systems Planning LOS website.

In addition anyone who downloads LOSPLAN is entered into the FDOT Contact Database. Training announcements will be periodically e-mailed to those who download the software.

Although no certification process is proposed, FDOT District LOS Coordinators have the authority to determine whether consultants have met this training requirement.

Initial contacts should be made with FDOT district planning personnel.

13.2. Glossary

A

Acceleration lane	A freeway lane extending from the on-ramp gore to where it's taper ends.
Acceptable range	The limits of input values for use in FDOT's *conceptual planning software*.
Accessibility	The dimension of *mobility* that addresses the ease in which travelers can engage in desired activities.
Accuracy	The degree of a measure's conformity to a true value.
Actuated	Same as *actuated control*.
Actuated control	All *approaches* to the *signalized intersection* have *vehicle* detectors with each *phase* subject to a minimum and maximum *green time* and some phases may be skipped if no vehicle is detected.
Add-on/drop-off lanes	Roadway lanes added before an intersection and dropped after the intersection.
Adjacent	In this Q/LOS Handbook a categorization of *sidewalk/roadway separation* less than or equal to 3.0 feet.
Adjusted bus frequency	In this Q/LOS Handbook the *bus frequency* times *adjustment factors* that account for pedestrian *LOS*, *pedestrian crossing difficulty*, obstacles to *bus stops*, and *span of service*.
Adjusted capacity	In this Q/LOS Handbook the base capacity times the effect of many *roadway variables* and *traffic variables*.
Adjusted frequency	Same as *adjusted bus frequency*.
Adjusted saturation flow rate	In this Q/LOS Handbook the *base saturation flow rate* times the effect of many *roadway variables* and *traffic variables*.

Adjustment factor	In the *software* a multiplicative factor applied to the *base saturation flow rate* to represent a prevailing condition. In the *Generalized Service Volume Tables* additive or multiplicative factors to adjust *service volumes*.
All way STOP control	An intersection with STOP sign at all approaches.
Analysis type	In *HIGHPLAN* a choice between a *facility* analysis or a *segment* analysis.
Annual average daily traffic (AADT)	The volume passing a point or segment of a roadway in both directions for 1 year divided by the number of days in the year.
Approach	The set of lanes comprising one leg of an intersection or interchange.
Approach delay	The sum of stopped-time *delay* and the time lost in decelerating to a stop and accelerating to a steady speed.
Area type	In this Q/LOS Handbook a general categorization of an extent of surface based primarily on the degree of urbanization.
Areawide analysis	An evaluation within a geographic boundary.
Arrival type	A general categorization of the quality of signal progression.
Arterial	A signalized roadway that primarily serves through traffic with average *signalized intersection spacing* of 2.0 miles or less; a type of roadway based on FDOT functional classification.
ARTPLAN	FDOT's arterial planning software for calculating *level of service* and *service volume tables* for *interrupted flow* roadways.
ATS	Same as *average travel speed*.
Auto	Same as *automobile*.
Auto outside lane width	Same as *outside lane width*.

Automobile	A motorized vehicle with 4 or less wheels touching the pavement during normal operation. In this Q/LOS Handbook, all motorized vehicle traffic using a roadway, except for *buses*.
Auxiliary lane	An additional lane on a *freeway* connecting an on-ramp of one interchange to the off-ramp of the downstream interchange.
Average daily traffic	The total traffic volume during a given time period (more than a day and less than a year) divided by the number of days in that time period.
Average travel speed (ATS)	The facility length divided by the average travel time of all vehicles traversing the facility, including all stopped delay times.
Axle correction factors	Adjustment factors used to calculate AADT by compensating for an axle counter's tendency to count more vehicles than are actually present.

B

Base capacity	Same as *base saturation flow rate* for *uninterrupted flow* roadways.
Base conditions	The best possible characteristic in terms of capacity for a given type of facility.
Base saturation flow rate	The maximum steady flow rate, expressed in passenger cars per hour per lane, at which passenger cars can cross a *point* on *interrupted flow* roadways.
Basic segment	In this Q/LOS Handbook the length of a *freeway* in which operations are unaffected by interchanges.
Basic freeway segment	Same as *basic segment*.
Basic two-lane highway segments	Highway segment located upstream of the intersection influence area and downstream of the affected downstream highway segment, and thus not affected by signalized intersections.
Bicycle	A mode of travel with two wheels in tandem, propelled by human power.

Bicycle lane	In this Q/LOS Handbook a *designated* or *undesignated* portion of roadway for bicycles adjacent to motorized vehicle lanes.
Bicycle LOS Model	The *operational methodology* from which this Q/LOS Handbook's bicycle quality/level of service analyses are based.
Bicycle level of service score	A numerical value calculated by the *Bicycle LOS Model* that corresponds to a *bicycle level of service*.
Bicycle pavement condition	Same as *pavement condition*.
BLOS	Same as *bicycle level of service score*.
Boundaries	In this Q/LOS Handbook the geographical limits associated with *FDOT's Level of Service Standards* for the *State Highway System* or its MPO Administrative Manual.
Bus	In this Q/LOS Handbook a self-propelled, rubber-tired roadway vehicle designed to carry a substantial number of passengers and traveling on a *scheduled fixed route*.
Bus frequency	The number of buses per hour serving one direction of a roadway facility.
Bus span of service	The number of hours in a day of bus service along a *route segment*.
Bus stop	An area where *bus* passengers wait for, board, alight, and transfer.
Bus stop amenities	Enhancements for comfort or safety that can greatly influence perceived quality of service along a route. Four categories of bus stop amenities exist: excellent, good, fair, and poor.
Bus stop amenity factors	Factors used to determine the adjusted bus frequency value by applying a factor commensurate to the quality of bus stop amenities.
Bus stop type adjustment factors	Factors that adjust travel times along bus routes by adding 15 to 35 seconds of delay per route for typical and major bus stops, respectively.

C

Capacity	The maximum sustainable flow rate at which persons or vehicles reasonably can be expected to traverse a *point* or a uniform section of roadway during a given time period under prevailing conditions. As typically used in this Q/LOS Handbook, the maximum number of vehicles that can pass a point in a one hour time period under prevailing *roadway, traffic* and *control conditions*.
Capacity analysis	Same as *highway capacity analysis*.
Capacity constrained	A condition in which traffic *demand* exceeds the capacity of a roadway.
Capacity utilization	The dimension of mobility that addresses the quantity of operations relative to capacity.
Captive rider	Transit rider who is limited by circumstances to use transit as a primary source of transportation.
Choice rider	Transit rider who chooses to take transit over other readily available transportation options.
Class	Same as *roadway class*.
Class 1 arterial	A roadway that has posted speeds of 40 mph or higher.
Class 2 arterial	A roadway that has posted speeds of 35 mph or less.
Collector	A roadway providing land access and traffic circulation with residential, commercial and industrial areas.
Conceptual planning	A type of analysis performed to support decisions related to design concept and scope.
Concurrency	A systematic process utilized by local governments to ensure that new development does not occur unless adequate infrastructure is in place to support growth.

Congestion	Condition in which traffic demand approaches or exceeds the available capacity of the transportation facility(ies).
Constrained	Same as *capacity constrained.*
Constrained roadway	A roadway on the State Highway System that FDOT will not expand by 2 or more through lanes because of physical, environmental, or policy constraints.
Continuous left turn lane	Same as *two-way left-turn lane.*
Control	A variable or characteristic typically associated with a traffic signal, STOP sign, yield sign, flashing device, or other similar measure.
Control characteristics	Same as *control.*
Control delay	The component of delay that results when a signal causes traffic to reduce speed or to stop.
Control type	Same as *signal type.*
Control variables	Parameters associated with roadway controls.
Controlled access highway	A non-limited access highway whose access connections, median openings, and traffic signals are highly regulated.
Coordinated-actuated	Same as *coordinated-actuated control.*
Coordinated-actuated control	Fixed-cycle signal control of an intersection in which the through movement on the designated main roadway gets the unused green time from side movements because of limited or no vehicle activation from side movements.

Core freeways	Major, non-toll freeways going through the urbanized core areas of the largest metropolitan areas, such as I-4 in Orlando. FDOT has adopted lower K values for these freeways to represent a peak period as opposed to a peak hour analysis. The lower K values impact daily service volumes only in the Generalized Service Volume Tables, thus values for Core Freeways are only found in Table 1.
Corridor	A set of essentially parallel transportation facilities for moving people and goods between two points.
Critical intersection	Same as *critical signalized intersection.*
Critical signalized intersection	The signalized intersection with the lowest volume to capacity ratio (v/c), typically the one with the lowest effective green ratio (g/C) for the through movement.
Cycle length (C)	The time it takes a traffic signal to go through one complete sequence of signal indications.

D

D factor	Same as *directional distribution factor.*
Daily tables	In this Q/LOS Handbook, Service Volume Tables presented in terms of annual average daily traffic.
Deceleration lane	A freeway lane extending from the taper to the off-ramp gore.
Delay	The additional travel time experienced by a traveler.
Demand	The number of persons or vehicles desiring service on a roadway.
Demand traffic	Same as *demand.*
Density	The number of vehicles, averaged over time, occupying a given length of lane or roadway; usually expressed as vehicles per mile or vehicles per mile per lane.
Design hour factor	In this Q/LOS Handbook the proportion of annual average daily traffic occurring during the 30th highest hour of the design year.

Designated bicycle lane	A lane, usually 4 to 5 feet in width, that includes both a bicycle logo and a directional arrow.
Desirable	In this Q/LOS Handbook a categorization of pavement condition that is new or recently resurfaced pavement.
Deterministic	Description of a type of model that is not subject to randomness.
Developed areas	All areas not rural undeveloped.
	Same as rural developed areas.
Development of regional impact (DRI)	A development which, because of its character, magnitude, or location, would substantially affect the health, safety, or welfare of citizens of more than one county in Florida, as defined in Section 380.06(1), Florida Statutes, implemented by Rule 9J-2, Florida Administrative Code, and coordinated by the regional planning agency.
Directional distribution factor (D)	The proportion of an hour's total volume occurring in the higher volume direction.
Diverge area	Same as *off-ramp influence area*.
Divided	As used in the Generalized Service Volume Tables, a roadway with a median.
Driver population	A traffic variable included as part of the local adjustment factor that describes driver familiarity with a roadway and accounts for such differences in driving habits as those between commuters and other drivers.
Driver population factor	The factor associated with driver population.
Dual left-turn lanes	Two lanes designated exclusively for left turns at a signalized intersection.
Effective green ratio (g/C)	Typically in this Q/LOS Handbook the ratio of the effective green time (g) for the through movement at a signal intersection to its cycle length (C).

E

Effective green time (g)	The time allocated for the through movement to proceed; calculated as the through movement green plus yellow plus all red indication times less the lost time.
Effective lanes	Same as *number of effective lanes*.
Exclusive left effective green ratio	The ratio of the effective green time (g) from an exclusive left turn lane for the peak traffic flow direction at a signal intersection to its cycle length (C).
Exclusive left turn lanes	Same as *left turn lanes.*
Exclusive left turn storage length	The total amount of storage length in feet for exclusive left turn lanes.
Exclusive right turn lanes	Storage area designated to only accommodate right turning vehicles.
Exclusive through lane	Any Intrastate highway lane that is designated exclusively for intrastate travel, is physically separated from any general-use lane, and the access to which is highway regulated. These lanes may be used for high occupancy vehicles (HOVs), and express buses during peak travel hours if the level of service standards can be maintained.
Exclusive turn lane	A storage area designated to only accommodate left or right turning vehicles; in this Q/LOS Handbook the turn lane must be long enough to accommodate enough turning vehicles to allow the free flow of the through movement.
Expanded intersections	Same as *add-on/drop-off lanes.*
Facility	A length of roadway composed of points and segments. A generic term including points, segments or roadways.
Factor	A value by which a given quantity is multiplied, divided, added or subtracted in order to indicate a difference in measurement.
FDOT	Florida Department of Transportation.

FHWA	Federal Highway Administration.
Five-lane section	A roadway with 4 through lanes, 2 in each direction separated by a two-way left-turn lane; in the Generalized Service Volume Tables, a five-lane section is treated as a roadway with 4 lanes and a median.
Flow rate	In this Q/LOS Handbook the equivalent hourly rate at which vehicles pass a point on a roadway for a 15-minute time period.
Free flow delay	The additional travel time represented by the difference between the time associated with a roadway's free flow speed and average travel speed.
Free flow speed (FFS)	In this Q/LOS Handbook the average speed of vehicles under low flow traffic conditions and not under the influence of signals, STOP signs, or other fixed causes of interruption, generally assumed to be 5 mph over the posted speed limit.
FREEPLAN	FDOT's freeway planning software for calculating level of service and service volume tables.
Freeway	A multilane, divided highway with at least 2 lanes for exclusive use of traffic in each direction and full control of ingress and egress.
Freeway interchange influence area	Same as *interchange.*
Freeway segment	In this Q/LOS Handbook a basic segment, interchange or toll plaza.
FSUTMS	Florida Standard Urban Transportation Modeling System; Florida's software that forecasts travel demand.
Fully actuated control	Same as *actuated control.*

G

Functional classification	The assignment of roads into systems according to the character of service they provide in relation to the total road network.
g/C	Same as *effective green ratio.*
Generalized Service Volume Tables	Maximum service volumes based on areawide roadway, traffic and control variables and presented in tabular form.
Generalized planning	A broad type of planning application that includes statewide analyses, initial problem identification, and future year analyses; in this Q/LOS Handbook typically performed by use of the Generalized Tables.
Generalized Tables	Same as *Generalized Service Volume Tables.*
General-use lane	Any Intrastate highway lane not exclusively designated for long distance, high-speed travel. In urbanized areas these lanes include high occupancy vehicle (HOV) lanes that are not physically separated from other travel lanes.
Gore	The point located immediately between the left edge of a ramp pavement and the right edge of the roadway pavement at a merge or diverge area.
Green time (G)	The duration in seconds of the green indication for a given movement at a signalized intersection.
Growth management concepts	The ideas necessary for use in careful planning for urban growth so as to responsibly balance the growth of the infrastructure required to support a community's residential and commercial growth with the protection of its natural systems (land, air, water).
Guideline	Based on FDOT's Standard Operating System (Topic No: 025-020-002-d), a recommended process intended to provide efficiency and uniformity to the implementation of policies, procedures, and standards; a guideline is intended to provide general program direction with maximum flexibility.

Handbook	Based on FDOT's Standard Operating System (Topic No: 025-020-002-d), technical instructions or techniques used to assist or train users in performing specific functions.
HCM	Same as *Highway Capacity Manual.*
Headway	The time, in seconds, between two successive vehicles as they pass a point on a roadway.
Heavily congested	Same as *congestion.*
Heavy vehicle	A FHWA vehicle classification of 4 or higher, essentially vehicles with more than 4 wheels touching the pavement during normal operation.
Heavy vehicle factor (HV)	The adjustment factor for heavy vehicles.
Heavy vehicle percent	The percentage of heavy vehicles in the traffic stream.
High-occupancy vehicle (HOV) lane	A freeway lane reserved for the use of vehicles with a preset minimum number occupants; such vehicles often include buses, taxis, and carpools.
HIGHPLAN	FDOT's software for calculating levels of service and service volume tables for two-lane highways and multilane highways.
Highway	1) An uninterrupted flow roadway that is not a freeway. 2) A generic term meaning the same as *roadway.* 3) A roadway with all the transportation elements within the right-of-way.
Highway capacity analysis	An examination of the maximum of vehicles or persons that can reasonably be expected to pass a point on a roadway during a specified time period under prevailing roadway, traffic, and control conditions.
Highway Capacity Manual (HCM)	The Transportation Research Board document on highway capacity and quality of service.
Highway Capacity Software (HCS)	A software package faithfully replicating the Highway Capacity Manual.

H

	Highway mode	In this Q/LOS Handbook, either automobile, bicycle, bus, or pedestrian.
	HIGHPLAN	FDOT's uninterrupted flow highway planning software for calculating level of service and service volume tables.
	Highway system structure	Same as *transportation system structure.*
I	Indication	In this Q/LOS Handbook, the green, yellow or red appearance of a signal to a motorist.
	Interchange	In this Q/LOS Handbook the influence area associated with the off-ramp influence area, overpass/underpass, and on-ramp influence area of a connection to a freeway.
	Interchange influence area	Same as *interchange.*
	Interchange spacing	The distance between the centerlines of freeway interchanges.
	Interrupted flow	A category of roadways characterized by signals, STOP signs, or other fixed causes of periodic delay or interruption to the traffic stream with average spacing less than or equal to 2.0 miles.
	Intersection	The same as *signalized intersection*, unless specifically noted.
	Intersection influence area	In this Q/LOS Handbook a segment of an uninterrupted flow highway influenced by an isolated intersection.
	Interval	A period of time in which all traffic signal indications remain constant.
	Intrastate highways	Highways on the Florida Intrastate Highway System (FIHS).
	Isolated intersection	An intersection occurring along an uninterrupted flow highway.
K	K factor (K)	Same as *planning analysis hour factor*.

Lanes	Same as *number of through lanes*, unless specifically noted.	**L**
Large urbanized area	An MPO urbanized area greater than 1,000,000 population; in Florida these 7 areas consist of the following central cities: Ft. Lauderdale, Jacksonville, Miami, Orlando, St. Petersburg, Tampa, and West Palm Beach.	
Lateral clearance	Clearance distance from edges of outside lanes to fixed obstructions.	
Left turn lanes	In this Q/LOS Handbook storage areas designated to only accommodate left turning vehicles; a left turn lane must be long enough to accommodate enough left turning vehicles to allow the free flow of the through movement.	
Level of service (LOS)	A quantitative stratification of the quality of service to a typical traveler of a service or facility into six letter grade levels, with "A" describing the highest quality and "F" describing the lowest quality; a discrete stratification of a quality of service continuum.	
Level of service (LOS) analysis	A quantitative examination of traveler quality of service provided by a transportation facility or service.	
Level of service (LOS) standards	Same as *Statewide Minimum Level of Service Standards for the State Highway System.*	
Level terrain	A combination of horizontal and vertical alignments that permits heavy vehicles to maintain approximately the same running speed as passenger cars; this generally includes short grades of no more than 1 to 2 percent.	
Limited access highway	Same as *freeway.*	
Link	A length of roadway between two points; unlike a segment, a link does not include boundary points.	
Load factor	The ratio of passengers actually carried to the total passenger capacity of a bus.	

M

Local adjustment factor	In this Q/LOS Handbook an adjustment factor FDOT uses to adjust base saturation flow rates or base capacities to better match actual Florida traffic volumes; mostly consists of a driver population factor and an area type factor.
LOS	Same as *level of service.*
LOS standards	Same as *Level of Service Standards for the State Highway System*.
LOS threshold delay	Same as *threshold delay.*
Maintain	Continuing operating conditions at a level that prevents significant degradation.
Maximum acceptable value	The highest value for a traffic variable FDOT will accept when developing, reviewing or approving a LOS analysis.
Maximum service volume	The highest number of vehicles for a given level of service.
Measure of effectiveness	A quantitative parameter indicating the performance of a transportation facility or service.
Median	Areas at least 10 feet wide that are restrictive or non-restrictive that separate opposing-direction mid-block traffic lanes and that, on arterials, contain turn lanes that allow left turning vehicles to exit from the through traffic lanes.
	A mathematical measure of central tendency in which the value selected in an ordered set of values below and above which there is an equal number of values.
Median factor	A factor by which a service volume is multiplied to account for the effects of the existence of a median.
Median type	A classification of roadway medians as restrictive, non-restrictive, or no median.
Merge area	Same as *on-ramp influence area*.
Mid-block	In this Q/LOS Handbook the part of a roadway between two signalized intersections.

Minimum acceptable speed	In this Q/LOS Handbook the lowest average travel speed criterion for a given level of service as applied to two-lane highways in developed areas.
Minimum acceptable value	The lowest value for a traffic variable FDOT will accept when developing, reviewing or approving a LOS analysis.
Mobility	The movement of people and goods.
Mode	A method of travel; in this Q/LOS Handbook a highway mode.
Motorized mode	A method of travel by automobile or bus.
Motorized vehicle	Same as *vehicle*.
Movement	A flow of vehicles or people in a given direction.
MPO	Metropolitan Planning Organization.
Multilane	Having more than one through lane in the analysis direction.
Multilane highway	A non-freeway roadway with 2 or more lanes in each direction and, although occasional interruptions to flow at signalized intersections may exist, is generally uninterrupted flow.
Multimodal	In this Q/LOS Handbook more than one highway mode.
Multimodal Transportation District	An area in which secondary priority is given to vehicle mobility and primary priority is given to assuring a safe, comfortable, and attractive pedestrian environment, with convenient interconnection to transit (F.S. 163.3180(15)).
Narrow	In this Q/LOS Handbook a categorization of outside lane width less 11.0 feet.
No passing zone	In this Q/LOS Handbook a segment of a two-lane highway along which passing is prohibited in the analysis direction.
Non-restrictive median	A painted, at-grade area separating opposing mid–block traffic lanes.
Non-state signalized roadway	A signalized roadway not on the State Highway System.

Not Achievable	In this Q/LOS Handbook a situation in which a given level of service cannot be obtained because of the roadway, traffic and control variables and level of service thresholds used.
Not Applicable	In this Q/LOS Handbook a situation in which a given level of service is not relevant because of the roadway, traffic and control variables and level of service thresholds used.
Number of directional through lanes	The number of through lanes in a single direction.
Number of effective lanes	In terms of capacity the equivalent number of through lanes. Typically the number is expressed as a fraction (e.g., 2.7) to reflect the partial beneficial effects of freeway auxiliary lanes or arterial add-on/drop-off lanes.
Number of through lanes	The number of lanes relevant to an analysis of a roadway's level of service. Usually two-directional (the software will convert to one direction for analysis purposes). For arterials: ■ Usually at the signalized intersection, not mid-block ■ Usually through and shared-right-turn lanes ■ May be a fractional number reflecting add-on/drop-off lanes or other special lane utilization considerations ■ Using the Generalized Service Volume Tables the number at major signalized intersections For freeways and uninterrupted flow highways ■ Does not include auxiliary lanes between 2 points ■ Usually the predominant number of through lanes between 2 points

O

Off peak	The course of the lower flow of traffic. A time period not representing a peak hour.
Off-ramp influence area	The geographic limits affecting the capacity of a freeway associated with traffic exiting a freeway.
On-ramp influence area	The geographic limits affecting the capacity of a freeway associated with traffic entering a freeway.
One-way	A type of roadway in which vehicles are allowed to move in only one direction.
Operational analysis	A detailed analysis of a roadway's present or future level of service, as opposed to a generalized planning analysis or conceptual planning analysis.
Operational model	In this Q/LOS Handbook the use of the full methodologies contained in the 2010 Highway Capacity Manual and the Transit Capacity and Quality of Service Manual or other source to conduct an operational analysis.
Other urbanized area	An MPO urbanized area less than 1,000,000 population.
Outside lane	A roadway's motorized vehicle through lane closest to the edge of pavement.
Outside lane width	In this Q/LOS Handbook the width in feet of a roadway's motorized vehicle through lane closest to the edge of pavement.
Oversaturated	A traffic condition in which demand exceeds capacity.

P

Passenger cars per hour per lane (pcphpl)	The unit of expression used to represent base saturation flow rate.
Passenger load factors	Factors used to determine the adjusted bus frequency value by applying a factor commensurate to the level of passenger crowding.

Passing lane	A lane added to provide passing opportunities in one direction of travel on a two-lane highway. Two-way left-turn lanes are not considered passing lanes.
Passing lane spacing	The distance in miles between passing lanes on two-lane highways.
Paved shoulder/ bicycle lane	In this Q/LOS Handbook pavement at least 3 feet in width separated by a solid pavement marking from the outside motorized vehicle through lane to the edge of pavement.
Pavement condition	In this Q/LOS Handbook the general classification of the roadway surface where bicycling generally occurs.
Peak direction	The course of the higher flow of traffic.
Peak hour	In this Q/LOS Handbook a 1 hour time period with high volume.
Peak hour factor (PHF)	The ratio of the hourly volume to the peak 15-minute flow rate for that hour; specifically hourly volume / (4 x peak 15-minute volume).
Peak period	A multi-hour analysis period with high volume; peak periods rather than peak hours are typically used for analysis of core freeways or roadways within an MMTD.
Peak season	The 13 consecutive weeks with the highest daily volumes for an area.
Peak Season Weekday Average Daily Traffic (PSWADT)	The average daily traffic for Monday through Friday during the peak season.
Peak to daily ratio	The ratio of the highest 1 hour volume of a day to the daily volume.
Pedestrian	An individual traveling on foot.
Pedestrian accessibility	In this Q/LOS Handbook the ease in which a pedestrian can reach a bus stop.
Pedestrian crossing difficulty	In this Q/LOS Handbook a generalization of how hard it is for a pedestrian to go from one side of a roadway to the other side.

Pedestrian LOS Model	The operational methodology from which this Q/LOS Handbook's pedestrian quality/level of service analyses are based.
Pedestrian level of service score	A numerical value calculated by the Pedestrian LOS Model that corresponds to a pedestrian level of service.
Pedestrian refuge	In this Q/LOS Handbook a raised or grassed area at least 5 feet but less than 10 feet in width that separates opposing mid-block traffic lanes, and allows pedestrians to cross a roadway.
Pedestrian/ Sidewalk/Roadway separation	The lateral distance in feet from the outer edge of pavement to where a pedestrian walks on a sidewalk.
Percent free flow speed (%FFS)	The percentage of vehicle average travel speed to free flow speed.
Percent left turns	The percentage of vehicles performing a left-turning movement at a signalized intersection.
Percent no passing zone	In this Q/LOS Handbook the percentage of a two-lane highway along which passing is prohibited in the analysis direction.
Percent right turns	The percentage of vehicles performing a right-turning movement at a signalized intersection.
Percent time spent following	The average percent of total travel time that vehicles must travel in platoons behind slower vehicles due to inability to pass on a two-lane highway.
Percent turns from exclusive turn lanes	The percentage of vehicles approaching an intersection served by exclusive turn lanes and not part of the through movement.
Performance measure	A qualitative or quantitative factor used to evaluate a particular aspect of travel quality.
Permanent traffic recorders (PTR)	Permanent counters that continuously monitor traffic.
Person flow	Capacity on uninterrupted and interrupted flow facilities defined in terms of persons per hour.

Phase	The part of a traffic signal's cycle allocated to any combination of traffic movements receiving the right-of-way simultaneously during one or more intervals.
PHF	Same as *peak hour factor*.
Planning analysis hour factor (K)	The ratio of the traffic volume in the study hour to the annual average daily traffic.
Planning application	In this Q/LOS Handbook the use of default values and simplifying assumptions to an operational model to address a roadway's present or future level of service.
Planning horizon	A time period, typically 20 years, applicable to the analysis of a project, roadway or service.
Platoon	A group of vehicles traveling together as a group, either voluntarily or involuntarily because of signal control, geometrics or other factors.
PLOS	Same as *pedestrian level of service score*.
Point	A boundary between links; in this Q/LOS Handbook usually a signalized intersection, but may be other places where modal users enter, leave, or cross a facility, or roadway characteristics change.
Portable traffic monitoring site (PTMS)	Coverage counters at temporary sites.
Posted speed	The maximum speed at which vehicles are legally allowed to travel over a roadway segment.
Precision	The range of accurate and acceptable numerical answers.
Pretimed	Same as *pretimed control.*
Pretimed control	Traffic signal control in which the cycle length, phase plan, and phase times are preset and repeated continuously according to a preset plan.

Prevailing conditions	Existing circumstances that primarily include roadway, traffic, and control conditions, but may also include weather, construction, incidents, lighting and area type.
QOS	Same as *quality of service.*
Quality of service (QOS)	A traveler based perception of how well a service or facility is operating.
Quality of travel	The dimension of mobility that addresses traveler satisfaction with a facility or service.
Quality/level of service (Q/LOS)	A combination of the broad quality of service and more detailed level of service concepts.
Quantity of travel	The dimension of mobility that addresses the magnitude of use of a facility or service.
Queue spillback	When a link's queue of vehicles extends on to upstream links.
Ramp overlap segment	The length for which the upstream on-ramp influence area and the downstream off-ramp influence area overlap.
Restrictive median	A raised or grassed area that restricts crossing movements.
Roadway	A general categorization of an open way for persons and vehicles to traverse; in this Q/LOS Handbook it encompasses streets, arterials, freeways, highways and other facilities.
Roadway characteristics	Same as *roadway variables*.
Roadway class	Categories of arterials and two-lane highways; arterials are primarily grouped by signal density; two-lane highways are primarily grouped by area type.
Roadway crossing adjustment factors	Factors used to determine the adjusted bus frequency by applying a factor that captures crossing difficulty.
Roadway variables	Parameters associated with roadways.
Rolling terrain	A combination of horizontal and vertical alignments causing heavy vehicles to reduce their running speed substantially below that of passenger cars, but not to operate at crawl speeds for a significant amount of time.

Q

R

S

Route	As used in the Transit Capacity and Quality of Service Manual, a designated, specified path to which a bus is assigned.
Route segment	As used in the Transit Capacity and Quality of Service Manual, a portion of a bus route ranging from 2 stops to the entire length of the route.
Running speed	The distance a vehicle travels divided by the travel time the vehicle is in motion.
Running time	The portion of travel time during which a vehicle is in motion.
Rural	Same as *rural area*.
Rural area	In the Generalized Service Volume Tables and software, areas that are not urbanized areas, transitioning areas, or urban areas.
Rural developed areas	Portions of rural areas that are along coastal roadways or in generally populated areas with a population less than 5,000.
Rural undeveloped areas	Portions of rural areas with no or minimal population or development.
Scheduled fixed route	In this Q/LOS Handbook bus service provided on a repetitive, fixed-schedule basis along a specific route with buses stopping to pick up and deliver passengers to specific locations.
Seasonal adjustment factor	A factor used to adjust for the variation in traffic over the course of a year.
Section	A group of consecutive segments that have similar roadway characteristics, traffic characteristics and, as appropriate, control characteristics for a mode of travel. A characteristic describing laneage (i.e., three-lane section, five-lane section, seven-lane section).
Segment	A portion of a facility defined by 2 boundary points; usually the length of roadway from one signalized intersection to the next signalized intersection.
Segmentation	The partitioning of roadways for analysis purposes.

Service measure	A specific performance measure used to assign a level of service to a set of operating conditions for a transportation facility or service.
Service volume	Same as *maximum service volume*.
Service Volume Table	Maximum service volumes based on roadway, traffic and control variables and presented in tabular form.
Seven-lane section	A roadway with 6 through lanes, 3 in each direction separated by a two-way left-turn lane; in the Generalized Service Volume Tables, a seven-lane section is treated as a roadway with 6 lanes and a median.
Shared lane	A roadway lane shared by 2 or 3 traffic movements; in Florida a shared lane usually serves through and right turning traffic movements.
Sidewalk	A paved walkway for pedestrians at the side of a roadway.
Sidewalk/roadway protective barrier	Physical barriers separating pedestrians on sidewalks and motorized vehicles.
Sidewalk protective barrier factor	A factor that includes the added benefits of trees, on-street parking, or other barriers.
Sidewalk/roadway separation	The lateral distance in feet from the outside edge of pavement to the inside edge of the sidewalk.
Signal	In this Q/LOS Handbook: A traffic control device regulating the flow of traffic with green, yellow and red indications. A traffic control device that routinely stops vehicles during the study period; excluded from this definition are flashing yellow lights, railroad crossings, draw bridges, yield signs, and other control devices.
Signal density	The number of signalized intersections per mile.

Signal type	The kind of traffic signal (actuated, pretimed or coordinated-actuated) with respect to the way its cycle length, phase plan, and phase times are operated.
Signalization characteristics	Same as *control.*
Signalized intersection	A place where 2 roadways cross and have a signal controlling traffic movements.
Signalized intersection spacing	The distance between signalized intersections.
Simple average	An average that gives equal weight to each component.
Software	FDOT's ARTPLAN, FREEPLAN, and HIGHPLAN conceptual planning computer programs.
Span of service	Same as *bus span of service*.
Speed	In this Q/LOS Handbook the same as *average travel speed*, unless specifically noted.
Speed limit	Same as *posted speed*.
Standard	A Florida Department of Transportation formally established criterion for a specific or special activity to achieve a desired level of quality.
Standards	Same as *Level of Service Standards for the State Highway System.*
Standard K	FDOT's standard peak hour to annual average daily traffic ratio (K), based on a roadway's characteristics (facility type) and location (area type). Values less than 9% essentially represent a multi-hour peak period rather than a peak hour.
State Highway System (SHS)	All roadways that the Florida Department of Transportation operates and maintains; the State Highway System consists of the Florida Intrastate Highway System and other state roads.

Stochastic	Description of a type of model that that incorporates variability and uncertainty into analysis.
Storage length	The total amount of storage available for left turning vehicles, in feet.
Strategic Intermodal System (SIS)	Florida's system of transportation facilities and serves of statewide and interregional significance.
Study hour	An hour period on which to base quality/level of service analyses of a facility or service.
Study period	An hour or multi-hour period on which to base quality/level of service analyses of a facility or service. A length in time including a future year of analysis.
Subsegment	A further breakdown of segments; in this Q/LOS Handbook primarily used for pedestrian level of service analysis where pedestrian roadway elements change between signalized intersections.
System	A combination of facilities or services forming a network. A combination of facilities selected for analysis.
System analysis	An evaluation of a combination of facilities and modes within a region.
T	Truck factor
Telemetry traffic monitoring sites (TTMS)	Permanent counters that continuously monitor traffic.
Termini	In this Q/LOS Handbook the beginning and end points of a facility.
Terrain	A general classification used for analyses in lieu of specific grades.

T

Three-lane section	A roadway with 2 through lanes separated by a two-way left-turn lane; in the Generalized Service Volume Tables, a three-lane section is treated as a roadway with 2 lanes and a median; an exclusive passing lane on a two-lane highway is not considered a three-lane section.
Threshold	The breakpoints between level of service differentiations.
Threshold delay	The additional travel time represented by the difference between the time associated with a roadway's generally accepted speed (LOS D threshold in urbanized areas and LOS C threshold in non-urbanized areas) and average travel speed.
Through effective green ratio (g/C)	The ratio of the effective green time (g) for the through movement at a signal intersection to its cycle length (C).
Through lanes	Same as *number of through lanes.*
Through movement	In this Q/LOS Handbook the traffic stream with the greatest number of vehicles passing directly through a point. Typically this is the straight-ahead movement, but occasionally it may be a turning movement.
Traffic	A characteristic associated with the flow of vehicles.
Traffic characteristics	Same as *traffic variables*.
Traffic demand	The number of vehicles that desire to traverse a particular highway during a specified time period.
Traffic pressure	Effect of decreased vehicle headways under high-volume conditions as drivers are anxious to minimize their travel time.
Traffic variables	Parameters associated with traffic.
Traffic volume	The number of vehicles passing a point on a highway during a specified time period.
Transit	In this Q/LOS Handbook, the same as *bus*.

Transit Capacity and Quality of Service Manual (TCQSM)	The document and operational methodology from which this Q/LOS Handbook's bus quality/level of service analyses are based.
Transit system structure	The Transit Capacity and Quality of Service Manual's analytical methodology of transit stops, route segments, and system.
Transitioning	In the text of this Q/LOS Handbook, the same as *transitioning area.* In the software of this Q/LOS Handbook, the same as *transitioning/urban.*
Transitioning area	An area that exhibits characteristics between rural and urbanized/urban.
Transitioning/urban	The grouping of transitioning areas and urban areas into one analysis category in the Generalized Service Volume Tables and software.
Transportation planning boundaries	Precisely defined lines that delineate geographic areas. These boundaries are used throughout transportation planning in Florida; their mapping is described in FDOT's Procedure Topic Number 525-010-024b.
Transportation system structure	In this Q/LOS Handbook the 2010 Highway Capacity Manual's analytical methodology of points, segments, facilities, corridors, and areawide analysis.
Travel time	The average time spent by vehicles traversing a roadway.
Truck	In this Q/LOS Handbook the same as *heavy vehicle.*
Truck factor (T)	In this Q/LOS Handbook the same as *heavy vehicle factor (HV).*
Two-lane highway	A roadway with one lane in each direction on which passing maneuvers must be made in the opposing lane and, although occasional interruptions to flow at signalized intersections may exist, is generally uninterrupted flow.
Two-way	Movement allowed in either direction.

Two-way left-turn lane	A lane that simultaneously serves left turning vehicles traveling in opposite directions.
Two-way STOP control	The type of traffic control at an intersection where drivers on the minor street or a driver turning left from the major street wait for a gap in major-street traffic to complete a maneuver.
Typical	In this Q/LOS Handbook a categorization of: ■ Outside lane width greater than or equal to 11.0 feet and less than 13.5 feet ■ Pavement condition of most of Florida's roadways ■ Sidewalk/roadway separation greater than 3.0 feet and less than or equal to 8.0 feet

U

Undesignated bicycle lane	A lane, usually 4 feet in width, that does not contain a bicycle logo.
Undesirable	In this Q/LOS Handbook a categorization of pavement condition with noticeable cracks and/or ruts in it.
Undivided	As used in the Generalized Service Volume Tables, a roadway with no median.
Uninterrupted flow	A category of roadway not characterized by signals, STOP signs, or other fixed causes of periodic delay or interruption to the traffic stream.
Uninterrupted flow highway	A non-freeway roadway that generally has uninterrupted flow, with average signalized intersection spacing greater than 2.0 miles; a two-lane highway or a multilane highway.

Urban area	A place with a population between 5,000 and 50,000 and not in an urbanized area. The applicable boundary includes the Census's urban area and the surrounding geographical area agreed upon by the FDOT, the local government, and the Federal Highway Administration (FHWA). The boundaries are commonly called FHWA Urban Area Boundaries and include those areas expected to develop medium density before the next decennial census. A general characterization of places where people live and work.
Urban infill	A land development strategy aimed at directing higher density residential and mixed-use development to available sites in developed areas to maximize the use of adequate existing infrastructure; often considered an alternative to low density land development.
Urbanized area	An area within an MPO's designated urbanized area boundary. The minimum population for an urbanized area is 50,000 people. Based on the Census, any area the U.S. Bureau of Census designates as urbanized, together with any surrounding geographical area agreed upon by the FDOT, the relevant Metropolitan Planning Organization (MPO), and the Federal Highway Administration (FHWA), commonly called the FHWA Urbanized Area Boundary. The minimum population for an urbanized area is 50,000.
Utilization	The dimension of mobility that addresses the quantity of operations with respect to capacity.

V

v/c	The ratio of demand flow rate to capacity of a signalized intersection, segment or facility.
Vehicle	In this Q/LOS Handbook, a motorized mode of transportation, unless specifically noted.

W

Volume	In this Q/LOS Handbook usually the number of vehicles, and occasionally persons, passing a point on a roadway during a specified time period, often 1 hour; a volume may be measured or estimated, either of which could be a constrained value or a hypothetical demand volume.
Weaving distance	A length of freeway over which traffic streams cross paths through lane changing maneuvers.
Weaving segment	Same as *weaving distance*.
Weighted average	An average that results from multiplying each component by a factor reflecting its length or importance.
Weighted effective green ratio	In this Q/LOS Handbook the average of the critical intersection's through g/C and the average of all the other signalized intersections' through g/Cs along the arterial facility.
Weighted g/C	Same as *weighted effective green ratio.*
Wide	In this Q/LOS Handbook a categorization of: ■ Outside lane width greater than or equal to 13.5 feet ■ Sidewalk/roadway separation greater than 8.0 feet
Worst case	In this Q/LOS Handbook for: ■ Arterials, the critical intersection ■ Freeways, usually the influence area of an interchange

ARTERIAL DATA COLLECTION WORKSHEET

Road Name: | **Time:** | **Date:**

N W E S

Time of analysis: 5-6 PM weekday ☐
If not, indicate time

Area Type:			
Large Urbanized	Other Urbanized	Transitioning/ Urban	Rural Developed
1,000,000+	50,000+	5,000+	<5,000

Class:			
1	2	3	4
0-1.99 sig/mi	2 – 4.5 sig/mi	4.5+ sig/mi	Downtown Large Urbanized

*Thru Movement Signalization			
Signal Type	Actuated	Semiactuated	Pretimed
Arrival Type	3	4	4, 5
g/C	(G+4)/C	(G+4)/C	G/C

1st Cross Street:

Intersection #1							
Segment #1	Length:	**AADT:**	**# Directional Thru Lanes** (midblock):	Posted Speed:	Median: none restrictive non-restrictive		
	Auto Outside Lane Width: n typ w	Pavement: d typ u	**Bike Lane/Paved Shoulder** ☐	**Sidewalk:** ☐	Sidewalk Separation: a typ w	**Bus Freq.:**	Bus Span:

2nd Cross Street:

Intersection #2	Cycle Length:	Thru G:	**Thru g/C*:**	**# Directional Thru Lanes** (signal):	Excl. Left ☐	# Left Lanes:	Left G:	Left G/C:	Excl. Right ☐
Segment #2	Length:		**AADT:**	**# Directional Thru Lanes** (midblock):	Posted Speed:	Median: none restrictive non-restrictive			
	Auto Outside Lane Width: n typ w		Pavement: d typ u	**Bike Lane/Paved Shoulder** ☐	**Sidewalk:** ☐	Sidewalk Separation: a typ w	**Bus Freq.:**		Bus Span:

3rd Cross Street:

Intersection #3	Cycle Length:	Thru G:	**Thru g/C*:**	**# Directional Thru Lanes** (signal):	Excl. Left ☐	# Left Lanes:	Left G:	Left G/C:	Excl. Right ☐
Segment #3	Length:		**AADT:**	**# Directional Thru Lanes** (midblock):	Posted Speed:	Median: none restrictive non-restrictive			
	Auto Outside Lane Width: n typ w		Pavement: d typ u	**Bike Lane/Paved Shoulder** ☐	**Sidewalk:** ☐	Sidewalk Separation: a typ w	**Bus Freq.:**		Bus Span:

4th Cross Street:

Intersection #4	Cycle Length:	Thru G:	**Thru g/C*:**	**# Directional Thru Lanes** (signal):	Excl. Left ☐	# Left Lanes:	Left G:	Left G/C:	Excl. Right ☐
Segment #4	Length:		**AADT:**	**# Directional Thru Lanes** (midblock):	Posted Speed:	Median: none restrictive non-restrictive			
	Auto Outside Lane Width: n typ w		Pavement: d typ u	**Bike Lane/Paved Shoulder** ☐	**Sidewalk:** ☐	Sidewalk Separation: a typ w	**Bus Freq.:**		Bus Span:

5th Cross Street:

Intersection #5	Cycle Length:	Thru G:	**Thru g/C*:**	**# Directional Thru Lanes** (signal):	Excl. Left ☐	# Left Lanes:	Left G:	Left G/C:	Excl. Right ☐
Segment #5	Length:		**AADT:**	**# Directional Thru Lanes** (midblock):	Posted Speed:	Median: none restrictive non-restrictive			
	Auto Outside Lane Width: n typ w		Pavement: d typ u	**Bike Lane/Paved Shoulder** ☐	**Sidewalk:** ☐	Sidewalk Separation: a typ w	**Bus Freq.:**		Bus Span:

6th Cross Street:

Intersection #6	Cycle Length:	Thru G:	**Thru g/C*:**	**# Directional Thru Lanes** (signal):	Excl. Left ☐	# Left Lanes:	Left G:	Left G/C:	Excl. Right ☐

* Thru g/C - see Thru Movement Signalization in upper right corner | Collect G and calculate g/C for left turns at major intersections.
Auto Outside Lane Width: **n**arrow **typ**ical **w**ide | Bike Pavement Condition: **d**esirable **typ**ical **u**ndesirable | Sidewalk/Roadway Separation: **a**djacent **typ**ical **w**ide

GENERALIZED SERVICE VOLUME TABLES

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TABLE 1

Generalized **Annual Average Daily** Volumes for Florida's **Urbanized Areas**

12/18/12

INTERRUPTED FLOW FACILITIES

STATE SIGNALIZED ARTERIALS

Class I (40 mph or higher posted speed limit)

Lanes	Median	B	C	D	E
2	Undivided	*	16,800	17,700	**
4	Divided	*	37,900	39,800	**
6	Divided	*	58,400	59,900	**
8	Divided	*	78,800	80,100	**

Class II (35 mph or slower posted speed limit)

Lanes	Median	B	C	D	E
2	Undivided	*	7,300	14,800	15,600
4	Divided	*	14,500	32,400	33,800
6	Divided	*	23,300	50,000	50,900
8	Divided	*	32,000	67,300	68,100

Non-State Signalized Roadway Adjustments

(Alter corresponding state volumes by the indicated percent.)

Non-State Signalized Roadways - 10%

Median & Turn Lane Adjustments

Lanes	Median	Exclusive Left Lanes	Exclusive Right Lanes	Adjustment Factors
2	Divided	Yes	No	+5%
2	Undivided	No	No	-20%
Multi	Undivided	Yes	No	-5%
Multi	Undivided	No	No	-25%
–	–	–	Yes	+ 5%

One-Way Facility Adjustment

Multiply the corresponding two-directional volumes in this table by 0.6

BICYCLE MODE[2]

(Multiply motorized vehicle volumes shown below by number of directional roadway lanes to determine two-way maximum service volumes.)

Paved Shoulder/Bicycle Lane Coverage	B	C	D	E
0-49%	*	2,900	7,600	19,700
50-84%	2,100	6,700	19,700	>19,700
85-100%	9,300	19,700	>19,700	**

PEDESTRIAN MODE[2]

(Multiply motorized vehicle volumes shown below by number of directional roadway lanes to determine two-way maximum service volumes.)

Sidewalk Coverage	B	C	D	E
0-49%	*	*	2,800	9,500
50-84%	*	1,600	8,700	15,800
85-100%	3,800	10,700	17,400	>19,700

BUS MODE (Scheduled Fixed Route)[3]

(Buses in peak hour in peak direction)

Sidewalk Coverage	B	C	D	E
0-84%	> 5	≥ 4	≥ 3	≥ 2
85-100%	> 4	≥ 3	≥ 2	≥ 1

UNINTERRUPTED FLOW FACILITIES

FREEWAYS

Core Urbanized

Lanes	B	C	D	E
4	47,400	64,000	77,900	84,600
6	69,900	95,200	116,600	130,600
8	92,500	126,400	154,300	176,600
10	115,100	159,700	194,500	222,700
12	162,400	216,700	256,600	268,900

Urbanized

Lanes	B	C	D	E
4	45,800	61,500	74,400	79,900
6	68,100	93,000	111,800	123,300
8	91,500	123,500	148,700	166,800
10	114,800	156,000	187,100	210,300

Freeway Adjustments

Auxiliary Lanes Present in Both Directions	Ramp Metering
+ 20,000	+ 5%

UNINTERRUPTED FLOW HIGHWAYS

Lanes	Median	B	C	D	E
2	Undivided	8,600	17,000	24,200	33,300
4	Divided	36,700	51,800	65,600	72,600
6	Divided	55,000	77,700	98,300	108,800

Uninterrupted Flow Highway Adjustments

Lanes	Median	Exclusive left lanes	Adjustment factors
2	Divided	Yes	+5%
Multi	Undivided	Yes	-5%
Multi	Undivided	No	-25%

[1] Values shown are presented as two-way annual average daily volumes for levels of service and are for the automobile/truck modes unless specifically stated. This table does not constitute a standard and should be used only for general planning applications. The computer models from which this table is derived should be used for more specific planning applications. The table and deriving computer models should not be used for corridor or intersection design, where more refined techniques exist. Calculations are based on planning applications of the Highway Capacity Manual and the Transit Capacity and Quality of Service Manual.

[2] Level of service for the bicycle and pedestrian modes in this table is based on number of motorized vehicles, not number of bicyclists or pedestrians using the facility.

[3] Buses per hour shown are only for the peak hour in the single direction of the higher traffic flow.

* Cannot be achieved using table input value defaults.

** Not applicable for that level of service letter grade. For the automobile mode, volumes greater than level of service D become F because intersection capacities have been reached. For the bicycle mode, the level of service letter grade (including F) is not achievable because there is no maximum vehicle volume threshold using table input value defaults.

Source:
Florida Department of Transportation
Systems Planning Office
www.dot.state.fl.us/planning/systems/sm/los/default.shtm

TABLE 1
(continued)

Generalized **Annual Average Daily** Volumes for Florida's **Urbanized Areas**

12/18/12

INPUT VALUE ASSUMPTIONS	Uninterrupted Flow Facilities				Interrupted Flow Facilities					
					State Arterials				Class I	
	Freeways	Core Freeways	Highways		Class I		Class II		Bicycle	Pedestrian
ROADWAY CHARACTERISTICS										
Area type (u,lu)	lu	lu	u	u	u	u	u	u	u	u
Number of through lanes (both dir.)	4-10	4-12	2	4-6	2	4-8	2	4-8	4	4
Posted speed (mph)	70	65	50	50	45	50	30	30	45	45
Free flow speed (mph)	75	70	55	55	50	55	35	35	50	50
Auxiliary Lanes (n,y)	n	n								
Median (n, nr, r)			n	r	n	r	n	r	r	r
Terrain (l,r)	l	l	l	l	l	l	l	l	l	l
% no passing zone			80							
Exclusive left turn lane impact (n, y)			[n]	y	y	y	y	y	y	y
Exclusive right turn lanes (n, y)					n	n	n	n	n	n
Facility length (mi)	4	4	5	5	2	2	1.9	1.8	2	2
Number of basic segments	4	4								
TRAFFIC CHARACTERISTICS										
Planning analysis hour factor (K)	0.090	0.085	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090
Directional distribution factor (D)	0.547	0.547	0.550	0.550	0.550	0.560	0.565	0.560	0.565	0.565
Peak hour factor (PHF)	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Base saturation flow rate (pcphpl)			1,700	2,100	1,950	1,950	1,950	1,950	1,950	1,950
Heavy vehicle percent	4.0	4.0	2.0	2.0	1.0	1.0	1.0	1.0	2.5	2.0
Local adjustment factor	0.91	0.91	0.97	0.98						
% left turns					12	12	12	12	12	12
% right turns					12	12	12	12	12	12
CONTROL CHARACTERISTICS										
Number of signals					4	4	10	10	4	6
Arrival type (1-6)					3	3	4	4	4	4
Signal type (a, c, p)					c	c	c	c	c	c
Cycle length (C)					120	150	120	120	120	120
Effective green ratio (g/C)					0.44	0.45	0.44	0.44	0.44	0.44
MULTIMODAL CHARACTERISTICS										
Paved shoulder/bicycle lane (n, y)									n, 50%, y	n
Outside lane width (n, t, w)									t	t
Pavement condition (d, t, u)									t	
On-street parking (n, y)										
Sidewalk (n, y)										n, 50%, y
Sidewalk/roadway separation(a, t, w)										t
Sidewalk protective barrier (n, y)										n

LEVEL OF SERVICE THRESHOLDS

Level of Service	Freeways	Highways		Arterials		Bicycle	Ped	Bus
	Density	Two-Lane	Multilane	Class I	Class II	Score	Score	Buses/hr.
		%ffs	Density	ats	ats			
B	≤ 17	> 83.3	≤ 17	> 31 mph	> 22 mph	≤ 2.75	≤ 2.75	≤ 6
C	≤ 24	> 75.0	≤ 24	> 23 mph	> 17 mph	≤ 3.50	≤ 3.50	≤ 4
D	≤ 31	> 66.7	≤ 31	> 18 mph	> 13 mph	≤ 4.25	≤ 4.25	< 3
E	≤ 39	> 58.3	≤ 35	> 15 mph	> 10 mph	≤ 5.00	≤ 5.00	< 2

% ffs = Percent free flow speed   ats = Average travel speed

TABLE 2

Generalized **Annual Average Daily** Volumes for Florida's **Transitioning Areas** and **Areas Over 5,000 Not In Urbanized Areas**[1]

12/18/12

INTERRUPTED FLOW FACILITIES

STATE SIGNALIZED ARTERIALS

Class I (40 mph or higher posted speed limit)

Lanes	Median	B	C	D	E
2	Undivided	*	14,400	16,200	**
4	Divided	*	34,000	35,500	**
6	Divided	*	52,100	53,500	**

Class II (35 mph or slower posted speed limit)

Lanes	Median	B	C	D	E
2	Undivided	*	6,500	13,300	14,200
4	Divided	*	9,900	28,800	31,600
6	Divided	*	16,000	44,900	47,600

Non-State Signalized Roadway Adjustments

(Alter corresponding state volumes by the indicated percent.)

Non-State Signalized Roadways - 10%

Median & Turn Lane Adjustments

Lanes	Median	Exclusive Left Lanes	Exclusive Right Lanes	Adjustment Factors
2	Divided	Yes	No	+5%
2	Undivided	No	No	-20%
Multi	Undivided	Yes	No	-5%
Multi	Undivided	No	No	-25%
–	–	–	Yes	+ 5%

One-Way Facility Adjustment

Multiply the corresponding two-directional volumes in this table by 0.6

BICYCLE MODE[2]

(Multiply motorized vehicle volumes shown below by number of directional roadway lanes to determine two-way maximum service volumes.)

Paved Shoulder/Bicycle Lane Coverage	B	C	D	E
0-49%	*	2,600	6,100	19,500
50-84%	1,900	5,500	18,400	>19,500
85-100%	7,500	19,500	>19,500	**

PEDESTRIAN MODE[2]

(Multiply motorized vehicle volumes shown below by number of directional roadway lanes to determine two-way maximum service volumes.)

Sidewalk Coverage	B	C	D	E
0-49%	*	*	2,800	9,400
50-84%	*	1,600	8,600	15,600
85-100%	3,800	10,500	17,100	>19,500

BUS MODE (Scheduled Fixed Route)[3]

(Buses in peak hour in peak direction)

Sidewalk Coverage	B	C	D	E
0-84%	> 5	≥ 4	≥ 3	≥ 2
85-100%	> 4	≥ 3	≥ 2	≥ 1

UNINTERRUPTED FLOW FACILITIES

FREEWAYS

Lanes	B	C	D	E
4	44,100	57,600	68,900	71,700
6	65,100	85,600	102,200	111,000
8	85,100	113,700	135,200	150,000
10	106,200	141,700	168,800	189,000

Freeway Adjustments

Auxiliary Lanes Present in Both Directions	Ramp Metering
+ 20,000	+ 5%

UNINTERRUPTED FLOW HIGHWAYS

Lanes	Median	B	C	D	E
2	Undivided	9,200	17,300	24,400	33,300
4	Divided	35,300	49,600	62,900	69,600
6	Divided	52,800	74,500	94,300	104,500

Uninterrupted Flow Highway Adjustments

Lanes	Median	Exclusive left lanes	Adjustment factors
2	Divided	Yes	+5%
Multi	Undivided	Yes	-5%
Multi	Undivided	No	-25%

[1]Values shown are presented as two-way annual average daily volumes for levels of service and are for the automobile/truck modes unless specifically stated. This table does not constitute a standard and should be used only for general planning applications. The computer models from which this table is derived should be used for more specific planning applications. The table and deriving computer models should not be used for corridor or intersection design, where more refined techniques exist. Calculations are based on planning applications of the Highway Capacity Manual and the Transit Capacity and Quality of Service Manual.

[2] Level of service for the bicycle and pedestrian modes in this table is based on number of motorized vehicles, not number of bicyclists or pedestrians using the facility.

[3] Buses per hour shown are only for the peak hour in the single direction of the higher traffic flow.

* Cannot be achieved using table input value defaults.

** Not applicable for that level of service letter grade. For the automobile mode, volumes greater than level of service D become F because intersection capacities have been reached. For the bicycle mode, the level of service letter grade (including F) is not achievable because there is no maximum vehicle volume threshold using table input value defaults.

Source:
Florida Department of Transportation
Systems Planning Office
www.dot.state.fl.us/planning/systems/sm/los/default.shtm

TABLE 2
(continued)

Generalized **Annual Average Daily** Volumes for Florida's **Transitioning** and **Areas Over 5,000 Not In Urbanized Areas**

12/18/12

INPUT VALUE ASSUMPTIONS	Uninterrupted Flow Facilities			Interrupted Flow Facilities					
				State Arterials				Class I	
	Freeways	Highways		Class I		Class II		Bicycle	Pedestrian
ROADWAY CHARACTERISTICS									
Area type (t,uo)	t	t	t	t	t	t	t	t	t
Number of through lanes (both dir.)	4-10	2	4-6	2	4-6	2	4-6	4	4
Posted speed (mph)	70	50	50	45	50	30	30	45	45
Free flow speed (mph)	75	55	55	50	55	35	35	50	50
Auxiliary lanes (n,y)	n	n	n						
Median (n, nr, r)		n	r	n	y	n	y	r	r
Terrain (l,r)	l	l	l	l	l	l	l	l	l
% no passing zone		60							
Exclusive left turn lane impact (n, y)		[n]	y	y	y	y	y	y	y
Exclusive right turn lanes (n, y)				n	n	n	n	n	n
Facility length (mi)	8	5	5	1.8	2	2	2	2	2
Number of basic segments	4								
TRAFFIC CHARACTERISTICS									
Planning analysis hour factor (K)	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090
Directional distribution factor (D)	0.555	0.550	0.550	0.550	0.570	0.570	0.565	0.570	0.570
Peak hour factor (PHF)	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Base saturation flow rate (pcphpl)		1,700	2,100	1,950	1,950	1,950	1,950	1,950	1,950
Heavy vehicle percent	9.0	4.0	4.0	2.0	3.0	2.0	3.0	3.0	3.0
Local adjustment factor	0.85	0.97	0.95						
% left turns				12	12	12	12	12	12
% right turns				12	12	12	12	12	12
CONTROL CHARACTERISTICS									
Number of signals				5	4	10	10	4	6
Arrival type (1-6)				4	3	4	4	4	4
Signal type (a, c, p)				c	c	c	c	c	c
Cycle length (C)				120	150	120	150	120	120
Effective green ratio (g/C)				0.44	0.45	0.44	0.45	0.44	0.44
MULTIMODAL CHARACTERISTICS									
Paved shoulder/bicycle lane (n, y)								n, 50%, y	n
Outside lane width (n, t, w)								t	t
Pavement condition (d, t, u)								t	
On-street parking (n, y)								n	n
Sidewalk (n, y)									n, 50%, y
Sidewalk/roadway separation (a, t, w)									t
Sidewalk protective barrier (n, y)									n

LEVEL OF SERVICE THRESHOLDS

Level of Service	Freeways	Highways		Arterials		Bicycle	Ped	Bus
		Two-Lane	Multilane	Class I	Class II			
	Density	%ffs	Density	ats	ats	Score	Score	Buses/hr.
B	≤ 17	> 83.3	≤ 17	> 31 mph	> 22 mph	≤ 2.75	≤ 2.75	≤ 6
C	≤ 24	> 75.0	≤ 24	> 23 mph	> 17 mph	≤ 3.50	≤ 3.50	≤ 4
D	≤ 31	> 66.7	≤ 31	> 18 mph	> 13 mph	≤ 4.25	≤ 4.25	< 3
E	≤ 39	> 58.3	≤ 35	> 15 mph	> 10 mph	≤ 5.00	≤ 5.00	< 2

% ffs = Percent free flow speed ats = Average travel speed

TABLE 3

Generalized **Annual Average Daily** Volumes for Florida's **Rural Undeveloped Areas** and **Developed Areas Less Than 5,000 Population**[1]

12/18/12

INTERRUPTED FLOW FACILITIES

STATE SIGNALIZED ARTERIALS

Lanes	Median	B	C	D	E
2	Undivided	*	12,900	14,200	**
4	Divided	*	29,300	30,400	**
6	Divided	*	45,200	45,800	**

Non-State Signalized Roadway Adjustments

(Alter corresponding state volumes by the indicated percent.)

Non-State Signalized Roadways - 10%

Median & Turn Lane Adjustments

Lanes	Median	Exclusive Left Lanes	Exclusive Right Lanes	Adjustment Factors
2	Divided	Yes	No	+5%
2	Undivided	No	No	-20%
Multi	Undivided	Yes	No	-5%
Multi	Undivided	No	No	-25%
–	–	–	Yes	+ 5%

One-Way Facility Adjustment

Multiply the corresponding two-directional volumes in this table by 0.6

BICYCLE MODE[2]

(Multiply motorized vehicle volumes shown below by number of directional roadway lanes to determine two-way maximum service volumes.)

Rural Undeveloped

Paved Shoulder/Bicycle Lane Coverage	B	C	D	E
0-49%	*	1,300	2,000	3,200
50-84%	1,000	2,100	3,200	10,600
85-100%	2,600	3,900	18,500	>18,500

Developed Areas

Paved Shoulder/Bicycle Lane Coverage	B	C	D	E
0-49%	*	2,300	4,900	15,600
50-84%	1,700	4,500	13,300	18,500
85-100%	5,900	18,500	>18,500	**

PEDESTRIAN MODE[2]

(Multiply motorized vehicle volumes shown below by number of directional roadway lanes to determine two-way maximum service volumes.)

Sidewalk Coverage	B	C	D	E
0-49%	*	*	2,700	9,200
50-84%	*	1,500	8,400	14,900
85-100%	3,600	10,200	16,700	>19,200

UNINTERRUPTED FLOW FACILITIES

FREEWAYS

Lanes	B	C	D	E
4	28,800	43,000	52,300	60,000
6	43,000	64,000	78,300	92,500
8	57,500	85,400	104,400	123,500

Freeway Adjustments

Auxiliary Lanes
Present in Both Directions
+ 20,000

UNINTERRUPTED FLOW HIGHWAYS

Rural Undeveloped

Lanes	Median	B	C	D	E
2	Undivided	4,700	8,400	14,300	28,600
4	Divided	25,700	40,300	51,000	57,900
6	Divided	38,800	60,400	76,700	86,800

Developed Areas

Lanes	Median	B	C	D	E
2	Undivided	8,700	16,400	23,100	31,500
4	Divided	25,900	40,700	52,400	59,600
6	Divided	38,800	61,000	78,400	89,500

Passing Lane Adjustments

Alter LOS B-D volumes in proportion to the passing lane length to the highway segment length

Uninterrupted Flow Highway Adjustments

Lanes	Median	Exclusive left lanes	Adjustment factors
2	Divided	Yes	+5%
Multi	Undivided	Yes	-5%
Multi	Undivided	No	-25%

[1]Values shown are presented as two-way annual average daily volumes for levels of service and are for the automobile/truck modes unless specifically stated. This table does not constitute a standard and should be used only for general planning applications. The computer models from which this table is derived should be used for more specific planning applications. The table and deriving computer models should not be used for corridor or intersection design, where more refined techniques exist. Calculations are based on planning applications of the Highway Capacity Manual and the Transit Capacity and Quality of Service Manual.

[2] Level of service for the bicycle and pedestrian modes in this table is based on number of motorized vehicles, not number of bicyclists or pedestrians using the facility.

* Cannot be achieved using table input value defaults.

** Not applicable for that level of service letter grade. For the automobile mode, volumes greater than level of service D become F because intersection capacities have been reached. For the bicycle mode, the level of service letter grade (including F) is not achievable because there is no maximum vehicle volume threshold using table input value defaults.

Source:
Florida Department of Transportation
Systems Planning Office
www.dot.state.fl.us/planning/systems/sm/los/default.shtm

TABLE 3
(continued)

Generalized **Annual Average Daily** Volumes for Florida's **Rural Undeveloped Areas** and **Developed Areas Less Than 5,000 Population**

12/18/12

INPUT VALUE ASSUMPTIONS	Uninterrupted Flow Facilities					Interrupted Flow Facilities				
	Freeways	Highways				Arterials		Bicycle		Pedestrian
ROADWAY CHARACTERISTICS										
Area type (ru, rd)	rural	ru	ru	rd	rd	rd	rd	ru	rd	rd
Number of through lanes (both dir.)	4-8	2	4-6	2	4-6	2	4-6	4	4	2
Posted speed (mph)	70	55	65	50	55	45	45	55	45	45
Free flow speed (mph)	75	60	70	55	60	50	50	60	50	50
Auxiliary lanes (n,y)	n									
Median (n, nr, r)		n	r	n	r	n	r	r	r	n
Terrain (l,r)	l	l	l	l	l	l	l	l	l	l
% no passing zone		20		60						
Exclusive left turn lanes (n, y)		[n]	y	[n]	y	y	y	y	y	y
Exclusive right turn lanes (n, y)						n	n	n	n	n
Facility length (mi)	14	10	10	5	5	1.9	2.2	4	2	2
Number of basic segments	4									
TRAFFIC CHARACTERISTICS										
Planning analysis hour factor (K)	0.105	0.095	0.095	0.095	0.095	0.095	0.095	0.095	0.095	0.095
Directional distribution factor (D)	0.555	0.550	0.550	0.550	0.550	0.550	0.550	0.570	0.570	0.550
Peak hour factor (PHF)	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Base saturation flow rate (pcphpl)		1,700	2,300	1,700	2,200	1,950	1,950	1,950	1,950	1,950
Heavy vehicle percent	12.0	5.0	12.0	4.0	4.0	3.0	3.0	6.0	3.5	3.0
Local adjustment factor	0.84	0.88	0.73	0.97	0.82					
% left turns						12	12		12	12
% right turns						12	12		12	12
CONTROL CHARACTERISTICS										
Number of signals						5	6	2	4	4
Arrival type (1-6)						3	3	3	3	3
Signal type (a, c, p)						c	c	a	a	a
Cycle length (C)						90	90	60	90	90
Effective green ratio (g/C)						0.44	0.44	0.37	0.44	0.44
MULTIMODAL CHARACTERISTICS										
Paved shoulder/bicycle lane (n, y)								n,50%,y	n,50%,y	n
Outside lane width (n, t, w)								t	t	t
Pavement condition (d, t, u)								t	t	
Sidewalk (n, y)										n,50%,y
Sidewalk/roadway separation(a, t,w)										t
Sidewalk protective barrier (n, y)										n

LEVEL OF SERVICE THRESHOLDS

Level of Service	Freeways	Highways				
		Two-Lane ru		Two-Lane rd	Multilane ru	Multilane rd
	Density	%tsf	ats	%ffs	Density	Density
B	≤ 14	≤ 50	≤ 55	> 83.3	≤ 14	≤ 14
C	≤ 22	≤ 65	≤ 50	> 75.0	≤ 22	≤ 22
D	≤ 29	≤ 80	≤ 45	> 66.7	≤ 29	≤ 29
E	≤ 39	> 80	≤ 40	> 58.3	≤ 34	≤ 34

Level of Service	Arterials	Bicycle	Pedestrian
	Major City/Co.(ats)	Score	Score
B	> 31 mph	≤ 2.75	≤ 2.75
C	> 23 mph	≤ 3.50	≤ 3.50
D	> 18 mph	≤ 4.25	≤ 4.25
E	> 15 mph	≤ 5.00	≤ 5.00

%tsf = Percent time spent following %ffs = Percent of free flow speed ats = Average travel speed ru = Rural undeveloped rd = Rural developed

TABLE 4

Generalized **Peak Hour Two-Way** Volumes for Florida's **Urbanized Areas**[1]

12/18/12

INTERRUPTED FLOW FACILITIES

STATE SIGNALIZED ARTERIALS

Class I (40 mph or higher posted speed limit)

Lanes	Median	B	C	D	E
2	Undivided	*	1,510	1,600	**
4	Divided	*	3,420	3,580	**
6	Divided	*	5,250	5,390	**
8	Divided	*	7,090	7,210	**

Class II (35 mph or slower posted speed limit)

Lanes	Median	B	C	D	E
2	Undivided	*	660	1,330	1,410
4	Divided	*	1,310	2,920	3,040
6	Divided	*	2,090	4,500	4,590
8	Divided	*	2,880	6,060	6,130

Non-State Signalized Roadway Adjustments

(Alter corresponding state volumes by the indicated percent.)

Non-State Signalized Roadways - 10%

Median & Turn Lane Adjustments

Lanes	Median	Exclusive Left Lanes	Exclusive Right Lanes	Adjustment Factors
2	Divided	Yes	No	+5%
2	Undivided	No	No	-20%
Multi	Undivided	Yes	No	-5%
Multi	Undivided	No	No	-25%
–	–	–	Yes	+ 5%

One-Way Facility Adjustment

Multiply the corresponding two-directional volumes in this table by 0.6

BICYCLE MODE[2]

(Multiply motorized vehicle volumes shown below by number of directional roadway lanes to determine two-way maximum service volumes.)

Paved Shoulder/Bicycle Lane Coverage	B	C	D	E
0-49%	*	260	680	1,770
50-84%	190	600	1,770	>1,770
85-100%	830	1,770	>1,770	**

PEDESTRIAN MODE[2]

(Multiply motorized vehicle volumes shown below by number of directional roadway lanes to determine two-way maximum service volumes.)

Sidewalk Coverage	B	C	D	E
0-49%	*	*	250	850
50-84%	*	150	780	1,420
85-100%	340	960	1,560	>1,770

BUS MODE (Scheduled Fixed Route)[3]

(Buses in peak hour in peak direction)

Sidewalk Coverage	B	C	D	E
0-84%	> 5	≥ 4	≥ 3	≥ 2
85-100%	> 4	≥ 3	≥ 2	≥ 1

UNINTERRUPTED FLOW FACILITIES

FREEWAYS

Lanes	B	C	D	E
4	4,120	5,540	6,700	7,190
6	6,130	8,370	10,060	11,100
8	8,230	11,100	13,390	15,010
10	10,330	14,040	16,840	18,930
12	14,450	18,880	22,030	22,860

Freeway Adjustments

Auxiliary Lanes Present in Both Directions	Ramp Metering
+ 1,800	+ 5%

UNINTERRUPTED FLOW HIGHWAYS

Lanes	Median	B	C	D	E
2	Undivided	770	1,530	2,170	2,990
4	Divided	3,300	4,660	5,900	6,530
6	Divided	4,950	6,990	8,840	9,790

Uninterrupted Flow Highway Adjustments

Lanes	Median	Exclusive left lanes	Adjustment factors
2	Divided	Yes	+5%
Multi	Undivided	Yes	-5%
Multi	Undivided	No	-25%

[1] Values shown are presented as peak hour two-way volumes for levels of service and are for the automobile/truck modes unless specifically stated. This table does not constitute a standard and should be used only for general planning applications. The computer models from which this table is derived should be used for more specific planning applications. The table and deriving computer models should not be used for corridor or intersection design, where more refined techniques exist. Calculations are based on planning applications of the Highway Capacity Manual and the Transit Capacity and Quality of Service Manual.

[2] Level of service for the bicycle and pedestrian modes in this table is based on number of motorized vehicles, not number of bicyclists or pedestrians using the facility.

[3] Buses per hour shown are only for the peak hour in the single direction of the higher traffic flow.

* Cannot be achieved using table input value defaults.

** Not applicable for that level of service letter grade. For the automobile mode, volumes greater than level of service D become F because intersection capacities have been reached. For the bicycle mode, the level of service letter grade (including F) is not achievable because there is no maximum vehicle volume threshold using table input value defaults.

Source:
Florida Department of Transportation
Systems Planning Office
www.dot.state.fl.us/planning/systems/sm/los/default.shtm

TABLE 4
(continued)

Generalized **Peak Hour Two-Way** Volumes for Florida's **Urbanized Areas**

12/18/12

INPUT VALUE ASSUMPTIONS	Uninterrupted Flow Facilities			Interrupted Flow Facilities					
				State Arterials				Class I	
	Freeways	Highways		Class I		Class II		Bicycle	Pedestrian
ROADWAY CHARACTERISTICS									
Area type (lu, u)	lu	u	u	u	u	u	u	u	u
Number of through lanes (both dir.)	4-12	2	4-6	2	4-8	2	4-8	4	4
Posted speed (mph)	70	50	50	45	50	30	30	45	45
Free flow speed (mph)	75	55	55	50	55	35	35	50	50
Auxiliary lanes (n,y)	n								
Median (n, nr, r)		n	r	n	r	n	r	r	r
Terrain (l,r)	l	l	l	l	l	l	l	l	l
% no passing zone		80							
Exclusive left turn lane impact (n, y)		[n]	y	y	y	y	y	y	y
Exclusive right turn lanes (n, y)				n	n	n	n	n	n
Facility length (mi)	4	5	5	2	2	1.9	1.8	2	2
Number of basic segments	4								
TRAFFIC CHARACTERISTICS									
Planning analysis hour factor (K)	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090
Directional distribution factor (D)	0.547	0.550	0.550	0.550	0.560	0.565	0.560	0.565	0.565
Peak hour factor (PHF)	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Base saturation flow rate (pcphpl)		1,700	2,100	1,950	1,950	1,950	1,950	1,950	1,950
Heavy vehicle percent	4.0	2.0	2.0	1.0	1.0	1.0	1.0	2.5	2.0
Local adjustment factor	0.91	0.97	0.98						
% left turns				12	12	12	12	12	12
% right turns				12	12	12	12	12	12
CONTROL CHARACTERISTICS									
Number of signals				4	4	10	10	4	6
Arrival type (1-6)				3	3	4	4	4	4
Signal type (a, c, p)				c	c	c	c	c	c
Cycle length (C)				120	150	120	120	120	120
Effective green ratio (g/C)				0.44	0.45	0.44	0.44	0.44	0.44
MULTIMODAL CHARACTERISTICS									
Paved shoulder/bicycle lane (n, y)								n, 50%, y	n
Outside lane width (n, t, w)								t	t
Pavement condition (d, t, u)								t	
On-street parking (n, y)								n	n
Sidewalk (n, y)									n, 50%, y
Sidewalk/roadway separation (a, t, w)									t
Sidewalk protective barrier (n, y)									n

LEVEL OF SERVICE THRESHOLDS

Level of Service	Freeways	Highways		Arterials		Bicycle	Ped	Bus
	Density	Two-Lane	Multilane	Class I	Class II	Score	Score	Buses/hr.
		%ffs	Density	ats	ats			
B	≤ 17	> 83.3	≤ 17	> 31 mph	> 22 mph	≤ 2.75	≤ 2.75	≤ 6
C	≤ 24	> 75.0	≤ 24	> 23 mph	> 17 mph	≤ 3.50	≤ 3.50	≤ 4
D	≤ 31	> 66.7	≤ 31	> 18 mph	> 13 mph	≤ 4.25	≤ 4.25	< 3
E	≤ 39	> 58.3	≤ 35	> 15 mph	> 10 mph	≤ 5.00	≤ 5.00	< 2

% ffs = Percent free flow speed   ats = Average travel speed

TABLE 5

Generalized **Peak Hour Two-Way** Volumes for Florida's **Transitioning** and **Areas Over 5,000 Not In Urbanized Areas**[1]

12/18/12

INTERRUPTED FLOW FACILITIES

STATE SIGNALIZED ARTERIALS

Class I (40 mph or higher posted speed limit)

Lanes	Median	B	C	D	E
2	Undivided	*	1,300	1,460	**
4	Divided	*	3,060	3,200	**
6	Divided	*	4,690	4,820	**

Class II (35 mph or slower posted speed limit)

Lanes	Median	B	C	D	E
2	Undivided	*	580	1,200	1,280
4	Divided	*	890	2,590	2,850
6	Divided	*	1,440	4,040	4,280

Non-State Signalized Roadway Adjustments

(Alter corresponding state volumes by the indicated percent.)

Non-State Signalized Roadways - 10%

Median & Turn Lane Adjustments

Lanes	Median	Exclusive Left Lanes	Exclusive Right Lanes	Adjustment Factors
2	Divided	Yes	No	+5%
2	Undivided	No	No	-20%
Multi	Undivided	Yes	No	-5%
Multi	Undivided	No	No	-25%
–	–	–	Yes	+ 5%

One-Way Facility Adjustment

Multiply the corresponding two-directional volumes in this table by 0.6

BICYCLE MODE[2]

(Multiply motorized vehicle volumes shown below by number of directional roadway lanes to determine two-way maximum service volumes.)

Paved Shoulder/Bicycle Lane Coverage	B	C	D	E
0-49%	*	140	550	1,760
50-84%	170	500	1,650	>1,760
85-100%	670	1,760	>1,760	**

PEDESTRIAN MODE[2]

(Multiply motorized vehicle volumes shown below by number of directional roadway lanes to determine two-way maximum service volumes.)

Sidewalk Coverage	B	C	D	E
0-49%	*	*	250	850
50-84%	*	150	780	1,410
85-100%	340	950	1,540	>1,760

BUS MODE (Scheduled Fixed Route)[3]

(Buses in peak hour in peak direction)

Sidewalk Coverage	B	C	D	E
0-84%	> 5	≥ 4	≥ 3	≥ 2
85-100%	> 4	≥ 3	≥ 2	≥ 1

UNINTERRUPTED FLOW FACILITIES

FREEWAYS

Lanes	B	C	D	E
4	3,970	5,190	6,200	6,460
6	5,860	7,710	9,190	9,990
8	7,660	10,230	12,170	13,500
10	9,550	12,750	15,190	17,010

Freeway Adjustments

Auxiliary Lanes Present in Both Directions	Ramp Metering
+ 1,800	+ 5%

UNINTERRUPTED FLOW HIGHWAYS

Lanes	Median	B	C	D	E
2	Undivided	820	1,550	2,190	2,990
4	Divided	3,170	4,460	5,660	6,260
6	Divided	4,750	6,700	8,480	9,400

Uninterrupted Flow Highway Adjustments

Lanes	Median	Exclusive left lanes	Adjustment factors
2	Divided	Yes	+5%
Multi	Undivided	Yes	-5%
Multi	Undivided	No	-25%

[1] Values shown are presented as peak hour two-way volumes for levels of service and are for the automobile/truck modes unless specifically stated. This table does not constitute a standard and should be used only for general planning applications. The computer models from which this table is derived should be used for more specific planning applications. The table and deriving computer models should not be used for corridor or intersection design, where more refined techniques exist. Calculations are based on planning applications of the Highway Capacity Manual and the Transit Capacity and Quality of Service Manual.

[2] Level of service for the bicycle and pedestrian modes in this table is based on number of motorized vehicles, not number of bicyclists or pedestrians using the facility.

[3] Buses per hour shown are only for the peak hour in the single direction of the higher traffic flow.

* Cannot be achieved using table input value defaults.

** Not applicable for that level of service letter grade. For the automobile mode, volumes greater than level of service D become F because intersection capacities have been reached. For the bicycle mode, the level of service letter grade (including F) is not achievable because there is no maximum vehicle volume threshold using table input value defaults.

Source:
Florida Department of Transportation
Systems Planning Office
www.dot.state.fl.us/planning/systems/sm/los/default.shtm

TABLE 5
(continued)

Generalized **Peak Hour Two-Way** Volumes for Florida's **Transitioning Areas** and **Areas Over 5,000 Not In Urbanized Areas**

12/18/12

INPUT VALUE ASSUMPTIONS	Uninterrupted Flow Facilities			Interrupted Flow Facilities					
				State Arterials				Class I	
	Freeways	Highways		Class I		Class II		Bicycle	Pedestrian
ROADWAY CHARACTERISTICS									
Area type (t,uo)	t	t	t	t	t	t	t	t	t
Number of through lanes (both dir.)	4-10	2	4-6	2	4-6	2	4-6	4	4
Posted speed (mph)	70	50	50	45	50	30	30	45	45
Free flow speed (mph)	75	55	55	50	55	35	35	50	50
Auxiliary lanes (n,y)	n	n	n						
Median (n, nr, r)		n	r	n	y	n	y	r	r
Terrain (l,r)	l	l	l	l	l	l	l	l	l
% no passing zone		60							
Exclusive left turn lane impact (n, y)		[n]	y	y	y	y	y	y	y
Exclusive right turn lanes (n, y)				n	n	n	n	n	n
Facility length (mi)	8	5	5	1.8	2	2	2	2	2
Number of basic segments	4								
TRAFFIC CHARACTERISTICS									
Planning analysis hour factor (K)	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090
Directional distribution factor (D)	0.555	0.550	0.550	0.550	0.570	0.570	0.565	0.570	0.570
Peak hour factor (PHF)	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Base saturation flow rate (pcphpl)		1,700	2,100	1,950	1,950	1,950	1,950	1,950	1,950
Heavy vehicle percent	9.0	4.0	4.0	2.0	3.0	2.0	3.0	3.0	3.0
Local adjustment factor	0.85	0.97	0.95						
% left turns				12	12	12	12	12	12
% right turns				12	12	12	12	12	12
CONTROL CHARACTERISTICS									
Number of signals				5	4	10	10	4	6
Arrival type (1-6)				4	3	4	4	4	4
Signal type (a, c, p)				c	c	c	c	c	c
Cycle length (C)				120	150	120	150	120	120
Effective green ratio (g/C)				0.44	0.45	0.44	0.45	0.44	0.44
MULTIMODAL CHARACTERISTICS									
Paved shoulder/bicycle lane (n, y)								n, 50%, y	n
Outside lane width (n, t, w)								t	t
Pavement condition (d, t, u)								t	
On-street parking (n, y)								n	n
Sidewalk (n, y)									n, 50%, y
Sidewalk/roadway separation (a, t, w)									t
Sidewalk protective barrier (n, y)									n

LEVEL OF SERVICE THRESHOLDS

Level of Service	Freeways	Highways		Arterials		Bicycle	Ped	Bus
	Density	Two-Lane	Multilane	Class I	Class II	Score	Score	Buses/hr.
		%ffs	Density	ats	ats			
B	≤ 17	> 83.3	≤ 17	> 31 mph	> 22 mph	≤ 2.75	≤ 2.75	≤ 6
C	≤ 24	> 75.0	≤ 24	> 23 mph	> 17 mph	≤ 3.50	≤ 3.50	≤ 4
D	≤ 31	> 66.7	≤ 31	> 18 mph	> 13 mph	≤ 4.25	≤ 4.25	< 3
E	≤ 39	> 58.3	≤ 35	> 15 mph	> 10 mph	≤ 5.00	≤ 5.00	< 2

% ffs = Percent free flow speed   ats = Average travel speed

TABLE 6

Generalized **Peak Hour Two-Way** Volumes for Florida's **Rural Undeveloped Areas** and **Developed Areas Less Than 5,000 Population**[1]

12/18/12

INTERRUPTED FLOW FACILITIES

STATE SIGNALIZED ARTERIALS

Lanes	Median	B	C	D	E
2	Undivided	*	1,220	1,350	**
4	Divided	*	2,790	2,890	**
6	Divided	*	4,300	4,350	**

Non-State Signalized Roadway Adjustments

(Alter corresponding state volumes by the indicated percent.)

Non-State Signalized Roadways - 10%

Median & Turn Lane Adjustments

Lanes	Median	Exclusive Left Lanes	Exclusive Right Lanes	Adjustment Factors
2	Divided	Yes	No	+5%
2	Undivided	No	No	-20%
Multi	Undivided	Yes	No	-5%
Multi	Undivided	No	No	-25%
–	–	–	Yes	+ 5%

One-Way Facility Adjustment

Multiply the corresponding two-directional volumes in this table by 0.6

BICYCLE MODE[2]

(Multiply motorized vehicle volumes shown below by number of directional roadway lanes to determine two-way maximum service volumes.)

Rural Undeveloped

Paved Shoulder/Bicycle Lane Coverage	B	C	D	E
0-49%	*	120	190	300
50-84%	100	200	310	>1,010
85-100%	250	370	1,760	>1,760

Developed Areas

Paved Shoulder/Bicycle Lane Coverage	B	C	D	E
0-49%	*	220	460	1,480
50-84%	170	430	1,270	>1,760
85-100%	560	1,760	>1,760	**

PEDESTRIAN MODE[2]

(Multiply motorized vehicle volumes shown below by number of directional roadway lanes to determine two-way maximum service volumes.)

Sidewalk Coverage	B	C	D	E
0-49%	*	*	220	840
50-84%	*	120	780	1,390
85-100%	320	940	1,560	>1,820

UNINTERRUPTED FLOW FACILITIES

FREEWAYS

Lanes	B	C	D	E
4	3,020	4,510	5,490	6,300
6	4,510	6,720	8,220	9,720
8	6,040	8,970	10,960	12,970

Freeway Adjustments

Auxiliary Lanes
Present in Both Directions
+ 1,800

UNINTERRUPTED FLOW HIGHWAYS

Rural Undeveloped

Lanes	Median	B	C	D	E
2	Undivided	440	790	1,350	2,710
4	Divided	2,440	3,820	4,840	5,500
6	Divided	3,680	5,730	7,280	8,240

Developed Areas

Lanes	Median	B	C	D	E
2	Undivided	820	1,550	2,190	2,990
4	Divided	2,460	3,860	4,970	5,660
6	Divided	3,680	5,790	7,440	8,500

Passing Lane Adjustments

Alter LOS B-D volumes in proportion to the passing lane length to the highway segment length

Uninterrupted Flow Highway Adjustments

Lanes	Median	Exclusive left lanes	Adjustment factors
2	Divided	Yes	+5%
Multi	Undivided	Yes	-5%
Multi	Undivided	No	-25%

[1]Values shown are presented as peak hour two-way volumes for levels of service and are for the automobile/truck modes unless specifically stated. This table does not constitute a standard and should be used only for general planning applications. The computer models from which this table is derived should be used for more specific planning applications. The table and deriving computer models should not be used for corridor or intersection design, where more refined techniques exist. Calculations are based on planning applications of the Highway Capacity Manual and the Transit Capacity and Quality of Service Manual.

[2] Level of service for the bicycle and pedestrian modes in this table is based on number of motorized vehicles, not number of bicyclists or pedestrians using the facility.

* Cannot be achieved using table input value defaults.

** Not applicable for that level of service letter grade. For the automobile mode, volumes greater than level of service D become F because intersection capacities have been reached. For the bicycle mode, the level of service letter grade (including F) is not achievable because there is no maximum vehicle volume threshold using table input value defaults.

Source:
Florida Department of Transportation
Systems Planning Office
www.dot.state.fl.us/planning/systems/sm/los/default.shtm

TABLE 6
(continued)

Generalized **Peak Hour Two-Way** Volumes for Florida's **Rural Undeveloped Areas** and **Developed Areas Less Than 5,000 Population**

12/18/12

INPUT VALUE ASSUMPTIONS	Uninterrupted Flow Facilities					Interrupted Flow Facilities				
	Freeways	Highways				Arterials		Bicycle		Pedestrian
ROADWAY CHARACTERISTICS										
Area type (ru, rd)	rural	ru	ru	rd	rd	rd	rd	ru	rd	rd
Number of through lanes (both dir.)	4-8	2	4-6	2	4-6	2	4-6	4	4	2
Posted speed (mph)	70	55	65	50	55	45	45	55	45	45
Free flow speed (mph)	75	60	70	55	60	50	50	60	50	50
Auxiliary lanes (n,y)	n									
Median (n, nr, r)		n	r	n	r	n	r	r	r	n
Terrain (l,r)	l	l	l	l	l	l	l	l	l	l
% no passing zone		20		60						
Exclusive left turn lanes (n, y)		[n]	y	[n]	y	y	y	y	y	y
Exclusive right turn lanes (n, y)						n	n	n	n	n
Facility length (mi)	14	10	10	5	5	1.9	2.2	4	2	2
Number of basic segments	4									
TRAFFIC CHARACTERISTICS										
Planning analysis hour factor (K)	0.105	0.095	0.095	0.095	0.095	0.095	0.095	0.095	0.095	0.095
Directional distribution factor (D)	0.555	0.550	0.550	0.550	0.550	0.550	0.550	0.570	0.570	0.550
Peak hour factor (PHF)	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Base saturation flow rate (pcphpl)		1,700	2,300	1,700	2,200	1,950	1,950	1,950	1,950	1,950
Heavy vehicle percent	12.0	5.0	12.0	4.0	4.0	3.0	3.0	6.0	3.5	3.0
Local adjustment factor	0.84	0.88	0.73	0.97	0.82					
% left turns						12	12		12	12
% right turns						12	12		12	12
CONTROL CHARACTERISTICS										
Number of signals						5	6	2	4	4
Arrival type (1-6)						3	3	3	3	3
Signal type (a, c, p)						c	c	a	a	a
Cycle length (C)						90	90	60	90	90
Effective green ratio (g/C)						0.44	0.44	0.37	0.44	0.44
MULTIMODAL CHARACTERISTICS										
Paved shoulder/bicycle lane (n, y)								n,50%,y	n,50%,y	n
Outside lane width (n, t, w)								t	t	t
Pavement condition (d, t, w)								t	t	
Sidewalk (n, y)										n,50%,y
Sidewalk/roadway separation(a, t,w)										t
Sidewalk protective barrier (n, y)										n

LEVEL OF SERVICE THRESHOLDS

Level of Service	Freeways	Highways				
		Two-Lane ru		Two-Lane rd	Multilane ru	Multilane rd
	Density	%tsf	ats	%ffs	Density	Density
B	≤ 14	≤ 50	≥ 55	> 83.3	≤ 14	≤ 14
C	≤ 22	≤ 65	≥ 50	> 75.0	≤ 22	≤ 22
D	≤ 29	≤ 80	≥ 45	> 66.7	≤ 29	≤ 29
E	≤ 39	> 80	≥ 40	> 58.3	≤ 34	≤ 34

Level of Service	Arterials	Bicycle	Pedestrian
	Major City/Co.(ats)	Score	Score
B	> 31 mph	≤ 2.75	≤ 2.75
C	> 23 mph	≤ 3.50	≤ 3.50
D	> 18 mph	≤ 4.25	≤ 4.25
E	> 15 mph	≤ 5.00	≤ 5.00

%tsf = Percent time spent following %ffs = Percent of free flow speed ats = Average travel speed ru = Rural undeveloped rd = Rural developed

TABLE 7

Generalized **Peak Hour Directional** Volumes for Florida's **Urbanized Areas**[1]

12/18/12

INTERRUPTED FLOW FACILITIES

STATE SIGNALIZED ARTERIALS

Class I (40 mph or higher posted speed limit)

Lanes	Median	B	C	D	E
1	Undivided	*	830	880	**
2	Divided	*	1,910	2,000	**
3	Divided	*	2,940	3,020	**
4	Divided	*	3,970	4,040	**

Class II (35 mph or slower posted speed limit)

Lanes	Median	B	C	D	E
1	Undivided	*	370	750	800
2	Divided	*	730	1,630	1,700
3	Divided	*	1,170	2,520	2,560
4	Divided	*	1,610	3,390	3,420

Non-State Signalized Roadway Adjustments

(Alter corresponding state volumes by the indicated percent.)

Non-State Signalized Roadways - 10%

Median & Turn Lane Adjustments

Lanes	Median	Exclusive Left Lanes	Exclusive Right Lanes	Adjustment Factors
1	Divided	Yes	No	+5%
1	Undivided	No	No	-20%
Multi	Undivided	Yes	No	-5%
Multi	Undivided	No	No	-25%
–	–	–	Yes	+ 5%

One-Way Facility Adjustment

Multiply the corresponding directional volumes in this table by 1.2

BICYCLE MODE[2]

(Multiply motorized vehicle volumes shown below by number of directional roadway lanes to determine two-way maximum service volumes.)

Paved Shoulder/Bicycle Lane Coverage	B	C	D	E
0-49%	*	150	390	1,000
50-84%	110	340	1,000	>1,000
85-100%	470	1,000	>1,000	**

PEDESTRIAN MODE[2]

(Multiply motorized vehicle volumes shown below by number of directional roadway lanes to determine two-way maximum service volumes.)

Sidewalk Coverage	B	C	D	E
0-49%	*	*	140	480
50-84%	*	80	440	800
85-100%	200	540	880	>1,000

BUS MODE (Scheduled Fixed Route)[3]

(Buses in peak hour in peak direction)

Sidewalk Coverage	B	C	D	E
0-84%	> 5	≥ 4	≥ 3	≥ 2
85-100%	> 4	≥ 3	≥ 2	≥ 1

UNINTERRUPTED FLOW FACILITIES

FREEWAYS

Lanes	B	C	D	E
2	2,260	3,020	3,660	3,940
3	3,360	4,580	5,500	6,080
4	4,500	6,080	7,320	8,220
5	5,660	7,680	9,220	10,360
6	7,900	10,320	12,060	12,500

Freeway Adjustments

Auxiliary Lane	Ramp Metering
+ 1,000	+ 5%

UNINTERRUPTED FLOW HIGHWAYS

Lanes	Median	B	C	D	E
1	Undivided	420	840	1,190	1,640
2	Divided	1,810	2,560	3,240	3,590
3	Divided	2,720	3,840	4,860	5,380

Uninterrupted Flow Highway Adjustments

Lanes	Median	Exclusive left lanes	Adjustment factors
1	Divided	Yes	+5%
Multi	Undivided	Yes	-5%
Multi	Undivided	No	-25%

[1] Values shown are presented as peak hour directional volumes for levels of service and are for the automobile/truck modes unless specifically stated. This table does not constitute a standard and should be used only for general planning applications. The computer models from which this table is derived should be used for more specific planning applications. The table and deriving computer models should not be used for corridor or intersection design, where more refined techniques exist. Calculations are based on planning applications of the Highway Capacity Manual and the Transit Capacity and Quality of Service Manual.

[2] Level of service for the bicycle and pedestrian modes in this table is based on number of motorized vehicles, not number of bicyclists or pedestrians using the facility.

[3] Buses per hour shown are only for the peak hour in the single direction of the higher traffic flow.

* Cannot be achieved using table input value defaults.

** Not applicable for that level of service letter grade. For the automobile mode, volumes greater than level of service D become F because intersection capacities have been reached. For the bicycle mode, the level of service letter grade (including F) is not achievable because there is no maximum vehicle volume threshold using table input value defaults.

Source:
Florida Department of Transportation
Systems Planning Office
www.dot.state.fl.us/planning/systems/sm/los/default.shtm

TABLE 7
(continued)

Generalized **Peak Hour Directional** Volumes for Florida's **Urbanized Areas**

12/18/12

INPUT VALUE ASSUMPTIONS	Uninterrupted Flow Facilities			Interrupted Flow Facilities					
				State Arterials				Class I	
	Freeways	Highways		Class I		Class II		Bicycle	Pedestrian
ROADWAY CHARACTERISTICS									
Area type (lu, u)	lu	u	u	u	u	u	u	u	u
Number of through lanes (both dir.)	4-12	2	4-6	2	4-8	2	4-8	4	4
Posted speed (mph)	70	50	50	45	50	30	30	45	45
Free flow speed (mph)	75	55	55	50	55	35	35	50	50
Auxiliary lanes (n,y)	n								
Median (n, nr, r)		n	r	n	r	n	r	r	r
Terrain (l,r)	l	l	l	l	l	l	l	l	l
% no passing zone		80							
Exclusive left turn lane impact (n, y)		[n]	y	y	y	y	y	y	y
Exclusive right turn lanes (n, y)				n	n	n	n	n	n
Facility length (mi)	4	5	5	2	2	1.9	1.8	2	2
Number of basic segments	4								
TRAFFIC CHARACTERISTICS									
Planning analysis hour factor (K)	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090
Directional distribution factor (D)	0.547	0.550	0.550	0.550	0.560	0.565	0.560	0.565	0.565
Peak hour factor (PHF)	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Base saturation flow rate (pcphpl)		1,700	2,100	1,950	1,950	1,950	1,950	1,950	1,950
Heavy vehicle percent	4.0	2.0	2.0	1.0	1.0	1.0	1.0	2.5	2.0
Local adjustment factor	0.91	0.97	0.98						
% left turns				12	12	12	12	12	12
% right turns				12	12	12	12	12	12
CONTROL CHARACTERISTICS									
Number of signals				4	4	10	10	4	6
Arrival type (1-6)				3	3	4	4	4	4
Signal type (a, c, p)				c	c	c	c	c	c
Cycle length (C)				120	150	120	120	120	120
Effective green ratio (g/C)				0.44	0.45	0.44	0.44	0.44	0.44
MULTIMODAL CHARACTERISTICS									
Paved shoulder/bicycle lane (n, y)								n, 50%, y	n
Outside lane width (n, t, w)								t	t
Pavement condition (d, t, w)								t	
On-street parking (n, y)								n	n
Sidewalk (n, y)									n, 50%, y
Sidewalk/roadway separation (a, t, w)									t
Sidewalk protective barrier (n, y)									n

LEVEL OF SERVICE THRESHOLDS

Level of Service	Freeways	Highways		Arterials		Bicycle	Ped	Bus
	Density	Two-Lane	Multilane	Class I	Class II	Score	Score	Buses/hr.
		%ffs	Density	ats	ats			
B	≤ 17	> 83.3	≤ 17	> 31 mph	> 22 mph	≤ 2.75	≤ 2.75	≤ 6
C	≤ 24	> 75.0	≤ 24	> 23 mph	> 17 mph	≤ 3.50	≤ 3.50	≤ 4
D	≤ 31	> 66.7	≤ 31	> 18 mph	> 13 mph	≤ 4.25	≤ 4.25	< 3
E	≤ 39	> 58.3	≤ 35	> 15 mph	> 10 mph	≤ 5.00	≤ 5.00	< 2

% ffs = Percent free flow speed   ats = Average travel speed

TABLE 8

Generalized **Peak Hour Directional** Volumes for Florida's **Transitioning** and **Areas Over 5,000 Not In Urbanized Areas**[1]

12/18/12

INTERRUPTED FLOW FACILITIES

STATE SIGNALIZED ARTERIALS

Class I (40 mph or higher posted speed limit)

Lanes	Median	B	C	D	E
1	Undivided	*	710	800	**
2	Divided	*	1,740	1,820	**
3	Divided	*	2,670	2,740	**

Class II (35 mph or slower posted speed limit)

Lanes	Median	B	C	D	E
1	Undivided	*	330	680	720
2	Divided	*	500	1,460	1,600
3	Divided	*	810	2,280	2,420

Non-State Signalized Roadway Adjustments

(Alter corresponding state volumes by the indicated percent.)

Non-State Signalized Roadways - 10%

Median & Turn Lane Adjustments

Lanes	Median	Exclusive Left Lanes	Exclusive Right Lanes	Adjustment Factors
1	Divided	Yes	No	+5%
2	Undivided	No	No	-20%
Multi	Undivided	Yes	No	-5%
Multi	Undivided	No	No	-25%
–	–	–	Yes	+ 5%

One-Way Facility Adjustment

Multiply the corresponding directional volumes in this table by 1.2

BICYCLE MODE[2]

(Multiply motorized vehicle volumes shown below by number of directional roadway lanes to determine two-way maximum service volumes.)

Paved Shoulder/Bicycle Lane Coverage	B	C	D	E
0-49%	*	140	320	1,000
50-84%	100	280	940	>1,000
85-100%	380	1,000	>1,000	**

PEDESTRIAN MODE[2]

(Multiply motorized vehicle volumes shown below by number of directional roadway lanes to determine two-way maximum service volumes.)

Sidewalk Coverage	B	C	D	E
0-49%	*	*	140	480
50-84%	*	80	440	800
85-100%	200	540	880	>1,000

BUS MODE (Scheduled Fixed Route)[3]

(Buses in peak hour in peak direction)

Sidewalk Coverage	B	C	D	E
0-84%	> 5	≥ 4	≥ 3	≥ 2
85-100%	> 4	≥ 3	≥ 2	≥ 1

UNINTERRUPTED FLOW FACILITIES

FREEWAYS

Lanes	B	C	D	E
2	2,200	2,880	3,440	3,580
3	3,260	4,280	5,100	5,540
4	4,260	5,680	6,760	7,500
5	5,300	7,080	8,440	9,440

Freeway Adjustments

Auxiliary Lane	Ramp Metering
+ 1,000	+ 5%

UNINTERRUPTED FLOW HIGHWAYS

Lanes	Median	B	C	D	E
1	Undivided	450	850	1,200	1,640
2	Divided	1,740	2,450	3,110	3,440
3	Divided	2,610	3,680	4,660	5,170

Uninterrupted Flow Highway Adjustments

Lanes	Median	Exclusive left lanes	Adjustment factors
1	Divided	Yes	+5%
Multi	Undivided	Yes	-5%
Multi	Undivided	No	-25%

[1]Values shown are presented as peak hour directional volumes for levels of service and are for the automobile/truck modes unless specifically stated. This table does not constitute a standard and should be used only for general planning applications. The computer models from which this table is derived should be used for more specific planning applications. The table and deriving computer models should not be used for corridor or intersection design, where more refined techniques exist. Calculations are based on planning applications of the Highway Capacity Manual and the Transit Capacity and Quality of Service Manual.

[2] Level of service for the bicycle and pedestrian modes in this table is based on number of motorized vehicles, not number of bicyclists or pedestrians using the facility.

[3] Buses per hour shown are only for the peak hour in the single direction of the higher traffic flow.

* Cannot be achieved using table input value defaults.

** Not applicable for that level of service letter grade. For the automobile mode, volumes greater than level of service D become F because intersection capacities have been reached. For the bicycle mode, the level of service letter grade (including F) is not achievable because there is no maximum vehicle volume threshold using table input value defaults.

Source:
Florida Department of Transportation
Systems Planning Office
www.dot.state.fl.us/planning/systems/sm/los/default.shtm

TABLE 8
(continued)

Generalized **Peak Hour Directional** Volumes for Florida's **Transitioning** and **Areas Over 5,000 Not In Urbanized Areas**

12/18/12

INPUT VALUE ASSUMPTIONS	Uninterrupted Flow Facilities			Interrupted Flow Facilities					
				State Arterials				Class I	
	Freeways	Highways		Class I		Class II		Bicycle	Pedestrian
ROADWAY CHARACTERISTICS									
Area type (t,uo)	t	t	t	t	t	t	t	t	t
Number of through lanes (both dir.)	4-10	2	4-6	2	4-6	2	4-6	4	4
Posted speed (mph)	70	50	50	45	50	30	30	45	45
Free flow speed (mph)	75	55	55	50	55	35	35	50	50
Auxiliary lanes (n,y)	n	n	n						
Median (n, nr, r)		n	r	n	y	n	y	r	r
Terrain (l,r)	l	l	l	l	l	l	l	l	l
% no passing zone		60							
Exclusive left turn lane impact (n, y)		[n]	y	y	y	y	y	y	y
Exclusive right turn lanes (n, y)				n	n	n	n	n	n
Facility length (mi)	8	5	5	1.8	2	2	2	2	2
Number of basic segments	4								
TRAFFIC CHARACTERISTICS									
Planning analysis hour factor (K)	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090
Directional distribution factor (D)	0.555	0.550	0.550	0.550	0.570	0.570	0.565	0.570	0.570
Peak hour factor (PHF)	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Base saturation flow rate (pcphpl)		1,700	2,100	1,950	1,950	1,950	1,950	1,950	1,950
Heavy vehicle percent	9.0	4.0	4.0	2.0	3.0	2.0	3.0	3.0	3.0
Local adjustment factor	0.85	0.97	0.95						
% left turns				12	12	12	12	12	12
% right turns				12	12	12	12	12	12
CONTROL CHARACTERISTICS									
Number of signals				5	4	10	10	4	6
Arrival type (1-6)				4	3	4	4	4	4
Signal type (a, c, p)				c	c	c	c	c	c
Cycle length (C)				120	150	120	150	120	120
Effective green ratio (g/C)				0.44	0.45	0.44	0.45	0.44	0.44
CONTROL CHARACTERISTICS									
Paved shoulder/bicycle lane (n, y)								n, 50%, y	n
Outside lane width (n, t, w)								t	t
Pavement condition (d, t, u)								t	
On-street parking (n, y)								n	n
Sidewalk (n, y)									n, 50%, y
Sidewalk/roadway separation (a, t, w)									t
Sidewalk protective barrier (n, y)									n

LEVEL OF SERVICE THRESHOLDS

Level of Service	Freeways	Highways		Arterials		Bicycle	Ped	Bus
	Density	Two-Lane %ffs	Multilane Density	Class I ats	Class II ats	Score	Score	Buses/hr.
B	≤ 17	> 83.3	≤ 17	> 31 mph	> 22 mph	≤ 2.75	≤ 2.75	≤ 6
C	≤ 24	> 75.0	≤ 24	> 23 mph	> 17 mph	≤ 3.50	≤ 3.50	≤ 4
D	≤ 31	> 66.7	≤ 31	> 18 mph	> 13 mph	≤ 4.25	≤ 4.25	< 3
E	≤ 39	> 58.3	≤ 35	> 15 mph	> 10 mph	≤ 5.00	≤ 5.00	< 2

% ffs = Percent free flow speed ats = Average travel speed

TABLE 9

Generalized **Peak Hour Directional** Volumes for Florida's **Rural Undeveloped Areas** and **Developed Areas Less Than 5,000 Population**[1]

12/18/12

INTERRUPTED FLOW FACILITIES

STATE SIGNALIZED ARTERIALS

Lanes	Median	B	C	D	E
1	Undivided	*	670	740	**
2	Divided	*	1,530	1,580	**
3	Divided	*	2,360	2,400	**

Non-State Signalized Roadway Adjustments

(Alter corresponding state volumes by the indicated percent.)

Non-State Signalized Roadways - 10%

Median & Turn Lane Adjustments

Lanes	Median	Exclusive Left Lanes	Exclusive Right Lanes	Adjustment Factors
1	Divided	Yes	No	+5%
1	Undivided	No	No	-20%
Multi	Undivided	Yes	No	-5%
Multi	Undivided	No	No	-25%
–	–	–	Yes	+ 5%

One-Way Facility Adjustment

Multiply the corresponding directional volumes in this table by 1.2

BICYCLE MODE[2]

(Multiply motorized vehicle volumes shown below by number of directional roadway lanes to determine two-way maximum service volumes.)

Rural Undeveloped

Paved Shoulder/Bicycle Lane Coverage	B	C	D	E
0-49%	*	70	110	170
50-84%	60	120	180	580
85-100%	140	210	1,000	>1,000

Developed Areas

Paved Shoulder/Bicycle Lane Coverage	B	C	D	E
0-49%	*	120	260	840
50-84%	100	240	720	1,000
85-100%	320	1,000	>1,000	**

PEDESTRIAN MODE[2]

(Multiply motorized vehicle volumes shown below by number of directional roadway lanes to determine two-way maximum service volumes.)

Sidewalk Coverage	B	C	D	E
0-49%	*	*	120	460
50-84%	*	80	430	770
85-100%	180	520	860	>1,000

UNINTERRUPTED FLOW FACILITIES

FREEWAYS

Lanes	B	C	D	E
2	1,680	2,500	3,040	3,500
3	2,500	3,720	4,560	5,400
4	3,360	4,980	6,080	7,200

Freeway Adjustments

Auxiliary Lanes Present in Both Directions

+ 1,000

UNINTERRUPTED FLOW HIGHWAYS

Rural Undeveloped

Lanes	Median	B	C	D	E
1	Undivided	240	430	740	1,490
2	Divided	1,340	2,100	2,660	3,020
3	Divided	2,020	3,150	4,000	4,530

Developed Areas

Lanes	Median	B	C	D	E
1	Undivided	450	850	1,200	1,640
2	Divided	1,350	2,120	2,730	3,110
3	Divided	2,020	3,180	4,090	4,670

Passing Lane Adjustments

Alter LOS B-D volumes in proportion to the passing lane length to the highway segment length

Uninterrupted Flow Highway Adjustments

Lanes	Median	Exclusive left lanes	Adjustment factors
1	Divided	Yes	+5%
Multi	Undivided	Yes	-5%
Multi	Undivided	No	-25%

[1]Values shown are presented as peak hour directional volumes for levels of service and are for the automobile/truck modes unless specifically stated. This table does not constitute a standard and should be used only for general planning applications. The computer models from which this table is derived should be used for more specific planning applications. The table and deriving computer models should not be used for corridor or intersection design, where more refined techniques exist. Calculations are based on planning applications of the Highway Capacity Manual and the Transit Capacity and Quality of Service Manual.

[2] Level of service for the bicycle and pedestrian modes in this table is based on number of motorized vehicles, not number of bicyclists or pedestrians using the facility.

* Cannot be achieved using table input value defaults.

** Not applicable for that level of service letter grade. For the automobile mode, volumes greater than level of service D become F because intersection capacities have been reached. For the bicycle mode, the level of service letter grade (including F) is not achievable because there is no maximum vehicle volume threshold using table input value defaults.

Source:

Florida Department of Transportation
Systems Planning Office
www.dot.state.fl.us/planning/systems/sm/los/default.shtm

TABLE 9
(continued)

Generalized **Peak Hour Directional** Volumes for Florida's **Rural Undeveloped Areas** and **Developed Areas Less Than 5,000 Population**

12/18/12

INPUT VALUE ASSUMPTIONS	Uninterrupted Flow Facilities					Interrupted Flow Facilities				
	Freeways	Highways				Arterials		Bicycle		Pedestrian
ROADWAY CHARACTERISTICS										
Area type (ru, rd)	rural	ru	ru	rd	rd	rd	rd	ru	rd	rd
Number of through lanes (both dir.)	4-8	2	4-6	2	4-6	2	4-6	4	4	2
Posted speed (mph)	70	55	65	50	55	45	45	55	45	45
Free flow speed (mph)	75	60	70	55	60	50	50	60	50	50
Auxiliary lanes (n,y)	n									
Median (n, nr, r)		n	r	n	r	n	r	r	r	n
Terrain (l,r)	l	l	l	l	l	l	l	l	l	l
% no passing zone		20		60						
Exclusive left turn lanes (n, y)		[n]	y	[n]	y	y	y	y	y	y
Exclusive right turn lanes (n, y)						n	n	n	n	n
Facility length (mi)	14	10	10	5	5	1.9	2.2	4	2	2
Number of basic segments	4									
TRAFFIC CHARACTERISTICS										
Planning analysis hour factor (K)	0.105	0.095	0.095	0.095	0.095	0.095	0.095	0.095	0.095	0.095
Directional distribution factor (D)	0.555	0.550	0.550	0.550	0.550	0.550	0.550	0.570	0.570	0.550
Peak hour factor (PHF)	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Base saturation flow rate (pcphpl)		1,700	2,300	1,700	2,200	1,950	1,950	1,950	1,950	1,950
Heavy vehicle percent	12.0	5.0	12.0	4.0	4.0	3.0	3.0	6.0	3.5	3.0
Local adjustment factor	0.84	0.88	0.73	0.97	0.82					
% left turns						12	12		12	12
% right turns						12	12		12	12
CONTROL CHARACTERISTICS										
Number of signals						5	6	2	4	4
Arrival type (1-6)						3	3	3	3	3
Signal type (a, c, p)						c	c	a	a	a
Cycle length (C)						90	90	60	90	90
Effective green ratio (g/C)						0.44	0.44	0.37	0.44	0.44
MULTIMODAL CHARACTERISTICS										
Paved shoulder/bicycle lane (n, y)								n,50%,y	n,50%,y	n
Outside lane width (n, t, w)								t	t	t
Pavement condition (d, t, u)								t	t	
Sidewalk (n, y)										n,50%,y
Sidewalk/roadway separation(a, t,w)										t
Sidewalk protective barrier (n, y)										n

LEVEL OF SERVICE THRESHOLDS

Level of Service	Freeways	Highways				
		Two-Lane ru		Two-Lane rd	Multilane ru	Multilane rd
	Density	%tsf	ats	%ffs	Density	Density
B	≤ 14	≤ 50	≤ 55	> 83.3	≤ 14	≤ 14
C	≤ 22	≤ 65	≤ 50	> 75.0	≤ 22	≤ 22
D	≤ 29	≤ 80	≤ 45	> 66.7	≤ 29	≤ 29
E	≤ 39	> 80	≤ 40	> 58.3	≤ 34	≤ 34

Level of Service	Arterials	Bicycle	Pedestrian
	Major City/Co.(ats)	Score	Score
B	> 31 mph	≤ 2.75	≤ 2.75
C	> 23 mph	≤ 3.50	≤ 3.50
D	> 18 mph	≤ 4.25	≤ 4.25
E	> 15 mph	≤ 5.00	≤ 5.00

%tsf = Percent time spent following %ffs = Percent of free flow speed ats = Average travel speed ru = Rural undeveloped rd = Rural developed

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION
Systems Planning Office
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http://www.dot.state.fl.us/planning/systems/sm/los