Automobile Level of Service:

A Liability for Health and Environmental Quality

Working Policy Paper

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Summary

Though widely used as a metric in Transportation Planning and Environmental Impact Assessment (EIA), automobile LOS does not capture known adverse environmental consequences of transportation. Instead, automobile LOS measures and values the convenience of motor vehicle travel, effectively promoting motor vehicle use. Better LOS thus increases vehicle trips and driving distances and consequently increases injuries, noise, air pollution, and greenhouse gases. In addition, LOS analysis often inappropriately concludes that environmentally beneficial transportation projects such as bus-only lanes, bicycle lanes, and traffic safety improvements are adverse to the environment.

LOS should be replaced in practice of EIA with measures that capture changes in vehicle use and volume. Three such transportation performance metrics are Vehicle Miles Traveled, Mode Split, and Vehicle Trips. Methods to estimate vehicle trips and vehicle miles exist but need to better distinguish projects that reduce motor vehicle use (e.g., locally-oriented retail, infill housing) and those that increase it (e.g., a regional shopping mall, low density housing). Transportation analysis in EIA can further improved by adding metrics for the quality of the pedestrian and bicycle environments.

Introduction

Indicators are measures to help society evaluate its progress towards goals. Planners use indicators and related analytic methods to help forecast and monitor the consequences of public policies and decisions. Different indicators measure different objectives. For example, fuel-efficiency and air emissions are measures for air quality but do not reflect congestion, motor-vehicle accidents, and social segregation. The choice of indicator for analysis is important because indicators drive public action towards the specific objectives reflected by the indicator.

A comprehensive approach to planning and indicator selection is especially important for transportation policy-making. Transportation systems affect diverse economic and social goals including mobility, accessibility, health and safety, equity, and environmental quality.[1] However, transportation planners have historically chosen indicators that focus on and privilege motor vehicle travel.

The California Environmental Quality Act (CEQA) aims to make transparent adverse environmental impacts. The law requires that public agencies identify and, where feasible, avoid or mitigate significant adverse environmental impacts resulting from public decisions and actions. Furthermore, CEQA specifically requires an agency to identify and mitigate changes in the environment that may adverse impact humans, either directly or indirectly.

The transportation performance indicator most commonly used in CEQA analysis as a measure of transportation impacts is automobile level of service (LOS). Automobile LOS is a measure of the convenience of motor vehicle travel (as time delay at an intersection) and roadway capacity.

Measures used for CEQA analysis should meaningfully capture adverse impacts of a physical change on environmental quality. Unfortunately, automobile LOS analysis does not reflect an evidence-based understanding of the relationships between transportation and the environment. Because automobile LOS privileges motor-vehicle travel and speed often at the expense of the safety of non-motorized travel, transportation policy decisions would change if planners used indicators which reflected the objectives for other uses of the street.[2] This policy report briefly reviews the environmental and human costs of automobile transportation, the use of LOS as an environmental indicator, and alternative transportation system indicators.

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[1] Litman T. Well Measured: Developing indicators for comprehensive and sustainable transportation planning. Victoria: Victoria Transport Policy Institute; 2005.

[2] Litman T. Evaluating Transportation Equity: Methods For Incorporating Distributional Impacts Into Transport Planning Victoria Transport Policy Institute 2005

Environmental and Public Health Costs of Automobiles

Transportation affects the environment through changes in habitats, air quality, water resources, noise, safety, and climate. These changes are also significant for pubic health. Health impacts related to transportation include respiratory disease, traffic-related injuries, sleep disturbance, cognitive development, and reduced physical activity. On the other hand effective transportation systems can improve health care access and social support. Adverse impacts of transportation on health are primarily related to the use of automobiles. Some of the most notable transportation—human health relationships are listed below.

- Nationally, the air quality impacts of automobiles cost the country 50-70 million days with restricted levels of activity, 20,000 to 46,000 cases of chronic respiratory illness, and 40,000 premature deaths.[3]
- Epidemiologic studies have found associations between living in housing next to busy roadways and respiratory disease symptoms and lung function measures.[4] [5]
- Transportation is responsible for 59% of California's greenhouse gas emissions.[6] Carbon emissions from transportation are projected to grow by 47% between the years 1996-2020.
- Nationally, for people aged one to 40, traffic injuries are the single greatest cause of disability and death. In 2002, San Francisco had over 5000 injuries involving motor vehicles. The probability of serious injury in a collision increases rapidly triples from 20 mph to 30 mph.[7] Broadly speaking, each 1mph reduction in speed may reduce accident frequency by 5% with effects greatest for urban main roads and low speed residential roads.[8]
- Research shows that people walk on average 70 minutes longer in pedestrian oriented communities. Walking and bicycling can prevent stress, obesity, diabetes, and heart disease.[9]
- Traffic flow and traffic speed are the major determinants of levels of noise in urban areas.[10] Exposure to high levels of noise significantly affects sleep, school and work performance,

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[3] Our Built and Natural Environments: A Technical Review of the Interactions between Land Use, Transportation, and Environmental Quality. United States Environmental Protection Agency. 2001

[4] Mikkelsen J. Effect of vehicular particulate matter on the lung function of asthmatic children in Fresno CA. Unupublished Manuscript.

[5] Brauer M et al. Air pollution from traffic and the development of respiratory infections and asthmatic and allergic symptoms in children American Journal of Respiratory and Critical Care Medicine. 2002; 166; 1092-1098.

[6] California Air Resources Board, 2003.

[7] New directions in Speed Management: a review of policy.

[8] Taylor M, Lynam D, Baruay A The effects of drivers speed on the frequency of road accidents. Transport Research Laboratory. TRL Report 421 Crowthorne, UK, 2000.

[9] Regional Development and Physical Activity: Issues and Strategies for Promoting Health Equity. Policy Link 2002.

[10] Dora C, Phillips M. Transport, Environment, and Health. World Health Organization 1999.

temperament, hearing impairment, and high blood pressure.[11] The combination of noise and poor housing has been associated with stress, stress hormone levels, and impaired learning in children.[12]

Liabilities of Automobile LOS used as a transportation indicator in CEQA review

The usual measure of transportation impacts in environmental analysis is automobile level of service (LOS). LOS is an inappropriate measure for environmental analysis for all the reasons listed below:

- LOS reflects the convenience of motor vehicle travel measured as time delay at an intersection. This measures privileges motor-vehicle travel and speed often at the expense of the safety of non-motorized travel.
- Transportation research has shown that increasing roadway capacity is not an effective long-term strategy to manage roadway congestion. For example, mitigating reductions in LOS by increasing roadway capacity simply increase traffic flow by inducing more use of a roadway.[13]
- LOS analysis does not account for modal shift, where reduced motor vehicle capacity encourages auto trips to shift to other travel times, routes or travel mode. Removal of roadway lanes can actually reduce traffic. Sally Cairns and her colleagues reviewed over 70 case studies where roadway lanes were reduced (e.g., lane reductions, temporary closures). In these cases, available data allowed for a "before and after" analysis of vehicle flow. Overall, reduction in roadway capacity led to reduced traffic volumes as measured on the affected roadway as well as on alternative routes (mean reduction -21.9%; median reduction -10.6%).[14] A number of behavioral responses explain why traffic volumes can fall following reductions in roadway capacity. Reductions in road space can lead to changes in the route of a journey, changes in the time at which trips are made, changes in the means of travel, changes in the frequency of travel, changes in the destination of travel, trip elimination, and consolidation of trips to serve several destinations on one journey.[15]
- Many public agency officials responsible for environmental review assume that the loss of roadway capacity must be studied in CEQA because congestion means air pollution around affected roadways. Carbon monoxide (CO) and some larger particulates are related to distance to traffic and traffic volume; however, smaller particulates disperse more widely, and ozone is a product of regional emissions. In addition, improvements in engine and emissions performance

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[11] Guidelines for Community Noise. World Health Organization. 1999 (available at; http://www.who.int/docstore/peh/noise/guidelines2.html)

[12] Evans G, Marcynyszyn :LA. Environmental Justice, Cumulative Environmental Risk, and Health among Low- and Middle-Income Children in Upstate New York. American Journal of Public Health 2004;94: 1942-1944.

13 EPA, 2001.

14 Cairns, 2002

15 Hunt, 2002

make it unlikely that adverse levels of CO will exist even on congested roadways. Analysis of air quality impacts can also occur without analysis of LOS.

- Improving LOS corresponds to increasing speed. There is a non-linear and U-shared relationship between speed and vehicle emissions. In general, emissions per mile fall with increasing speeds to about 30 then increase. Particulate matter and Nitrogen oxide emissions increase with increasing speed above 30-40 mph. Carbon dioxide emissions are proportional to fuel consumption, also increasing above a threshold of about 30-40 mph. This suggests that speed reduction to 30-40 mph will improve air quality.
- Transportation projects such as transit only lanes and bicycle lanes and pedestrian improvements such as sidewalk widening can reduce driving and its environmental costs. Paradoxically, LOS analyses as currently performed often conclude that such projects result in adverse environment impacts.
- LOS measures in environmental review can actually exacerbate environmental problems by creating a regulatory and legal obstacle to resource efficient land use. For example, LOS analysis does not differentiate between land use development that increases automobile traffic (e.g., a large retail mall) and development that reduces automobile demand, (e.g. transit-oriented or mixed use development)
- The use of automobile LOS in isolation does not take into account relationships and conflicts among modes. For example, higher traffic speeds, higher flows, broader roadways, and reduced lateral separation harm pedestrian safety.

LOS Analysis and Environmentally Beneficial Projects

Many proposed land use and transportation projects aim to reduce motor vehicle use. Paradoxically, automobile LOS analysis as currently performed can conclude that such projects worsen road congestion. In part, this issue is a consequence of the methods used to estimate vehicle trips and assign trips to routes and modes. These models generally do not account for reductions of traffic from projects that are designed to provide greater access or to facilitate alternative modes of transportation. Examples of projects that may be found to have adverse transportation impacts through LOS analysis include:

- Dedicated Bus-only lanes
- New Light rail lines
- Bicycle Lanes
- Sidewalk widening
- Traffic safety improvements such as lengthening crossing times and removal of double left turn lanes.
- Infill residential housing projects
- Transit-oriented development

Several recent examples show how the use of LOS as a CEQA criterion conflicts with human health and environmental quality objectives. For example, the EIR for the Third Street Light Rail project in San Francisco found adverse impacts on transportation based on LOS analysis and this resulted in the city narrowing some sidewalks on Third Street. This mitigation for the sake of *environmental quality* will not only limit future pedestrian activity but also may interfere with developing Third Street as a vibrant, retail and residential corridor.

Attempts to lengthen sidewalk crossing times to accommodate children and seniors can also be in conflict with LOS analysis. In these cases, lengthening crossing times results in unacceptable delays to vehicles. In some neighborhoods, residents have threatened to sue the City over plans to increase the density of housing along transit corridors, claiming that increased density would result in unacceptable level of service for automobiles.

Alternative Measures and Metrics for Transportation Analysis in Environmental Review

Transportation policy decisions could support environmental and health objectives if planning and analysis reflected the needs of other uses of the street.[16] With regards to transportation-related environmental indicators, metrics and standards should capture the following environmental and health-related aspects of the transportation system changes:

- Impacts on the quality and safety of the environment for pedestrians
- Impacts on the quality and safety of the environment for bicyclists
- Impacts of vehicles on neighborhood air quality
- Impacts of vehicles on environmental noise
- Impacts on public transit service and reliability
- Impacts on physical activity
- Impacts on social interactions

Environmental analysis of transportation impacts should also consider the impacts on sensitive populations including seniors, the disabled and young children and sensitive environments such as schools, senior centers, and high hazard intersections.

Alternative measures for studying transportation performance and transportation's environmental impacts are feasible. The table below provides one set of potential indicators for diverse transportation-related objectives.

16 Litman T. Evaluating Transportation Equity: Methods For Incorporating Distributional Impacts Into Transport Planning Victoria Transport Policy Institute 2005

Candidate Indicators for Comprehensive Transportation Planning

Social Goal	Potential Indicator
Mobility and Access	• Trip frequency • Mode Split • Public services within 20 minute travel distance • Job opportunities within a 20 minute travel distance • Per capita travel distances • Distance to transit services
Health and Safety	• Population physical activity levels • Respiratory disease incidence • Pedestrian Injuries • Motor vehicle injuries • Access to health care services • Children walking or bicycling to school • Household exposure to roadway noise • Household exposure to roadway emissions
Environmental Quality	• Commute distances • Mode Split (non-motorized and transit) • Per capita air emissions • Per capita energy consumption • Per capita land allocated to transportation • Environmental noise levels
Economic Efficiency	• Commute time • Per capita transport system costs • Job opportunities within a 20 minute commute • Mode Split
Social Equity	• Proportion of income devoted to basic mobility needs • Public services within 0.5 mile

CEQA allows local jurisdictions to develop locally relevant indicators and standards for environmental impacts. Guidance for development of local environmental impact assessment indicators and thresholds has been published by the Governor's Office of Planning and Research. The City of Los Angeles recently adopted by ordinance guidelines and significance thresholds for CEQA analysis. The cities of Santa Barbara and Mountain View also have locally specific Guidance.

No city in California has yet discarded the use of LOS in environmental analysis. The San Francisco County Transportation Authority (TA) has been evaluating alternatives to automobile LOS as a metric for transportation impacts in CEQA analysis.[17] Staff of the TA has proposed a measure of vehicle trips as a replacement measure for LOS. The TA is currently evaluating how to develop a trip generation model that is sensitive to urban form characteristics such as residential density and use intensity. A pending Board Resolution in San Francisco proposes to exempt, pedestrian facility, bicycle facility, and transit facility improvements from auto LOS analysis.

In Washington State which does not have an CEQA like regulation, King County uses planning indicators that reflect several objectives of its land use and transportation policies, including linking transportation and land use, decreasing the use of the automobile, and reducing traffic congestion. Mode split, the proportion of total person-trips using various modes of transportation, and vehicle miles traveled (VMT) are two indicators that relate to transportation's environmental costs including air and noise pollution, noise pollution, traffic injuries, and physical inactivity. Both indicators are outputs of regional traffic demand models. In California, the Department of Transportation (CalTrans) is developing *Transportation System Performance Measures*, including measures developed for reliability, accessibility, sustainability, safety and security, equity, and environmental quality.

Three of the most readily available metrics that could serve to capture vehicle-related environmental quality and health effects are Vehicle Miles Traveled (VMT), Mode Split, and Vehicle Trips Generated. Travel demand and trip generation models used by County Congestion Management Agencies and the Metropolitan Transportation Agency estimate VMT and Trips. VMT is already used in CEQA analysis as a parameter required for air quality analysis. The table compares the likely findings of LOS and VMT analysis using common transportation projects in an urban environment.

	Environmental Impact Assessment Measure	
	Auto Level of Service Worse	**Vehicle Miles Travel Worse**
Dedicated Bus-only lanes or light rail line	Yes, if vehicle lane replaced or reduced	No
Additional Roadway Lane	No	Yes
Bicycle Lanes	Yes, if vehicle lane replaced or reduced	No
Sidewalk widening	Yes, if vehicle lane replaced or reduced	No
Longer crossing times	Potentially, if signal delay increased	No
Infill residential housing	Yes	No

17 Strategic Analysis Report ofn Transportation System Level of Service Methodologies. San Francisco County Transportation Authority. San Francisco. 2003.

Nationally, interest has also focused on developing indicators for service quality and capacity for non-motorized travel modes as a way to compliment auto LOS analysis. The FHWA has funded several efforts to develop and validate LOS measures for pedestrians and bicyclists.[18] The status of these efforts is described below:

- In **Gainesville, Florida**, Dixon developed Pedestrian LOS quantitative level of services measures and standards for the City and tested and evaluated these standards both on existing conditions and proposed projects.[19] Factors included facility type, facility width, driveway conflicts, pedestrian signals, turn conflicts, crossing widths, speeds, buffers, lighting, and shade trees.

- In **Western Australia**, Gallin developed a pedestrian LOS standard based on design factors (path width, surface quality, obstructions, crossing opportunities, and support facilities); location factors (connectivity, path environment, vehicle conflicts); and user factors (pedestrian volume, mix of path users, and personal security).[20]

- The **Florida Department of Transportation** evaluated the relationship between perceived environmental quality and physical characteristics. The study found that traffic volume, traffic speed and lateral separation between pedestrians and traffic explained 85% of the variation in perceived safety and comfort for pedestrians.[21]

- The **City of Charlotte, North Carolina** developed a method for pedestrian and bicycle level of service for intersections in 2005.[22] The pedestrian LOS metric weighs crossing distance, signal phasing and timing, corner radii, cross walk treatments, and traffic flow.

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[18] Federal Highway Administration.

[19] Dixon LB. Bicycle and Pedestian Level-of-Service Performance Measures for Congestion Management Systems. Transportation Research Record. Number 1538. 1996.

[20] Gallin N. Quantifying Pedestrian Friendliness: guidelines for assessing pedestrian level of service. Road and Transport Research. 2001.

21 Landis BW, Vatttikuti VR, Ottenberg RM, McLeod DS, Guttenplan M. Modeling the Roadside Walking Environment: A Pedestrian Level of Service. TRB Paper -1-0511 Tallahassee. 2000.

[22] Charlotte Department of Transportation. Pedestrian and Bicycle Level of Service: Methodology for crossings as signalized intersections. 2005

Recommendations for San Francisco's Environmental Impact Assessment Practice

1. Create an exemption from project-level LOS analysis for certain project types that decrease vehicle trips or vehicle miles and / or enhance transportation-related environmental quality, safety, and health goals:

- Bicycle lanes that are part of with a citywide bicycle network
- Pedestrian improvements part of a citywide pedestrian network
- Bus lanes
- Urban rail projects
- Mixed-use or transit oriented developments that reduce traffic
- Higher density residential construction

2. Replace LOS as a measure in CEQA analysis with vehicle miles traveled or vehicle trips generated as the indicator. While this indicator is already generated by traffic demand models, methods for trip generation and mode assignment must distinguish projects that reduce local and regional vehicle trips from projects that generate them, such as auto oriented retail use, parking lots, and offices.

3. Develop and evaluate alternative pedestrian and bicycle level of service metrics. Require analysis of pedestrian and bicycle LOS metrics in environmental review.