# Public Transportation Level of Service

*Final White Paper - August 2020*

Oregon Public Transportation Plan

# Introduction

The Oregon Public Transportation Plan (OPTP) establishes statewide policies and strategies to guide transportation investments and deliver useful, efficient, and accessible public transportation options for communities throughout the state. The OPTP provides a foundation for supporting and influencing the work of public transportation providers in addition to the work of the Oregon Department of Transportation (ODOT) and other state, regional, and local agencies.

### OPTP VISION

"In 2045, public transportation is an integral, interconnected component of Oregon's transportation system that makes Oregon's diverse cities, towns, and communities work. Because public transportation is convenient, affordable, and efficient, it helps further the state's quality of life and economic vitality and contributes to the health and safety of all residents, while reducing greenhouse gas emissions."

A part of the OPTP's key initiative, "public transportation plan integration," is to further explore the concept of public transportation "level of service" (LOS). ODOT received mixed responses on this subject during plan development. Some stakeholders thought state guidance regarding service availability under different conditions might help provide a foundation for public transportation plans and advance local conversations about public transportation. Other stakeholders wanted to make sure any statewide expectations did not limit the ability of service providers to adapt and innovate to meet local needs. ODOT and its stakeholders recognized that exploring this concept further could help advance progress toward the OPTP vision and goals.

Transportation engineers have applied LOS in the context of motor vehicle operating conditions for decades, and the concept has been more recently adapted and applied to other transportation modes including public transportation. LOS in the context of public transportation is different from commonly used performance measures that capture a snapshot of a provider's operational efficiency (e.g., operational expenses per passenger mile, etc.) and also different from how it relates to motor vehicle operations. Public transportation LOS (PTLOS) generally considers the quality and availability of public transportation services. There is no industry or academic consensus on the definition and application of public transportation LOS that is broadly applicable to communities of various sizes and characteristics. To the limited extent that local or state governments have used PTLOS, it has primarily been within urban environments. This white paper discusses various approaches to PTLOS, considers applications in both urban and rural settings, and evaluates the feasibility of implementing a statewide LOS program for public transportation in Oregon.

## Purpose

The purpose of this paper is:

- To introduce LOS as an evaluation tool for public transportation service
- To understand the purpose, strengths, and limitations of LOS concepts
- To explore how cities and states have defined and implemented PTLOS
- To examine potential scenarios for using PTLOS in the State of Oregon

## Methods

The following sources were used to inform this paper:

- A review of city, regional, and statewide transportation plans to identify examples of applied LOS models for public transportation,
- A desktop review of past and current research on the relationship of various public transportation characteristics to travel behavior, ridership, and overall customer satisfaction,
- An evaluation of the *Transit Capacity and Quality of Service Manual* 3rd edition (TCQSM), which describes practical methods for defining and applying quality of service for public transportation, and
- An understanding of Oregon's Transit Network Exploration Tool (TNExT).

# Level of Service Concepts

First introduced by the Highway Capacity Manual (HCM) in 1965, LOS was originally designed to evaluate roadway performance with respect to motor vehicle traffic. Its scoring system, based on auto capacity, delay, and prevailing speeds, is commonly used in communities across North America. As public goals have evolved, practitioners and researchers have developed comparable methods to evaluate system performance for non-automobile modes of transportation. However, conventional LOS concepts that scored facilities on efficiency were inadequate for public transportation, bicycling, and walking. The performance of these other modal systems related far more closely to variables like frequency and service (public transportation), comfort and safety (bicycling), and connectivity and proximity to destinations (walking).

A 2010 update to the HCM sought to address this gap in adequate measures by proposing a unified multimodal level of service model (MMLOS).[1] This approach uses 37 variables to predict overall satisfaction by a traveler of any mode on any given roadway. For public transportation, these variables include headways, bus speed, and reliability, among others. More recently, bicycle and pedestrian planning has branched out from MMLOS to develop a more tailored level of traffic stress (LTS)

methodology, an LOS concept that assigns scores to every street based upon perceived comfort and willingness to ride or walk. In 2013, Oregon updated its Analysis Procedures Manual (APM) to include MMLOS and LTS methodologies.[2] The current version of the APM recommends using LTS for regional and transportation system plans, and suggests MMLOS for facility plans, project development, and development reviews.

The common denominator among these LOS concepts is a street-level unit of analysis. Despite their different priorities, these concepts all evaluate modal performance on individual roadways. However, such an analysis fails to capture many elements that make public transportation useful and desirable. An effective PTLOS framework must therefore account for its complex modal characteristics, described in greater detail below:

- **System design**: Public transportation is best understood as a connected network of travel options. PTLOS should, to a large degree, look beyond individual public transportation services and routes and consider the system as a whole.
- **Multiple, conflicting goals**: Public transportation systems are designed with specific goals, which often seek to reconcile conflicting principles of efficiency (ridership) and coverage, in mind. A PTLOS framework must reflect a community's chosen target along this continuum, and apply measures that are compatible with a community's adopted goals.
- **Accessibility**: Public transportation options do not exist on every street in every community. Convenient access to public transportation is therefore a key element of a system's overall quality. Moreover, the nature and quality of this access will vary by community type (urban, suburban, or rural).
- **Scale**: Community characteristics determine the viability of specific public transportation types and services. Density, geography, job and activity centers, land use patterns, and proximity to central cities are key variables that influence public transportation system design and service. PTLOS thresholds must change and scale according to these community characteristics.
- **Equitable service**: In many parts of Oregon, people of color and lower-income residents comprise a disproportionately high share of overall public transportation ridership. However, many such communities have lower levels of access and service than white and more affluent areas. Equitable access to public transportation is a major issue, while public transportation is a tool for helping reducing access and mobility inequities. The equity dynamics of public transportation are an important overarching consideration for any PTLOS concept.

## Designing LOS for Public Transportation

In a public transportation context, LOS is best understood as a framework with three interrelated parts: **concepts, indicators,** and **targets**. These important distinctions help frame what LOS means and how it might 'explain' public transportation in different locations. LOS *concepts* are higher-order categories that connect LOS with a specific and measurable goal. For example, motor vehicle LOS uses

the concept of efficient traffic flow to evaluate roadway performance like vehicle speed, density, delay, and congestion. For bicyclists and pedestrians, LTS draws upon the concept of comfort to help local officials understand an individual's willingness to ride or walk any given route. Likewise, any LOS program for public transportation must first identify one or more relevant concepts that can help relate the public transportation system to a relevant goal.

Once identified, these LOS concepts can be disaggregated into *indicators* that have a reasonably strong explanatory relationship. Indicators should be specific and measurable. However, on their own, indicators cannot draw conclusions about LOS. For those final assessments, the third element of an LOS framework is used: *targets*. Creating a set of targets or standards contextualizes LOS indicators and gives them value, allowing a local community, region, or state to evaluate public transportation service relative to goals.

The TCQSM, released in 2013, illustrates this approach.[3] The TCQSM asserts that transit quality of service (interchangeable with LOS in this context) should evaluate whether the system meets the needs of local residents – in other words, is the system useful and usable for people who could choose to drive instead ***and*** those who rely on public transportation? Its version of PTLOS therefore uses the concept of passenger perceptions and experiences to understand public transportation utility. The TCQSM draws from research into travel behavior and consumer preferences to distill this concept of passenger experience into two categories: **1) public transportation availability,** and **2) public transportation comfort and convenience**. Tables 1 and 2 define these concepts more precisely and provide an illustrative set of associated LOS indicators.

*Table 1. TCQSM on Public Transportation Availability, and Additional Indicator Options*

| **Public Transportation LOS Concept 1: Availability** | |
|---|---|
| ***Definition:*** Availability determines whether public transportation is an **option** for any given trip. It has four components: (1) spatial availability (origin and destination), (2) temporal availability, (3) information availability, and (4) capacity availability. These are largely yes/no characteristics; however, the specific threshold for each (the point at which someone may answer yes or no) may vary by individual. For example, while some people may be willing to wait 30 minutes for a bus, others may only tolerate 15 minutes. | |
| ***TCQSM Illustrative Indicators for Availability:***<br>***Fixed-Route Service:***<br>**Access**<br>• What percent of residents are within ¼ and ½ mile of public transportation stops?<br>• What is the residential and/or job density within a one-quarter and one-half mile catchment area around public transportation stops?<br>• What is the average route spacing (route density) for public transportation lines? | ***Additional Indicator Options for Availability:***<br>***Fixed-Route Service:***<br>**Access**<br>• What percent of residents are within one-quarter and one-half mile of public transportation stops?<br>• What percent of residents are within one-quarter and one-halfmile of public transportation stops with x or more scheduled transit visits per defined-time-period?<br>• What percent of jobs are within one-quarter and one-half mile of public transportation stops with x |

- What % of public transportation-supportive areas have access to public transportation lines (within one-half mile)?

**Service**

- What are the hours of operation for the system as a whole?
- What percent of residents have access to late-night service?
- What percent of revenue miles run frequent service?
- What percent of routes run frequent service all day?

**Information**

- Do passengers have access to real-time information about service and schedules?
- What percent of public transportation stops provide service, scheduling, and wayfinding information?

**Capacity**

- How often are customers denied service due to lack of on-board capacity?

### *Demand-Responsive Transportation (DRT)*

- Does a public transportation system offer standing-order or subscription services?
- What is the average response time for a spontaneous trip request?
- What is the DRT service span (days per week, hours per day)?
- What percent of residents in a community live within the DRT coverage area?

or more scheduled transit visits per defined-time-period?

- What percent of residents are within one-quarter- and one-half- mile of high-frequency routes?
- What is the residential and/or job density within a one-quarter and one-half mile catchment area around public transportation stops?
- What percent of public transportation-supportive areas have access to public transportation routes (within one-halfmile)?
- How often are customers denied service due to lack of on-board capacity?

**Service**

- What percent of routes run frequent service?
- What percent of revenue miles run frequent service?

### *Demand-Responsive Transportation (DRT):*

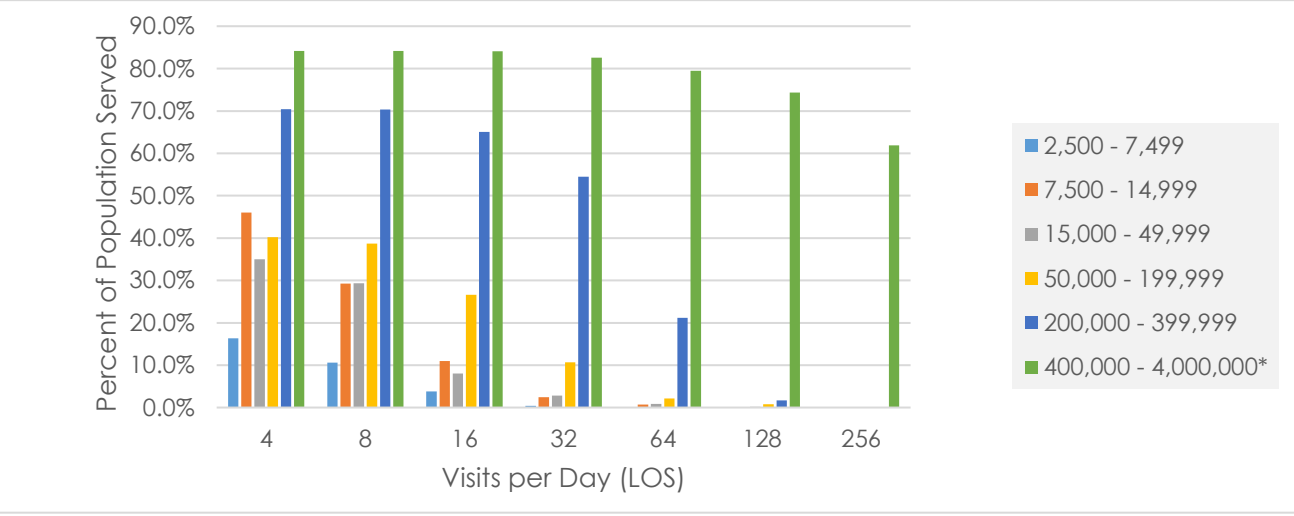
**Response Time / Service Options**

- What is the maximum period of time for a subscription service?
- What is the average response time for a spontaneous trip request (if allowed)?
- What is the required minimum notice (in minutes/hours) for a trip request before the desired pick-up time?

**Service Coverage**

- Is DRT service offered for specific locations outside of the core jurisdiction (town, city, or county)?
- Do all communities within the core jurisdiction have equal access to DRT service (e.g. service span, response time, etc.)?

Figure 1. Weekday Oregon population served at level of service size categories of urbanized areas/urban clusters, based on one-half mile radius.




*Source: 2019 Oregon Transit Network Report, including TNExT data.*

Table 2. TCQSM on Public Transportation Comfort and Convenience, and Additional Indicator Options

| **Public Transportation LOS Concept 2: Comfort and Convenience** | |
|---|---|
| ***Definition:*** Comfort and convenience refers to a range of characteristics that influence whether an available public transportation option is **desirable**. Examples include reliability, security, station amenities, physical comfort, financial cost, and overall trip duration. Although preferences, norms, and biases may affect how individuals perceive these characteristics, this concept attempts to identify the elements that *on average* shape rider experiences and affect an individual's willingness to use public transportation on a consistent basis. | |
| ***TCQSM Considerations for Comfort and Convenience: Fixed-Route Service***<br><br>**Safety and Security**<br>• What is the accident rate (number of vehicle accidents per specified distance or time)?<br>• What is the passenger accident rate (number of passenger injuries/fatalities per specific number of boardings or time period)?<br>• What is the percent of buses that exceed the speed limit?<br>• What is the crime rate (can be expressed and categorized in several ways)?<br>• What percent of vehicles have specified safety devices (e.g. cameras, alarms, etc.)? | ***Additional Indicator Options for Comfort and Convenience: Fixed-Route Service***<br><br>**Safety and Security**<br>• What percent of public transportation stops have adjacent, pedestrian-oriented lighting?<br>• What percent of public transportation stops have limited or obstructed visibility to adjacent buildings?<br><br>**Customer Service**<br>• What is the average customer service response time?<br>• What is the level of convenience and access to submit complaints/compliments? |

| | |
|---|---|
| **Reliability**<br>• What is the on-time performance of fixed-route service?<br>• What is the headway adherence (consistency of the interval between vehicles)?<br>• What is the excess wait time (average departure time after the scheduled time)?<br>• What is the average number of missed trips (scheduled trips not made)?<br>• What is the average distance traveled between mechanical breakdowns?<br>**Quality of the Passenger Environment**<br>• Passenger surveys can establish satisfaction with a variety of factors (e.g. vehicle and station cleanliness, quality of customer information and wayfinding, professionalism of operators, condition of equipment, etc.)<br>**Passenger Load**<br>• What is the average load factor (ratio of on-board passengers to seats)?<br>• What is the average number of passengers that stand for more than X minutes?<br>• What is the average standing passenger space (square feet per standing passenger)?<br>**Travel Time**<br>• What is the transit-auto travel time ratio for fixed-route service (the in-vehicle transit travel time divided by the in-vehicle private auto travel time for a given trip)?<br>**Customer Service**<br>• What is the average customer service response time?<br>• What is the level of convenience and access to submit complaints/compliments? | **Reliability**<br>• What is the on-time performance during peak and non-peak periods?<br>• What is the average difference in time between scheduled arrivals and actual arrivals?<br>**Quality of the Passenger Environment**<br>• What percent of public transportation stops have benches, shelters, and/or other amenities for physical support and comfort?<br>• What percent of public transportation stops provide service, scheduling, and wayfinding information?<br>*Oregon's Key Transit Hubs Report contains many of these metrics for the ~40 Oregon key transit hubs.* |
| ***Demand-Responsive Transportation (DRT)***<br>**Reliability**<br>• What is the on-time performance of DRT pick-ups and drop-offs? | ***Demand-Responsive Transportation (DRT)***<br>**Physical Comfort**<br>• What percent of DRT trips provide point-to-point service (customer-requested |

| | |
|---|---|
| • What percent of DRT trip requests are denied by the service provider?<br>**Travel Time**<br>• What is the DRT-auto travel time ratio for DRT service (the in-vehicle DRT travel time divided by the in-vehicle private auto travel time for a given trip)?<br>**No Shows**<br>• What percent of DRT passengers fail to show up for a scheduled trip? | locations, instead of pre-designated pick-up and drop-off points)? |

Using these concepts and indicators, the TCQSM describes several approaches for calculating PTLOS, placing a total score on a scale of A through F. However – and perhaps more importantly – it discusses several applications for PTLOS at a local and statewide level. Depending upon the specific application, a subset of PTLOS indicators and calculation techniques may be more or less appropriate.

## Applications for Public Transportation LOS

The TCQSM describes how PTLOS can support a diverse range of planning exercises, from a street-level analysis at one end of the spectrum, to a comprehensive plan or public transportation development plan at the other.

### Long-Range Planning

- Communities can use PTLOS to inform discussions about the appropriate service levels, based on predicted patterns of growth and demographic change.
- Long-range planning can use PTLOS to set standards for an entire community, different neighborhoods, and specific corridors.

### Statewide Planning

- Oregon can use PTLOS to help establish service goals, both across the entire state, for various sizes of community or within certain regions, or for specific areas and corridors (See Figure 1, above, provides population served at level of service across different sizes of community and different minimum levels of service.)
- PTLOS can be a component of statewide funding formulas for specific programs, and it can contribute to evaluation criteria for grants to local governments. Criteria should have parallel but distinct standards for urban and rural areas to support a more geographically equitable environment.
- States can use PTLOS to set standards for intercity services, such as intercity rail and regional buses.

- PTLOS can help set standards for public transportation on state-owned highways, and provide a basis for evaluating impacts from private development or facility improvements.

### Transit Development Plans

- Transit Development Plans can use PTLOS to help establish service goals, both across an entire system and within certain areas and corridors.
- ODOT's Transit Development Plan Guidebook can help local and regional transit providers integrate PTLOS methods into their transit planning exercises.
- PTLOS can inform discussions about investment requirements to reach specific service standards.

### Corridor Analysis

- PTLOS can be used to designate priority corridors or districts for public transportation.
- Communities can use PTLOS to evaluate the potential impact of roadway design changes or new development on public transportation service and passenger experiences.
- Comparing transit frequency to travel demand in more heavily used regional corridors can establish baseline relationships between the two. Oregon is beginning such work.

### Service Coverage Analysis

- PTLOS can help communities understand levels of access, comfort, and convenience in different neighborhoods and corridors.
- Communities can also use PTLOS to understand potential disparities in service for areas with lower-income residents and communities of color. Similarly, it can be used to understand disproportionate benefits or impacts of service changes or investments for those same communities.

# Case Studies and Lessons Learned

The four case studies below present a diverse range of PTLOS models, based largely on the applications listed in the prior section. The following sections analyze what each set of PTLOS standards say about the public transportation environment, and discuss whether they can apply – in part or in whole – to a statewide environment.

## Fort Collins (Colorado)

**PTLOS application:** Long-range planning (local level)

The City of Fort Collins was an early adopter of MMLOS standards. It produced a Multimodal Level of Service Manual in 1997 that connected transportation system performance with adopted City goals in

its Comprehensive Plan.[4] Although the manual predated the TCQSM by more than 15 years, it conceptualized PTLOS in similar terms, focusing on availability and comfort. The City connected its MMLOS standards framework to explain how these measures related to the City's objectives and goals. For PTLOS, this framework included the elements shown in Table 3.

*Table 3. Fort Collins' PTLOS Framework*

| Goal | Objective | LOS Indicators |
|---|---|---|
| • A well-connected intermodal transportation system<br>• Frequent, reliable, and accessible transit service<br>• Transit service oriented around activity centers<br>• Comfortable transit service | • Ensure that 70% of the city has access to transit service (within ¼ mile walk)<br>• Double the size of existing service by 2002<br>• Increase the area served, frequency of service, and hours of operation by 2002<br>• Increase ridership to 2,000,000 annual trips by 2002<br>• Reduce transfer wait times | • Hours of weekday service<br>• Weekday frequency of service<br>• Travel time factor<br>• Peak load factor |

Using this framework, the manual describes a system for assigning LOS scores to different areas of the city. These scores (A through F) are based upon service targets attached to each of the four PTLOS indicators, and areas are rated according to how many service targets they meet. These targets are shown in Table 4.

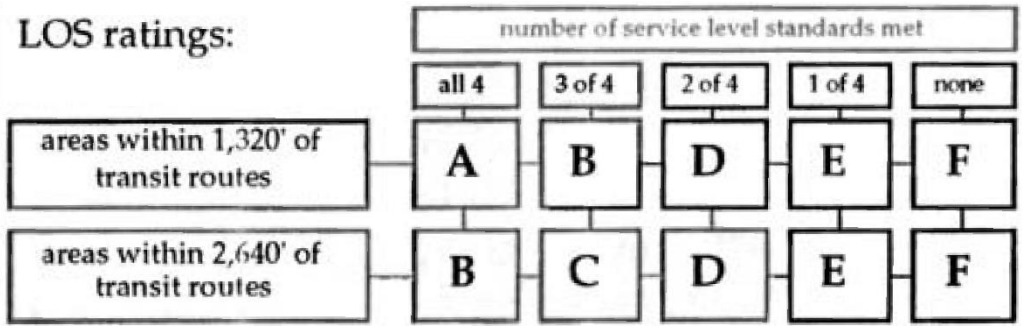
*Table 4. Fort Collins' PTLOS Indicators and Targets*

| LOS Indicator | Mixed-use centers and commercial corridors | Remainder of service area |
|---|---|---|
| **Hours of weekday service** | 18 hours | 16 hours |
| **Weekday frequency of service** | 15 minutes | 20 minutes |
| **Travel time factor (relative to automobile travel time)** | 2.0 x | 2.0 x |
| **Peak load factor** | <= 1.2 | <= 1.2 |

Areas across the city receive a PTLOS score based on how many of the four targets they meet. However, the scoring system only applies to areas within ½ mile (walking distance) of public transportation routes, and these areas are further broken down into two categories: areas within ¼ mile of public transportation routes, and areas between ¼ mile and ½ mile of public transportation

routes. For areas within ¼ mile, meeting all four targets would achieve an "A" PTLOS rating. Meeting three out of four would achieve a "B" rating, and so on. Areas between ¼ and ½ mile of public transportation routes are graded on a similar scoring spectrum, but start with a maximum score of "B" (meeting all four targets) to reflect their lower level of access to public transportation stops.

*Figure 2. Fort Collins' PTLOS Scoring Matrix*




*Source: Fort Collins' Multimodal Level of Service Manual*

Overall, the City uses this scoring system to establish two high-level targets:

- At least 70% of land area outside of mixed-use centers and commercials corridors should have a minimum score of PTLOS D.
- All mixed-use centers and commercial corridors should have a minimum score of PTLOS B.

## What does this model say about public transportation?

Fort Collins designed its PTLOS model to help the City manage growth and pursue goals within its Comprehensive Plan. LOS targets align with different land use intensities, and scores apply to areas of the city rather than specific streets. By including land use categories – mixed-use/commercial and all other areas – this model links PTLOS to density of people, jobs, and desirable destinations.

Like the TCQSM, these LOS standards adopt a passenger-oriented view of public transportation performance. They attempt to characterize whether public transportation services are useful and usable for riders by focusing on availability, comfort, and convenience.

However, these LOS standards only apply to areas within ½ mile of public transportation routes, meaning they are not applicable to areas of the city that do not already have service. Second, the standards are implicitly limited to fixed-route services. On-demand and other public transportation services are not included in the overall evaluation, even though these may have a significant impact on passenger perceptions of the overall system. Third, this LOS model evaluates the system's potential to attract riders, rather than expand coverage to increase overall access.

### Can this LOS model be applied at a statewide level?

The Fort Collins LOS model provides a high level of flexibility that could be useful in the statewide context. Its focus on land use and proximity to public transportation routes can be scaled to communities of different sizes and characteristics. It could be made more broadly applicable by considering demand response and other services that are often the only service available in small cities and rural communities. The targets for each indicator could also be adjusted based on community type. For example, in a densely populated urban area, service frequency thresholds might be lower (such as 10 minutes versus 20 minutes).

## Carlsbad (California)

**PTLOS application:** Corridor analysis

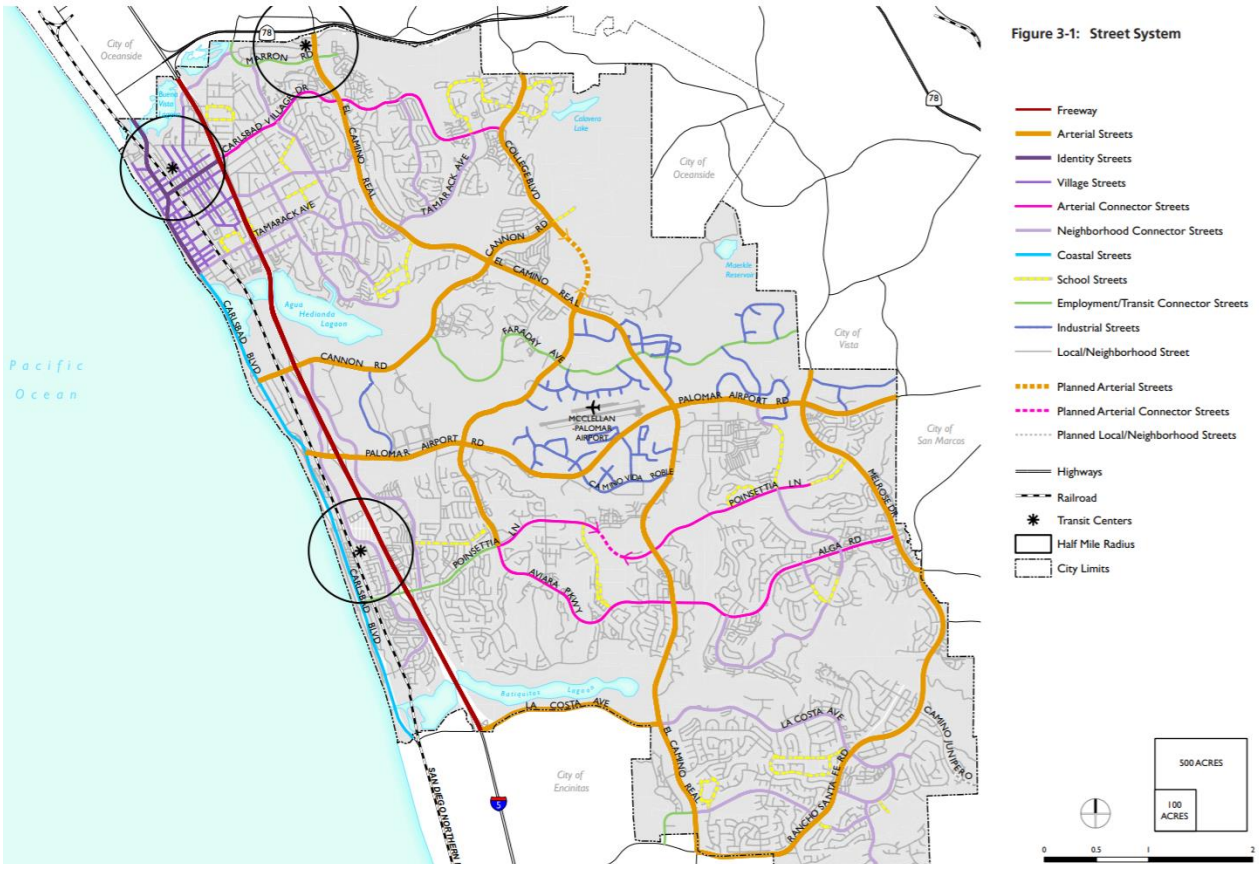
In its 2015 General Plan update, the City of Carlsbad introduced a multimodal LOS program to balance various demands on its transportation system and create a sustainable and livable network of streets.[5] The city's livable streets approach asserts that optimum service levels cannot be provided for all travel modes on all roadways. The MMLOS framework therefore assigns a modal LOS score to all *eligible* streets based on a variety of physical and modal characteristics. Eligibility is determined by a combination of functional class and adjacent land uses, and not all streets are subject to LOS scores for all modes. The MMLOS program therefore includes two steps: (1) Determining which streets throughout the city are eligible to receive an LOS score, and (2) developing modal criteria for eligible streets and assigning points for specific characteristics.

Using its own typology, Carlsbad designated streets as eligible for PTLOS scores if they qualified as: (1) employment/public transportation connectors, (2) streets within one-half mile of public transportation centers, and (3) industrial streets. The City then created the following point system for these areas:

- **Right-of-way**
  - 0.5 point for dedicated right-of-way (public transportation only)
- **Service**
  - 1.5 points for 15-minute headways (or better) during peak hours
  - 1 point for 30-minute headways during peak hours
  - 0.5 point for 60-minute headways during peak hours
  - 1.5 points for good on-time performance
  - 1.5 points if the route provides a single transfer to reach
- **Visual Interest**
  - 0.5 point for covered bus stops
  - 0.5 point for a bench
  - 0.5 point for a well-lit stop that provides a sense of security
- **Other Elements**

- 0.5 point for a corridor that has public transportation preemption to reduce delays
- 0.5 point for routes that have available seats on the bus
- 0.5 point for the availability to directly access multiple routes
- 1 point for bike parking availability at the bus stop
- 1 point for buses that provide on-board bike racks

*Figure 3. The map below shows Carlsbad's full typology of streets.*




*Source: Carlsbad's 2015 General Plan Update*

The total scores for each street relate to a particular LOS grade. LOS A goes to total street scores between 9.0 and 10. LOS B applies to streets between 8.0 and 8.9, and so on.

## What does this LOS model say about public transportation?

Carlsbad chooses to evaluate only specific typologies that it designates as "transit-eligible." However, as Figure 3 shows, this limits the evaluation to narrow pockets of the city. This PTLOS approach – which analyzes specific streets rather than larger areas or the full system – can illustrate the efficiency or appeal of a specific corridor, but it does not necessarily capture overall public transportation access or usefulness for a broad range of trip purposes.

### Can this LOS model be applied at a statewide level?

Many of the specific variables can apply statewide and scale to various communities. The scoring for different criteria can be adjusted (or weighted) based on community preferences, which can yield PTLOS results that reflect individual community desires. Moreover, focusing on "public transportation-eligible" streets or corridors, while limiting from a coverage standpoint, could be a useful way to account for differences in land use patterns, density, and long-range goals.

Although Carlsbad does not include equity measures in its criteria, a statewide application of this approach could certainly add scores that relate to service characteristics (access, comfort, and convenience) in communities of concern. Another approach to understanding disparities could use these PTLOS scores for a community-wide equity analysis, which could include: (1) calculating PTLOS scores for every street with existing transit service, and (2) evaluating potential disparities in PTLOS scores for streets through areas with higher populations of communities of concern.

## State of Florida

**PTLOS application:** Statewide planning

In 2009, Florida released a Quality/Level of Service (Q/LOS) handbook that provided guidance on designing LOS standards for various modes in different environments.[6] This handbook seeks to provide local, regional, and statewide planners a consistent methodology to evaluate PTLOS in different communities across the state, and it recommends using PTLOS for two types of planning:

- **Generalized Planning**: This includes statewide analyses, initial problem identification, and future year analyses.
- **Conceptual Planning**: This refers to analysis that supports decisions related to design concept and scope, including alternatives analyses and assessing development impacts.

Although it draws on the TCQSM and its research on passenger perceptions, the handbook prioritizes what it considers to be the most relevant variable for public transportation users: frequency. Its PTLOS model stratifies quality of service into six letter grades (A through F) that relate to average headways. Each grade includes a generalized description of the passenger experience. Figure 4 shows the complete PTLOS scoring matrix.

However, Florida also recognizes that comfort and convenience influence overall passenger perceptions of public transportation, and it built in adjustment factors for two specific variables: (1) bus stop amenities, and (2) bus load factor. For bus stop amenities, the Q/LOS Handbook uses a qualitative assessment (excellent to poor) to score the overall quality of a bus stop (based on shelter, benches, lighting, etc.). The bus load factor looks at the ratio of passengers to available seats to evaluate the desirability of a route. Both variables produce a numeric adjustment factor for the overall PTLOS score based on their respective level of comfort and convenience. Tables 5 and 6 provide a breakdown of this approach.

*Figure 4. Florida's PTLOS Scoring System*

| 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 |

*Source: Florida's Quality/Level of Service Handbook*

*Table 5. Bus Stop Amenities Adjustment Factor*

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

*Source: Florida's Quality/Level of Service Handbook*

*Table 6. Passenger Load Adjustment Factor*

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

*Source: Florida's Quality/Level of Service Handbook*

### What does this LOS model say about public transportation?

Frequency is an important factor influencing public transportation ridership. It describes one element of the "availability" LOS concept that is used in the TCQSM approach. Florida's model builds in adjustment factors for bus stop amenities and passenger load, which gives the PTLOS scores important elements of comfort and convenience. Florida's model also connects frequency with passenger perceptions.

### Can this LOS model be applied at a statewide level?

A focus on frequency correctly identifies one of the key factors of public transportation attractiveness. Frequency is a variable that is easy to measure, broadly applicable in areas with fixed-route service, and a strong predictor of ridership. Florida's approach demonstrates that a frequency PTLOS standard can also be supplemented with other variables to produce an adjusted score. Like frequency, bus stops amenities and bus load factor – the two supplemental variables in Florida's model – are applicable statewide and easy to measure. They can also be replaced with other measures of comfort and convenience, depending upon the state's priorities.

## State of Virginia

**PTLOS category:** Long-range planning (state level)

The State of Virginia presents a fundamentally different approach through its 2014 Statewide Public Transportation Plan.[7] Rather than evaluate elements of a system's performance (its various outputs), the state presents a high-level approach for thinking about the public transportation inputs for any given community. Virginia creates a typology of 10 locations – from urban core to rural, based on population density – and suggests the type of public transportation options that are (or may be) appropriate for respective areas. These public transportation options extend far beyond fixed-route bus public transportation to include regional bus, rail, and demand-driven services – each of which is disaggregated further into sub-categories. Table 7, which is similar to the continuum of transit services in the OPTP, presents the full array of potentially appropriate public transportation options for every type of community.

Virginia uses this matrix as part of a gap analysis to help communities plan for long-term growth (in Virginia's case, growth and investment patterns are being modeled over a 25-year time horizon). It looks at areas that may shift to a higher (or lower) category along the continuum, compares existing services to potential needs based on projected growth, and calculates estimated investments (statewide and local) to accommodate service changes and meet long-term needs.

*Table 7. Virginia Transit Service Categories by Area Type*

| Service Category | Area Type | Urban Core | | | | Urban / Suburban | | | Small Urban | Non-Urban | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Service Type | Urban Core | Large Urban | Medium Urban | Urban County | Urbanizing | Suburban | Emerging | Small Urban | Rural Village | Rural |
| Demand | Urban | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | |
| | Response | | | | | | | ✔ | ✔ | ✔ | ✔ |
| Local Route Services | Fixed Route | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | | |
| | Deviated Fixed Route | | | | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | |
| | Circulators | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | | ✔ | | |
| | Urban BRT | ✔ | ✔ | ✔ | ✔ | | | | | | |
| Regional Bus | Commuter/Express Bus | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | |
| | Rural Regional | | | | | | | | ✔ | ✔ | |
| | Regional BRT | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | | | |
| Rail Services | Streetcar | ✔ | ✔ | | | | | | | | |
| | Light Rail | ✔ | ✔ | | ✔ | | | | | | |
| | Heavy Rail | ✔ | ✔ | | ✔ | | | | | | |
| | Commuter Rail | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | | | |
| | Intercity Pass. Rail | ✔ | ✔ | | ✔ | | | | | | |

*Source: Virginia's Statewide Public Transportation and Transportation Demand Management Plan, 2014*

## What does this LOS model say about public transportation?

Virginia's approach generates a statewide typology of communities and matches them with public transportation options that *could* fit needs. This is a dynamic model that anticipates how communities might change and grow over time. As these changes occur, it helps communities consider how their public transportation needs or opportunities might change as well. Second, it looks at the entire collection or public transportation options rather than a single element (e.g., fixed-route bus public transportation). By including regional services, rail, and even demand-response, this framework could provide the foundation for a measurable set of public transportation LOS standards in various locations. Finally, by using a gap analysis approach, Virginia's model can inform a discussion about statewide, regional, and local financial investments.

## Can this LOS model be applied at a statewide level?

Virginia's approach considers how public transportation options might change by community over time. Its focus on overall service options (and potential gaps based on projected growth) provides a useful and straightforward way to evaluate communities of all types and sizes across a state. Because it focuses on general system characteristics (whether a community might need fixed-route, demand-response, rail, and so on), it is not a full and complete conceptualization of PTLOS because it doesn't look at specific elements of service availability or comfort and convenience. But it might be possible to blend this approach with other service-oriented standards for a statewide LOS program.

## Summary of Case Studies

The following table provides a summary of the main elements for each case study.

*Table 8. Descriptions, Measures, and Applications for the Four Case Studies*

| Case Study | Description | PTLOS Measure | Application |
|---|---|---|---|
| **Fort Collins** | Part of the city's broader MMLOS approach. Its PTLOS methodology looks at service for different land uses (commercial/ mixed-use, and everything else) across the city. | Evaluates areas within ½ mile of transit routes. Letter grades (A-F) assigned based on four indicators: (1) hours of service, (2) frequency, (3) travel time, and (4) peak load factor. | The city uses LOS to evaluate progress toward city objectives and goals for its transportation system. |
| **Carlsbad** | The city assigns a PTLOS score to all transit-eligible streets, which include (1) employment/public transportation connectors, (2) streets within ½ mile of public transportation centers, and (3) industrial streets. | Letter grades (A-F) assigned based on a street's score (1-10). Points are given for multiple variables within four categories: (1) right-of-way, (2) service, (3) visual interest, and (4) other elements. | The city uses MMLOS to implement its livable streets program, which assigns modal priorities for specific streets and corridors. PTLOS is used to understand service levels on transit-priority streets. |
| **Florida** | Frequency is the primary component of PTLOS, supplemented with bus stop amenities and bus load factor. | Letter grades (A-F) assigned based on average headways, and the final score is adjusted for bus stop amenities and bus load factor. | Florida uses PTLOS for generalized planning and conceptual planning on a local and statewide level. |
| **Virginia** | Areas within the state are categorized along an urban-rural continuum to help identify potential service options. | Service categories include demand, local route services, regional bus, and rail. Each is disaggregated into more precise service options, and community types are assigned suggested service options. | Virginia uses this matrix as part of a gap analysis to help communities plan for long-term growth and identify areas for investment and added service options. |

# Applying LOS to Oregon Public Transportation

Despite a diversity of ideas for public transportation LOS – both in research and practice – there is no consensus on how to apply it at a local or statewide level. However, the methods and examples reviewed in previous sections provide a starting point for considering LOS implementation in Oregon.

## How Can ODOT use PTLOS at the Statewide Level?

### Identifying Underserved Areas

As the case studies demonstrate, PTLOS is a flexible concept that can be used to understand service at the street, neighborhood, and community level. It can therefore be used to identify underserved areas and disparities within and between communities. Moreover, using PTLOS measures that are broadly applicable across the state – such as frequency, service span, and travel time multiples (relative to comparable auto trips) – can assist with cross-community comparisons. Other measures such as passenger load, may become available across the state in the future when/if GTFS-ride data is generally available.

### Funding Decisions

PTLOS could support funding priorities at the state level. PTLOS could be a factor considered by grant programs in understanding relative needs among communities. Applicants could demonstrate how planning, projects, or investments would improve PTLOS (for the area under consideration) relative to statewide targets, and evaluate the extent to which an applicant's concept influences the variables that contribute to PTLOS scores.

### Development Review and Facility Planning

Similar to the use of motor vehicle LOS for evaluating the impact of development on motor vehicle delay, PTLOS can be used to understand how private development and roadway design impacts public transportation service. PTLOS is a potential mechanism to further integrate public transportation into the project development and review process, and this could apply to infrastructure improvements and treatments on state-owned roads. For example, PTLOS could inform ODOT design guidelines and project development for public transportation stop locations and amenities, such as connected and marked crosswalks, ADA accessibility, and bus pullouts where appropriate. Design guidelines could be informed by existing information like the location of key transit hubs and stop level visit frequency. However, broader policy changes may be needed to implement this approach.

### Planning for Future Growth

The State of Virginia provides a framework to connect community size with a general package of public transportation options. Oregon could draw from this model to (1) create a continuum of community types and public transportation services, based on the OPTP typology; (2) help local communities match service options with existing demographic profiles; and (3) provide clear pathways with measurable "sign posts" to help communities know when it may be appropriate to consider new

services. This model could be a useful tool for regional and transportation system plans as well, providing communities with a framework to identify potential gaps and plan for investments commensurate with projected growth.

# Challenges and Opportunities

## Identifying a Goal for Statewide PTLOS

The four case studies demonstrate a wide variety of PTLOS applications and the section above detail some of the limitations and challenges of a statewide program. To design a useful PTLOS model, it is important to establish clear goals from the outset. For example, PTLOS could inform state funding formulas and grant evaluations, employing a PTLOS framework that includes communitywide measures for access, comfort, and convenience that are broadly applicable across the state. PTLOS could be used as an information tool for communities as they develop their own goals for the system by matching communities with a suggested package of service options and identifying gaps in service or disparities for communities. A related goal could be defining minimum service levels at a community, neighborhood, or corridor level. PTLOS could incorporate additional variables associated with demand and equity, such as land use, density, coverage, and areas with higher populations of low-income residents and people of color.

Defining the goals for statewide PTLOS is key to understanding how implementation would affect local providers and communities who plan, operate, provide, and use the majority of service in the state. PTLOS could be deployed in a range of ways, from an "information only" tool to influencing funding and provision of services in communities statewide.

## Data Availability

The State of Oregon has access to a significant amount of data from local and regional transit providers. This includes measures for public transportation (collected by transit providers and reported to the National Transit Database), along with GTFS data through the Transit Network Explorer Tool (TNExT), a web-based platform to analyze and visualize transit data across the state. TNExT measures include population served by public transportation, population served by public transportation at level of service, frequency of rural public transportation, service miles per capita, public transportation access to employment and employees, agency connectivity, and the location of transit hubs.

However, some of these potential PTLOS indicators are not collected by all communities – and if they are, the data may not be compatible with PTLOS models. This reflects different levels of local capacity for data collection and management, community-defined objectives and goals for public transportation, and a lack of standardized and structured formats for data inputs. Complex PTLOS models could, therefore, create substantial challenges for statewide management and local compliance. The result may be gaps in data reporting and an incomplete picture of public transportation across the state.

Simplifying PTLOS models to focus on broadly applicable variables – such as frequency and measures of comfort and convenience – may streamline collection and reporting on a local level and ease the management burden for ODOT.

## Accounting for Community Differences

Oregon has a broad spectrum of communities, from large cities to unincorporated rural areas. These communities have a similarly wide spectrum of public transportation service designs, responsive to geography, rurality, and local needs. Each transit provider establishes their own goals for public transportation, which can fall at different points along the continuum of coverage-ridership and relate to different packages of service options. Land uses – particularly the intensity of uses – vary widely from community to community. This can influence whether specific areas possess public transportation-supportive densities of people and jobs, and also determines the types of options that are viable. These local characteristics create significant challenges for a statewide LOS program to effectively evaluate public transportation across all contexts.

However, drawing from the case studies and TCQSM's approach, it may be possible to design a dynamic and flexible PTLOS program that accounts for community differences while addressing common needs and goals. This could include scaling PTLOS targets by community size (perhaps using OPTP's continuum of communities) and creating different weighting standards based upon a community's characteristics or goals. A point system similar to the Carlsbad case study, for example, could be one way to account for these community differences by scaling targets and weighting criteria for each community category.

Recognizing that rural areas have different service needs and priorities than urban areas, a PTLOS program could also provide a separate rural track that prioritizes a variety of appropriate demand-responsive measures.

## Communicating PTLOS Scores and Standards

Motor vehicle LOS – through its focus on efficiency, roadway segments, and a letter grade scoring system – established a precedent for thinking about LOS in other contexts. This paper has already discussed why efficiency and street-level analysis are not always applicable to public transportation. However, the state should also consider whether the letter grade scale (A through F) is a useful rubric for communicating PTLOS. Three of the four case studies adopted letter grades; however, it's important to note that not all of them applied a normative definition of "A = good" and "F = bad," and some of them explicitly suggested "lower" grade levels for certain environments. Florida, for example, asserts that LOS A is not always a desirable goal, and also recognizes that the meaning of A through F is not consistent across modes. Fort Collins uses letter grades to establish minimum service levels, rather than applying giving the grades a normative value.

Given the diversity of public transportation options, needs, and goals, a letter grade scoring system may contribute to public misperceptions and confusion. It may be helpful to consider alternative options to communicate PTLOS scores.

## Integrating PTLOS with Other LOS Models

Establishing modal service standards can help the state and local communities develop a more complete picture of the transportation system, particularly as it relates to users with different preferences, options, and demographic profiles. However, multiple standards can lead to some confusion when plans or improvements for one mode negatively impact another. Some jurisdictions address this conflict by creating a typology of streets with associated modal priorities (like the Carlsbad case study). Another option is evaluating the viability of a unified LOS model that combines all modes into a single score.

This latter approach may be problematic for a few reasons. First, as Florida's Q/LOS Handbook notes, it's very difficult to blend various modes into a single LOS score. Second, modal patterns are distinct and often serve different purposes, which can reduce the meaning of a combined LOS score. Third, and perhaps most importantly, LOS concepts and meaning vary by mode. Motor vehicle LOS evaluates delay, bike and pedestrian LTS measures willingness to ride or walk, and PTLOS – as understood through TCQSM and each of the case studies – looks at elements of access, comfort, and convenience. It is difficult to aggregate conceptually distinct models.

However, these distinct concepts for each mode can help state and local planners design a more efficient and useful transportation system for everyone. They can facilitate the development of modal hierarchies in different areas or along different corridors, as many communities are starting to do. Having a collection of modal LOS frameworks that measure different elements of transportation service – and are prioritized in some meaningful way – can lead to better outcomes across a community.

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[1] Highway Capacity Manual. Transportation Research Board of the National Academies, 2010.
[2] Analysis Procedures Manual. Oregon Department of Transportation, 2014.
[3] Transit Capacity and Quality of Service Manual. Transit Cooperative Research Program Report 165, Transportation Research Board of the National Academies, 2013.
[4] Multimodal Transportation Level of Service Manual. City of Fort Collins, 1997.
[5] General Plan Mobility Element. City of Carlsbad, 2015.
[6] 2013 Quality/Level of Service Handbook. Department of Transportation, State of Florida, 2013.
[7] Statewide Public Transportation and Transportation Demand Management Plan. Department of Rail and Public Transportation, Commonwealth of Virginia, 2014.