

APPENDIX F5
Level of Service

The Road to *Change*

Halton Region Transportation Master Plan



Level of Service



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1. Purpose of Report

The purpose of this technical reference is to review acceptable levels of service for transportation modes (including automobiles, public transit, bicycles and walking) on Regional roads. Level of Service (LOS) can be defined broadly as a performance indicator of the speed, comfort and safety of a trip. LOS is a concept that traditionally has been used to define the quality of service of automobile traffic conditions at an intersection and/or road section. This working paper also examines transit, cyclists and pedestrians in order to provide a complete view of the quality of service of an analysed portion of the transportation network. Implementation of LOS guidelines will establish a threshold with which to evaluate transportation facilities. Using the threshold will help identify transportation segments that may be constrained and will help direct future investments to improve these transportation facilities to acceptable levels.

This technical reference will be a guide for the Region and will be provided to the Local Municipalities, service providers and stakeholders for consideration.

2. Introduction

This is one of a series of technical references to help guide the development of the Halton Region Transportation Master Plan. This reference supports the following master plan guiding principles:

- Balanced Needs – provide choice for the travel needs of residents;
- Healthy Communities – support a healthy and active lifestyle;
- Economic Vitality – transportation will be a major contributor to the Region’s prosperity;
- Sustainability – balance economic, social and environmental goals; and
- Well-Maintained Infrastructure – keep the Region’s infrastructure in a good state of repair.

This LOS technical reference has been organized into several sections:

- *Guiding Documents*: presents a summary of key principles and policies addressing LOS;
- *Existing Conditions in Halton Region*: provides a summary of current practice in Halton Region regarding LOS;
- *LOS Opportunities*: identifies areas for guideline development to enhance ongoing LOS analysis efforts;
- *Recommended LOS Guidelines and Indicators and Implementation*

3. Official Plans Policies and Conformance

The guiding principles outlined in the Introduction provide the set of fundamental beliefs that will lead the development of the Halton Region Transportation Master Plan. In addition to these principles, Halton Region's Regional Official Plan Amendment 38 (ROPA 38) and Metrolinx's Regional Transportation Plan (The Big Move) are two guiding documents reviewed in this section to highlight how each addresses LOS. This technical reference conforms to the overall goals and policies related to LOS included in both of these documents.

3.1 Regional Official Plan Amendment 38 (ROPA 38)



On December 16, 2009, Halton Regional Council adopted ROPA 38 "An Amendment to Incorporate the Results of Sustainable Halton, Official Plan Review Directions and Other Matters".

With ROPA 38's adoption, Halton Region fulfils the provincial requirements to plan for growth, integrates the principle of sustainability into its Official Plan.

ROPA 38 outlines how and where Halton will grow from 2021-2031. ROPA 38 is the final phase of a process that began in 2006 as a response to provincial requirements set out in policy including the Places to Grow Plan, the Greenbelt Plan and the Provincial Policy Statement.

ROPA 38 addresses LOS in several clauses:

- Provide a safe, economic and efficient highway network for both people and goods movements with an acceptable level of service (section 172(2));
- Coordinate with the Province, Metrolinx and the local municipalities the planning, development and funding of both highway and interregional higher order transit projects in Halton to ensure the provision of a balanced transportation system with an acceptable level of service (section 173(10)); and
- Require the local municipalities to provide in their Official Plan or appropriate area-specific plans and policies related to the provision of transit service addressing general locations and anticipated levels of service (section 172 (9)).

These clauses highlight the need for an acceptable LOS in order to provide a balanced and efficient transportation system for people and goods. This technical reference for the Halton Region Transportation Master Plan takes the ROPA 38 clauses to the next step by recommending acceptable LOS for Halton’s transportation system.

3.2 The Big Move



The Regional Transportation Plan for the Greater Toronto and Hamilton Area, entitled “The Big Move” was adopted by Metrolinx in November of 2008. While the document does not define the LOS desired to be achieved for different transportation modes, it does include goals that infer a connection to LOS, such as:

- Comfort and Convenience: improved travel time reliability; and
- Efficiency and Effectiveness: increased productivity of the transportation system.

Big Move strategies also support LOS through “Strategy 3”:

- Improve the efficiency of the road and highway network.

Improving travel time, efficiency and productivity of the transportation network all would have a positive affect on the LOS, regardless the mode of travel. The Big Move document has laid out ambitious goals to improve transportation in the GTHA, but has left the interpretation of the desired LOS to jurisdictions on a more local level.

4. Current Practices

4.1 Units of Measure

There is no “universal” tool for measuring LOS for all road users in a transportation system, the primary reason for this is that a road users’ expectation of transportation system service and the quality of service is a function of the travel mode and the type of facility. The LOS definitions by mode as presented in the year 2000 version of the Highway Capacity Manual (HCM) include:

- Autos: delay and volume to capacity ratio, speed;
- Transit: frequency, reliability, distance to bus stops;
- Bicycles: cycle speed / flow, cycle facilities, comfort; and
- Pedestrians: pedestrian speed / flow, walking distance, presence of sidewalks/paths.

4.2 Roadway Planning Analysis

In long range roadway planning applications (20 year horizon), level of service is defined as the ratio of volume to capacity (V/C) at a specific screenline. A screenline is an imaginary line defined in the transportation network that captures traffic flows across a broad corridor (typically two or more roads running parallel to each other). The strategic nature of the analysis lends itself to capturing broad flows across major corridors to assess the timing and investment levels over longer periods of time. The transportation system is analyzed to identify roadway improvements rather than at the more detailed level of an intersection.

A road with a V/C ratio of 1.0 is completely saturated and cannot theoretically accommodate more vehicles. Volume to capacity ratios greater than 1.0 reflect oversaturation of the road as more vehicles desire to use the road than the road is theoretically capable of carrying. These conditions result in congestion and vehicle delay.

Halton Region uses a critical screenline volume to capacity ratio of 0.9 in its transportation master planning analyses. This means that the road segments, making up a screenline in the Region’s demand forecasting model found to have a V/C ratio of 0.9 or greater, are considered to be in need of more detailed analysis and possibly monitoring and eventual action to implement improvements if it is determined that the roadway segment will have an unacceptable LOS. For planning purposes, the

Region uses varying capacities (measured in number of vehicles per hour per lane) depending on the roadway classification. The typical ranges are shown in the table below.

Table 1 –Roadway Planning Capacity for Urban and Rural Roads

Road Classification	Urban Road Capacity (vehicles per hour per lane)	Rural Road Capacity (vehicles per hour per lane)
Provincial Freeways	1,850	Not applicable
Former Highways (i.e., Regional Road 5)	850 - 950	950 - 1,250
Major Arterial	800 - 900	Not applicable
Minor Arterial	750 - 950	400 - 750
Collector	400 - 500	500 - 700

4.3 Roadway Operational Analysis

Roadway operational analysis considers existing conditions or the near-term horizon (up to 5 years); where LOS is generally defined based on average delay per vehicle within an intersection. The short-term nature of the analysis allows for greater confidence of the various turning movements that occur at an intersection or intersections being analyzed. Intersections generally are analyzed instead of road segments in roadway operational analysis as intersections represent the critical capacity control points for a road network. Roadway operational analysis is used to test alternative solutions for intersections already identified as needing improvements due to existing conditions. Roadway operational analysis also is used to analyse near-term (up to 5 years) intersections to discover probable problem intersections and plan solutions before the intersections reach a state of over capacity.

For signalized intersections, the level of service (LOS) is based on average delay per vehicle for various movements within the intersection. Delay is a measure of the quality of service to the road user and is comprised of several factors. Level of service is described using a range of values ‘A’ through ‘F’. For unsignalized intersections, the overall performance is established by the LOS of the most critical movement. At unsignalized intersections this typically corresponds to the left turn movement from the minor street.

The level of service and average vehicle delay for signalized and unsignalized intersections and the description of the conditions are detailed in Table 2 below.

Table 2 – Description of Level of Service Based on Average Vehicle Delay at Intersection

Level of Service	Average Delay (seconds/vehicle) (Signalized)	Average Delay (seconds/vehicle) (Un-signalized)	Description
A	0-10	0-10	<u>Signalized</u> : Good progression, few stops, and short cycle length. <u>Un-signalized</u> : Good operating conditions.
B	> 10-20	> 10-15	<u>Signalized</u> : Good progression, acceptable delays and space capacity. <u>Un-signalized</u> : Acceptable delays and spare capacity
C	> 20-35	>15-25	<u>Signalized</u> : Fair progression, longer cycle lengths, significant portion of vehicles stopping. <u>Un-signalized</u> : Satisfactory but safety issues will need to be considered.
D	> 35-55	>25-35	<u>Signalized</u> : Congestion becomes noticeable, operating near capacity and longer delays. <u>Un-signalized</u> : Near capacity.
E	> 55-80	>35-50	<u>Signalized</u> : Poor progression, facility at capacity, delays excessive and long queues. <u>Un-signalized</u> : At capacity, requires other control mode
F	> 80	>50	<u>Signalized</u> : Unappreciable delays for motorists, demand exceeds the capacity of the facility and unstable flows. <u>Un-signalized</u> : Unsatisfactory, requires other control mode.

At LOS D, the influence of congestion or excessive traffic becomes more noticeable. This level is considered to be the limit of acceptable delay. LOS E and F describe operations considered to be unacceptable and often occur with over saturation (i.e., vehicle demand exceeds the capacity of the intersection).

Halton Region has existing LOS standards for roadway operational analyses, such as those undertaken in traffic impact studies prepared in support of development applications or as part of a corridor analysis. This information is documented on page 11 of Halton Region's Guidelines for the Preparation of Traffic Impact Studies (August 2001).

- Signalized Intersections
 - Overall Intersection $V/C > 0.85$
 - Through / Shared Movements $V/C > 0.85$
 - Left turn movements $V/C > 0.95$
- Unsignalized Intersection
 - Movements with an $LOS < E$

Conditions exceeding the noted values would constitute “unacceptable” operating conditions and would require transportation mitigation measures in order to produce acceptable operating conditions.

4.4 Transit

Transit service in Halton Region is provided by three local municipal transit authorities: Burlington, Oakville and Milton. Transit service to and from Halton Region (as opposed to “within”) is provided by GO Transit, Mississauga Transit and the Hamilton Street Railway, as well as via Oakville and Burlington Transit. In addition to the local conventional services, paratransit services for persons with disabilities are provided by Burlington, Oakville, Milton and Halton Hills.

Burlington Transit is the second largest local system in Halton, carrying 1.86 million passengers in 2009 with a fleet of approximately 44 vehicles. Burlington Transit currently operates 15 different bus routes and also has a Dial-a-Ride service that replaces regular bus service with taxicabs on some routes during hours when ridership is low. During the school year Burlington Transit also operates several school specials. The existing bus routes provide coverage within Burlington, including to the Aldershot, Burlington and Appleby GO Stations. Generally, peak period frequency ranges from 15 to 30 minutes.

Oakville Transit is a well-established transit system, operating over 23 different base transit routes, 8 school specials and 3 seniors' specials. Starting in 2009, Oakville Transit moved from a radial based route structure to a modified grid structure. Many of the routes provide service to and from the Bronte and Oakville GO Stations and have a peak period frequency of 20 minutes with a

40 minute frequency in off peak times. Inter-municipal connections are also provided to Burlington and Mississauga (South Common Mall and the Clarkson GO Station).

Milton Transit is the smallest local system in Halton, carrying 103,000 passengers in 2009 with a peak fleet of five vehicles. Milton Transit currently consists of six bus routes, all of which originate at the Milton GO Transit Station and generally have a 30 minute peak period frequency.

4.5 Cycling

Cycling currently represents a minor proportion of the modal split (approximately 2% of seasonal urban trips). Halton Region currently does not have a specific system of performance thresholds for cycling. One goal of the Halton Region Transportation Master Plan (2031) – *The Road to Change* is to provide the incentives (i.e., via the proper infrastructure) to increase this mode share. Halton Region has established Regional Roads Right-of-Way Guidelines that include provisions for cyclists such as wider curb lanes, bike lanes and paved shoulders.

4.6 Pedestrians

Level of Service for pedestrian travel in Halton Region, like cycling, is not an issue of capacity but one of safety and convenience. The implementation of sidewalks on Regional roads is a responsibility of the local municipality; however, Halton Region has made allowances for sidewalks in the Regional Roads Right-of-Way Guidelines and local municipalities are encouraged to provide sidewalks and/or multi-use paths that provide continuity and serve active travel needs.

4.7 Urban and Rural Analysis

Halton Region does not distinguish different LOS criteria for urban or rural settings for roadway planning or operational analyses.

4.8 Intensification Areas

Intensification area is a term used in the *Growth Plan for the Greater Golden Horseshoe*, part of the Places to Grow Act of 2005, and is defined as “lands identified by municipalities or the Minister of Public Infrastructure Renewal within a settlement area that are to be the focus for accommodating intensification. Intensification areas include urban growth centres, intensification corridors, major transit station areas, and other major opportunities that may include infill, redevelopment,

brownfield sites, the expansion or conversion of existing buildings and greyfields.” As intensification areas are a relatively new concept just beginning implementation, Halton Region may review separate LOS guidelines or practices for these areas.

5. LOS Guidelines Opportunities

Traditionally, LOS has focused on increasing the capacity of the road network to accommodate more vehicles. The solution most often applied has been building more road infrastructure. This could be additional lanes through a road widening or adding turn lanes and other road-related improvements to intersections. It could also be constructing a new road in order to provide additional capacity to the network.

The approach of constructing new lanes, intersections or entire new roads must accommodate people riding transit, cycling or walking. With Metrolinx’s emphasis on transit and active transportation, all approaches to addressing congestion must be considered.

The opportunities presented below and the corresponding recommended guidelines and indicators further in this document address the Halton Region Transportation Master Plan guiding principle of “balanced needs” by providing travel choices. The opportunities and guidelines also incorporate successes in other parts of North America in implementing quality of service indicators for transit, cycling and pedestrian transportation modes.

Opportunities to improve LOS or quality of service for transit, cycling and pedestrians will need to be undertaken hand in hand with local municipalities and service providers. The Regional Roads Right-of-Way Guidelines provide a foundation that encourages transit, cycling and pedestrian activities.

5.1 Roadway Planning Analysis

Planning is the best time to address capacity issues as solutions can be developed to mitigate traffic congestion. Table 3 shows the roadway planning analysis thresholds adopted by other jurisdictions in Ontario.

Halton Region is consistent with other jurisdictions in Ontario in terms of its volume to capacity threshold for roadway planning analysis.

Table 3 – Comparison of Roadway Planning LOS Thresholds across Jurisdictions

Jurisdiction	LOS Threshold
Halton Region	0.9
York Region	0.9 (0.8 rural)
Peel Region	0.9
Durham Region	0.9
City of Hamilton	0.85
City of Kingston	0.9
City of Ottawa	0.9 (except for downtown where 1.0 is accepted)

5.2 Roadway Operational Analysis

Many jurisdictions and agencies have identified traffic level of service thresholds for automobiles as presented in Table 4. These examples are extracted from the City of Hamilton’s *Level of Service Policy Paper* (January 2005).

Table 4 – Comparison of Roadway Operational Analysis LOS Thresholds across Jurisdictions

Jurisdiction / Reference	Overall Intersection	Through / Shared Movements	Left Turn Movements	Unsignalized Intersection Movements
	Volume to Capacity Ratio			LOS
Halton Region	>0.85	>0.85	>0.95	LOS<E
Oakville	> 0.85	> 0.85	> 1.0	> LOS E
Burlington	> 0.90	> 0.90	> 0.90	N/A
Peel	> 0.90	> 0.90	> 1.0	N/A
Durham	> 0.90	> 0.90	> 0.90	N/A
ITE	> 1.0	> 1.0	> 1.0	
City of Toronto	> 0.85	> 0.85	> 1.0	N/A
Town of Milton	> 0.9	> 0.9	> 0.95	N/A
City of Hamilton	LOS D – combined minimum LOS for walking, cycling, transit and vehicles			
Ministry of Transportation of Ontario	LOS B – rural intersection design LOS C – urban/commuter intersection design			
ITE Traffic Engineering Handbook (Fifth Edition)	LOS C – communities with a population < 25,000 LOS D – communities with a population > 25,000 LOS D/E – for minor traffic movements in central or major outlying business districts			

Again, Halton Region is consistent with other jurisdictions and agencies in terms of its operational thresholds for roadway operational analysis.

5.3 Transit

Transit in Halton Region is operated by the Local Municipalities. Transit LOS can be defined using criteria such as: availability, safety, accessibility, comfort and convenience. Typical factors to consider in defining transit LOS include:

- Service Frequency (vehicle headways);
- Hours of Service (hours per day);
- Service Coverage (coverage along route);
- Vehicle / Passenger Loads (area per passenger / used vehicle capacity);
- Reliability (time on schedule); and
- Travel Time (competitive to alternative mode – mostly auto).

5.4 Cycling

Cycling quality of service is typically measured by:

- Availability of separate cycle lanes;
- On-street painted designated cycle lanes;
- Connectivity of cycle network; and
- Vehicle speeds on roads.

5.5 Pedestrians

Pedestrian quality of service is typically measured by:

- Availability of sidewalks/multi-use paths,
- Accessibility;
- Crosswalks with crossing signals;
- Adequate crossing time;
- Street lighting;
- Street furniture; and
- Convenience and connectivity of pedestrian routes to activity centres.

5.6 Urban and Rural Analysis

Urban areas generally have a higher threshold for an acceptable road LOS than rural areas, if there is any distinguishing criterion at all. In some downtown areas (e.g., City of Ottawa), a lower threshold (V/C ratio of 1.0) is accepted to allow for further development deemed prudent and to recognise the high concentration of people and traffic in these areas. For planning purposes, a distinction in threshold between urban and rural areas is made for minor arterial and collector roads. It is recognised that if the V/C ratio is high in a rural area, then the area probably is undergoing urbanization. Otherwise, transportation improvements may need to be made as the rural area transforms into an urban area.

5.7 Intensification Areas

Intensification areas are designated to accommodate greater densities and mixed land uses. The industry has not yet completed recommended transportation practices for these areas as they are in the early stages of planning. The practice to date in many jurisdictions has been to lower the performance standard for automobile LOS. Others have applied area-wide standards as opposed to intersection specific LOS to reflect total throughput of the area.

Given the multi-mode travel opportunities in intensification areas, level of service analyses need to expand beyond the traditional auto-defined measures of delay and volume to capacity. Performance measures need to be defined for pedestrians, cyclists, transit and automobiles.

6. Recommended LOS Guidelines and Indicators

LOS measures have been reviewed in the context of the TMP Guiding Principle of “Balanced Needs”. The review incorporated successes and best practices found in other parts of North America.

Roadway Planning Analysis

It is recommended that Halton Region:

- Continue the use of a critical V/C ratio of 0.9 at the screenline level for both urban and rural settings.
- Consider the use of an overall critical V/C ratio of 1.0 at the screenline level for roads in intensification areas, particularly if these areas are well served by transit.

Roadway Operational Analysis

It is recommended that through the Technical Traffic Advisory Committee the Region and its local municipalities define consistent performance measures for rural, urban and intensification areas.

Maintaining a high LOS for automobile travel will not help achieve the desire shift to other modes by 2031 or sooner. Therefore there needs to be a reallocation of LOS for automobiles (mainly intersection LOS). The changes to signalised intersections would apply to the overall intersection values as well as all movements. This reflects a reduction in the V/C from current practice but it is also more representative of “mature” urban areas. A balance of level of service among all modes being promoted by Halton’s Transportation Master Plan (2031) - The Road to Change is required.

7. Conclusion

Guidelines on level of service are important to the Halton Region Transportation Master Plan as they will help define the threshold for future transportation improvements. This technical reference supports a view that includes options for mode of travel. The LOS by mode should be defined in conjunction with the local municipalities through the Region’s Technical Traffic Advisory Committee.

8. References

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