An Alternative to Auto LOS for Transportation Impact Analysis

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ABSTRACT

Automobile Level of Service (LOS) standards are the measure of the adequacy of roadways to serve vehicle demand. Increasingly, research is published on alternatives to conventional automobile LOS. Practicing transportation planners have also shown increasing interest in applying these alternative tools, particularly in urban locations encouraging multimodal transportation systems or infill development. Much of the research and activity on alternatives to auto LOS has focused on two approaches: 1) creating transportation performance measures to complement auto LOS, such as "user based" LOS measures for transit, bicycling, and walking; and 2) applying conventional auto LOS standards more flexibly. Neither approach is likely to effectively address the shortcomings of auto LOS as the measure of transportation impact in urban, multimodal contexts. The approaches are particularly unlikely to be effective where state law requires formal standards for transportation facilities and significant public and private sector resources have been dedicated to achieving auto LOS conformity. This paper presents an alternative to auto LOS for environmental impact analysis purposes under investigation by the San Francisco County Transportation Authority, developed to support the transportation system development objectives of an urban, multimodal context, and to respond specifically to the legal requirements and constraints of California's environmental impact analysis requirements. Local jurisdictions with similar situations, such as urban areas with growth management, concurrency management, or public facilities requirements, may find these alternatives more effective than the user-based measures and flexible auto LOS applications most frequently discussed in the literature.

BACKGROUND

What is Level of Service?

Automobile Level-of-Service (LOS) is a conventional traffic engineering tool that quantifies the ability of roads and freeways to serve traffic demand. LOS, most recently set forth in the 2000 Highway Capacity Manual (HCM) (1), is the most widely used measure of transportation facility performance (2).

The first HCM introduced LOS measures during the development of the Interstate Highway System in the 1950s (3). The current (2000) approach to LOS is based on the 1985 HCM or the Transportation Research Circular 212, "Interim Materials on Highway Capacity." (4). These methodologies estimate LOS for intersections or roadway segments based on the ratio of vehicle demand to capacity of the roadway (V/C ratio), or on the average seconds of delay to vehicles at intersections (5).

LOS is popular because it is widely professionally accepted, the data required to calculate it are easily available, and the concept offers discrete standards (letters A – F) for "grading" the performance of a transportation facility.

The Statutory Review Context

LOS is applied to describe and evaluate the actual performance of freeways, roadway links, or intersections, and when travel forecasts are available, to predict the future performance of those transportation facilities given changes in development patterns, traffic capacity, or other factors which affect travel demand. LOS is used to comply with state and local laws requiring local governments to evaluate the expected traffic impacts of proposed developments projects on the transportation system and inform development project approvals. These laws include environmental impact assessment; concurrency and growth management; and adequate public facilities management (3). In many cases, local governments set legally binding standards for transportation performance in terms of LOS. This paper addresses statutory contexts where LOS has been required by state law or has a long, legally established statewide precedent, because these are the situations where adopting an alternative standard to LOS is more difficult.

Environmental Impact Assessment

The California Environmental Quality Act (CEQA) requires that local jurisdictions disclose any negative impacts that proposed projects may have on the environment, including the transportation environment. To comply with CEQA local governments must identify how impacts to transportation are measured, and define a threshold at which impacts to transportation are considered significant environmental impacts. Projects with potential impacts on the environment cannot be approved unless the project sponsor undertakes a variety of actions depending on the nature of the impact, such as preparing an Environmental Impact Reports and implementing measures to mitigate the negative impacts (6).

Concurrency management, growth management, and adequate public facilities ordinances.

These laws limit the development that a local jurisdiction may approve, based on the availability of public infrastructure and services (including transportation infrastructure) to serve that development. The availability of transportation infrastructure is typically assessed using LOS.

For instance, growth management acts in Florida (1985) (7) and Washington state (1990) (8) require local jurisdictions to set service level standards for transportation facilities, and also mandate that they deny development permits that would results in conditions exceeding these

adopted standards. Local governments adopt these LOS standards as part of their local comprehensive plans, and incorporate them in local capital improvements plans. Local jurisdictions must deny development proposals that are expected to cause declines in LOS on below the adopted standards, unless transportation improvements or strategies to accommodate the impacts of development are made concurrent with the development (9).

The State of Maryland has enabled cities and counties to adopt Adequate Public Facilities Ordinances (APFOs), in order to prevent new development projects until adequate transportation infrastructure capacity is available to accommodate the added trips (10). LOS standards are established for determining the adequacy of transportation infrastructure to accommodate development. No development project can be approved by the city if LOS on the transportation infrastructure will drop below this LOS (11).

The state of California also requires, through the 1990 Congestion Management statutes, urbanized counties to set and monitor service level standards for major highways and arterials. When LOS on any congestion management roadway falls below the adopted standard, a countywide Congestion Management Agency is responsible for developing a deficiency plan to return the roadway to the adopted LOS (12). However, congestion Management in California has no direct link to the development approvals process, however, and thus does not have as far reaching implications for the allocation and expenditure of public and private resources.

Level of Service Standards for Environmental Review in San Francisco

Pursuant to CEQA, San Francisco uses auto LOS to estimate the environmental significance of impacts from proposed projects on the transportation system (13).

The expected impacts of proposed projects on transit, bicycling, and walking are also evaluated to varying extents. San Francisco currently defines transportation impact with distinct measures for each mode, some more clearly defined than others. The city's measure of transit LOS compares the capacity of one or more transit lines in the vicinity of a proposed project with the projected transit demand for that direction of travel. Called the "load factor," this is an aggregate measure of crowding on transit vehicles at a point of the network.

Pedestrian LOS is evaluated using a similar "crowding" measure that estimates he amount of usable sidewalk space per pedestrian, and is supplemented by a qualitative evaluation of safety impacts measured according to unpublished criteria. Bicycle LOS is assessed either qualitatively or with a "crowding" measure (amount of dedicated bicycle space per bicyclist).

SHORTCOMINGS OF AUTO LOS AS STANDARD FOR TRANSPORTATION IMPACT IN THE URBAN, MULTIMODAL CONTEXT

Increasingly, local jurisdictions seek alternatives to auto LOS as the adequacy standard for transportation. Auto LOS standards are particularly shortsighted for cities with multimodal transportation systems. Using auto LOS as the legal standard for transportation system adequacy to support new development has three general consequences that may be inconsistent with urban infill development and multimodal transportation system development. An LOS standard is likely to:

1) Reinforce the use of public right-of-way for moving cars, and discourage the development of transit, bicycle, and pedestrian improvement projects where they will increase delay for cars;

2) Increase the costs in time and money for implementing transit, bicycle, and pedestrian projects; and

3) Hinder a city's ability to advance other local policies such as promoting infill development and mode shift to transit, bicycling, and walking.

Though auto LOS provides valuable information for planning purposes, it does not meet the needs of urban multimodal areas when used as a legal *standard* to define the adequacy of transportation facilities.

Reinforcing the Incumbent Mode

Strict standards for auto LOS can make infill development and improvements to modes other than the auto difficult, particularly on mature street networks where roadway space is constrained. San Francisco's next generation of transportation improvements to transit, pedestrian, and bicycle facilities will require reallocating roadway space from mixed traffic uses to pedestrian, bicycle, or transit use, sometimes worsening auto LOS (14). Consequently, using auto LOS as the standard for roadway adequacy ostensibly favors preserving auto LOS at the expense of improvements to transit, bicycle, and pedestrian conditions.

Discouraging Multimodal Improvements

In San Francisco, a proposed project with impacts forecast to worsen LOS to grade "E" or "F" must typically either: 1) mitigate the impact by reducing auto delay; 2) modify the project to reduce auto delay; or 3) the project is denied approval. Although projects with unmitigatible significant negative impacts may nevertheless be approved by elected officials through a declaration of overriding considerations, the project sponsor must complete the costly and unpredictable impact assessment process. Project sponsors may therefore be reluctant to propose projects that potentially impact auto LOS.

Avoiding "Difficult" Multimodal Projects

In practice, proposed bicycle or transit lanes that would remove a lane of auto traffic are considered to have significant negative environmental effects since removing a lane of auto traffic often worsens auto LOS. Moreover, it is often difficult to identify mitigations that restore auto LOS while preserving the spirit of the project to improve conditions for transit, bicycling, or walking.

The City of San Francisco has attempted to minimize the burden of environmental review process within the constraints of current LOS standards. These strategies include implementing bicycle projects as "trials" before undertaking the environmental process and earning final project approval. This is only feasible when the project in question is "reversible" in the event that auto LOS impacts are unacceptable (e.g., projects which involve primarily re-striping).

Because San Francisco has a mature road network and finite public rights-of-way, it is easy to assume a priori that many bicycle, pedestrian, and transit improvements cannot be implemented without significantly impacting auto LOS. But, an increasing body of research shows that when vehicle capacity is reduced, trip patterns have adjust in terms of absolute vehicle trips or the time and route of trips. This is especially so when alternative modes and routes are available. However, it is easy to suspect that projects don't move beyond the conceptual phase because from the project sponsor perspective, lane removal functions as a "de facto" rejection criterion because removal of a traffic lane usually decreases auto LOS.

Auto-Oriented Mitigation Measures

Maintaining LOS affects local transportation investments. CEQA and other growth management rules allow for project sponsors to make project changes that "mitigate" the impacts of the project on LOS. The proposed project may then be approved if it is timed to occur with mitigations that would preserve LOS at adopted standards (8).

Typically, the developer may also pay impact fees to allow the local government to make road improvements that will retain the required LOS, that is, to increase roadway capacity by some means in order to accommodate the projected new trips.

Because auto LOS is based on roadway capacity, increases in roadway capacity to reduce auto delays are the easiest, if not the only, way to mitigate auto LOS impacts, given a set volume of auto trips. If auto LOS is the basis for concurrency, then investment priorities will de facto prioritize auto LOS (15). However, in San Francisco as in other urban places with multimodal transportation systems, adding auto capacity to meet LOS standards is not only undesirable, but often not feasible. With auto LOS as the transportation standard in an urban, multimodal area, infill development projects and projects that reallocate ROW from mixed traffic to transit, bicycle, or pedestrian use thus face barriers to implementation not faced by development in suburban areas where excess roadway capacity is more abundant and mitigations to increase roadway capacity are more readily implemented (16).

Inconsistency with Transit First Policies

As an urban area with a multimodal transportation system and a finite capacity for moving and storing cars, San Francisco recognizes the importance of attractive alternatives to auto transportation. San Francisco's City Charter formalizes the city's policy approach to transportation system development in the Transit First Policy (17).

FIGURE 1 San Francisco's Transit First Policy

TRANSIT-FIRST POLICY, San Francisco City Charter

1. To ensure quality of life and economic health in San Francisco, the primary objective of the transportation system must be the safe and efficient movement of people and goods.

2. Public transit, including taxis and vanpools, is an economically and environmentally sound alternative to transportation by individual automobiles. Within San Francisco, travel by public transit, by bicycle, and on foot must be an attractive alternative to travel by private automobile.

3. Decisions regarding the use of limited public street and sidewalk space shall encourage the use of public rights of way by pedestrians, bicyclists, and public transit, and shall strive to reduce traffic and improve public health and safety.

4. Transit priority improvements, such as designated transit lanes and streets and improved signalization, shall be made to expedite the movement of public transit vehicles (including taxis and vanpools) and to improve pedestrian safety.

5. Pedestrian areas shall be enhanced wherever possible to improve the safety and comfort of pedestrians and encourage travel by foot.

6. Bicycling shall be promoted by encouraging safe streets for riding, convenient access to transit, bicycle lanes, and secure bicycle parking.

7. Parking policies for areas well served by public transit shall be designed to encourage travel by public transit and alternative transportation.

8. New transportation investment should be allocated to meet the demand for public transit generated by new public and private commercial and residential developments.

9. The ability of the City and County to reduce traffic congestion depends on the adequacy of regional public transportation. The City and County shall promote the use of regional mass transit and continued development of an integrated, reliable regional public transportation system.

Short term auto delays (that is, auto LOS impacts) are a predictable and at times unavoidable consequence of implementing Transit First policy. The assumption behind the transit first policy is that mode shift will occur gradually as transit, bicycle, and pedestrian networks are improved.

Transportation impact standards should reflect local transportation and environmental priorities in order to support decision making about what projects advance city policy. The state CEQA statute and its Guidelines not only give local jurisdictions responsibility for defining significant impact and establishing methodologies for measuring impacts, but also grant local jurisdictions the ability to set their own measures and standards for significant impact on the

environment based on local context and policy (18). The auto LOS standard is not the right tool for determining which projects advance the San Francisco's Transit First transportation system development objectives with minimal environmental impact. San Francisco – like other urban, multimodal places – is considering an alternative to auto LOS that reflects already existing policies.

Beginning in spring 2004, the San Francisco County Transportation Authority convened a technical working group to develop revisions to the way the City measures impacts to transportation under CEQA. This working group was convened by Staff per the request of the Authority Board to study alternatives to auto LOS. The Authority Board requested this work in response to a sense of community frustration over the unpredictability and costs in time and money to implement bicycle projects. The more general concern was that San Francisco's transportation impact analysis under CEQA should support projects that will lead to increased use of modes of transportation other than the automobile, and that the current impact analysis process inadvertently works at cross purposes with the City's Transit First vision and policy. The working group includes representation from the San Francisco Planning Department's Office of Major Environmental Assessment (in charge of CEQA compliance), the Metropolitan Transportation Agency, which includes the transit operator, MUNI, and the City's Department of Parking and Traffic; user advocacy group representatives, and industry practitioners. The participation of working group members experienced in CEQA law was particularly essential, as was reviewing the working group's progress with the City's Attorney and other legal counsel. At the time of writing the working group had met 5 times since spring 2004.

SHORTCOMINGS OF USER-BASED LOS AND FLEXIBLE LOS FOR URBAN ENVIRONMENTAL ANALYSIS

An increasing number of transportation researchers and professionals, as well as pioneer states and local jurisdictions, have sought to identify alternatives to auto LOS to address these issues. Two primary approaches have emerged:

1) Establishing standards to complement auto LOS, such as "user-based" LOS measures for transit, bicycling, and walking;

2) Applying conventional auto LOS standards more flexibly.

Based on San Francisco's working group deliberations on the issue, the legal constraints and requirements of CEQA suggest that these two primary approaches are unlikely to be responsive to the problems posed by auto LOS standards in urban, multimodal places such as San Francisco. These barriers cannot be reduced by complementing this standard with more rigorous LOS standards for other modes. Additionally, San Francisco, perhaps like other major urban areas with multimodal transportation systems, has also already "squeezed" flexibility from the auto LOS tool. Neither of these approaches, which are now becoming discussed more widely, are likely to be responsive to the challenges of urban, multimodal areas seeking transportation impact or concurrency standards more supportive of local policies for infill and multimodal transportation system development.

User-based LOS methodologies for all modes

One of the most well developed areas for LOS alternatives is in "user-based" LOS measures for all modes. "User based" methodologies contrast in some important ways from the more common "crowding" LOS methodologies for evaluating transit, bicycle, and pedestrian LOS.

The 2000 HCM, for instance, includes chapters for estimating pedestrian and bicycle LOS (1). Pedestrian LOS is measured by the ratio of sidewalk area to volume of pedestrians. HCM LOS for bicyclists is also based on the "crowding" of bike lanes. Crowding

methodologies define pedestrian LOS as the ratio of sidewalk area to volume of pedestrians. By this measure, a near-empty sidewalk provides a high level of service. Transit LOS is defined by "load factor," a ratio of transit passengers to number of seats on the transit vehicle, which implies that a vehicle is not crowded, transit provides a high LOS.

Although crowding is one measure of the attractiveness of a mode, other aspects of transit, bicycle, and pedestrian travel are more important to the quality of the service as perceived by the user. For transit, these factors include travel time reliability, wait time reliability, and frequency of service. For bicyclists and pedestrians, they include safety from vehicular conflicts, especially at intersections, and other aspects of comfort and safety. Travel time and network connectivity are important for these nodes. "Crowding" based methodologies do not reflect these aspects of modal LOS.

A number of user-based transit, bicycle, and pedestrian methodologies have been developed, perhaps beginning with Epperson's 1994 bicycle LOS measure (19) or Sorton's bicycle stress measure (20). Table 1 summarizes some features of LOS methodologies for all modes. Widely known LOS methodologies, e.g., HCM methods, are included along with user-based modal LOS methodologies.

The Florida DOT has commissioned extensive research and development efforts on user-based multimodal LOS methodologies. In 1998, the Florida legislature created the Transportation and Land Use Study Committee. As a response to the Committee's recommendations, The 1999 Florida Legislature passed the Urban Infill and Redevelopment Act, which allows local governments to establish multimodal transportation districts. In these, the local comprehensive plan assigns secondary priority to auto mobility and primary priority to ensuring a pedestrian and transit mobility. The Act allowed local governments to establish multimodal level of service standards that rely primarily on non-vehicular modes of transportation within the districts. The Act also allows exemptions to public transit facilities from compliance with roadway concurrency (15). The FDOT's 2002 Quality/Level of Service Handbook of user-based multimodal LOS methodologies is used to support concurrency management (21).

TABLE 1 Multimodal and User-Based LOS Methodologies

LOS Methodologies				
	Location	**Mode(s)**	**Facility type**	**Definition of service**
HCM 2000 Urban Streets (17)		Auto	Link w/ high signal density	Travel speed for thru-vehicle
HCM 2000 signalized intersections (17)	San Francisco	Auto	Intersection	Control delay
HCM 2000 transit (17)		Transit	Stops, route segment	Multi variable
HCM 2000 bicycles (17)		Bicycle	On and off street	Speed, control delay

HCM 2000 pedestrian (17)		Ped	Sidewalks, crossings, more	Space per ped (crowding), pedestrian delay
SF Planning (9)	San Francisco	Transit	Screenline	Load factor (crowding)
CMP method (8)	San Francisco	Transit	System or route	Coverage, frequency, Inter-operator coordination
2002 Quality/Level of Service Handbook (18)	Florida DOT	Transit	Stop or route	Availability (frequency), comfort, convenience
2002 Quality/Level of Service Handbook (18)	Florida DOT	Peds	Roadway	Sidewalk; lateral separation from of pedestrians from vehicles; motor vehicle volumes, speeds
2002 Quality/Level of Service Handbook (18)	Florida DOT	Bicycle	Roadway	Bicycle lane width; motor vehicle volumes, speeds, weight; pavement condition.
HCM Transit Capacity and Quality of Service Manual (19)	US Transit Cooperative Research Program	Transit	Stops, route segments, systems	Availability (frequency, accessibility, pax loads); quality (reliability)
Multimodal Point Level of Service (20)	Florida DOT	Transit	Stop	Availability (frequency, accessibility); comfort/ convenience (pax loads, amenities, reliability)
Multimodal Point Level of Service (20)	Florida DOT	Ped	Points: transit access, crossings	Thru-movement conflict, exposure, delay
Multimodal Point Level of Service (20)	Florida DOT	Bicycle	Intersection, site	Thru-movement conflicts, exposure, delay. Parking.
IBF multimodal LOS calculator (21)		Transit	Route	Delay, reliability, capacity utilization

IBF multimodal LOS calculator (21)		Bicycle	Street segments	Lane width; motor vehicle volume, speed, weight; crowding; turning movements; on street parking
IBF multimodal LOS calculator (21)		Peds	Street segments	Walkarea width to volume; buffers; motor vehicle volume, speed; turning movements; intersection delay
Urban Space for Pedestrians (22)	San Francisco	Peds	Sidewalk, intersection	Space per ped (crowding)
Bicycle Level of Service Model (BLOS) (23)	SCI Consulting	Bicycle	On street links	Level of comfort, threat of hazard (motor vehicle volume, speed, weight; cross traffic; pavement condition; lane width
Bicycle Compatibility Index (24)	FHWA	Bicycle	On street	Intersection conflicts, exposure, delay
SCI roadside conditions LOS model (25)	Florida MPOs	Peds	Roadway	Sidewalk; Separation of peds from vehicles; motor vehicle volume, speed, weight.
Multimodal LOS Analysis at Planning Level (26)	Florida DOT	Transit	Point, segment, facility, corridor, areawide	Frequency, ped LOS, span of service, ped crossing difficulty, sidewalk connections to stops
Multimodal LOS Analysis at Planning Level (26)	Florida DOT	Bicycles	Point, segment	Bike lane; proximity to motor vehicles; motor vehicle speed, volume, weight; pavement conditions; on street auto parking
Multimodal LOS Analysis at Planning Level (26)	Florida DOT	Peds	Point, segment	Sidewalk; lateral separation from autos; buffers; motor vehicle volume, speed

San Francisco's working group concluded that the city's environmental impact process would benefit from more explicitly drawn checklist of factors which do impact LOS for other modes, and could be used to identify more concrete impact standards for these modes in CEQA analysis. However, the working group concluded the problems caused by legal standards for auto LOS would not be alleviated by adopting user-based multimodal LOS measures to *complement* auto LOS. The working group recommended using multimodal LOS measures in other applications, such as network performance measurement, facility evaluation, or to identify network gaps.

Complements to Auto LOS

As described above, the working group considered complementing auto LOS standards with user based measures for all modes, or other complementary measures. For instance, the Florida model for performance measures recognizes that delays to autos are alone inadequate to address transportation impacts (31). The FDOT's 1998 Mobility Performance Measures Handbook outlines four dimensions of transportation performance: quantity, quality, accessibility, and utilization. The Handbook indicates that for transportation impact analysis, all four dimensions of mobility should be addressed, not just one. Thus, one approach to LOS reform is to add additional, complementary standards beyond LOS to address the other three dimensions of mobility and access.

However, the working group concluded that San Francisco's transportation objectives canno be advanced while retaining auto LOS as an environmental impact standard – even if complemented by other measures. The main reason for this is that CEQA does not allow environmental impact standards to be prioritized. A project which improves conditions for transit or pedestrians relative to adopted impact standards, but worsens auto LOS relative to adopted impacts standards, remains subject to reporting and mitigation requirements (30). For instance, travel time reliability is one potential complementary, user-based measure of transportation performance and adequacy. Conversion of a lane of mixed traffic to dedicated transit lane may improve travel time reliability for transit, but may also worsen travel time reliability and delays for autos – thus triggering a significant impact.

For this reason, the working group concluded that complementing auto LOS with additional standards would be ineffective. Rather, a more effective approach would be to discontinue the use of auto LOS as a legal impact standard; use it for planning purposes only; and replace auto LOS with a new measures.

The working group concluded that as a matter of policy, the various dimensions of mobility and access should be prioritized by local decision makers, and reflected in CEQA standards and measures. San Francisco's Transit First Policy recognizes that delay to autos is an unavoidable short term consequence of implementing the policy to achieve mode shift. Therefore, the working group concludes that auto delay should not be included among the array of local measures and standards for transportation impact.

Approaches to increase flexibility of an LOS standard

The other approach that has been discussed increasingly widely in professional practice is to increase the flexibility of LOS standards. Approaches to increase the flexibility of auto LOS standards include setting area-wide or corridor-wide, rather than intersection-based, LOS standards, setting LOS standards below the traditional "F" grade, or setting LOS standards based on the functional classification of a roadway.

Area-Wide LOS Standards

A number of different methodologies, all variations on basic HCM concepts of average delay or volume/capacity ratio, have been applied. These more flexible areawide approaches include:

- Summing volumes and capacities across several intersections or roadway segments to determine surplus capacity within an area.
- Averaging levels of service on a main arterial and its parallel collectors or within an area.
- Specifying the percentage of roads that must be at or above a particular level of service standard, rather than LOS for each intersection.

All three allow individual roadways to operate below adopted LOS as long as others are improved and operate above.

The Florida legislature revised the transportation concurrency requirements in 1993 (7), stating that it found that concurrency LOS practices discourage urban infill development and redevelopment (32). A key amendment allowed for creation of multimodal districts, called Transportation Concurrency Management Areas (TCMAs), where LOS standards are averaged across all intersections in the district. Development permits may be issued within a TCMA as long as the overall LOS adopted for the area is maintained (33).

Area-wide methodologies are no different in principle than conventional LOS methods – they sum or average conventional LOS for a larger area or set of transportation facilities. Calculating LOS in this way provides cities more flexibility to approve development and make transportation system improvements (roadway improvements can be made on any road in the network to "mitigate" new development) (2).

A corridor-based definition of LOS standards is similar. Standard HCM intersection LOS focuses attention on relatively isolated intersections and roadway segments, rather than the functioning of the system along corridors and between destinations. Maintaining an auto LOS standard encourages a piecemeal approach to system improvements, with the goal of improvements to preserve LOS rather than access over an area or along corridors (2). Perhaps in response to the increasing popularity of applying LOS to sets of transportation facilities or intersections, HCM now provides area-wide and corridor wide methods for LOS (1).

San Francisco's working group did not support this approach because it retains the premise that auto delay is a key measure of transportation performance – a premise that conflicts with the city's Transit First Policy. Rather than explicitly recognizing that short term delays to autos are accepted as improvements are made to transit, bicycle, and pedestrian networks, the area-wide or corridor-wide approach could be interpreted as "masking" congestion at individual intersections.

LOS Grades Beyond F

The 1985 Highway Capacity Manual originally established the ranges for LOS grades A to F (34). An LOS grade is intended to be a description of driver experience, and does change from one edition to the next of the HCM (5). If current and future traffic volumes and movements, and current and future facility capacity, can be estimated properly, then any categories may be assigned to describe the levels of delay that may result (35).

A few agencies have attempted to define additional LOS grades beyond F in order to capture local driving conditions.

Extended LOS ranges in California are based on a *speed* definition of LOS, commonly used for freeways and arterials but not for signalized intersections. The California Department of Transportation (DOT) uses a range of LOS F (F1, F2, F3 and F4) to indicate the number of hours per day a facility is projected to operate at LOS F. The Alameda County Congestion Management Agency developed an LOS F range based on speed and which applies only to freeways, where LOS F30 indicates an average speed < 30 mph, LOS F20 an average speed < 20

mph, and LOS F10 an average speed < 10 mph (36). The Virginia DOT uses LOS G to indicate "worse than" LOS F (37). The City of Tukwila, Washington, defines additional LOS grades for durations of delay beyond 60 seconds. This extension of the HCM scale defines LOS G – I to cover seconds of delay at signalized intersections ranging from 120 to over 300 seconds per vehicle (38).

However, setting LOS grades beyond F would have unintended consequences. Under CEQA, standards of environmental impact apply to all proposed projects alike. Although different areas of a city may have different LOS impact thresholds based on land use and multimodal context, the LOS standard in one area is not permitted to vary from project to project. Were a city to adopt an LOS threshold lower than F, both development projects and transportation projects such as a bicycle or transit lane would be subject to the same standard. Development projects that add significant traffic to San Francisco's streets would have no requirement to address those impacts or pay any development fees to support the new demand. LOS standards beyond F would reduce the possibility for significant negative impacts from infill and transit-supportive projects, but also reduce the possibility that auto-generating project would be responsible for impacts to the transportation system.

Variation in LOS standards across the transportation network

San Francisco's working group considered replacing the city's single, uniform LOS standard with a tiered set of LOS standards based on a street's functional role in the transportation network. This approach is based on the premise that more congestion is tolerated in some areas of San Francisco than others. For instance, streets designated as part of the city's Transit Priority Network could be designated with low auto LOS standards (i.e., more auto congestion is tolerated) and high transit LOS standards (i.e., superior transit performance is expected). Streets that comprise the city's bicycle network should likewise be designated with low auto LOS standards and high bicycle LOS standards. The working group rejected this approach due to concerns about the potential complexity for project sponsors, and because LOS F is considered too strict a standard for many areas of San Francisco where auto congestion is expected.

In general, the working group concluded that auto LOS standards do not support growth and development in urban, multimodal contexts. Neither varying the existing menu of LOS grades, nor applying auto LOS more flexibly, offer a solution for an urban area like San Francisco. Urban, multimodal areas may be best served by discontinuing the use of auto LOS as a legally binding standard for transportation system performance, and replace it with a measure that supports more efficient implementation of the city's Transit First Policy through improvements to alternative modes.

PROPOSED ALTERNATIVE TO AUTO LOS IN THE URBAN ENVIRONMENTAL ANALYSIS CONTEXT

The main conclusion of the working group is that: 1) complementing auto LOS with additional measures in tended to capture other dimensions of transportation performance, such as user-based LOS measures for all modes, is not an effective solution to the drawbacks of LOS for urban areas; and 2) applying LOS standards more flexibly, though it has been successfully used in other places most notably Florida, does not itself provide the right development incentives for San Francisco. Based on the deliberations of the San Francisco working group, two recommendations are identified that can replace auto LOS as the legal standard for assessing the impacts of projects on the transportation environment. First, the City of San Francisco can replace auto LOS with a measure of auto trips generated as the impact measure and standard. Concurrently, the City can establish a transportation impact mitigation fee (TIMF) program to

mitigate transportation impacts at the system level. The working group felt that the TIMF program would be a necessary element of the package of LOS reform to ensure political acceptability.

Automobile Trip Generation Measure

As described above, CEQA grants local jurisdictions the authority to define impact measures and standards consistent with local policy. Replacing auto LOS altogether as the impact standards for purposes similar to these has been attempted in some other places performance by creating "exemptions" from a LOS standard under certain circumstances. The States of Florida and California have both amended their state legislation relating to LOS to allow exemptions from the standards under certain circumstances.

The State of Florida's 1993 revisions to the GMA, among the amendments described previously, enabled exceptions to LOS requirements for infill and redevelopment areas. Transportation Concurrency Exception Areas (TCEAs) were permitted by the state's 1993 revisions explicitly to address concerns that concurrency rules pushed development farther out from the urban fringe (39). Cities in Florida may designate TCEAs for urban infill, downtown, or redevelopment areas – or simply areas where development projects will promote public transportation - in their comprehensive plans. Development projects proposed within a TCEA are exempt from complying with concurrency standards.

In California, the California state legislature amended its Congestion Management Program (CMP) legislation to exempt designated areas exempt from CMP LOS requirements (40). Prior law required urbanized counties to maintain and measure auto LOS on major roads in a countywide congestion management plan. New law allows cities or counties to designate "infill opportunity zones" in which streets and highways are exempt from LOS standards set forth in the congestion management plans. Within "infill opportunity zones," local governments are required to either: 1) apply an alternative, infill-friendly LOS measure in lieu of conventional methodologies, or 2) adopt flexible, infill-friendly mitigation measures. However, as mentioned earlier, CMP LOS standards are unrelated to environmental review and the LOS standards enforced under CEQA. Nevertheless, the legislation describes an example for how auto LOS could be replaced in urban, multimodal areas by an alternative measure of transportation system impact.

Theoretically, California cities including SF already enjoy authority under CEQA to set standards for transportation impact according to any measure they choose. Based on the working group deliberations, San Francisco is considering replacing auto LOS standards with a by a measure and standard based on the number of automobile trips generated by a project.

The Transit First policy of the City Charter recognizes that some short-term auto congestion is a predictable and unavoidable consequence of implementing Transit First policies, since mode shift will occur gradually as the transit, bicycle and pedestrian networks are improved. A measure of auto delay – auto LOS – is inconsistent with the Transit First policy for this reason. A measure of auto trips generated, in contrast, recognizes that adding additional automobile trips to San Francisco streets is environmentally undesirable, while allowing for automobile congestion impacts that may result from improving the city's networks for transit, walking, and cycling.

Transit-first transportation projects by definition do not generate new automobile trips. Though they may increase delays for cars by decreasing mixed flow capacity, a bicycle or transit lane does not generate new auto trips. A measure of automobile trip generation does capture the factor most important to the public and to decision-makers – adding new car trips or traffic.

However, the measure also recognizes that the transit first policy allows for short term congestion to achieve improved networks for other, non-incumbent modes.

Before an auto trip generation measure can be adopted to replace auto LOS as the CEQA standards in San Francisco, the trip generation methodology must be carefully considered. Auto trip generation methodologies are well developed and would not require extensive further development, although more work is needed to establish a clear and transparent methodology for this particular application. For example, the LOS TWG may define the significance threshold on an absolute (specific number of trips) or relative (% increase in trips) basis, taking a street's current level of vehicle demand and capacity into account. Ideally the trip generation rates, would vary by land use typology and parking supply, and reflect expected mode shifts associated with projects such as bicycle or transit lanes. An appropriate threshold to define a significant increase in automobile trips would need to be defined, not a trivial matter.

The working group agreed that supplemental impact methodologies, such as a measure of transit crowding, may be important to retain in transportation impact analysis alongside the auto trip generation measure.

Once a specific methodology has been defined, the auto trips generated would replace auto LOS as the CEQA transportation impact measure. Auto LOS could be used by the City's planners and engineers for planning purposes, but would not need to be enforced as a legally binding standard for significant transportation impacts.

For cities in CA under environmental review, not unlike any development review process in other states, past practice and past legal decisions are a hurdle to overcome when changing standards. States with concurrency, adequate public facilities, etc., laws will have similar barriers to change posed by past legal practice.

Because auto LOS has been used as a legal standard for many years in California, replacing LOS must be supported by evidence in the legal record - technical reports and analyses that explain the reasons for the new measure. The City must undertake a technical analysis to support the change, which includes a description of how the new measure will be calculated and applied and any changes recommended over the way the city currently estimates auto trip generation for CEQA purposes.

Transportation Impact Mitigation Fee

The working group felt that the TIMF program would be a necessary element of the package of LOS reform to ensure political acceptability. A transportation impact mitigation fee (TIMF) is a development fee levied on new development in proportion to the expected impacts of that development on the transportation system. San Francisco currently has a transit impact development fee, payment of which mitigates, in part, the impacts of new development on MUNI transit service. This proposal would extending or complementing the existing development fee to cover all modes of transportation, and designate fee revenues to fund a multimodal countywide program of transportation projects, designed to mitigate the cumulative impacts of countywide growth at the system level.

The transportation impact analysis process under TIMF might work as follows. The new measure of auto trip generation would be used to screen projects for potential significant transportation impacts. If significant impacts are possible, and a project is eligible for the TIMF, then the project sponsor would pay a fee in proportion to the expected auto trips generated. Payment of the fee would mitigate the transportation impacts of the project. The linkage between development projects and the countywide program of projects would have been demonstrated by a prior nexus study.

One of the chief benefits of a TIMF program is increased ability for the City's Planning Department and project sponsors to assess transportation impacts efficiently, through a transparent approach to impact mitigation. A TIMF would increase the predictability of impact analysis, reducing the time and money costs of impact analysis for both the Planning Department and for project sponsors. Another key benefit of the TIMF program is that the CEQA burden on the city's desired multimodal transportation improvements will be reduced. Inclusion in the countywide program of mitigation projects will reduce the CEQA burden on the included transportation projects. Finally, the fee itself will raise revenue to implement the mitigation projects.

To adopt a TIMF program, a nexus study must first be prepared to determine the reasonable relationship between the projects that must pay the fee, the fee structure and level, and the mitigation projects that would be funded by fee revenues. Any new measure and standard for transportation impact – e.g., auto trips generated – must be ready to incorporate into the nexus study's evaluation. A countywide program of projects that the fee will be expended upon must also be identified, and the institutional mechanism to administer the revenues must be determined.

CONCLUSION

Much of the research and activity on alternatives to auto LOS has focused on two approaches: 1) creating complements to auto LOS, such as user-based versions of LOS for other modes of transportation, and 2) applying LOS standards more flexibly, such as by setting an average auto LOS standard for a group of intersections rather than one.

User-based LOS measures, themselves, are unlikely to be effective given the legal context which does not allow prioritizing among an array of adopted standards. However, San Francisco is pursuing the use of multimodal LOS measures to evaluate network performance and identify network gaps. Moreover, San Francisco has already applied LOS standards as flexibly as possible while balancing the goal of simple, clear standards. The more flexible application of LOS standards, such as varying LOS standards by area or roadway type, may be more relevant for less urbanized areas with no significant multimodal transportation infrastructure. Urban, multimodal areas may find that the most effective LOS reform is to replace auto LOS standards with a measure and standard that allows for the short term auto congestion that results from infill development and improvements to transit, walking, and cycling.

The case for replacing auto LOS with a measure and standard of auto trip generated is presented. The political acceptability and potential for effectiveness of this approach could be multiplied by combining it with a city or countywide multimodal mitigation program that is funded by development impact fee. This alternative was identified through a policy analysis process in San Francisco specifically oriented to the legal requirements and constraints of California's environmental impact analysis, and therefore may be a relevant solution for cities with similar statutory contexts, including environmental review, growth management, concurrency management, or public facilities management.

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