Region of Waterloo
Transportation Impact Studies (TIS)
Requirements for Capacity Analysis, Roundabouts, Signal Warrants

Software: The Region of Waterloo (ROW) prefers analysis using a software program which utilizes the methodology of the 2010 Highway Capacity Manual for signalized and stop controlled intersections. We prefer Synchro/ SimTraffic 7 or 8 but accept analysis in older versions of Synchro. Please contact us if using an alternative software program.

LANE SETTINGS

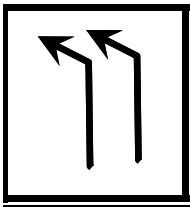
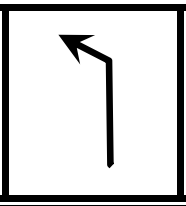
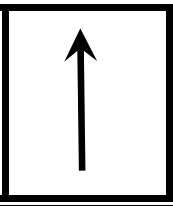
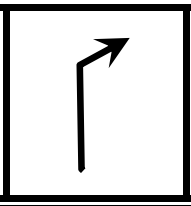
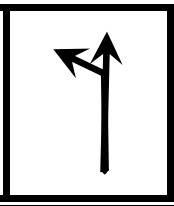
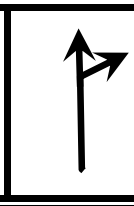
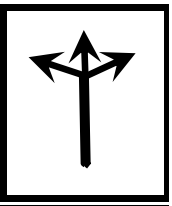
Link Distance (m)- The distance between two intersections measured from the centre of each intersection. It is important this information be correct when analysing two adjacent intersections in a coordinated signal system.

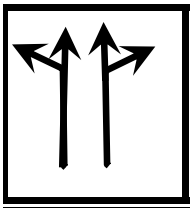
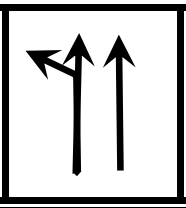
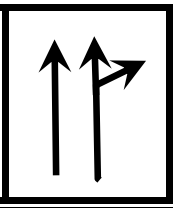
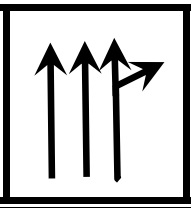
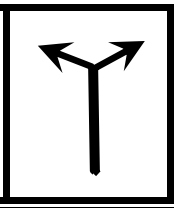
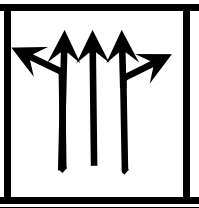
Link Speed (km/h)- Use the posted speed limit of the roadway, regardless of the operating speed *(only required for two or more adjacent co-ordinated signals)*

Ideal Saturated Flow (Vphpl)- Refer to the table below for flow rates.

SATURATION FLOW VALUES

REGION OF WATERLOO — **TRAFFIC SYSTEMS MANAGEMENT**

						
1775	1775	1900	1750	1650	1650	1550
DUAL TURN LANES	LEFT TURN LANE	THROUGH LANE	RIGHT TURN LANE	THROUGH/ LEFT LANE	THROUGH/ RIGHT LANE	SINGLE LANE ONLY

						
1650	1775	1775	1820	1765	1735	1000
TWO LANE THROUGH LEFT/RIGHT	TWO LANE THROUGH LEFT	TWO LANE THROUGH RIGHT	THREE LANE TWO THROUGH RIGHT	SINGLE LANE LEFT/RIGHT	THREE LANE ONE THROUGH LEFT & RIGHT	BLANK

Lane Width (m)- Unless lane widths have been measured in the field, Use 3.5 metres as a standard for all lanes. Increasing the lane width will artificially show increased capacity.

Area Type CBD- Check this box if the intersection is in a central business district *("uptown" or "downtown" core)*. This will lower the saturated flow rates to account for short blocks, parking manoeuvres and high pedestrian activity.

Storage Length (m)- Enter the length of the storage bay (without the taper) available for storing vehicles. This information is important for identifying queuing and blocking problems when running SimTraffic simulations.

Storage Lanes (#)- Code the number of storage lanes for right and left-turn bays. This field can be overwritten to code a through lane as a storage lane *(if applicable).*

Right-turn Channelized:

- None- no right-turn channelization
- Yield- There is a right-turn channelization, where right-turning vehicles are faced with a "Yield" sign
- Stop- There is a right-turn channelization, where right-turning vehicles are faced with a "Stop" sign
- Free- The right-turn channelization has its own receiving lane. There are no "Stop" or 'Yield" signs *(see Add Lanes below)*
- Signal- There are separate signal heads and an associated right-turn phase

Add Lanes (#)-controls how a right-turn lane enters the intersection street. Adding a (1) adds a continuation to the right-turn lane. A (0) is standard for a "Yield" or 'Stop" condition

Lane Utilization Factor- Generally the default values will suffice. You may be asked to conduct field studies to confirm the lane utilization factor in some cases *(ex- lane drop).* The reasoning behind this change would need to be documented in the TIS.

Right-turn on Red (RTOR)- The default is "YES". Uncheck this box for approaches where a "No RTOR" sign exists at the intersection

VOLUME SETTINGS

Volume (Vph)- To be obtained from the ROW turning movement counts (TMCs) when possible or collected for peak periods not included in the TMC's *(ex- Saturday peak).*

Conflicting Peds (#/hr)- To be obtained from the ROW TMCs when possible or collected for peak periods not included in the TMC's *(ex- Saturday peak).* Future volume analysis should use the existing pedestrian volumes unless anticipated to change.

Peak Hour Factor (PHF)- Unless otherwise directed, TIS's no longer need to account for 15 minute fluctuations within peak hourly volumes. A PHF of **1.0** should be used to simulate a flat hourly peak.

Heavy Vehicles (%)-To be obtained from the ROW TMC's when possible or collected for peak periods not included in the TMCs *(ex- Saturday peak).* Future volume analysis must use the existing heavy vehicle percentages unless anticipated to change.

NODE SETTINGS

This information is included in the signal timing provided by the ROW. Incorrect coding of phasing, timing intervals, control type, offsets, recall mode or clearance timing will result in an automatic resubmission of the analysis. Please contact Traffic Systems Management staff if you are unclear with any of the information provided in the timing.

Control Type:

- Fixed Time **=** Pre-timed
- Fixed Time with Actuated Left Turn phasing **=** Actuated-Coordinated
- Semi-Actuated **=**
    - Actuated-Coordinated (if signal is in a coordinated signal network)
    - Semi-Actuated-Uncoordinated (if signal is not coordinated)
- Fully Actuated **=** Actuated-Uncoordinated

Cycle length (s)-Existing cycle length/phasing must be used for existing analysis. A common cycle length must be used for progression along a corridor. Generally common cycle lengths in the region are between 60-120 seconds. On major arterial roads cycle lengths up to 140 seconds are permitted if needed to improve overall progression

Offset (s)- Used in a coordinated traffic signal network. The offset is referenced to the beginning of green on the main street *(phase 2 or 2 & 6).* The offset provided is a percentage of the cycle length and needs to be converted into seconds for Synchro input.

Turn Types:

LEFT-TURN TYPES

- **Split**- Used at intersection where a left-turn and through movement operate on the same protected phase for two opposing directions.
- **Permissive** (Perm)- Left-turning vehicle must yield to oncoming traffic and pedestrians during the solid green ball indication
- **Protected** (Prot)- Left-turning vehicles have a dedicated left-turn arrow and are not permitted to turn on the solid green ball indication.
- **Protected/Permissive** (Pm+Pt)- left-turn movements are protected during the left-turn arrow and permitted during the solid green ball indication

Note: Dual left-turn lanes must be analyzed with either protected or split phasing if there is oncoming traffic. The ROW does not permit dual left-turn lanes to operate with protected/permissive left-turn phasing

RIGHT-TURN TYPES

- **Permissive** (Perm)- Right-turning vehicle must yield to pedestrians during the solid green ball indication.
- **Protected** (Prot)- Right-turning vehicles have a dedicated right-turn arrow and are not permitted to turn on the solid green ball indication.
- **Protected + Overlap** (pt+ov)- A right-turn arrow is displayed in an exclusive right-turn lane with a compatible protected left-turn or through phase. Right-turns are not permitted on the solid green ball indication
- **Permissive + Overlap** (pt+ov)- A right-turn arrow is displayed in an exclusive right-turn lane with a compatible permissive left-turn phase
- **Free**- The right-turn movement is not controlled by a traffic signal indication. Used in cases with channelized right-turn lanes

Note: Dual right-turn lanes must be analyzed with either protected or protected + overlap phasing

Phasing- The main street must be coded as either phase 2 or phases 2 & 6. The side street must be coded as either phase 4 or phases 4 & 8. Left-turn phases should be coded so that there is not a phasing conflict.

Minimum Initial (s)- Refer to the existing timing. For new or modified traffic signals use the following:

- Side street through movements= 8 seconds
- Left-turn phases= 5 seconds

Yellow Time (s)-Refer to the current timing. Otherwise use the following parameters:

- Posted Speed is 60 km/h or less= 4 seconds
- Posted Speed is 70 km/h= 4.2 seconds
- Posted Speed is 80 km/h= 4.6 seconds
- Protected/Permissive left-turn phasing= 3 seconds
- Fully Protected left-turn phasing= 4 seconds

All-Red Time (s)-Refer to the current timing. Otherwise use the following parameters:

- Through movements= 2 seconds
- Protected/Permissive left-turn phasing= 1 second
- Fully Protected left-turn phasing= 2 seconds

Lost Time Adjustment (s)- The total lost time must equal 4 seconds for all movements. Adjust this field accordingly based on the clearance intervals provided or assumed.

Lagging Phase- Generally not used. Only allow a lagging left-turn phase if there are geometry issues that necessitate a lagging protected left-turn phase.

Allow Lead/Lag Optimize? Uncheck this box so that a lagging left-turn phase is not selected during an optimization.

Vehicle Extension Time (s)- Refer to the current timing. Use 3 seconds as a default.

Recall Mode:

- **None**- Use on side streets for semi-actuated and fully-actuated intersections as well as for left-turn lanes with left-turn phasing.
- **Minimum**- Use on the main street for fully-actuated intersections
- **Pedestrian**- Generally not used but can be used on semi-actuated or fully-actuated intersections with consistent pedestrian activity
- **Maximum**- Used on fixed time phases as well as left-turn phases in shared left/through lane configurations

Pedestrian Phase: This box should be checked to accommodate a pedestrian phase within the current cycle. Adequate pedestrian timing should be provided for in all analysis.

Pedestrian Calls (#/hr)- This can be assumed from the turning movement count based on pedestrian volume. Include the assumed number of pedestrian calls for actuated intersections.

Walk Time (s)- Provide a minimum of 10 seconds of walk time, unless our timing differs.

Flashing Don't Walk (s)- Refer to the current timing. We calculate this parameter by measuring the centre of the crosswalk from curb to curb using a walking speed of 1.25 m/s. *FDW= {(Distance measured / 1.25 m/s) – (Amber + All-Red time)}*

Note: If you are proposing a road widening or the addition of auxiliary lanes then you will need to increase the "Flashing Don't Walk" time accordingly to accommodate the longer pedestrian crossing distance.

Reports

Synchro – Lanes, Volumes Timing Report must be provided for signalized intersections including the queues options. Simulation and detector settings are not required. The HCM 2010 Signalized Report **does not** show the detail required for Regional staff to fully access the intersection operations and therefore should **not be used**. The HCM Unsignalized report for TWSC or AWSC must be provided for all stop or yield controlled intersections.

The following measures of effectiveness must be provided in tables contained in the TIS:

- Queue Length (m)- Use 95th percentile. Note if 95th %ile queue exceeds capacity
- Total Delay (s)- Include for each lane/approach
- Volume to Capacity Ratio (v/c)- Include for each lane/approach
- Level of Service- Include for each lane/approach

SimTraffic Requirements

Simulations are sometimes requested by the Region. If using SimTraffic results in a report please explain your reasoning for doing so, opposed to using the Synchro analysis. A queuing and blocking report is often useful to determine the effectiveness of an unsignalized access. Use the following settings:

- **Seeding Time:** generally 5 minutes (or enough time to get a vehicle through the network)
- **Recording Time:** 60 minutes
- **Multiple runs:** 5 minimum, random number seed 0 (zero)

Roundabout Analysis

RODEL or ARCADY analysis is required for roundabouts. Existing roundabouts should use the actual geometric parameters, which can be obtained from the Region upon request. The following inputs should be used when assessing the operation of a proposed or modified roundabout:

Geometric Parameters	Single Lane Entry	Dual-Lane Entry	Triple-Lane Entry
Entry Width (E)*	4.5m	8.0m	11.0m
Effective Flare Length (L')*	30m	30m	30m
Half Width (V)* (Maximum 3.5m per lane)	3.5m	7.0m**	10.5m**
Entry Radius (RAD)	20m	20m	20m
Entry Angle (phi)	25	25	25
Inscribed Diameter (DIA)	40m	55m	70m
Grade Separation (GRAD SEP)	0 or No	0 or No	0 or No

*High influence on capacity **Depends on number of lanes on approach Road

All roundabout analysis must be accompanied by a Roundabout Traffic Flow worksheet that shows the proposed lane configuration for each entry and exit of the roundabout. This worksheet can be found on the Region's Website under Doing business-> Design Standards-> Guidelines.

Arcady Analysis Notes

The following settings are to be used for roundabouts located or proposed on Regional Roads:

- **Default Driving Side:** Drive on Right
- **US Terminology:** True
- **Traffic Profile Type:** ONE HOUR.
- **Model Time Period Length:** 90 minutes
- **Time Segment Length**: 15 minutes

Additionally to calibrate the analysis to reflect current driver behavior the Advanced Options menu needs to be enabled. The following intercept adjustments are required:

- **Opening Day - 10 year horizon:** adjust each leg to have an 85 % intercept adjustment
- **10+ year horizon:** adjust each leg to have a 90 % intercept adjustment

Rodel Analysis Notes

The following settings are to be used for roundabouts located or proposed on Regional Roads:

- **Time Period:** 90 minutes
- **Time Slice:** 15 minutes
- **Results/ Flow Periods:** 15 75 minutes

Traffic Signal Warrants

Existing Conditions Signal Warrant Analysis

- Signal warrants for existing conditions must be completed as per the most recent version of the Ontario Traffic Manual - Book 12, Traffic Signals. Based on this method, engineering judgment may indicate that traffic control signals are not warranted if there is, for example, poor geometrics such as inadequate sight distance; spacing too close to another signal or roundabout (less than 200m); expected multi-lane queues blocking a full-moves driveway causing a potential collision problem with vehicles turning left-in and left-out through queues, or other traffic operational issues.
- If the signal warrant is met for existing conditions then there is no need to analyze traffic signal warrants for future conditions, unless future road improvements are expected to divert a significant amount of traffic away from the intersection.
- Assumptions: Warrants for traffic control signals are based on a typical weekday rather than the peak day of the week. Volumes in channelized right-turn lanes are not included in warrant calculations unless the right-turn traffic spills back into the adjacent through lane.

- Unwarranted traffic control signals are not recommended, even if a developer or a local municipality is willing to pay for them.
- The Region may consider installing underground provisions and auxiliary lanes for unwarranted traffic control signals if engineering judgement indicates that the intersection geometry would be suitable for signals and if a developer or local municipality is willing to pay 100% of the cost with the understanding between the Region and the developer or local municipality that there is no guarantee that the signals will ever be installed.

Future Conditions Signal Warrant Analyses

- Signal warrants for future conditions for an existing or new intersection must be completed as per the most recent version of Section 4.10a of the Ontario Traffic Manual - Book 12, Traffic Signals.
- Signal warrants shall be completed for all phases of a development (if necessary) up to and including full build-out. Signal warrants shall be completed for the 1, 5 and 10-year horizon years. Once a traffic signal warrant has been met for a future condition, there is no need to analyze traffic signal warrants for scenarios further into the future, unless future road improvements are expected to divert a significant amount of traffic away from the intersection..
- The Region will consider the installation of signals in the current year where warrants for future conditions are expected to be met within one year.

Note: These requirements should be used in conjunction with the Transportation Impact Study (TIS) Guidelines as well as other related documents. These documents can be found on the Region of Waterloo website under Doing business-> Design Standards-> Guidelines.

Requests for Information

Requests for signal timing information, traffic counts, collision history, roundabout parameter drawings, or questions relating to the topics covered above should be sent to:

REGIONAL MUNICIPALITY OF WATERLOO
TRANSPORTATION AND ENVIRONMENTAL SERVICES DIVISION
150 Frederick Street, 7th Floor
Kitchener ON N2G 4J3
Phone: 519-575-4558
Fax: 519-575-4453
Email: transportation@regionofwaterloo.ca