# Evolving Use of Level of Service Metrics in Transportation Analysis – Introduction

Since the passage of the surface transportation bill Moving Ahead for Progress in the 21st Century (MAP-21) Act in 2012, national attention on performance management and performance metrics in transportation has increased. Through a series of federal rulemakings included in MAP-21 and reaffirmed in the 2015 Fixing America's Surface Transportation (FAST) Act, state departments of transportation (DOTs) and metropolitan planning organizations (MPOs) will be required to establish targets related to safety, bridge and pavement condition, air quality, freight movement, and performance of the National Highway System (NHS), and to use performance measures to track their progress toward meeting those targets.


*Figure 1: Transit, automobiles, and bicycles share the roadway in Portland, Oregon*
*Source: Laura Sandt*

At the same time, separate from the national rulemakings but consistent with the national attention on performance metrics, some agencies are reevaluating how they use the longest-standing performance metric in transportation, automobile Level of Service (LOS). LOS metrics can provide a useful framework for understanding the operation of the system and its impacts on users. Many jurisdictions have imbedded LOS in their transportation decision-making at the planning, design and operations phases of roadway systems. However, the extensive use of a metric that produces a single letter grade to indicate congested or free-flowing conditions provides only a narrow view of transportation system performance and no longer serves the needs of many communities moving toward a broader set of performance measures that can provide a more comprehensive assessment of transportation system performance.

These case studies show how some state and local agencies are taking advantage of existing federal flexibility in reconsidering their use of LOS as they attempt to resolve broader transportation-related challenges. They are intended to serve as resources for other states and local entities seeking to better understand what flexibility is available to them surrounding the use of LOS in conjunction with other performance measures for design, safety, operations, and planning. While there are newer methodologies for calculating LOS for pedestrian, bicycle and transit modes,[1] they are not yet widely used or evaluated and may have similar limitations as those associated with automobile LOS. For the purposes of this document, unless otherwise noted, LOS refers to automobile LOS.

[1] Multimodal Level of Service (MMLOS) was incorporated into the 2010 edition of the Highway Capacity Manual

# Background

## Level of Service in Transportation Decisionmaking

Level of service (LOS) is the term used to refer to a collection of measures of automobile congestion and travel time delay, and it is among the longest-standing and most widely adopted metrics for reporting transportation system performance in the country. LOS is intended to represent a traveler's perception of the quality of service provided by an individual intersection or roadway segment, as measured by the standard of free-flowing automobile traffic. LOS is also intended to easily communicate the results of detailed technical analyses to non-technical audiences. Traditionally, transportation engineers and planners use LOS in planning, design, and land use applications, as well as operational and environmental analyses.

LOS was first introduced in the Highway Capacity Manual (HCM) in 1965 and is a result of a series of calculations that take into account a roadway's size and context (e.g., urban vs. rural), and current or future conditions related to travel time, speed, delay, maneuverability, and user comfort.[2] Though not recommended by the HCM in most situations, LOS is sometimes calculated and used in more of a shorthand fashion, as a simple ratio between volume (or user demand) and roadway capacity.

AASHTO's A Policy on Geometric Design of Highways and Streets (commonly known as the "Green Book") provides industry guidance to transportation engineers and planners on highway and street geometric design. FHWA has adopted the Green Book as the standard for the NHS, and some states adopt it as standard for state managed roads. The Green Book uses the HCM-defined LOS measure to characterize transportation system performance.

> *The 2010 HCM defines LOS as: "A quantitative stratification of a performance measure or performance measures that represent quality of service measured on an A-F scale with LOS A representing the best operating conditions from the traveler's perspective and LOS F the worst."*

At a local level, LOS can be evaluated for a particular roadway segment or intersection. On the system level, state DOTs, MPOs, and local governments may set a target LOS level and then use LOS scores on intersections and roadway segments throughout the system to communicate the adequacy of transportation infrastructure and to prioritize improvements.

| Level of Service | General Operating Conditions |
|---|---|
| A | Free flow, with low volumes and high speeds. |
| B | Reasonably free flow, but speeds beginning to be restricted by traffic conditions. |
| C | Stable flow, but most drivers are restricted in the freedom to select their own speeds. |
| D | Approaching unstable flow; drivers have little freedom to select their own speeds. |
| E | Unstable flow; may be short stoppages. |
| F | Forced or breakdown flow; unacceptable congestion; stop-and-go. |

*Table 1: Level of Service General Definitions*
*Source: Adapted from the AASHTO Green Book and Flexibility in Highway Design*

[2] See also HCM Volume 4: Applications Guide

As the transportation industry broadens its goals beyond congestion reduction and associated capacity expansion, there has been increasing discussion of the role of LOS as a performance metric. Communities that have adopted goals such as improving safety for other roadway users (e.g., pedestrians, bicyclists, and transit users), or encouraging infill development, find that the way LOS standards are traditionally used is not helpful in reaching those goals.[3][4] This report is motivated by the need to incorporate additional measures in the planning process beyond mobility. Comprehensive performance management requires the ability to consider all factors in the transportation system, moving away from the idea that there is only one target and threshold, and addressing the need of transportation agencies to evaluate tradeoffs among multiple priorities (e.g., travel speed, reliability, safety, asset preservation, quality of life, etc.) when making investment decisions. Balancing these many issues is not easily summarized in a single letter grade. This effort focuses on LOS precisely because the assumptions that go into its calculation and the ways in which its results are used have the ability to impact so many components of the transportation system, and it only describes one aspect of transportation system performance.

## Federal Flexibility

No federal highway design regulations require the use of LOS targets explicitly, though regulations indirectly include LOS by pointing agencies to design guidelines in the Green Book, which include recommended LOS targets for various facility types.[5] Developed independently from, but with some coordination with, USDOT, the HCM and Green Book do not set legal standards for how LOS targets should be used by state or local transportation officials; instead, the two documents provide industry guidance for how to compute LOS and use it to rate highway performance. However, this guidance may be misinterpreted by state and local transportation experts and decisionmakers who mistakenly point to perceived federal requirements as the reason for employing LOS in the ways that they do.

Federal laws and regulations mention LOS directly only in relation to the National Environmental Policy Act (NEPA)[6] and project selection with federal funds.[7] Various federal guides and technical documents point to LOS as one of various potential measures, and many also note the limitations of LOS, especially as a system-wide performance measure.

As the USDOT continues the process of transitioning to a broader base of performance measures with the MAP-21 and FAST performance management requirements, the Department has clarified the role of LOS while also providing greater flexibility in how states and localities can meet targets through design, operations, and process. Responding to the mistaken perception held by some state and local planners and engineers that the USDOT requires not only the use of LOS in roadway design but also the attainment of a certain LOS score, FHWA published a memo in May 2016 to clarify that "FHWA does not have regulations or policies that require specific minimum LOS values for projects on the NHS."[8]

[3] Decisions, Values, and Data: Understanding Bias in Transportation Performance Measures (Dumbaugh, Tumlin, and Marshall, 2014)
[4] Livability, Level of Service, and Design Choices (FHWA, 2014)
[5] 23 CFR 625
[6] 40 CFR 93.123
[7] 23 U.S. Code 133
[8] FHWA Level of Service on the National Highway System (May 6, 2016)

In recent years, FHWA has continued to promote design flexibility to allow for roadway designs that better meet the objectives set through the state and local planning processes. FHWA has provided longstanding support for Context Sensitive Solutions (CSS), a collaborative and holistic approach that addresses community needs and considers goals beyond an identified transportation challenge.[9] FHWA also recommends that agencies evolve toward a Performance-Based Practical Design (PBPD) approach to make more informed decisions when scoping projects.[10] In May 2016, FHWA made changes to the 13 design controlling criteria, to allow more flexibility for state, city, and county engineers in the design of highway projects, and "encourage the design of lower-speed roads to be more in line with community and environmental needs."[11] As a result of the update to the controlling criteria, only two of the remaining 10 criteria now apply to non-freeways with design speeds less than 50 miles per hour.[12] As agencies begin and continue to incorporate a broader array of transportation performance measures required under MAP-21, they will need to assess tradeoffs among performance measures relating to safety, asset preservation, system performance, and other factors. States and MPOS and local governments may also be taking a second look due to local planning processes that have indicated the need for a broader set of performance metrics. In order to do so, it may be appropriate for these agencies to reevaluate their use of LOS.

## Case Studies: Adjusting Use of LOS to Meet Agency Goals and Comply with Legislative Directives

Even as performance metrics evolve, automobile LOS remains widely used in the industry, and in many jurisdictions, it is integrated into the project review and development process. A number of states, MPOs, and industry groups are working to develop and implement either expanded Multimodal LOS or new performance metrics distinct from the LOS model. The following cases present the experiences of agencies working to achieve specific goals—related to financial constraints, safety, and the environment—and finding that in order to do so, they must update their use of LOS. The cases are based on discussions with staff members of these agencies, as well as review of their published documents.

- The Metropolitan Council (Met Council), the Minneapolis-St. Paul area MPO, lacked the funding to continue using roadway expansion to address congestion, so it reconsidered its use of LOS as a primary performance metric. The Met Council introduced measures aimed at system efficiency, including people-moving capacity and person throughput.
- The Florida Department of Transportation (FDOT), motivated by its challenges with pedestrian and bicycle safety even after a long history of using MMLOS, launched an extensive initiative that focused on systematically revising policies and standards, including those related to LOS.
- In 2013, California enacted legislation that changes how public agencies evaluate transportation impacts of projects under the California Environmental Quality Acts (CEQA). This is part of the state's ambitious goals related to reducing greenhouse gas emissions, improving safety, increasing active transportation and transit mode shares to benefit health, increasing infill development, and facilitating development of vibrant communities. The state is in the process of shifting from using LOS to instead using vehicle miles traveled (VMT) to measure the environmental impact of land use and transportation projects.

[9] What is CSS?
[10] Performance-Based Practical Design
[11] FHWA Move to Encourage Highway Design Flexibilities Kicks Off with Changes for Lower Speed Roads
[12] Revisions to the Controlling Criteria for Design and Documentation for Design Exceptions

These case studies share a number of lessons learned, most notably that none began from an explicit effort to supplement or replace LOS. Rather, in pursuit of agency goals or compliance with external directives, these agencies concluded that their use of LOS needed adjustment. Because there is no federal requirement associated with LOS or standard for its use, there is flexibility to change its role as needed when balancing many goals and objectives. Agencies may not recognize the extent to which such flexibility is available, and one of the purposes of this study is to highlight examples of how some agencies have revisited their use of LOS in the context of transitioning to a broader base of performance measures. Each of these examples are works in progress but may provide useful insight for other agencies that are exploring moving toward adopting a broader set of performance measures that provide a more comprehensive assessment of transportation system performance.