CITY OF VANCOUVER

GUIDELINES FOR USING SYNCHRO VERSION 10

Revision 1.4

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PARSONS

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1.0 INTRODUCTION

This document provides details on using Synchro Version 10 to perform traffic analyses with City of Vancouver specific inputs. The document is intended for both City Staff and consultants who are a beginner or advanced users of the software. Users of this document are also referred to City of Vancouver Traffic Signal Timing Guidelines for additional context and information related to signal timing operations.

A how-to guide on using the software is presented in addition to City of Vancouver specific conventions, a discussion of data inputs that deviate from default values, a coding example, and a glossary of terms. It is noted that modelling of existing conditions may require variances to some of the following Guidelines to provide an actual representation of existing conditions. These variances must be discussed with City staff prior to proceeding. This guide is also relevant to Synchro 11 users. However, new features such as the Scenario Manager and the default Bing Maps are not incorporated.

1.1 BACKGROUND

Synchro is a widely used macroscopic software used for modelling, optimizing, managing, and simulating transportation networks. The City of Vancouver uses Synchro to conduct operational and planning analyses. The guidelines were developed to provide guidance for City staff and consultants working for the City when developing transportation models and conducting traffic analysis using Synchro Version 10.

This City of Vancouver Synchro User Manual provides specific guidelines and standards and is intended for users working on City of Vancouver projects. Users responsible for analyzing City of Vancouver transportation networks using Synchro shall comply with the guidelines and standards detailed in this document. Upon completion of the traffic analysis using Synchro, the user is responsible for submitting the Synchro files to the City of Vancouver such that City staff can review the modelling assumptions, input parameters, and analysis of the associated transportation network. Any assumptions made by the user that do not comply with this document's guidelines and standards or are rejected by the City of Vancouver may be required to resubmit the Synchro files. Note that bus lanes are not typically modelled in Synchro, but rather using traffic microsimulation tools such as VISSIM, Aimsun, or Paramics.

1.2 DOCUMENT STRUCTURE

This Synchro User Manual is composed of six main sections as follows:

1. Introduction
2. City of Vancouver Conventions
3. Data Input Guidelines
4. How-To Guidelines
5. Coding Example
6. Glossary

The City of Vancouver Conventions section provides the user with specific conventions prescribed by the City of Vancouver that accounts for local variances from default values.

The Data Input Guidelines, How-To Guidelines, Coding Example, and Glossary sections are categorized into sub-sections corresponding to the order of the setting tabs presented in Synchro: Map Settings [F2], Lane Settings [F3], Volume Settings [F4], Node Settings [F5/F6], Timing Settings [F5], and Phasing Settings [F6].

The Data Input Guidelines section provides the user with the Synchro input parameters prescribed by the City of Vancouver. This section is intended for intermediate to advanced Synchro users who are familiar with the software and are only interested in understanding Vancouver specific data inputs.

The How-To Guidelines section provides the user with detailed step-by-step instructions for coding a transportation network in Synchro. A coding example is also shown in the Section 5.0. These two sections are intended for beginner to intermediate Synchro users who are not familiar with the software.

The Glossary section provides the user with a brief description of the terminology used in each of the Synchro setting tabs.

2.0 CITY OF VANCOUVER CONVENTIONS

This section provides the user with City of Vancouver conventions that account for the local context for using Synchro. This section is intended for all Synchro users.

2.1 UNITS AND DIRECTIONALITY

All City of Vancouver transportation networks must be coded in metric units. The City of Vancouver can be classified into two areas defined by the road network directionality: 45° and 90° directionality areas, as shown in ***Figure 2.1*** below. The 45° directionality area, as shown in green, encompasses downtown Vancouver. Roads within this area are generally oriented 45 degrees from the true north. The 90° directionality area, as shown in blue, encompasses the area outside of downtown Vancouver. Roads within this area are generally oriented with the true north. The analyst shall ensure that the orientation of the coded road network is in-line with the above directionality.

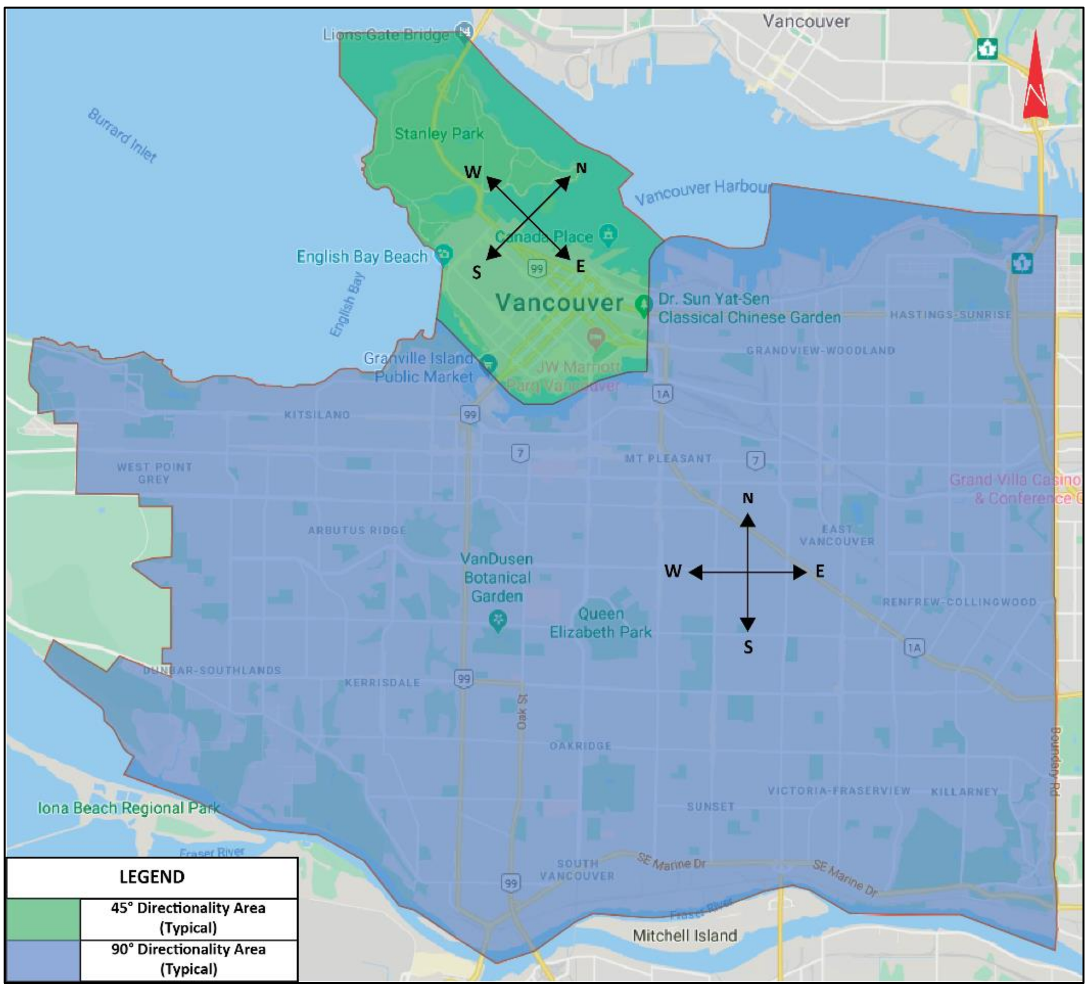

Figure 2.1: City of Vancouver – Directionality

2.2 OVERSATURATED CONDITIONS

If existing traffic conditions are oversaturated (demand exceeds capacity with a v/c ratio greater than 1.0), then traffic count data may not capture the full extent of demand, as the number of vehicles arriving may be greater than the number of vehicles that can be processed. Therefore, if only the traffic count data is used as an input in oversaturated conditions, Synchro outputs may underrepresent the actual traffic conditions. To ensure a more accurate and realistic model, unmet demand should be added to the corresponding turning movements by accounting for residual queues. For sites with oversaturated traffic conditions, data on residual queues should be collected for each signal cycle and then averaged over the analysis period. The number of vehicles and cycles taken for back of queue vehicles to clear the intersection should also be recorded and added to the traffic count. Another method to capture demand data would be to collect additional traffic counts at upstream locations away from any queuing, given that there is no significant sink or source that would cause volume imbalances.

2.3 TRAFFIC SIGNAL CONTROL TYPES

Traffic signals can be classified into different control types that cater to their localized environment. They may operate independently of any other traffic signal or their operation may be related to other traffic signals (coordinated) forming a traffic control signal system. The City of Vancouver currently operates traffic signals with either Fixed Time, Pedestrian/Bicycle, Semi-Actuated, Fully Actuated, or Emergency Vehicle Actuation modes of operation. The control type terminology adopted by the City of Vancouver deviates from the terminologies used in Synchro and are detailed in ***Table 2.1*** below to provide the analogous control types.

Table 2.1: CoV vs Synchro Control Type Terminology

COV CONTROL TYPE	SYNCHRO CONTROL TYPE	DESCRIPTION
Fixed Time (FxT)	Pretimed	The duration of each phase is fixed throughout a time of day plan alternating between the main street and side street. Timings are all pre-determined.
Fixed Time with Actuated Turn (FxT)	Semi-Actuated	The duration of the through and side street phases remains constant; however, left or right-turns can be actuated.
Pedestrian/Bicycle (Ped/Bike)	Semi-Actuated Uncoordinated	Maintains the through phase for the main street unless a pedestrian or cyclist push-button is actuated. The side streets are stop sign controlled, which requires vehicles/cyclists to stop before proceeding through the intersection. For a conservative analysis, use a pedestrian recall mode.
	Actuated Coordinated	
Semi-Actuated (SA)	Semi-Actuated Uncoordinated	Maintains the through phase for the main street unless a side street vehicle detector is actuated. Control type can be uncoordinated or coordinated.
	Actuated Coordinated	
Fully Actuated (FA)	Actuated Uncoordinated	Every movement contains vehicle, cyclist, and/or pedestrian detectors that moderate the length of green time based on the current vehicle demand. Control type can be uncoordinated or coordinated depending.
	Actuated Coordinated	
Emergency Vehicle Actuation (Fire Signal)	Semi-Actuated	Can only be actuated by a Fire Hall.

2.4 PHASE DEFINTIONS

Each signalized intersection is generally composed of eight phases. A group of phases are classified into rings, as shown in blue in the figures below. Ring 1 is composed of Phases 1 through 4, while Ring 2 is composed of Phases 5 through 8.

A barrier, as shown in red below, separates Phases 1/2/5/6 from Phases 3/4/7/8. This barrier acts as to prevent conflicting traffic from entering an intersection while the adjacent traffic is in operation. Only one phase from each ring is active at any given time since phases are read from left to right.

When assigning phases to a signalized intersection, Phases 2 and 6 are typically assigned to main street movements. These two phases can be assigned as the coordinated phases. If the main street is aligned in the north/south direction, assign the phases as per ***Figure 2.2*** while if the main street is aligned in the east/west direction, assign the phases as per ***Figure 2.3***.

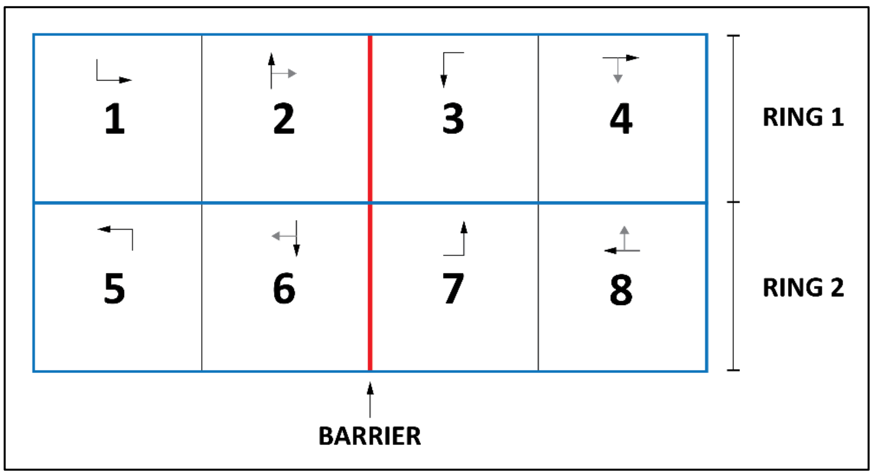

Figure 2.2: Phase Definition for North/South Main

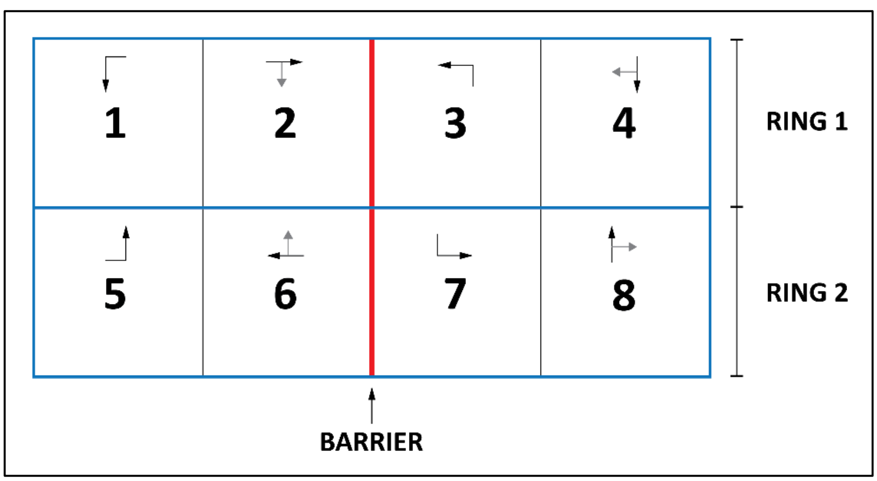

Figure 2.3: Phase Definition for East/West Main

2.5 SIGNAL TIMINGS

2.5.1 Traffic Signals

Typical conventions for City of Vancouver traffic signals are outlined in ***Table 2.2***. Where exceptions occur, refer to the traffic signal record.

Table 2.2: Traffic Signals Conventions

INTERVAL TYPE	CONVENTION
Minimum Vehicle Green Intervals	• Protected/Permissive Turn Phase: 5.0 seconds • Protected Only Phase (Left/Right): 8.0 seconds • Main Street Through at a Fully Actuated Intersection: 10.0 seconds • Main Street Pedestrian/Bicycle Signal: 16.0 seconds • Main Street Through at a Semi-Actuated Signal: 16.0 seconds • Side Street Through: 10.0 seconds • Side Street Through without Cyclist Actuation: 8.0 seconds
Amber Clearance Intervals[1]	• Left-Turn or Right-Turn (Protected Only): 3.5 seconds • Left-Turn or Right-Turn (Protected/Permissive): 4.0 seconds • Through: 3.5 seconds
All-Red Clearance Intervals[1]	• Pedestrian / Bicycle Signal: 2.5 seconds • Full Intersection / Protected Only Phase: 1.5 seconds • Protected/Permissive Phase: 0.0 seconds • Leading Pedestrian Interval: 5.0 seconds (Recommend coding a 5.0 second dummy phase instead of an all-red interval)

1 - For large / skewed intersections, use the methodology in the Canadian Capacity Guide for Signalized Intersections (Section 3.3.3) to confirm minimum requirements.

2.5.2 Bike and Pedestrian Facilities for Signalized Intersections

Conventions for City of Vancouver bike and pedestrian facilities for signalized intersections are outlined in ***Table 2.3***.

Table 2.3: Bike and Pedestrian Signals Conventions

PARAMETER	CONVENTION
Pedestrian Walk Times	A minimum of 7.0 seconds of initial walk time shall be provided for pedestrian/bicycle signals unless rationale is provided to City Staff. In areas with higher pedestrian volumes and/or where pedestrian storage is an issue, the walk duration can extend beyond 7.0 seconds.
Bike Signal Phasing and Timing	Generally, bike/vehicle intergreen phases coincide and intergreen period does not need to be modified for cyclist facilities. However, the minimum green time for bike phases is 10 seconds. To increase safety, throughput, and/or convenience of cyclists, a protected-only phase must be implemented. Please see the Signal Timing Guideline for details of when a protected only phase should be implemented.
Pedestrian Clearance Timing / Interval	Pedestrian Flash Don't Walk (FDW) time, in seconds, is 7 seconds or calculated by subtracting the vehicle intergreen period from the crosswalk midpoint pedestrian walk time as shown in the formula below, whichever is greater: $FDW = \frac{D}{S} - Y - AR$ where: D = Curb-to-Curb Crossing Distance at the Middle of the Crosswalk (m) S = Walk Speed (m/s) = 1 m/s Y = Amber Interval (s) AR = All-Red Interval (s)

2.6 OPTIMIZATION

Optimization of traffic signals is an important consideration when analysing traffic operations. The intent of optimization is to provide smooth flow of traffic along arterial streets in order to maximize person-throughput, stops, delay and fuel consumption. Generally, the Synchro network should be coded to reflect at least one intersection both upstream and downstream of the study area to capture appropriate arrival platoons when assessing network optimization.

2.6.1 Cycle Length

Cycle lengths should be optimized with preference to a lower cycle length, where feasible, for both peak and non-peak hours to minimize pedestrian/cyclist and side street delays while minimizing significant impacts to main street traffic operations. A maximum cycle length of 135 seconds is permitted only in locations well outside of the metro core. In the Downtown area, all cycle lengths are generally coordinated at 65 seconds.

2.6.2 Signalized Splits

Signalized splits should be optimized to maximize person-throughput and must account for the minimum time to serve pedestrians crossing an intersection at a walk speed of 1.0 m/s.

2.6.3 Signal Coordination

Signal coordination should be optimized, where feasible, to reduce stops and allow for maximizing person-throughput along a corridor. Therefore, transit corridors should be favoured during the peak periods. The analyst shall prioritize user experience when optimizing signal coordination and adjust the offset value for each intersection along the corridor being analyzed based on the distance and design speed between each intersection.

Factors including queuing, delay and resultant level of service, and continuous progression through the corridor should be considered in conjunction with the time-space diagram. The City of Vancouver is divided into discrete coordination zones / corridors to categorize similar cycle lengths and time of day plans. Within these zones, corridor coordination should be prioritized. A graphic highlighting these zones is provided in ***Figure 2.4***. Revisions to the coordination zones may occur, and it is recommended to confirm the coordination boundaries with the City of Vancouver prior to modelling.

Consideration should also be made for coordinating signals for active transportation modes. The difference in acceleration and speed should be taken into account where separate facilities exist for each mode. Select corridors may be prioritized for active transportation signal coordination.

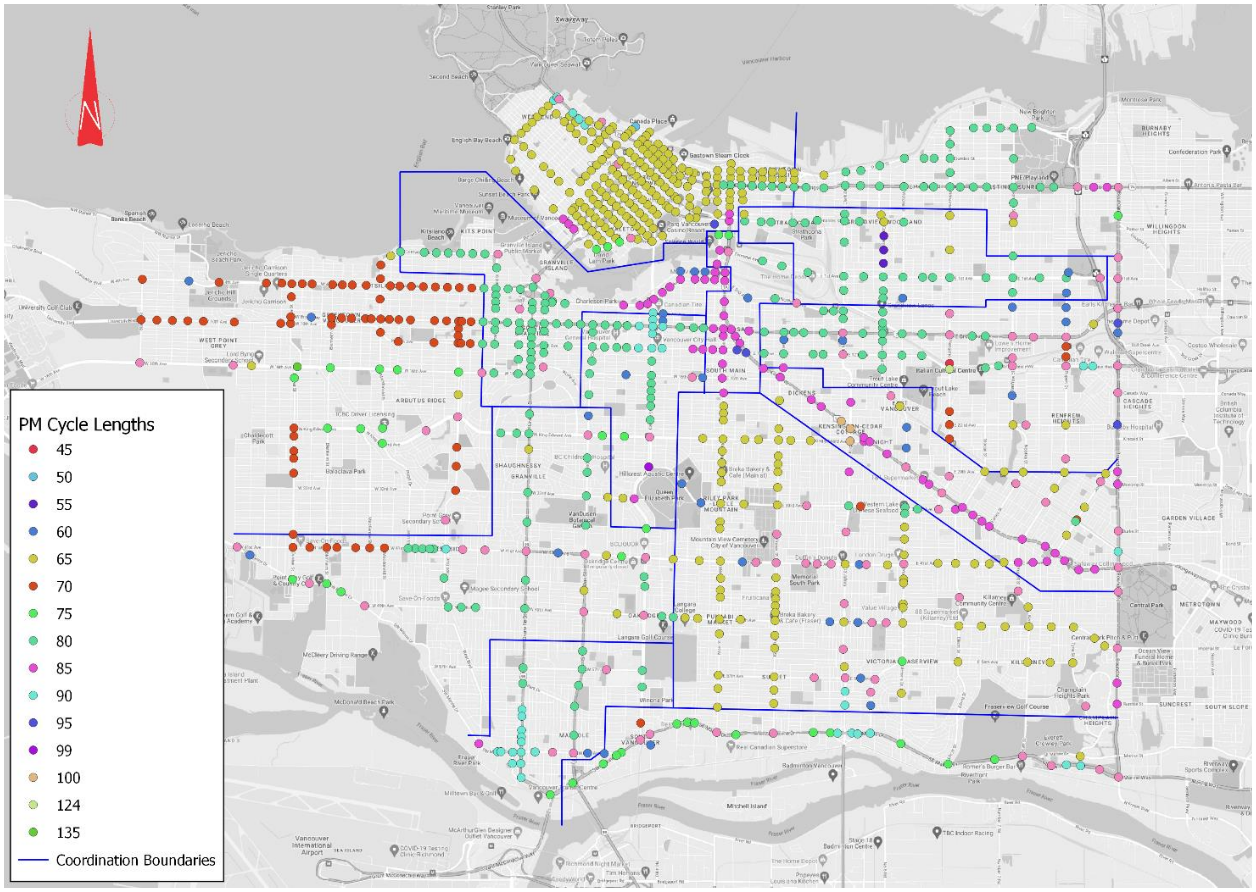

Figure 2.4: City of Vancouver Traffic Signal Coordination / Cycle Length Zones

2.7 SOFTWARE COMPARISON: SYNCHRO VS SIMTRAFFIC

SimTraffic is a built-in software in Synchro used for the animation and simulation of traffic, while Synchro is a macroscopic tool for analyzing intersection traffic operations. SimTraffic is a microscopic model used to simulate a wide variety of traffic controls. Each vehicle in the traffic system is individually tracked through the model and operational measures of effectiveness are collected on every vehicle during each 0.1-second of the simulation. Unlike Synchro, SimTraffic measures the full impact of queuing and blocking. While Synchro and SimTraffic have a variety of common input parameters, SimTraffic often requires additional simulation inputs. Key SimTraffic parameters are listed below and include:

- Storage Length;
- Right Turn Channelized Inputs;
- Link OD Volumes;
- Traffic in Shared Lane;
- Mandatory Stop on Yellow;
- Detector Settings;
- Taper Length;
- Turn Speed; and
- Seeding/Recording Time and Multiple Runs.

Queues in SimTraffic can impact the operations of adjacent intersections while in Synchro, queues are not modelled on an individual vehicle basis but on a statistical basis and therefore do not interfere with movements at adjacent approaches / intersections.

Generally, SimTraffic provides a visual representation of the expected traffic conditions for existing or future scenarios. SimTraffic can be used for verifying signal phasing and corridor coordination. Some important elements to consider before using SimTraffic include:

- Larger computer time and storage requirements. This can be improved by running models on a local drive instead of on a network drive and limiting the size of the model.
- Does not optimize signal timing. Model must be re-recorded after making changes in Synchro.
- Calibration of simulation models is time consuming.
- A single error can cause inaccurate results at all study intersections.
- Calibrating a SimTraffic model can be a time-consuming process, but it is an important step in the traffic modeling process.

When using SimTraffic, the number of runs, along with the seeding/recording times are dependent on the size of the model. The following rules should be followed:

- Model consists of three or fewer intersections
  - 3 to 5 runs
  - 10 minute seeding time
  - 60 minute recording time
- Model consists of more than three intersections
  - 5 to 10 runs
  - 10 minute seeding time
  - 60 minute recording time

Please refer to the official Synchro Studio 10 User Guide for more details.

2.8 METHODOLOGY AND OUTPUTS

2.8.1 Methodology Comparison: Synchro vs HCM

Synchro results can be calculated and presented using two different methodologies: Intersection Capacity Utilization (ICU) Methodology or Highway Capacity Manual (HCM) Methodology (HCM 6th Edition/HCM 2000/HCM 2010). The ICU Methodology uses a more direct and robust approach for analyzing intersection operations, while the HCM Methodology is more rigid. For example, HCM calculations can only be conducted using specific phasing inputs. By default, Synchro uses the ICU methodology for the calculations in the LANE SETTINGS [F3], VOLUME SETTINGS [F4], NODE SETTINGS [F5/F6], TIMING SETTINGS [F5], and PHASING SETTIGNS [F6] windows. City of Vancouver accepts results calculated and reported using the ICU Methodology, unless otherwise stated. Refer to the official Synchro Studio 10 User Guide for more detail.

2.8.2 Synchro Outputs

As a baseline, Synchro results presented to the City of Vancouver must be calculated using the ICU Methodology and include Observed Volumes, Delay, Level of Service (LOS), 50th Percentile Queue, 95th Percentile Queue for each lane/approach, as well as the Intersection Overall LOS. The analyst shall provide the City with additional data upon City of Vancouver's request and shall present the data in a format similar to the one shown in ***Figure 2.5***.

SCENARIO	INT ID	LOCATION	CONTROL TYPE	DESCRIPTION	MOE	APPROACH																INTERSECTION OVERALL
						EB				WB				NB				SB				
						EBL	EBT	EBR	Total	WBL	WBT	WBR	Total	NBL	NBT	NBR	Total	SBL	SBT	SBR	Total	
SCENARIO DESCRIPTION	1	LOCATION 1	CONTROL TYPE 1	DESCRIPTION 1	Observed Volume																	
					Delay (s / veh)																	
					LOS																	
					95th %ile Queue (m)																	
	2	LOCATION 2	CONTROL TYPE 2	DESCRIPTION 2	Observed Volume																	
					Delay (s / veh)																	
					LOS																	
					95th %ile Queue (m)																	
	3	LOCATION 3	CONTROL TYPE 3	DESCRIPTION 3	Observed Volume																	
					Delay (s / veh)																	
					LOS																	
					95th %ile Queue (m)																	
	4	LOCATION 4	CONTROL TYPE 4	DESCRIPTION 4	Observed Volume																	
					Delay (s / veh)																	
					LOS																	
					95th %ile Queue (m)																	
	5	LOCATION 5	CONTROL TYPE 5	DESCRIPTION 5	Observed Volume																	
					Delay (s / veh)																	
					LOS																	
					95th %ile Queue (m)																	

Figure 2.5: Synchro Formatted Output Table Sample

Any Delay value or LOS letter that exceeds the threshold shown in ***Table 2.4*** shall be colour-coded.

Table 2.4: Delay and Level of Service Text Colour

DELAY (S/VEH)	LEVEL OF SERVICE (LOS)
≤ 10	A
≤ 20	B
≤ 35	C
≤ 55	D
≤ 80	E
> 80	F

3.0 DATA INPUT GUIDELINES

This section provides the user with data input guidelines prescribed by the City of Vancouver. This section is intended for intermediate to advanced Synchro users who are familiar with the software. If the user is a beginner to intermediate Synchro user who is not familiar with the software, read Section 4.0 and 5.0 containing a step-by-step how-to guide and coding example, respectively.

Table 3.1: City of Vancouver – Synchro Data Input Guidelines

PARAMETER	SYNCHRO DEFAULT VALUE	COV STANDARD VALUE (WHERE FIELD DATA NOT AVAILABLE)	JUSTIFICATION
LANE SETTINGS [F3]			
Lanes and Sharing (#RL)	None	Existing or future lane/sharing configuration.	
Street Name	None	Full street name.	
Link Speed (km/h)	48	50 km/hr unless otherwise posted.	
Ideal Satd. Flow (vphpl)	1900	• Downtown = 1,800 vph (CBD must be toggled ON) • Non-Downtown = 1,900 vph	Based on saturation flow rate surveys of nine different intersections in the City. For Downtown intersections, the Central Business District (CBD) must be toggled = ON to reflect reduced saturation flows.
Lane Width (m)			
Non-Bus/Truck Route Travel Lanes	3.7	Non-Curb (General) Lane: 3.2 Curb Lane: 3.4	Value obtained using "City of Vancouver Engineering Design Manual (2019)". Preferred Width used and values were averaged where available.
Bus/Truck Route Travel Lanes	3.7	Non-Curb (General) Lane: 3.3 Curb Lane: 3.6 Single Lane Against Curb: 3.7	Value obtained using "City of Vancouver Engineering Design Manual (2019)". Preferred Width used and values were averaged where available.
Residential Route Travel Lanes	3.7	Low-Zoned Laneway: 1.8 High-Zoned Laneway: 3.0	Value obtained using "City of Vancouver Standard Detail Drawings Roadworks (2018)". Typical Width used and values were averaged where available.
Grade (%)			
Grade Data Available	0	Existing or future grade.	
Grade Data Unavailable	0	Approach is Typical: 0 Approach is Steep: 5	As per "City of Vancouver Engineering Design Manual (2019)", minimum grade is 0.5-1.0%, preferred grade is 1.0-1.5%, and maximum grade is 10.0-12.0%. Typical grade set as 0% since approach having grade of 1.0-1.5% will be hard to decipher. Steep grade set as 5% since it is the average between the minimum and maximum grades.

PARAMETER	SYNCHRO DEFAULT VALUE	COV STANDARD VALUE (WHERE FIELD DATA NOT AVAILABLE)	JUSTIFICATION
Area Type CBD	Unchecked Box	Area with No CBD characteristics: Unchecked Box Area with CBD characteristics (Downtown): Checked Box.	I.e. CBD Checked for modelling of Downtown Vancouver
Storage Length (m)	0	Existing or future storage length (excludes taper length).	
Storage Lanes (#)	None	Existing or future number of storage lanes.	
Right Turn Channelized	None	Channelized Right Turn Not Present: None Channelized Right Turn Present: Yield, Free, Stop, Signal	
Curb Radius (m)	15	Existing or future curb radius.	
Add Lanes (#)	None	Existing or future number of additional channelized right turn lanes.	
Lane Utilization Factor	Calculated Default	Lane Utilization Factor can either use default values if lane volumes are balanced or calculated if lanes are significantly imbalanced based on if lane data is available.	
Right Turn Factor	Calculated Default	Default value unless field data available.	
Left Turn Factor (prot)	Calculated Default	Default value unless field data available.	
Saturated Flow Rate (prot)	Calculated Default	Default value unless field data available.	
Left Turn Factor (perm)	Calculated Default	Default value unless field data available.	
Saturated Flow Rate (perm)	Calculated Default	Default value unless field data available.	
Right Turn on Red?	Checked Box	RTOR Not Allowed: Unchecked Box RTOR Allowed: Checked Box	RTOR must be unchecked if there is a corresponding protected only signal phase. In addition, if the right-turn conflicts with a bi-directional cycle track, then RTOR must be unchecked.
Saturated Flow Rate (RTOR)	Calculated Default	Default value unless field data available.	
Link is Hidden	Unchecked Box	Default setting.	
Hide Name in Node Title	Unchecked Box	Default setting.	

PARAMETER	SYNCHRO DEFAULT VALUE	COV STANDARD VALUE (WHERE FIELD DATA NOT AVAILABLE)	JUSTIFICATION
VOLUME SETTINGS [F4]			
Traffic Volume (vph)	None	Reference traffic count data - traffic volumes. If survey provides unmet demand, analyst should adjust traffic volumes using their judgement.	
Conflicting Peds. (#/hr)	0	Reference traffic count data - conflicting pedestrians.	
Conflicting Bicycles (#/hr)	0	Reference traffic count data - conflicting bicyclists.	
Peak Hour Factor			
15-Minute Volume Data Available	0.92	Reference traffic count data and calculate peak hour factor.	
15-Minute Volume Data Unavailable	0.92	AM Peak: 0.93 PM Peak: 0.94	Value obtained using 2014-2016 turning movement count data for 88 intersections.
Growth Factor	1	Default value.	Future volume to be calculated externally and imported into Synchro model.
Heavy Vehicle (%)			
Heavy Vehicle Data Available	2	Reference traffic count data and calculate heavy vehicle percentage.	
Heavy Vehicle Data Unavailable and Non-Truck Route	2	Main Street: 2% Side Street:0%	
Heavy Vehicle Data Unavailable and Truck Route	2	7.5% (or higher) *Mid-day heavy vehicle percentage may be higher	Value obtained using 2014-2016 turning movement count data. Major truck routes were used including Marine Dr, Main St, Knight St, Clark Dr, and Boundary Rd.
Bus Blockages (#/hr)	0	If bus stop is in-lane, reference TransLink Bus schedule to determine bus frequencies. Assume buses always stop.	
Adj. Parking Lane?	Unchecked Box	Adjacent Parking Lane Not Present: Unchecked Box Adjacent Parking Lane Present: Checked Box	
Parking Maneuvers (#/hr)	None	Default value unless field data available.	
Traffic from Mid-block (%)	0	Default value unless field data available.	
Traffic in Shared Lane (%)	None	Default value unless field data available.	

PARAMETER	SYNCHRO DEFAULT VALUE	COV STANDARD VALUE (WHERE FIELD DATA NOT AVAILABLE)	JUSTIFICATION
NODE SETTINGS [F5/F6]			
Control Type	Pretimed	Reference traffic signal record - control type. *Refer to Section 2.3 for more information.	
Cycle Length (s)	45	Reference traffic signal record - cycle length.	
Lock Timings	Unchecked Box	Data Not Inputted for [F5] and [F6]: Unchecked Box Data Inputted for [F5] and [F6]: Checked Box	
Optimize Cycle Length	Toggle Available	Parameter provides optimization as per Synchro standards. Analyst to optimize as per Section 2.6.	
Optimize Splits	Toggle Available	Parameter provides optimization as per Synchro standards. Analyst to optimize as per Section 2.6.	
Offset (s)	0	Reference traffic signal record - offset.	
Offset Reference To	Begin of Green	Default setting.	
Offset Reference Phase	2+6 - NBTL SBTL	2+6 - Main Street / 4+8 - Side Street	
Master Intersection	Unchecked Box	Reference traffic signal record - offset of 0s indicates master intersection.	
Yield Point	Single	Default setting.	
Mandatory Stop On Yellow	Unchecked Box	Default setting.	
TIMING SETTINGS [F5]			
Turn Type	Perm	Reference existing/future site condition turn types and/or traffic signal record - turn type.	
Protected Phases			
Phase Definition Available	4/8/2/6	Reference traffic signal record - phase definitions.	
Phase Definition Unavailable	4/8/2/6	Main Street Movements: Use Phase 2 and 6 Side Street Movements: Use Phase 4 and 8	

PARAMETER	SYNCHRO DEFAULT VALUE	COV STANDARD VALUE (WHERE FIELD DATA NOT AVAILABLE)	JUSTIFICATION
		*Reference Section 2.4 for more information.	
Permitted Phases			
Phase Definition Available	4/8/2/6	Reference traffic signal record - phase definitions.	
Phase Definition Unavailable	4/8/2/6	Main Street Movements: Use Phase 2 and 6 Side Street Movements: Use Phase 4 and 8 *Refer to Section 2.4 for more information.	
Detector Phases	4/8/2/6	Default value.	
Switch Phase	0	Default value.	
Leading Detector (m)	30.5 for Through / 6.1 for Left & Right	Only needs to be entered for actuated signals and does not need to be entered for the main street approaches of semi-actuated and coordinated signals. For protected / permitted left-turns, refer to Section 4.8 for more information.	Protected / permitted left-turns require 3 cars minimum
Trailing Detector (m)	0	Default value.	In Synchro, trailing detectors are defined as extension detectors only.
Lost Time Adjust (s)	0	Peak Period: -1 second Off-Peak Period: 0 second	
PHASE SETTINGS [F6]			
Minimum Initial (s)	5	Reference traffic signal record - minimum green.	
Minimum Split (s)	22.5	Reference traffic signal record and/or calculate minimum split.	
Maximum Split (s)	22.5	Reference traffic signal record and/or calculate maximum split.	
Yellow Time (s)	3.5	Reference traffic signal record - yellow-time.	
All-Red Time (s)	1	Reference traffic signal record - all-red time.	
Lagging Phase?	Unchecked	Default unchecked unless otherwise specified.	
Allow Lead/Lag Optimize?	Unchecked	Default unchecked unless otherwise specified.	
Optimize Phs Weights - Delays	1	Default value.	

<table>
<tr><th>PARAMETER</th><th>SYNCHRO DEFAULT VALUE</th><th>COV STANDARD VALUE
(WHERE FIELD DATA NOT AVAILABLE)</th><th>JUSTIFICATION</th></tr>
<tr><td>Vehicle Extension (s)</td><td>3</td><td>3</td><td></td></tr>
<tr><td>Minimum Gap (s)</td><td>3</td><td>1.5</td><td></td></tr>
<tr><td>Time Before Reduce (s)</td><td>0</td><td>Default value.</td><td></td></tr>
<tr><td>Time to Reduce (s)</td><td>0</td><td>Default value.</td><td></td></tr>
<tr><td>Recall Mode</td><td>Max</td><td>Reference traffic signal record - recall mode.</td><td></td></tr>
<tr><td>Pedestrian Phase</td><td>Checked Box</td><td>Pedestrian Phase Not Present: Unchecked Box
Pedestrian Phase Present: Checked Box</td><td></td></tr>
<tr><td>Walk Time (s)</td><td>7</td><td>Reference traffic signal record - walk time.</td><td></td></tr>
<tr><td>Flash Don’t Walk (s)</td><td>11</td><td>Reference traffic signal record - flash don’t walk.</td><td></td></tr>
<tr><td>Pedestrian Calls (#/hr)</td><td>0</td><td>If pedestrian call data is available, enter the data to the corresponding intersection phase. If no call data is available, use the values below:
<table>
<tr><th>Pedestrians / Hour</th><th>Calls / Hour</th></tr>
<tr><td><10</td><td>0</td></tr>
<tr><td>>=10 and <100</td><td>10</td></tr>
<tr><td>>=100</td><td>60</td></tr>
</table></td><td></td></tr>
<tr><td>Dual Entry</td><td>Checked Box</td><td>Default setting.</td><td></td></tr>
<tr><td>Fixed Force Off</td><td>Checked Box</td><td>Reference traffic signal record – fixed force off.</td><td>When this parameter is set to:
• On – Extra time is given to side streets; and
• Off – Extra time is given to main streets.</td></tr>
</table>

4.0 HOW-TO GUIDELINES

This section provides the user with detailed step-by-step instructions for coding City of Vancouver transportation networks in Synchro Version 10 and is intended for beginner to intermediate users who are not familiar with the software. A coding example is shown in Section 5.0. This guide is also relevant to Synchro 11 users. However, new features such as the Scenario Manager and the default Bing Maps are not incorporated. The following key input guidelines corresponding to the Synchro data input tabs are provided in this section and detailed sequentially in the order that the analyst should proceed with.

- Map Settings [F2]
- Lane Settings [F3]
- Volume Settings [F4]
- Node Settings [F5/F6]
- Timing Setting [F5]
- Phasing Settings [F6]
- Confirmation of Timing and Phasing Settings [F5/F6]

4.1 MAP SETTINGS [F2]

The MAP SETTINGS enable the user to import aerial images and code the transportation network. This settings window is shown when the program is first initialized, or it can be accessed by pressing [F2]. Typically, the user will overlay aerial images into the background, draw the existing transportation network, set-up the correct units, and import csv files containing information relevant to the analysis. The “Home”, “Options”, and “Transfer” tabs, as shown in ***Figures 4.1*** to ***4.3***, are modified. Each tab is labelled and a description corresponding to the label can be found below.

A. Home Tab

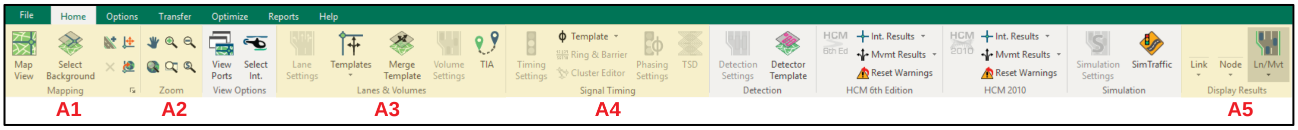

Figure 4.1: Map Settings [F2] – Home Tab

A1. Mapping

A1.1. Overlaying Aerial Image

1. Home tab > Mapping panel > Click "Select Background".
2. In the "Select Backgrounds" dialogue box,
   a. Click "Bing Region List".
   b. Click "Create Bing Region".
3. In the "Create Bing Region" dialogue box, navigate to the desired study area.
   a. Click "Select Region" to mark the boundaries of the desired study area.
   b. Set a reference point inside the desired study area.
   c. Click "Next".
4. In the "Set Synchro Reference Point" dialogue box, enter the X and Y World Coordinates (if applicable), otherwise use default. Click "Ok".

Note(s)
• After overlaying the aerial image, you can go to the "Select Backgrounds" dialogue box to rename the region and hide/remove the aerial image. • After the network has been coded and to ensure the Synchro interface is not slow, it is recommended that you hide the aerial image when analyzing the network.

A1.2. Drawing Links (Roads)

1. Home tab > Mapping panel > Click the "Add Link (A)" button (or press [A]).
2. In the drawing area, draw the links on the overlaid aerial image.
3. To further adjust the link you drew, click on the link > right-click on the link. If you want to:
   a. Delete a link, click delete (or press [Delete]). In the "Confirm" dialogue box, click "Yes".
   b. Add curvature to a link, click "Add Curvature". Click the square points (curvature points) and move the points until the link is aligned with the curved geometry of the road in the overlaid aerial image.

Note(s)
• Generally, draw one link for each street/corridor. • Ensure links are offset downstream of the intersections that are at the study area boundary. You do not want the beginning/end of the links to stop at an intersection.

A1.3. Drawing Nodes (Intersections)

1. Home tab > Mapping panel > Click the "Add Link (A)" button (or press [A]).
2. In the drawing area, draw the main street links on the overlaid aerial image. To create:
   a. Intersecting nodes, draw secondary adjacent side street links on the overlaid aerial image that connects the main street links – nodes will automatically be generated.
   b. Non-intersecting nodes (i.e. on/off ramps, bridges, etc. that is above a road), hold down [Ctrl] while drawing the links – nodes will not be generated.

Note(s)
Connecting two linear links together form a node. Add curvature to links after the nodes have been created.

A1.4. Moving Nodes

1. Home tab > Mapping panel > Click the "Move Node (M)" button (or press [M]).
2. Select the node and move it to the desired position (links would be moved subsequently).

A2. Zoom

A2.1. Pan

1. Home tab > Zoom panel > Click the "Drag Map" button (or click and hold onto the mouse scroll wheel).
2. In the drawing area, drag to the desired position.

A2.2. Zoom In/Out

1. Home tab > Zoom panel > Click the "Zoom In" or "Zoom Out" button (or use the mouse scroll wheel).
2. In the drawing area, zoom in/out to the desired position.

A2.3. Zoom All

1. Home tab > Zoom panel > Click the "Zoom All" button (or press [Home]).
2. In the drawing area, the extents of the model are zoomed to.

A2.4. Zoom Window

1. Home tab > Zoom panel > Click the "Zoom Window" button (or press [W]).
2. In the drawing area, a crosshair will appear. Select the extents of the window you want to zoom to.

A2.5. Zoom Scale

1. Home tab > Zoom panel > Click the "Zoom Scale" button (or press [Shift]+[S]).
2. In the "Synchro 10 – Scale Map" dialogue box, enter the scale at which you want to zoom to.

Note(s)
• Small #'s = Zoom into the drawing area • Large #'s = Zoom out of the drawing area

A3. Lane & Volume Settings [F3/F4]

Note(s)
• Draw links and nodes first before entering data for the [F3/F4] settings. • Refer to Section 4.2 and 4.3 for more detail.

To change the parameters in the Lane Settings [F3] and/or Volume Settings [F4], perform the following:

1. Click on the desired node.
2. Home tab > Lanes & Volumes panel. To access:
   a. Lane settings, click "Lane Settings" (or press [F3]).
   b. Volume settings, click "Volume Settings" (or press [F4]).

A4. Signal Timing Settings [F5/F6]

Note(s)
• Draw links and nodes first before entering data for the [F5/F6] settings. • Refer to Section 4.4 to 4.7 for more detail.

To change the parameters in the Node Settings [F5/F6], Timing Settings [F5], and/or Phasing Settings [F6], perform the following:

1. Click on the desired node.
2. Home tab > Signal Timing panel. To access:
   a. Timing settings, click "Timing Settings" (or press [F5]).
   b. Phasing settings, click "Phasing Settings" (or press [F6]).

A5. Displaying Results

> **Note(s)**
> Draw links and nodes, and enter data in the [F3/F4/F5/F6] settings before displaying results.

To display the results in the coded network/drawing area, perform the following:

1. Home tab > Display Results panel > Ln/Mvt dropdown.
2. Select the result options to be displayed in the coded network/drawing area. These options include:
    a. Show Lane Arrows on Map;
    b. Show Volumes on Map;
    c. Show Adjusted Flow;
    d. Show Start of Greens;
    e. Show Start of Yellow Times;
    f. Maximum Green Times;
    g. Show %-ile V/C Ratios;
    h. Show %-ile Mvt Delays;
    i. Show %-ile Mvt LOS;
    j. Show Phase Numbers; and
    k. None.

B. Options Tab

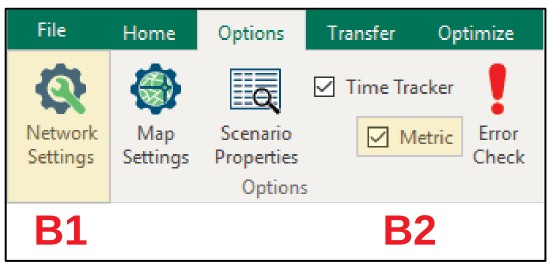

Figure 4.2: Map Settings [F2] – Options Tab

B1. Network Settings

> **Note(s)**
> Default values for various parameters in the [F3/F4/F5/F6] settings are defined here.

Network Settings allow the user to define the default values for the parameters used in Synchro. To define these parameters/default values, perform the following:

1. Options tab > Options panel > Click "Network Settings".
2. In the "Network Settings" dialogue box, change the parameter default values in the "Lanes", "Volumes", "Timings", "Phases", "Simulation", and "Emissions" tab as per City of Vancouver standard values detailed in Section 3.

B2. Unit Settings

> **Note(s)**
> By default, Imperial units are used when Synchro first opens.

To change the units from Imperial to Metric, perform the following:

1. Options tab > Options panel > Check the "Metric" box.
2. In the "Confirm – Convert Units" dialogue box, click "Yes".

C. Transfer Tab

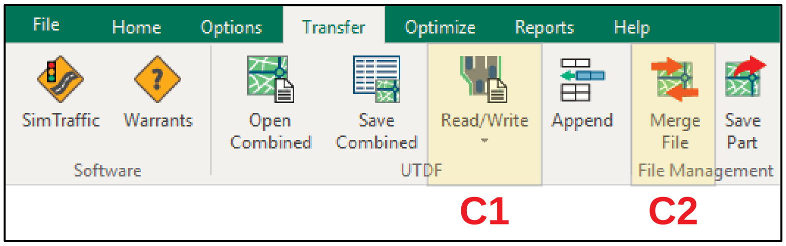

Figure 4.3: Map Settings [F2] – Transfer Tab

C1. Read/Write – Importing Hourly Vehicle Volumes

To import hourly vehicle volumes (Vol60), perform the following:

1. Prepare CSV file(s) that contain hourly vehicle volumes as per the format in ***Figure 4.4*** below. Note that the "DATE" and "TIME" (24 hour clock) can be an arbitrary date and time, respectively. The importing process and results would not be changed due to incorrect date and time. To be consistent, input the date and time that reflects the analysis period. The "INTID" will need to reflect the "Node #" in Synchro and hourly vehicle volumes are entered in the empty cells corresponding to the "INTID" and direction of travel.

Turning Movement Count														
60 Minute Counts														
DATE	TIME	INTID	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR
1/1/2020	800	1												
1/1/2020	800	2												
1/1/2020	800	3												
1/1/2020	800	4												
1/1/2020	800	5												

Figure 4.4: Hourly Vehicle Volume Import CSV File Format

2. Transfer tab > UTDF panel > Read/Write dropdown > Click "UTDF Read Volumes" (or press [Ctrl]+[D]).
3. In the "UTDF Database Access" dialogue box, under:
   a. "Active File(s)", click "Select" to navigate and select the desired hourly vehicle volume CSV file to be imported into Synchro.
   b. "Scope", click "Entire Network" to append all the hourly vehicle volumes to the entire network.
   c. Click "Read".
   d. Perform a quick check in Synchro to see if the hourly vehicle volumes have been imported correctly.

Note(s)

- Under "Scope", you can also choose "Single Intersection" and select the desired intersection to append hourly vehicle volumes to the selected intersection.
- It is good practice to check if the data has been imported properly.

C2. Merge File – Importing Hourly Pedestrian/Bicycle Volumes, Peak Hour Factor, and Heavy Vehicle Percentage

C2.1. Pedestrian Volumes

1. Prepare CSV file(s) that contain hourly pedestrian volumes (Ped60) as per the format in ***Figure 4.5*** below. Note that the "INTID" will need to reflect the "Node #" in Synchro. The hourly pedestrian volumes in Synchro

represents the conflicting pedestrians for vehicle turning movements and are entered in the empty cells corresponding to the "INTID" and the direction of travel that conflicts with vehicle turning movements.

[Lanes]													
Lane Group Data													
RECORDNAME	INTID	NBL	NBT	NBR	WBL	WBT	WBR	SBL	SBT	SBR	EBL	EBT	EBR
Peds	1												
Peds	2												
Peds	3												
Peds	4												
Peds	5												

Figure 4.5: Hourly Pedestrian Volume Import CSV File Format

2. Transfer tab > File Management panel > Click "Merge File".
3. Navigate and select the desired hourly pedestrian volume CSV file to be imported into Synchro.
4. Perform a quick check in Synchro to see if the hourly pedestrian volumes have been imported correctly.

> **Note(s)**
> It is good practice to check if the data has been imported properly.

C2.2. Bicycle Volumes

1. Prepare CSV file(s) that contain hourly bicycle volumes (Bike60) as per the format in ***Figure 4.6*** below. Note that the "INTID" will need to reflect the "Node #" in Synchro. The hourly bicycle volumes in Synchro represents the conflicting bicycles for vehicle turning movements and are entered in the empty cells corresponding to the "INTID" and the direction of travel that conflicts with vehicle turning movements.

[Lanes]													
Lane Group Data													
RECORDNAME	INTID	NBL	NBT	NBR	WBL	WBT	WBR	SBL	SBT	SBR	EBL	EBT	EBR
Bicycles	1												
Bicycles	2												
Bicycles	3												
Bicycles	4												
Bicycles	5												

Figure 4.6: Hourly Bicycle Volume Import CSV File Format

2. Transfer tab > File Management panel > Click "Merge File".
3. Navigate and select the desired hourly bicycle volume CSV file to be imported into Synchro.
4. Perform a quick check in Synchro to see if the hourly bicycle volumes have been imported correctly.

> **Note(s)**
> It is good practice to check if the data has been imported properly.

C2.3. Peak Hour Factor

1. Prepare CSV file(s) that contain peak hour factor (PHF) data as per the format in ***Figure 4.7*** below. Note that the "INTID" will need to reflect the "Node #" in Synchro and the peak hour factors are entered in the empty cells corresponding to the "INTID" and direction of travel.

[Lanes]													
Lane Group Data													
RECORDNAME	INTID	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR
PHF	1												
PHF	2												
PHF	3												
PHF	4												
PHF	5												

Figure 4.7: Peak Hour Factor Import CSV File Format

2. Transfer tab > File Management panel > Click "Merge File".
3. Navigate and select the desired peak hour factor CSV file to be imported into Synchro.
4. Perform a quick check in Synchro to see if the peak hour factors have been imported correctly.

Note(s)
It is good practice to check if the data has been imported properly.

C2.4. Heavy Vehicle Percentage

1. Prepare CSV file(s) that contain heavy vehicle percentage data as per the format in ***Figure 4.8*** below. Note that the "INTID" will need to reflect the "Node #" in Synchro and the heavy vehicle percentages are entered in the empty cells corresponding to the "INTID" and direction of travel.

[Lanes]													
Lane Group Data													
RECORDNAME	INTID	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Heavy Vehicles (%)	1												
Heavy Vehicles (%)	2												
Heavy Vehicles (%)	3												
Heavy Vehicles (%)	4												
Heavy Vehicles (%)	5												

Figure 4.8: Heavy Vehicle Percentage Import CSV File Format

2. Transfer tab > File Management panel > Click "Merge File".
3. Navigate and select the desired heavy vehicle percentage CSV file to be imported into Synchro.
4. Perform a quick check in Synchro to see if the heavy vehicle percentages have been imported correctly.

Note(s)
It is good practice to check if the data has been imported properly.

4.2 LANE SETTINGS [F3]

The LANE SETTINGS display an input grid in which the user can enter lane and geometric information. This settings window can be accessed by pressing [F3]. Typically, the Lanes and Sharing (#RL), Street Name, Link speed (km/h), Ideal Satd. Flow (vphpl), Lane Width (m), Grade (%), Area Type CBD, Storage Length (m), Right Turn Channelized, Curb Radius (m), and Right Turn on Red parameters, as noted in ***Figure 4.9*** below, are modified. Each row is labelled where appropriate and a description corresponding to the label can be found below.

	LANE SETTINGS	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
A	Lanes and Sharing (#RL)												
	Traffic Volume (vph)	100	100	100	100	100	100	100	100	100	100	100	100
	Future Volume (vph)	100	100	100	100	100	100	100	100	100	100	100	100
B	Street Name	Street Name 1			Street Name 2			Street Name 3			Street Name 4		
	Link Distance (m)	—	1258.6	—	—	1165.4	—	—	871.7	—	—	896.8	—
C	Links Speed (km/h)	—	48	—	—	48	—	—	48	—	—	48	—
	Set Arterial Name and Speed	—	EB	—	—	WB	—	—	NB	—	—	SB	—
	Travel Time (s)	—	94.4	—	—	87.4	—	—	65.4	—	—	67.3	—
D	Ideal Satd. Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
E	Lane Width (m)	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7
F	Grade (%)	—	0	—	—	0	—	—	0	—	—	0	—
G	Area Type CBD	—	☑	—	—	☑	—	—	☑	—	—	☑	—
H	Storage Length (m)	50.0	—	0.0	0.0	—	50.0	0.0	—	0.0	0.0	—	0.0
	Storage Lanes (#)	1	—	—	—	—	1	—	—	—	—	—	—
I	Right Turn Channelized	—	—	None	—	—	Yield	—	—	None	—	—	None
J	Curb Radius (m)	—	—	—	—	—	15.0	—	—	—	—	—	—
	Add Lanes (#)	—	—	—	—	—	0	—	—	—	—	—	—
	Lane Utilization Factor	0.95	0.91	0.95	0.95	0.91	0.95	1.00	1.00	1.00	1.00	1.00	1.00
	Right Turn Factor	1.000	0.987	0.850	1.000	0.987	0.850	—	0.955	—	—	0.955	—
	Left Turn Factor (prot)	0.950	0.996	1.000	0.950	0.996	1.000	—	0.984	—	—	0.984	—
	Saturated Flow Rate (prot)	1530	1365	1369	1530	1365	1369	—	1593	—	—	1593	—
	Left Turn Factor (perm)	0.665	0.977	1.000	0.665	0.977	1.000	—	0.813	—	—	0.813	—
	Right Ped Bike Factor	1.000	1.000	1.000	1.000	1.000	1.000	—	1.000	—	—	1.000	—
	Left Ped Factor	1.000	1.000	1.000	1.000	1.000	1.000	—	1.000	—	—	1.000	—
	Saturated Flow Rate (perm)	1071	1339	1369	1071	1339	1369	—	1316	—	—	1316	—
K	Right Turn on Red?	—	—	☑	—	—	☑	—	—	☑	—	—	☑
	Saturated Flow Rate (RTOR)	0	11	98	0	11	98	—	67	—	—	67	—
	Link Is Hidden	—	☐	—	—	☐	—	—	☐	—	—	☐	—
	Hide Name in Node Title	—	☐	—	—	☐	—	—	☐	—	—	☐	—

Figure 4.9: Lane Settings [F3] Window

A. Lanes and Sharing (#RL)

1. Reference aerial images and confirm with field review (or Google Street View for instance) to identify the number of lanes and lane configuration for the intersection being analyzed.
2. Click the dropdown list to select the number of lanes and lane configuration for each intersection approach turning movement.

Note(s)
- Shared lanes always count as through lanes.
- Only exclusive turning lanes count as turning lanes.
- At a "T" intersection, the shared Right-Left lanes count as a left lane.

B. Street Name

1. Reference aerial images to identify the intersection street name being analyzed.
2. Input the full street name for each intersection approach.

C. Link Speed (km/h)

1. Reference street views and/or City of Vancouver speed limit guidelines to identify the posted speed limit of upstream road connecting to an intersection. Speed limit is 50 km/h unless otherwise posted.
2. Input the link speed for each upstream intersection approach.

D. Ideal Satd. Flow (vphpl)

1. If Ideal Satd. Flow data is provided by the City of Vancouver and/or can be calculated, input the Ideal Satd. Flow for each intersection approach turning movement.
2. If Ideal Satd. Flow data is not available, input the City of Vancouver Ideal Satd. Flow standard values as shown in ***Table 3.1***.

E. Lane Width (m)

1. If an existing network is being analyzed, reference aerial images to measure and input the lane width of each intersection approach lane.
2. If a new network is being analyzed, input the City of Vancouver Lane Width standard values as shown in ***Table 4.1***.

Table 4.1: CoV Lane Width Standard Values

LANE TYPE	COV STANDARD VALUE (M)
Non-Bus/Truck Route Travel Lanes	• Non-Curb (General) Lane: 3.2 • Curb Lane: 3.4
Bus/Truck Route Travel Lanes	• Non-Curb (General) Lane: 3.3 • Curb Lane: 3.6 • Single Lane Against Curb: 3.7
Residential Route Travel Lanes	• Low-Zoned Laneway: 1.8 • High-Zoned Laneway: 3.0

F. Grade (%)

1. If Grade data is provided by the City of Vancouver, input the Grade for each intersection approach.
2. If Grade data is not available, input the City of Vancouver Grade standard values as shown in ***Table 4.2***.

> **Note(s)**
> - Positive grades represent uphill.
> - Negative grades represent downhill.

Table 4.2: CoV Grade Standard Values

DESCRIPTION	COV STANDARD VALUE (%)
Grade Data Available	• Existing or future grade.
Grade Data Unavailable	• Approach is Typical: 0% • Approach is Steep: 5%

G. Area Type CBD

1. Uncheck the Area Type CBD box if the network being analyzed is not in a Central Business District (or downtown area).
2. Check the Area Type CBD box if the network being analyzed is in a Central Business District (or downtown area).

> **Note(s)**
> A CBD is characterized by high parking turnovers, narrow short-block roadways, and high pedestrian activity.

H. Storage Length (m)

1. If an existing network is being analyzed and:
   a. One storage lane is present, reference aerial images to measure and input storage lane length that excludes its taper length for each intersection approach turn bay. Reference ***Figure 4.10*** below.
   b. Two or more storage lane is present, reference aerial images to measure and input the average storage lane length (not the sum). Ensure to exclude its taper length for each intersection approach turn bay. Reference ***Figure 4.10***.
   c. Taper lengths are entered in SIMULATION SETTINGS (F10) and only applicable to SimTraffic. Synchro calculations do not account for taper lengths.

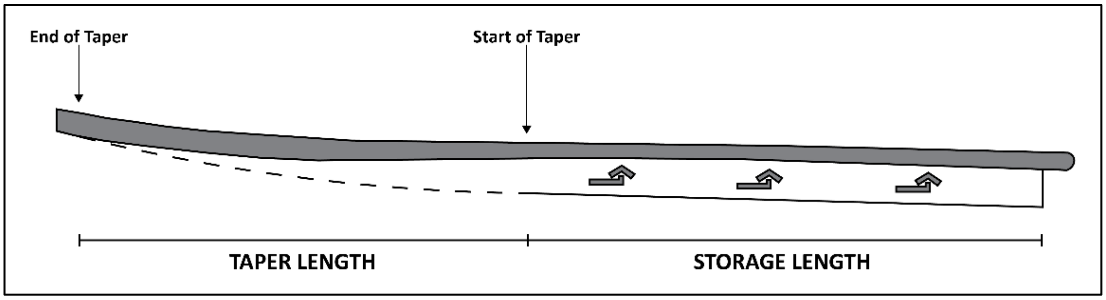

Figure 4.10: Storage Length Definition

I. Right Turn Channelized

1. Reference aerial images to identify if the intersection approach right turn movement being analyzed is channelized and street view to identify the turn control.
2. If the intersection approach right turn movement is not channelized, click the dropdown list and select "None". ***Skip Step J. Curb Radius (m)*** and proceed with ***Step K. Right Turn on Red?***
3. If the intersection approach right turn movement is channelized, click the dropdown list and select the identified control type ("Yield", "Stop", "Free", "Signal").

J. Curb Radius (m)

1. Reference aerial images or design drawings to measure and input the curb radius for each intersection approach channelized right turn.

Note(s)
Curb Radius is not a critical parameter and does not typically affect Synchro results. This parameter is mainly used for improving graphical representation.

K. Right Turn on Red?

1. Reference site imagery to identify if the intersection approach right turn movement being analyzed have "No Right Turn on Red" signs.
2. Uncheck the Right Turn on Red? box if there is a "No Right Turn on Red" sign for the right turn movement being analyzed.
3. Check the Right Turn on Red? box if there is "No Right Turn on Red" sign for the right turn movement being analyzed.

4.3 VOLUME SETTINGS [F4]

Observed traffic count data must be "balanced" to resolve inconsistencies in the field data. These discrepancies in the counts must be reconciled before proceeding to the model development task. The analyst must review the counts and determine (based on local knowledge and field observations) the probable causes of the discrepancies. Counting errors and counts made on different days are treated differently from counting differences caused by mid-block sources/sinks or mid-block queuing. The process for balancing counts is to review the data as a whole and identify directional traffic counts that are not consistent with the surrounding data. Traffic counts will have to be checked by starting at the beginning or perimeter of the system and add or subtract entering and exiting traffic. Along the way, count information should match from one station to the next. If it does not balance, engineering judgement should be used how to best reconcile the counts.

The VOLUME SETTINGS display a spreadsheet in which the user can enter vehicle, pedestrian, and bicycle volume information. This settings window can be accessed by pressing [F4]. Typically, the Traffic Volume (vph), Conflicting Peds. (#/hr), Conflicting Bicycles (#/hr), Peak Hour Factor, Heavy Vehicle (%), Bus Blockages (#/hr), Adj. Parking Lane?, Parking Maneuvers (#/hr), and Traffic from Mid-block (%) parameters, as noted in ***Figure 4.11*** below, are modified. Each row is labelled where appropriate and a description corresponding to the label can be found below.

	VOLUME SETTINGS	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
	Lanes and Sharing (#RL)												
A	Traffic Volume (vph)	100	100	100	100	100	100	100	100	100	100	100	100
	Development Volume (vph)	0	0	0	0	0	0	0	0	0	0	0	0
	Combined Volume (vph)	100	100	100	100	100	100	100	100	100	100	100	100
	Future Volume (vph)	100	100	100	100	100	100	100	100	100	100	100	100
B	Conflicting Peds. (#/hr)	0	—	0	0	—	0	0	—	0	0	—	0
C	Conflicting Bicycles (#/hr)	—	—	0	—	—	0	—	—	0	—	—	0
D	Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
	Growth Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Adjusted Flow (vph)	109	109	109	109	109	109	109	109	109	109	109	109
E	Heavy Vehicles (%)	2	2	2	2	2	2	2	2	2	2	2	2
F	Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
G	Adj. Parking Lane?	☐	☑	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐
H	Parking Maneuvers (#/hr)	—	0	—	—	0	—	—	—	—	—	—	—
I	Traffic from mid-block (%)	—	0	—	—	0	—	—	0	—	—	0	—
	Link OD Volumes	—	—	—	—	—	—	—	—	—	—	—	—
	Traffic in shared lane (%)	10	—	10	10	—	10	—	—	—	—	—	—
	Lane Group Flow (vph)	98	131	98	98	131	98	0	327	0	0	327	0

Figure 4.11: Volume Settings [F4] Window

A. Traffic Volume (vph)

1. Input the hourly traffic volume for the transportation network/period being analyzed.
2. If there is a small set of traffic volume to enter for the transportation network being analyzed, enter the traffic volume manually corresponding to the Node # (intersection) and direction of travel.
3. If there is a large set of traffic volume to enter for the transportation network being analyzed, refer to *Section 4.1* > *C* > *C1*.

B. Conflicting Peds. (#/hr)

Note(s)
• This parameter does not significantly change the Saturated Flow Rate. • Additional investigation may be required to ensure the analysis is as accurate as possible.

1. Calculate the hourly conflicting pedestrians for each left and right turn movements within the transportation network/period being analyzed.
   a. Conflicting pedestrians are calculated from the parallel crosswalk. For example, northbound right turns conflict with pedestrians on the east crosswalk.
2. If there is a small set of conflicting pedestrians to enter for the transportation network being analyzed, enter the conflicting pedestrians manually corresponding to the Node # (intersection) and direction of travel.
3. If there is a large set of conflicting pedestrians to enter for the transportation network being analyzed, refer to *Section 4.1* > *C* > *C2* > *C2.1*.

C. Conflicting Bicycles (#/hr)

Note(s)
• This parameter does not significantly change the Saturated Flow Rate. • Additional investigation may be required to ensure the analysis is as accurate as possible.

1. Calculate the hourly conflicting bicycles for the transportation network/period being analyzed.
   a. Each cyclist where vehicles turn across thru bike lanes of the same or opposite direction is a conflicting bicycle.
2. If there is a small set of conflicting bicycles to enter for the transportation network being analyzed, enter the conflicting bicycles manually corresponding to the Node # (intersection) and direction of travel.
3. If there is a large set of conflicting bicycles to enter for the transportation network being analyzed, refer to *Section 4.1* > *C* > *C2* > *C2.2*.

D. Peak Hour Factor

1. If quarter hour volumes are available, calculate the peak hour factor (PHF) for the transportation network/period being analyzed. In cases where there are:
   a. A small set of peak hour factors to enter for the transportation network being analyzed, enter the peak hour factors manually corresponding to the Node # (intersection) and direction of travel.
   b. A large set of peak hour factors to enter for the transportation network being analyzed, refer to *Section 4.1* > *C* > *C2* > *C2.3*.
2. If quarter hour volumes are not available, input the City of Vancouver peak hour factor standard values as shown in *Table 4.3*.

Table 4.3: CoV Peak Hour Factor Standard Values

TIME PERIOD	COV STANDARD VALUE
AM Peak	0.93
PM Peak	0.94

E. Heavy Vehicle (%)

1. If heavy vehicle data are available, calculate the heavy vehicle percentage for the transportation network/period being analyzed. If:
   a. There is a small set of heavy vehicle percentage to enter for the transportation network being analyzed, enter the heavy vehicle percentage manually corresponding to the Node # (intersection) and direction of travel.

b. If there is a large set of heavy vehicle percentage to enter for the transportation network being analyzed, refer to ***Section 4.1*** > ***C*** > ***C2*** > ***C2.4***.

2. If heavy vehicle data are not available, input the City of Vancouver heavy vehicle percentage standard values as shown in ***Table 4.4***.

Table 4.4: CoV Heavy Vehicle Percentage Standard Values

ROUTE TYPE	COV STANDARD VALUE (%)
Non-Truck Route	• Main Street:2% • Side Street:1%
Truck Route	• 7.5 (or higher) *Mid-day heavy vehicle percentage may be higher

F. Bus Blockages (#/hr)

1. If bus blockage data are available, enter the bus blockages corresponding to the Node # (intersection) and direction of travel.
2. If bus blockage data are not available, approximate blockages can be determined by analyzing TransLink bus schedule information.

> **Note(s)**
> This parameter is normally left as default but can be determined via TransLink bus schedules.

G. Adj. Parking Lane?

1. Reference aerial images and/or street view to identify if the intersection approach being analyzed has an adjacent parking lane that is not physically separated from vehicle traffic.
2. If the intersection approach does not have an adjacent parking lane or has an adjacent parking lane (but is physically separated from vehicle traffic), uncheck the boxes for that approach. Skip ***Step H. Parking Maneuvers (#/hr)*** and proceed with ***Step I. Traffic from Mid-block (%)***.
3. If the intersection approach has an adjacent parking lane that is not physically separated from vehicle traffic, check the box for the travel lane/any associated turning movements that is directly adjacent to the parking lane.

> **Note(s)**
> Example: The adjacent parking lane for the EB direction (west approach) on Pacific Blvd/Homer St is physically separated. Therefore, the "Adj. Parking Lane?" box is not checked.

H. Parking Maneuvers (#/hr)

1. If the "Adj. Parking Lane?" box is checked and parking maneuver data is available, input data.
2. If the "Adj. Parking Lane?" box is checked and parking maneuver data is unavailable, use default value.

I. Traffic from Mid-block (%)

1. If mid-block traffic percentage data is available, input data.
2. If mid-block traffic percentage data is not available, use default value.

4.4 NODE SETTINGS [F5/F6]

The NODE SETTINGS display a spreadsheet in which the user can enter the node (intersection) information. This settings window can be accessed by pressing either [F5] or [F6]. Typically, the Control Type, Cycle Length (s), Offset (s), Reference To, Reference Phase, and Master Intersection parameters, as noted in ***Figure 4.12***, are changed.

	NODE SETTINGS	
	Node #	13
	Zone:	
	X East (m):	13950.4
	Y North (m):	3589.3
	Z Elevation (m):	0.0
	Description	
A	Control Type	Pretimed
B	Cycle Length (s):	45.0
	Lock Timings:	☐
	Optimize Cycle Length:	Optimize
	Optimize Splits:	Optimize
	Actuated Cycle 90th (s):	45.0
	Actuated Cycle 70th (s):	45.0
	Actuated Cycle 50th (s):	45.0
	Actuated Cycle 30th (s):	45.0
	Actuated Cycle 10th (s):	45.0
	Natural Cycle(s):	45.0
	Max v/c Ratio:	0.58
	Intersection Delay (s):	10.7
	Intersection LOS:	B
	ICU:	0.50
	ICU LOS:	A
C	Offset (s) :	0.0
D	Referenced to:	Begin of Green
E	Reference Phase:	2+6 - NBTL SBTL
F	Master Intersection:	☐
	Yield Point:	Single
	Mandatory Stop On Yellow:	☐

Figure 4.12: Node Settings [F5/F6] Window

A. Control Type

1. If the intersection being analyzed is signalized, reference the corresponding traffic signal record to identify the control type. Note that the "Control Type" terminology, used in Synchro, is equivalent to "Signal Type" in the traffic signal record. The control type terminologies used in the traffic signal record differ slightly from the terminologies used in Synchro. ***Table 4.5*** provides a lookup table that compare these terminologies.

> **Note(s)**
> - If an intersection has offset value(s) in the TSR, it is coordinated.
> - If an intersection does not have offset value(s) in the TSR, it is uncoordinated. Skip ***Step C Offset (s) – F Master Intersection***.

Table 4.5: CoV vs Synchro Signalized Intersection Control Type Terminology

COV CONTROL TYPE	SYNCHRO CONTROL TYPE	DESCRIPTION
Fixed Time (FxT)	Pretimed	The duration of each phase is fixed throughout a time of day plan alternating between the main street and side street. Timings are all pre-determined. In some circumstances, an actuated protected/permissive left-turn phase may be provided along with the fixed time main and side street phase.
Fixed Time with Actuated Turn (FxT)	Semi-Actuated	The duration of the through and side street phases remains constant; however, left or right-turns can be actuated.
Pedestrian/Bicycle (Ped/Bike)	Semi-Actuated Uncoordinated	Maintains the through phase for the main street unless a pedestrian or cyclist push-button is actuated. The side streets are stop sign controlled, which requires vehicles/cyclists to stop before proceeding through the intersection.
	Actuated Coordinated	
Semi-Actuated (SA)	Semi-Actuated Uncoordinated	Maintains the through phase for the main street unless a side street vehicle detector is actuated. Control type can be uncoordinated or coordinated.
	Actuated Coordinated	
Fully Actuated (FA)	Actuated Uncoordinated	Every movement contains vehicle, cyclist, and/or pedestrian detectors that moderate the length of green time based on the current demand. Control type can be uncoordinated or coordinated.
	Actuated Coordinated	
Emergency Vehicle Actuation (Fire Signal)	Semi-Actuated Uncoordinated / Semi-Actuated Coordinated	Can only be actuated by a Fire Hall.

2. If the intersection being analyzed is unsignalized, select either “Unsig” or “Roundabout”. ***Table 4.6*** provides a description for each of these control types.

Table 4.6: Unsignalized Intersection Control Type Terminology

CONTROL TYPE	DESCRIPTION
Unsignalized (Unsig)	Control type used when traffic movements at unsignalized intersections are free flow or controlled by stop or yield signs.
Roundabout	Control type used when a roundabout is placed at an intersection, instead of a signal.

B. Cycle Length (s)

1. Do not calculate or update the cycle length parameter during this stage as this parameter automatically updates itself as signal timing information is being inputted into Synchro.
2. Calculate, check, and update the cycle length parameter after all signal timing information from the traffic signal record have been inputted for an intersection. Refer to ***Section 4.7*** for more information.

Note(s)
- In the TSR, different time periods may have different time plans/cycle lengths.
- It is important to back calculate the cycle lengths at a later step to ensure that it matches with the TSR’s time plan cycle lengths.

C. Offset (s)

1. In the traffic signal record, navigate to the time period you are analyzing.
2. Input the offset value for the intersection/time period you are analyzing.

Note(s)
In the TSR, different time periods may have different time plans/offset values.

D. Reference To

Leave as default unless specified.

E. Reference Phase

1. Do not choose a reference phase during this stage as this parameter is dependent on the signal timing information input into Synchro.
2. Choose a reference phase after all signal timing information from the traffic signal record have been inputted for an intersection. Refer to ***Section 4.7*** for more information.
3. Ensure the reference phase matches the coordinated direction on the traffic signal record, if one exists.

F. Master Intersection

Leave unchecked unless specified.

4.5 TIMING SETTINGS [F5]

The TIMING SETTINGS display a spreadsheet in which the user can define the phases of each turning movement and enter the signal timing information. This settings window can be accessed by pressing [F5]. Typically, the Turn Type, Protected Phases, Permitted Phases, Minimum Initial (s), Minimum Split (s), Total Split (s), Yellow Time (s), All-Red Time (s), Lost Time Adjust (s), and Recall Mode parameters, as noted in ***Figure 4.13***, are changed. Note that the signal timing information for the Minimum Initial (s), Minimum Split (s), Total Split (s), Yellow Time (s), All-Red Time (s), and Recall Mode parameters can be entered in the PHASING SETTINGS [F6] window. For simplicity, these parameters will be entered in the PHASING SETTINGS [F6] window.

	TIMING SETTINGS	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	PED	HOLD
	Lanes and Sharing (#RL)													—	—
	Traffic Volume (vph)	100	100	100	100	100	100	100	100	100	100	100	100	—	—
	Future Volume (vph)	100	100	100	100	100	100	100	100	100	100	100	100	—	—
A	Turn Type	Perm	—	Perm	Perm	—	Perm	Perm	—	—	Perm	—	—	—	—
B	Protected Phases		4			8			2	—		6	—		
C	Permitted Phases	4		4	8		8	2		—	6		—	—	—
	Permitted Flashing Yellow	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Detector Phases	4	4	4	8	8	8	2	2	—	6	6	—	—	—
	Switch Phase	0	0	0	0	0	0	0	0	—	0	0	—	—	—
	Leading Detector (m)	6.1	30.5	6.1	6.1	30.5	6.1	—	30.5	—	—	30.5	—	—	—
	Trailing Detector (m)	0.0	0.0	0.0	0.0	0.0	0.0	—	0.0	—	—	0.0	—	—	—
D	Minimum Initial (s)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	—	5.0	5.0	—	—	—
D	Minimum Split (s)	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	—	22.5	22.5	—	—	—
D	Total Split (s)	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	—	22.5	22.5	—	—	—
D	Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	—	3.5	3.5	—	—	—
D	All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	—	1.0	1.0	—	—	—
E	Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	—	0.0	—	—	0.0	—	—	—
	Lagging Phase?	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Allow Lead/Lag Optimize?	—	—	—	—	—	—	—	—	—	—	—	—	—	—
F	Recall Mode	Max	Max	Max	Max	Max	Max	Max	Max	—	Max	Max	—	—	—
	Speed limit (km/h)	—	48	—	—	48	—	—	48	—	—	48	—	—	—
	Actuated Effct. Green (s)	18.0	18.0	18.0	18.0	18.0	18.0	—	18.0	—	—	18.0	—	—	—
	Actuated g/C Ratio	0.40	0.40	0.40	0.40	0.40	0.40	—	0.40	—	—	0.40	—	—	—
	Volume to Capacity Ratio	0.23	0.24	0.16	0.23	0.24	0.16	—	0.58	—	—	0.58	—	—	—
	Control Delay (s)	10.7	9.8	3.3	10.7	9.8	3.3	—	13.2	—	—	13.2	—	—	—
	Queue Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0	—	0.0	—	—	0.0	—	—	—
	Total Delay (s)	10.7	9.8	3.3	10.7	9.8	3.3	—	13.2	—	—	13.2	—	—	—
	Level of Service	B	A	A	B	A	A	—	B	—	—	B	—	—	—
	Approach Delay (s)	—	8.1	—	—	8.1	—	—	13.2	—	—	13.2	—	—	—
	Approach LOS	—	A	—	—	A	—	—	B	—	—	B	—	—	—
	Queue Length 50th (m)	5.0	6.3	0.0	5.0	6.3	0.0	—	14.4	—	—	14.4	—	—	—
	Queue Length 95th (m)	12.9	15.6	6.3	12.9	15.6	6.3	—	33.5	—	—	33.5	—	—	—
	Stops (vph)	59	69	17	59	69	17	—	185	—	—	185	—	—	—
	Fuel Used (l/hr)	13	17	12	12	16	11	—	32	—	—	33	—	—	—

Figure 4.13: Timing Settings [F5] Window

A. Turn Type

1. Reference street view (field conditions) and/or traffic signal record to identify the left/right turn types for each intersection approach.
2. Select the corresponding left/right turn type. Refer to ***Table 4.7*** for more turn type information.

Note(s)
Left and right turn types have different turn protections.

Table 4.7: Left/Right Turn Type Terminology

LEFT TURN TYPE	RIGHT TURN TYPE
Permitted (Perm): Left turn movements are not protected, and vehicles must yield to oncoming traffic and pedestrians in the crosswalk.	**Permitted (Perm):** Permitted right turn movements are not protected and vehicles must yield to pedestrians in the crosswalk.
Protected (Prot): Left turn movements are protected by a dedicated signal and turning traffic can only move during the arrow indication of this signal.	**Protected (Prot):** Right turn movements are protected by a dedicated signal that provides a right-turn arrow that does not conflict with pedestrian indications.
Permitted + Protected (pm+pt): Left turn movements are protected during the protected (arrow) signal indication and permitted during the green ball indication. With permitted plus protected phasing, it is common to use three signal lenses plus additional arrows for the turn indications.	**Overlap (Over):** This turn type displays a right turn arrow with a protected left-turn movement on the intersecting street. Note: Overlap should not be used as a substitute for Right Turn on Red.
Split: Left and through traffic share a single protected phase. This type of phasing is commonly used if a lane is shared between left and through traffic or there are geometric constraints where opposing turns cannot be made simultaneously without conflicting. Split phasing ensures that shared left-turn lanes are protected and offer a greater level of protection compared with permitted left-turns. If there is no through approach, such as at a T intersection, then the left turn treatment should always be split.	**Permitted + Overlap (pm+ov):** This right turn overlap displays a right-turn arrow with a compatible left-turn and a permitted (green ball) indication with the through phase. Note that overlap assumes vehicles only proceed during a compatible left-turn phase while "Permitted + Overlap" corresponds to right-turn vehicles also proceeding during the through phase (permissively).
Dallas Permitted (D.Pm): A special type of phasing developed in the Dallas, Texas area. The left turn lane has its own signal head. The left signal head is louvered to make it invisible from adjacent lanes. The ball in the left lane displays the same phase displayed to oncoming through traffic. This configuration eliminates the lagging left turn trap problem.	**Protected + Overlap (pt+ov):** This right-turn overlap displays a right-turn arrow with the compatible left-turn and the through movement associated with the right-turn.
Dallas Permitted plus Protected (D.P+P): A special type of phasing developed in the Dallas, Texas area. The left turn lane has its own signal head. The left signal head is louvered to make it invisible from adjacent lanes. The ball in the left lane displays the same phase displayed to oncoming through traffic. This configuration eliminates the lagging left turn trap problem. Use this option for a protected plus permitted Flashing Yellow Arrow (FYA).	**Free:** A free right turn movement yields to pedestrians and is not assigned a signal phase and generally relates to a right-turn channel. The permitted phase is automatically set to Free by the Free turn type. Note: Free should not be used as a substitute for Right Turn on Red but should only be used if the movement has an acceleration lane downstream.

B. Protected Phases

Note(s)
Old traffic signal records do not have phasing defined.

1. If 4 phased traffic signal records are being referenced, set main street directions to be phases 2 and 6, and side street directions to be phases 4 and 8. Refer to *Section 2.4* for more information.
2. If 8 phased traffic signal records are being referenced, use the phasing definitions detailed in the traffic signal record.

C. Permitted Phases

Note(s)
Old traffic signal records do not have phasing defined.

1. If old traffic signal records are being referenced, set main street directions to be phases 2 and 6, and side street directions to be phases 4 and 8. Refer to *Section 2.4* for more information.
2. If new traffic signal records are being referenced, use the phasing definitions detailed in the traffic signal record.

D. Minimum Initial (s) to All-Red Time (s)

Do not enter these values at this stage. For simplicity, these parameters are defined in ***Section 4.6*** and/or ***4.7***.

E. Lost Time Adjust (s)

1. If lost time adjust data are available, enter the data to the corresponding intersection/turning movement.
2. If lost time adjust data are unavailable, refer to ***Table 4.8***.

Table 4.8: CoV Lost Time Adjust Values

TIME PERIOD	COV STANDARD VALUE (S)
Peak (AM, Midday, and PM weekday)	-1
Off-Peak (Weekend and non-peak weekday)	0

F. Recall Mode

Do not choose recall mode at this stage. For simplicity, this parameter is defined in ***Section 4.6*** and/or ***4.7***.

4.6 PHASING SETTINGS [F6]

The PHASING SETTINGS display a spreadsheet in which the user can enter the signal and pedestrian timing information for each defined phase. This settings window can be accessed by pressing [F6]. Typically, the Minimum Initial (s), Minimum Split (s), Maximum Split (s), Yellow Time (s), All-Red Time (s), Vehicle Extension (s), Minimum Gap (s), Recall Mode, Pedestrian Phase, Walk Time (s), Flash Don't Walk (s), Pedestrian Calls (#/hr), and Dual Entry? parameters, as noted in ***Figure 4.14***, are changed. Note that the signal timing information for the Minimum Initial (s), Minimum Split (s), Maximum Split (s), Yellow Time (s), All-Red Time (s), and Recall Mode parameters can be entered in the TIMING SETTINGS [F5] window. For simplicity, these parameters will be entered in the PHASING SETTINGS [F6] window.

	PHASING SETTINGS	2-NBTL	4-EBTL	6-SBTL	8-WBTL
A	Minimum Initial (s)	5.0	5.0	5.0	5.0
B	Minimum Split (s)	22.5	22.5	22.5	22.5
C	Maximum Split (s)	22.5	22.5	22.5	22.5
D	Yellow Time (s)	3.5	3.5	3.5	3.5
E	All-Red Time (s)	1.0	1.0	1.0	1.0
	Lagging Phase?	—	—	—	—
	Allow Lead/Lag Optimize?	—	—	—	—
	Optimize Phs Weights - Delays	1.0	1.0	1.0	1.0
F	Vehicle Extension (s)	3.0	3.0	3.0	3.0
G	Minimum Gap (s)	3.0	3.0	3.0	3.0
	Time Before Reduce (s)	0.0	0.0	0.0	0.0
	Time To Reduce (s)	0.0	0.0	0.0	0.0
H	Recall Mode	Max	Max	Max	Max
I	Pedestrian Phase	☑	☑	☑	☑
J	Walk Time (s)	7.0	7.0	7.0	7.0
K	Flash Dont Walk (s)	11.0	11.0	11.0	11.0
L	Pedestrian Calls (#/hr)	0	0	0	0
M	Dual Entry?	☑	☑	☑	☑
	Fixed Force Off?	☑	☑	☑	☑
	90th %ile Green Time (s)	18 cd	18 mr	18 cd	18 mr
	70th %ile Green Time (s)	18 cd	18 mr	18 cd	18 mr
	50th %ile Green Time (s)	18 cd	18 mr	18 cd	18 mr
	30th %ile Green Time (s)	18 cd	18 mr	18 cd	18 mr
	10th %ile Green Time (s)	18 cd	18 mr	18 cd	18 mr

Figure 4.14: Phasing Settings [F6] Window

A. Minimum Initial (s)

1. Reference traffic signal record to identify the minimum initial. Note that the "Minimum Initial" terminology, used in Synchro, is equivalent to "Minimum Green" or "Green" in the traffic signal record.
2. Input the minimum initial for the corresponding intersection phase.

B. Minimum Split (s)

1. Do not update minimum split during this stage as this parameter automatically updates as signal timing information is being inputted into Synchro.
2. Update/check the minimum split after all signal timing information from the traffic signal record have been inputted for an intersection. Refer to ***Section 4.7*** for more information.

C. Maximum Split(s)

1. Do not update maximum split during this stage as this parameter automatically updates as signal timing information is being inputted into Synchro.
2. Update/check the maximum split after all signal timing information from the traffic signal record have been inputted for an intersection. Refer to ***Section 4.7*** for more information.

D. Yellow Time (s)

1. Reference traffic signal record to identify the yellow time. Note that the "Yellow Time" terminology, used in Synchro, is equivalent to "Yellow" or "Amber" in the traffic signal record.
2. Input the yellow time for the corresponding intersection phase.

E. All-Red Time (s)

1. Reference traffic signal record to identify the all-red time. Note that the "All-Red Time" terminology, used in Synchro, is equivalent to "Red" or "All Red" in the traffic signal record.
2. Input the all-red time for the corresponding intersection phase.

F. Vehicle Extension (s)

1. If the traffic signal record has vehicle extension time for an associated phase, input the vehicle extension time. Note that the "Vehicle Extension" terminology, used in Synchro, is equivalent to the first number used in the "Vehicle Gap" or "Vehicle Passage" in the traffic signal record.
2. If the traffic signal record does not have vehicle extension time for an associated phase, input a default value of 3s unless specified by the City of Vancouver.

G. Minimum Gap(s)

1. If the traffic signal record has minimum gap time for an associated phase, input the minimum gap time. Note that the "Minimum Gap" terminology, used in Synchro, is equivalent to the second number used in the "Vehicle Gap" or "Minimum Gap" in the traffic signal record.
2. If the traffic signal record does not have minimum gap time for an associated phase, input a default value of 1.5s unless specified by the City of Vancouver.

H. Recall Mode

1. Reference traffic signal record to identify the recall mode for the corresponding intersection phase.
2. If an old traffic signal record is being referenced and if:
    a. A phase have "(VEH CALL)"/"(VEH)" and/or "(PED CALL)"/"(PED)", the phase is actuated. Set the recall mode as "None".
    b. A phase does not have "(VEH CALL)"/"(VEH)" and/or "(PED CALL)"/"(PED)", the phase is either "Min" or "Max". Reference field conditions either via Google Street View© or a site visit to determine whether or not loops exist in conjunction with guidance provided in ***Table 4.9*** to determine whether the recall mode is "Min" or "Max". Reference the traffic signal drawing for Wavetronix use at the intersection.
3. If a new traffic signal record is being referenced, select the specified recall mode.

Table 4.9: Recall Mode Terminology

RECALL MODE	DESCRIPTION
No Recall (None)	The phase can be skipped. The phase will only be serviced when it is actuated by a field input. The phase will be called for its minimum green time and then extended by the passage time to the maximum green time. The extension of the phase to the maximum green time is dependent upon vehicle activations. An actuated phase may be skipped in absence of vehicular or cyclist or pedestrian calls.
Minimum Recall (Min)	The phase will always be serviced each cycle for the minimum green time and cannot be skipped. The phase will be extended by the passage time to the maximum green time dependent upon vehicle actuations. Note: The lane being analyzed with a Minimum Recall Mode typically will have loop detectors.
Maximum Recall (Max)	The phase will always be serviced each cycle for its Maximum Green time, has no detection, cannot be skipped, gapped out, and extended. Field inputs has no effect. Note: The lane being analyzed with a Maximum Recall Mode typically will not have loop detectors.
Pedestrian Recall (Ped)	The pedestrian times (i.e. Walk + Flash Don't Walk) are always serviced and cannot be skipped or gapped out until the Walk and Flash Don't Walk intervals have passed.
Coordinated Minimum (C-Min)	Used with coordinated signals only. This option is available for phases selected as the reference phase in the Offset settings. Phase shows for its minimum time starting at its scheduled start time. Note: Coordinated movements for minimum time must have loop detectors for vehicle actuation to extend the minimum green time to maximum green time.
Coordinated Maximum (C-Max)	Used with coordinated signals only. This option is available for phases selected as the reference phase in the Offset settings. Phase shows for its maximum time starting at its scheduled start time. Coordinated movements for maximum time do not have loop detectors.

I. Pedestrian Phase

1. Reference traffic signal record to identify if the intersection phase has a pedestrian phase.
2. If the intersection phase does not have a pedestrian phase, uncheck box. Skip ***Step J. Walk Time (s) – Step L. Pedestrian Calls (#/hr)*** and proceed with ***Step M. Dual Entry?***.
3. If the intersection phase has a pedestrian phase, check box (or leave box checked).

Note(s)
A phase/turning movement has a pedestrian phase if the TSR have "Walk" or "Flash Don't Walk (FDW)" times associated with that phase.

J. Walk Time (s)

1. Reference traffic signal record to identify the walk time. Note that the "Walk Time" terminology, used in Synchro, is equivalent to "Walk" in the traffic signal record.
2. Input the walk time for the corresponding intersection phase.

K. Flash Don't Walk (s)

1. Reference traffic signal record to identify the flash don't walk time. Note that the "Flash Don't Walk" terminology, used in Synchro, is equivalent to "FDW" in the traffic signal record.
2. Input the flash don't walk time for the corresponding intersection phase.

L. Pedestrian Calls (#/hr)

1. If pedestrian call data are available, enter the data to the corresponding intersection phase.

2. If pedestrian call data are unavailable, refer to ***Table 4.10*** and enter the data to the corresponding intersection phase.

Table 4.10: CoV Pedestrian Call Values

NUMBER OF PEDESTRIANS	COV STANDARD VALUE (#/HR)
<10	0
>=10 and <100	10
>=100	60

M. Dual Entry

Leave as default unless specified by the City of Vancouver.

4.7 Confirm Node/Timing/Phasing Settings [F5/F6]

After all signal timing information have been inputted into Synchro for each intersection as per the steps detailed in ***Sections 4.1*** to ***4.6***, the Minimum Split, Maximum Split, Cycle Length, and Offset Reference Phase parameters in the NODE/TIMING/PHASING SETTINGS should be reconfirmed. To complete this confirmation step, follow the instructions below.

A. Minimum Split Confirmation

1. Press [F6] to access the PHASING SETTINGS and navigate to the Minimum Split parameter.
2. For each intersection phase, clear the Minimum Split parameter and press [Enter]. Synchro will reupdate the minimum splits as per the formula below:

$$Minimum\ Split = Max(Min\ Green + Yellow + All\ Red, Walk + FDW + Yellow + All\ Red)$$

B. Maximum Split Confirmation

1. Press [F6] to access the PHASING SETTINGS and navigate to the Maximum Split parameter.
2. Reference traffic signal record to identify the maximum split. Note that the “Maximum Split” terminology used in Synchro is equivalent to “PHASE DURATION” or “SPLITS” in the traffic signal record.
3. Input the maximum split corresponding to the intersection phase and time period.

C. Cycle Length Confirmation

1. Press [F5] or [F6] to access the NODE SETTINGS and navigate to the Cycle Length parameter.
2. Check that the cycle length matches with the cycle length in the traffic signal record. Note that the “Cycle Length” terminology is equivalent to “CYCLE” in the traffic signal record.

Note(s)
• Analyst can manually change the Cycle Length parameter. • Cycle length is the sum of maximum splits for any non-overlapping phases.

D. Offset Reference Phase Confirmation

1. Press [F5] or [F6] to access the NODE SETTINGS and navigate to the Offset Reference Phase parameter.
2. Reference the traffic signal record to identify the Offset Reference Phase. If:
    a. An old traffic signal record is being referenced, the first item on the "Description" list contains the direction of the movement. This is the Reference Phase.
    b. A new traffic signal record is being referenced, the Reference Phase is labelled in the upper right corner called "COORD. PHASE:".

4.8 Detector Settings [F11]

The steps outlined in this section only applies to the coding of intersections with protected / permitted left-turns. To actuate a protected / permitted left-turn phase, both the leading and trailing detectors need to be triggered. The distance between the two detectors is approximately three car lengths. By default, trailing detectors in Synchro can only extend a phase but cannot call a phase. To accurately call a protected / permitted left-turn phase, parameters in the DETECTOR SETTINGS will be updated. The settings window can be accessed by pressing [F11]. Typically, the Number of Detectors (#), Detector Position (m), Detector Size (m), and Detector Type as noted in ***Figure 4.15*** below, are changed.

	DETECTOR SETTINGS	EBL	EBT	WBL	WBT	NBT	SBT
	Lanes and Sharing (#RL)						
	Traffic Volume (vph)	0	0	0	0	0	0
	Future Volume (vph)	0	0	0	0	0	0
A	Number of Detectors (#)	2	2	2	2	2	2
	Detector Phases	4	4	8	8	2	6
	Switch Phase	0	0	0	0	0	0
	Leading Detector (m)	51.1	30.5	51.1	30.5	30.5	30.5
	Trailing Detector (m)	0.0	0.0	0.0	0.0	0.0	0.0
	Detector Template	(none)	Thru	(none)	Thru	Thru	Thru
	Add/Update Template						
B	Detector 1 Position (m)	0.0	0.0	0.0	0.0	0.0	0.0
C	Detector 1 Size (m)	6.1	1.8	6.1	1.8	1.8	1.8
D	Detector 1 Type	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex
	Detector 1 Channels						
	Detector 1 Extend	0.0	0.0	0.0	0.0	0.0	0.0
	Detector 1 Queue	0.0	0.0	0.0	0.0	0.0	0.0
	Detector 1 Delay	0.0	0.0	0.0	0.0	0.0	0.0
B	Detector 2 Position (m)	45.0	28.7	45.0	28.7	28.7	28.7
C	Detector 2 Size (m)	6.1	1.8	6.1	1.8	1.8	1.8
D	Detector 2 Type	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex
	Detector 2 Channels						
	Detector 2 Extend	0.0	0.0	0.0	0.0	0.0	0.0

Figure 4.15: Detector Settings [F11] Window

A. Number of Detectors (#)

1. For a protected / permitted left-turn, enter a value of "2".

B. Detector Position (m)

1. Detector 1 is placed at the stop bar. Enter a value of “0.0” meters.
2. The position of Detector 2 should be measured off aerial images if available, otherwise a typical value of “15.0“ meters should be entered.

C. Detector Size (m)

1. This setting defines the size of the detector in the travelled direction. Enter Synchro’s default size of “1.8” meters.

D. Detector Type

Since two detectors are required to actuate a protected / permitted left-turn, select the following:

1. For Detector 1, select “Extend” from the drop-down menu.
2. For Detector 2, select “Cl+Ex” from the drop-down menu.

5.0 CODING EXAMPLE

This section provides the user with a City of Vancouver traffic signal record sample and the corresponding Synchro coding example. This section is intended for beginner to intermediate Synchro users who are not familiar with the software.

5.1 FIELD DATA

Field data includes the traffic signal record and the most recent traffic count data for the modelled hour, as shown in ***Figure 5.1*** and ***Figure 5.2***. In this example, the intersection at Main Street and SE Marine Drive is modelled.

TRAFFIC SIGNAL RECORD

LOCATION: MAIN / MARINE

SIGNAL TYPE: FULLY ACTUATED WITH PROTECTED / PERMITTED LEFT TURNS

COORD PHASE:
MAX CYCLE: 116

PHASE	1	2	3	4	5	6	7	8
MOVEMENT	EB LT	WB	SBLT	NB	WB LT	EB	NB LT	SB
PRE-WALK								
MINIMUM WALK		10		7		10		7
FLASHING DON'T WALK		18		23		18		23
MINIMUM GREEN	5	15	5	10	5	15	5	10
AUDIBLES		PEEP HI		CUCKOO LOW		PEEP LOW		CUCKOO HI
AMBER	4	3.5	4	3.5	4	3.5	4	3.5
RED		1.5		1.5		1.5		1.5
MAXIMUM GREEN 1	25	48	14	35	15	53	14	35
MAXIMUM GREEN 2	38	72	21	53	23	82	21	53
VEHICLE PASSAGE	3	3	3	3	3	3	3	3
MINIMUM GAP	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
VEHICLE PHASE MINIMUMS	9	20	9	15	9	20	9	15
PEDESTRIAN PHASE MINIMUMS		33		35		33		35
EMERGENCY FLASH COLOR		RED		RED		RED		RED
	START UP AMBER PHASE 26				DWELL IN 26			
TIMING PLAN 1	MODE: FREE		CYCLE:		MAX:94		MIN:	
	OFFSET 1:		SCHEDULE: 0200-0600				PERMISSIVE PERIOD: NA	
PLAN 1 SPLITS	13	33	13	35	13	33	13	35
PLAN 1 RECALLS		MIN				MIN		
TIMING PLAN 2	MODE: FREE		CYCLE:		MAX:116		MIN:	
	OFFSET 1:		SCHEDULE: 0600-0930 MON - FRI				PERMISSIVE PERIOD: NA	
PLAN 2 SPLITS	20	48	13	35	15	53	13	35
PLAN 2 RECALLS		MIN				MIN		
TIMING PLAN 3	MODE: FREE		CYCLE:		MAX:116		MIN:	
	OFFSET 1:		SCHEDULE: MON-FRI: 0930-1500, 1800-0200. SAT-SUN: 0600-0200				PERMISSIVE PERIOD: NA	
PLAN 3 SPLITS	25	42	14	35	15	52	14	35
PLAN 3 RECALLS		MIN				MIN		
TIMING PLAN 4	MODE: FREE		CYCLE:		MAX:116		MIN:	
	OFFSET 1:		SCHEDULE: 1500-1800 MON - FRI				PERMISSIVE PERIOD: NA	
PLAN 4 SPLITS	25	42	14	35	15	52	14	35
PLAN 4 RECALLS		MIN				MIN		
TIMING PLAN 5	MODE:		CYCLE:		MAX:		MIN:	
	OFFSET 1:		SCHEDULE:				PERMISSIVE PERIOD: NA	
PLAN 5 SPLITS								
PLAN 5 RECALLS								

COMMENTS:
1.0 M/S WALKING RATE

DESIGN	SEAL	TDM MANAGER	DATE (y/m/d)	DATE (y/m/d)	TIME	BY
CHECK		THESE TIMINGS APPLIED:				
		SUPERSEDED BY CARD #				

CARD # 55-05 (08)

Figure 5.1: Traffic Signal Record Sample – Main Street & SE Marine Drive

City of Vancouver
Traffic and Data Management

File Name : TMC_Main&Marine - 2020-11-29
Site Code : TMC_MainSt&SEMarineDr
Start Date : 11/29/2020
Page No : 4

	From North					From East					From South					From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 10:00 to 13:55 - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 13:00																					
13:00	20	21	17	0	58	6	63	1	0	70	**6**	15	10	0	31	**13**	84	29	1	127	286
13:05	59	24	19	3	105	6	81	**9**	0	96	2	16	7	**5**	30	8	88	37	0	133	364
13:10	14	14	48	4	80	11	101	2	0	114	3	22	4	1	30	9	89	24	0	122	346
13:15	23	21	36	1	81	6	108	3	0	117	3	14	2	5	24	4	80	28	2	114	336
13:20	29	**35**	44	**5**	113	3	34	5	2	44	2	**30**	**12**	0	**44**	12	100	25	1	138	339
13:25	40	22	25	4	91	12	139	4	2	157	4	27	12	1	44	1	97	38	1	137	429
13:30	31	19	49	2	101	9	129	3	0	141	2	12	5	2	21	7	114	**54**	0	175	438
13:35	35	25	31	3	94	12	103	9	2	126	5	14	10	5	34	5	116	36	**3**	160	414
13:40	82	34	**58**	3	**177**	1	141	2	3	147	2	14	7	1	24	8	101	32	1	142	**490**
13:45	66	27	39	0	132	8	91	3	**4**	106	1	14	7	0	22	6	**140**	29	2	**177**	437
13:50	**95**	17	26	0	138	8	155	0	0	163	4	14	7	0	25	4	62	23	2	91	417
13:55	78	14	35	1	128	**14**	**157**	1	0	**172**	3	10	7	0	20	6	74	30	0	110	430
Total Volume	572	273	427	26	1298	96	1302	42	13	1453	37	202	90	20	349	83	1145	385	13	1626	4726
% App. Total	44.1	21	32.9	2		6.6	89.6	2.9	0.9		10.6	57.9	25.8	5.7		5.1	70.4	23.7	0.8		
PHF	.502	.650	.614	.433	.611	.571	.691	.389	.271	.704	.514	.561	.625	.333	.661	.532	.682	.594	.361	.766	.804
Passenger Vehicle	571	273	426	26	1296	96	1292	38	13	1439	36	200	89	20	345	82	1127	378	13	1600	4680
% Passenger Vehicle	99.8	100	99.8	100	99.8	100	99.2	90.5	100	99.0	97.3	99.0	98.9	100	98.9	98.8	98.4	98.2	100	98.4	99.0
Bus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	5	0	9	9
% Bus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.3	1.3	0	0.6	0.2
Truck	1	0	1	0	2	0	10	4	0	14	1	1	1	0	3	1	13	2	0	16	35
% Truck	0.2	0	0.2	0	0.2	0	0.8	9.5	0	1.0	2.7	0.5	1.1	0	0.9	1.2	1.1	0.5	0	1.0	0.7
Bicycle	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0	1	2
% Bicycle	0	0	0	0	0	0	0	0	0	0	0	0.5	0	0	0.3	0	0.1	0	0	0.1	0.0
MicroMobility	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% MicroMobility	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Figure 5.2: Traffic Count Sample – Sunday Peak Hour – Main Street and SE Marine Drive

5.2 PROCESSED DATA

Using the traffic signal record, signal timing information is added to the Synchro model as described in previous sections. Vehicle, pedestrian, and cyclist volumes are provided in the traffic count data and are input into Synchro manually or imported via the transfer option shown in ***Section 4.1C***. Heavy vehicle percentages should be calculated for the modelled hour by combining truck and bus counts. If the provided peak hour factor (PHF) is not based on 15-minute intervals, the PHF for each movement should be recalculated using the provided formula in ***Section 6.0*** under the subheading Volume Settings [F4].

At the intersection of Main Street and SE Marine Drive, far side bus stops will block curbside traffic in the eastbound and westbound directions. Since they are downstream of the intersection approaches, the parameter Bus Blockages (#/hr) under Volume Settings [F4] should be kept zero. To compensate for the downstream blockage, the lane utilization factor in the eastbound and westbound approaches should be altered if lane by lane data is available. In this case, lane data is not available, and the default lane utilization factor is used. This may overestimate the capacity of the roadway.

5.2.1 Map Settings [F2] Example

Figure 5.3: Map Settings Example – Main Street and SE Marine Drive

5.2.2 Lane Settings [F3] Example

LANE SETTINGS	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lanes and Sharing (#RL)												
Traffic Volume (vph)	385	1145	83	42	1302	96	90	202	37	427	273	572
Future Volume (vph)	385	1145	83	42	1302	96	90	202	37	427	273	572
Street Name	SE Marine Drive			SE Marine Drive			Main Street			Main Street		
Link Distance (m)	—	263.3	—	—	254.5	—	—	170.4	—	—	154.3	—
Links Speed (km/h)	—	50	—	—	50	—	—	50	—	—	50	—
Set Arterial Name and Speed	—	EB	—	—	WB	—	—	NB	—	—	SB	—
Travel Time (s)	—	19.0	—	—	18.3	—	—	12.3	—	—	11.1	—
Ideal Satd. Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (m)	3.3	3.3	3.6	3.3	3.3	3.6	3.3	3.3	3.6	3.3	3.3	3.6
Grade (%)	—	0	—	—	0	—	—	0	—	—	-5	—
Area Type CBD	—	☐	—	—	☐	—	—	☐	—	—	☐	—
Storage Length (m)	55.0	—	0.0	45.0	—	0.0	40.0	—	12.0	0.0	—	25.0
Storage Lanes (#)	1	—	—	1	—	—	1	—	1	—	—	1
Right Turn Channelized	—	—	None	—	—	None	—	—	None	—	—	None
Curb Radius (m)	—	—	—	—	—	—	—	—	—	—	—	—
Add Lanes (#)	—	—	—	—	—	—	—	—	—	—	—	—
Lane Utilization Factor	1.00	0.91	0.91	1.00	0.91	0.91	1.00	0.95	0.95	1.00	1.00	1.00
Right Turn Factor	1.000	0.988	—	1.000	0.990	—	1.000	0.980	—	1.000	1.000	0.850
Left Turn Factor (prot)	0.950	1.000	—	0.950	1.000	—	0.950	1.000	—	0.950	1.000	1.000
Saturated Flow Rate (prot)	1711	4880	—	1586	4903	—	1728	3224	—	1788	1694	1655
Left Turn Factor (perm)	0.096	1.000	—	0.139	1.000	—	0.336	1.000	—	0.460	1.000	1.000
Right Ped Bike Factor	1.000	0.995	—	1.000	0.997	—	1.000	0.996	—	1.000	1.000	0.973
Left Ped Factor	1.000	1.000	—	0.996	1.000	—	0.992	1.000	—	0.991	1.000	1.000
Saturated Flow Rate (perm)	173	4880	—	231	4903	—	606	3224	—	858	1694	1611
Right Turn on Red?	—	—	☑	—	—	☑	—	—	☑	—	—	☑
Saturated Flow Rate (RTOR)	0	15	—	0	11	—	0	14	—	0	0	372
Link Is Hidden	—	☐	—	—	☐	—	—	☐	—	—	☐	—
Hide Name in Node Title	—	☐	—	—	☐	—	—	☐	—	—	☐	

Figure 5.4: Lane Settings Example – Main Street and SE Marine Drive

5.2.3 Volume Settings [F4] Example

VOLUME SETTINGS	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lanes and Sharing (#RL)	↰	↑↑↱		↰	↑↑↱		↰	↑↱		↰	↑	↱
Traffic Volume (vph)	385	1145	83	42	1302	96	90	202	37	427	273	572
Development Volume (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Combined Volume (vph)	385	1145	83	42	1302	96	90	202	37	427	273	572
Future Volume (vph)	385	1145	83	42	1302	96	90	202	37	427	273	572
Conflicting Peds. (#/hr)	26	—	20	20	—	26	13	—	13	13	—	13
Conflicting Bicycles (#/hr)	—	—	1	—	—	0	—	—	1	—	—	0
Peak Hour Factor	0.79	0.86	0.69	0.75	0.81	0.80	0.87	0.71	0.84	0.77	0.88	0.60
Growth Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adjusted Flow (vph)	487	1331	120	56	1607	120	103	285	44	555	310	953
Heavy Vehicles (%)	2	1	1	10	1	0	1	0	3	0	0	0
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Adj. Parking Lane?	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☑	☐
Parking Maneuvers (#/hr)	—	—	—	—	—	—	—	0	—	—	0	—
Traffic from mid-block (%)	—	0	—	—	0	—	—	0	—	—	0	—
Link OD Volumes	—	—	—	—	—	—	—	—	—	—	—	—
Traffic in shared lane (%)	—	—	—	—	—	—	—	—	—	—	—	—
Lane Group Flow (vph)	487	1451	0	56	1727	0	103	329	0	555	310	953

Figure 5.5: Lane Settings Example – Main Street and SE Marine Drive

5.2.4 Node Settings [F5/F6] Example

NODE SETTINGS	
Node #	3
ATMS.now Controller ID	0
Import from ATMS.now:	Import
Export to ATMS.now:	Export
Zone:	
X East (m):	5797.9
Y North (m):	-2491.7
Z Elevation (m):	0.0
Description	
Control Type	Actd-Uncrd
Cycle Length (s):	116.0
Lock Timings:	☑
Optimize Cycle Length:	Optimize
Optimize Splits:	Optimize
Actuated Cycle(s):	115.3
Natural Cycle(s):	150.0
Max v/c Ratio:	1.44
Intersection Delay (s):	106.7
Intersection LOS:	F
ICU:	1.02
ICU LOS:	G
Offset (s) :	—
Referenced to:	—
Reference Phase:	—
Coordination Mode:	—
Master Intersection:	—
Yield Point:	—
Mandatory Stop On Yellow:	☐

Figure 5.6: Node Settings Example – Main Street and SE Marine Drive

5.2.5 Timing Settings [F5] Example

TIMING SETTINGS	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	PED	HOLD
Lanes and Sharing (#RL)													—	—
Traffic Volume (vph)	385	1145	83	42	1302	96	90	202	37	427	273	572	—	—
Future Volume (vph)	385	1145	83	42	1302	96	90	202	37	427	273	572	—	—
Turn Type	pm+pt	—	—	pm+pt	—	—	pm+pt	—	—	pm+pt	—	Perm	—	—
Protected Phases	1	6	—	5	2	—	7	4	—	3	8			
Permitted Phases	6		—	2		—	4		—	8		8	—	—
Permitted Flashing Yellow	☐	—	—	☐	—	—	☐	—	—	☐	—	—	—	—
Detector Phases	1	6	—	5	2	—	7	4	—	3	8	8	—	—
Switch Phase	0	0	—	0	0	—	0	0	—	0	0	0	—	—
Leading Detector (m)	21.1	30.5	—	21.1	30.5	—	21.1	30.5	—	21.1	30.5	1.8	—	—
Trailing Detector (m)	0.0	0.0	—	0.0	0.0	—	0.0	0.0	—	0.0	0.0	0.0	—	—
Minimum Initial (s)	5.0	15.0	—	5.0	15.0	—	5.0	10.0	—	5.0	10.0	10.0	—	—
Minimum Split (s)	9.0	33.0	—	9.0	33.0	—	9.0	35.0	—	9.0	35.0	35.0	—	—
Total Split (s)	25.0	52.0	—	15.0	42.0	—	14.0	35.0	—	14.0	35.0	35.0	—	—
Yellow Time (s)	4.0	3.5	—	4.0	3.5	—	4.0	3.5	—	4.0	3.5	3.5	—	—
All-Red Time (s)	0.0	1.5	—	0.0	1.5	—	0.0	1.5	—	0.0	1.5	1.5	—	—
Lost Time Adjust (s)	0.0	0.0	—	0.0	0.0	—	0.0	0.0	—	0.0	0.0	0.0	—	—
Lagging Phase?	☐	☑	—	☐	☑	—	☐	☑	—	☐	☑	☑	—	—
Allow Lead/Lag Optimize?	☑	☑	—	☑	☑	—	☑	☑	—	☑	☑	☑	—	—
Recall Mode	None	Min	—	None	Min	—	None	None	—	None	None	None	—	—
Speed limit (km/h)	—	50	—	—	50	—	—	50	—	—	50	—	—	—
Actuated Effct. Green (s)	63.0	52.6	—	45.4	37.0	—	39.5	29.3	—	41.0	30.0	30.0	—	—
Actuated g/C Ratio	0.55	0.46	—	0.39	0.32	—	0.34	0.25	—	0.36	0.26	0.26	—	—
Volume to Capacity Ratio	1.30	0.65	—	0.32	1.09	—	0.35	0.40	—	1.44	0.70	1.37	—	—
Control Delay (s)	183.9	26.5	—	19.2	89.6	—	26.8	35.7	—	240.7	48.7	199.3	—	—
Queue Delay (s)	0.0	0.0	—	0.0	0.0	—	0.0	0.0	—	0.0	0.0	0.0	—	—
Total Delay (s)	183.9	26.5	—	19.2	89.6	—	26.8	35.7	—	240.7	48.7	199.3	—	—
Level of Service	F	C	—	B	F	—	C	D	—	F	D	F	—	—
Approach Delay (s)	—	66.1	—	—	87.4	—	—	33.6	—	—	186.3	—	—	—
Approach LOS	—	E	—	—	F	—	—	C	—	—	F	—	—	—
Queue Length 50th (m)	~127.9	93.7	—	5.8	~162.9	—	15.0	31.0	—	~171.9	64.1	~221.7	—	—
Queue Length 95th (m)	#155.4	106.6	—	9.9	#159.4	—	26.1	33.5	—	#190.3	92.6	#120.1	—	—
Stops (vph)	251	918	—	24	1214	—	58	185	—	299	244	274	—	—
Fuel Used (l/hr)	70	76	—	2	157	—	5	15	—	92	20	102	—	—

Figure 5.7: Timing Settings Example – Main Street and SE Marine Drive

5.2.6 Phasing Settings [F6] Example

PHASING SETTINGS	1-EBL	2-WBTL	3-SBL	4-NBTL	5-WBL	6-EBTL	7-NBL	8-SBTL
Minimum Initial (s)	5.0	15.0	5.0	10.0	5.0	15.0	5.0	10.0
Minimum Split (s)	9.0	33.0	9.0	35.0	9.0	33.0	9.0	35.0
Maximum Split (s)	25.0	42.0	14.0	35.0	15.0	52.0	14.0	35.0
Yellow Time (s)	4.0	3.5	4.0	3.5	4.0	3.5	4.0	3.5
All-Red Time (s)	0.0	1.5	0.0	1.5	0.0	1.5	0.0	1.5
Lagging Phase?	☐	☑	☐	☑	☐	☑	☐	☑
Allow Lead/Lag Optimize?	☑	☑	☑	☑	☑	☑	☑	☑
Optimize Phs Weights - Delays	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Minimum Gap (s)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Time Before Reduce (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Time To Reduce (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Recall Mode	None	Min	None	None	None	Min	None	None
Pedestrian Phase	☐	☑	☐	☑	☐	☑	☐	☑
Walk Time (s)	—	10.0	—	7.0	—	10.0	—	7.0
Flash Dont Walk (s)	—	18.0	—	23.0	—	18.0	—	23.0
Pedestrian Calls (#/hr)	—	10	—	10	—	10	—	10
Dual Entry?	☐	☑	☐	☑	☐	☑	☐	☑
Fixed Force Off?	☐	☐	☐	☐	☐	☐	☐	☐
90th %ile Green Time (s)	21 mx	37 mx	10 mx	30 pd	9 gp	49 hd	10 mx	30 mx
70th %ile Green Time (s)	21 mx	37 mx	10 mx	30 hd	8 gp	50 hd	10 mx	30 mx
50th %ile Green Time (s)	21 mx	37 mx	10 mx	30 hd	7 gp	51 hd	10 mx	30 mx
30th %ile Green Time (s)	21 mx	37 mx	10 mx	29 hd	7 gp	51 hd	9 gp	30 mx
10th %ile Green Time (s)	21 mx	37 mx	10 mx	27 hd	0 sk	62 hd	7 gp	30 mx

Figure 5.8: Phasing Settings Example – Main Street and SE Marine Drive

6.0 GLOSSARY

This section provides the user with a brief description of the terminology used in each of the Synchro setting tabs. For more detailed descriptions of the terminology used, see the Synchro Version 10 User Guide by Trafficware.

Table 6.1: City of Vancouver – Synchro Glossary

PARAMETER	DESCRIPTION
LANE SETTINGS [F3]	
Lanes and Sharing (#RL)	The number of lanes and lane configuration for each lane group.
Street Name	Name of a street.
Link Distance (m)	Distance/length of a link. Distance from intersection center point to center point. Note: Link distance is determined automatically after drawing the link and are shown in blue. Overridden distances are shown in red.
Link Speed (km/h)	Posted speed limit along the arterial before/at/after the traffic signals along the link.
Travel Time (s)	Vehicle travel time along a specific link that is calculated by dividing the link speed by the link distance. Note: Travel Time is calculated automatically.
Ideal Satd. Flow (vphpl)	The maximum number of vehicles from that lane group that can pass through the intersection during one-hour of continuous green time under the prevailing traffic and roadway conditions.
Lane Width (m)	Width of the lane.
Grade (%)	The slope of roadway approaching the intersection. Positive grades represent uphill and negative grades represent downhill. Note: Saturation Flow Rate increases when traffic moves downhill (negative Grade).
Area Type CBD	Area describing the Central Business District (CBD) or “downtown” area. A CBD is characterized by high parking turnovers, narrow short-block roadways, and high pedestrian activity. Note: Saturation Flow Rate decreases when Area Type CBD is selected.
Storage Length (m)	Length of a right and/or left turn bay(s). Note: Storage Length data is used for analyzing potential blocking problems, including through traffic blocking left turn traffic, and left turn traffic blocking through traffic.
Storage Lanes (#)	Number of storage lanes in the right and/or left turn bay(s).
Right Turn Channelized	Dedicated right turn movement separated by a curb, with turn control of either: • None – No right turn channelization; • Yield – No phases are assigned, the saturation flow is that for the Right Turn on Red, and drivers must yield to incoming traffic before making a right turn; • Stop – No phases are assigned, the saturation flow is that for the Right Turn on Red, and drivers must stop and approach the intersection safely before making a right turn; • Free – The phase assigned is “Free” (100% green time), the saturation flow used is the permitted saturation flow, and drivers can make a right turn without yielding or stopping; • Signal – The movement is controlled by the signal.
Curb Radius (m)	The horizontal curvature of the street intersection and is measured from the back of the curb to the center point of the radius.
Add Lanes (#)	Controls how a right turn lane enters the intersection street. Add Lanes value of: • Zero (0) creates a yield or merge for drivers completing a right turn. • One (1) adds a continuation lane for the right turn.

PARAMETER	DESCRIPTION
Lane Utilization Factor	Determines how the traffic volumes assigned to a lane group are distributed across each lane. A Lane Utilization Factor of: • One (1) indicates equal distribution across all lanes. • Less than one (<1) indicates that all lanes are not working at full capacity and lowers the saturation flow rate. Note: Lane Utilization Factor fields are selected automatically by Synchro depending on the Lane Group Movements and # of Lanes but can be overridden.
Right Turn Factor	Represents how much the interference from right turning traffic reduces the Saturated Flow Rate. Note: Right Turn Factor fields are calculated but can be overridden.
Left Turn Factor	Represents how much the interference from left turning traffic reduces the Saturated Flow Rate. Note: Left Turn Factor fields are calculated but can be overridden.
Saturated Flow Rate	Actual maximum flow rate for a lane group after adjusting for all the interference factors. Represents the number of lanes multiplied by the Ideal Saturation Flow Rate and interference factors due to heavy vehicles, buses, parking maneuvers, lane widths, area type, grade, and turning movements. Note 1: Saturation Flow Rates are used in capacity and delay calculations, and for optimization calculations. Note 2: Saturation Flow Rate fields are calculated but can be overridden.
Right Ped Bike Factor	Factor is calculated based on the number of pedestrians and bicycles that are crossing the right turn movement. Factor considers the amount of green time for pedestrians and the bicycles as well as the number of downstream receiving lanes.
Left Ped Factor	Factor is calculated based on the number of pedestrians and bicycles that are crossing the permitted left turn movements. Factor considers the amount of green time for the pedestrians and vehicles, the amount of oncoming traffic, and the number of downstream receiving lanes.
Right Turn on Red (RTOR)	Specifies whether Right Turn on Red (RTOR) are allowed. Field can also be used to allow Left Turns on Red from a one-way to a one-way. Note: Synchro automatically calculates a Saturated Flow Rate for RTOR and applies this flow rate to movements when they are red.
Saturated Flow Rate (RTOR)	Saturation Flow Rate for Right Turns on Red (RTOR). This Saturation Flow Rate is applied to a movement whenever the movement has a red signal. This calculation is also made for Left Turns on Red crossing one-way streets. Calculation for RTOR Saturation Flow Rate is based on the signal timing, the volumes of the subject approach, and the volumes of any merging approaches. Note: It is possible to override the RTOR Saturation Flow rate to a measured or hand calculated value, but it is not recommended since overridden values will not be updated when the volumes or signal timings change.
Link is Hidden	Hides or unhides a link.
Hide Name in Node Title	Hides or unhides a street name in the node title.
VOLUME SETTINGS [F4]	
Traffic Volume (vph)	Traffic volumes of each intersection movement in vehicles per hour, typically for the time periods of: AM peak period, Mid-day, and PM peak period.
Development Volume (vph)	The sum of all primary and pass-by trips generated by development(s) selected in Traffic Impact Analysis.
Combined Volume (vph)	The sum of existing Traffic Volume and Development Volume.
Future Volume (vph)	Future Volume (FV) is equal to the Combined Volume with any select future scenarios applied using the volume-growth equation:

PARAMETER	DESCRIPTION
	$$FV = V(1+r)^t$$ where: V = Combined Volume (vph) r = Growth Rate t = Number of Years
Conflicting Peds. (#/hr)	The number of pedestrians per hour that conflict with permitted right turn movements. Note 1: This number affects the Right Ped Bike Factor and the Saturated Flow Rate for the permitted right turns, and the Ped Bike Factor. Note 2: Increasing the number of conflicting pedestrians and bicycles reduces the saturated flow rate of right turns conflicting with these movements.
Conflicting Bicycles (#/hr)	The number of through bicycles per hour that conflict with permitted right turn movements. Note: This number will affect the Right Ped Bike Factor.
Peak Hour Factor	Peak Hour Factor (PHF) is the sum of 15-minute volumes for any given hour in a day (typically the peak hour) divided by the maximum 15-minute volume within the selected hour: $$PHF = \frac{Vol15_1 + Vol15_2 + Vol15_3 + Vol15_4}{4 \times Max(Vol15_i)}$$ where: Vol15 = Quarter Hour Volume i = 1st, 2nd, 3rd, and 4th Quarter Hour Volume The PHF indicates how consistent traffic volume is for any given hour in a day. A PHF value of: • One (1) indicates the traffic volume is consistent/the same for the selected hour. • Less than one (<1) indicates the traffic volume is not consistent and varies within the selected hour.
Growth Factor	Used to adjust traffic volumes using a range from 0.5 to 3. The raw volume data is multiplied by the Growth Factor (GF) when calculating Adjusted Volumes and Lane Group Volumes. GF is calculated using the growth rate over several years: $$GF = (1+r)^Y$$ where: r = Growth Rate Y = Number of Years
Adjusted Flow (vph)	The Future Volume modified by the Peak Hour Factor and Growth Factor. Note: This field cannot be overridden.
Heavy Vehicle (%)	The percentage of trucks and buses for each traffic movement. Note: Increasing this value decreases the Saturated Flow Rate.
Bus Blockages (#/hr)	The number of buses per hour that stop and block traffic for each lane group. Note: Increasing this value decreases the Saturated Flow rate.
Adj. Parking Lane?	Parameter describing if there is on-street parking for an approach impeding traffic flow. Note: Saturated Flow Rate decreases if the Adj. Parking Lane? parameter is selected.
Parking Maneuvers (#/hr)	The number of parking maneuvers per hour for an approach. Note: Saturated Flow Rate decreases with increasing Parking Maneuvers.
Traffic from Mid-block (%)	Identifies vehicles originating from mid-block sources between the current intersection and the last upstream intersection modelled in Synchro. A value of:

PARAMETER	DESCRIPTION
	• Zero (0) indicates that 0% of traffic originated from driveways and 100% of traffic originated from the upstream intersection. • Fifty (50) indicates that 50% of traffic originated from driveways and 50% of traffic originated from the upstream intersection. • One hundred (100) indicates that 100% of traffic originated from driveways and 0% of traffic originated from the upstream intersection.
Link OD Volumes	Allow for detailed control over the origin and destination of traffic volumes for two adjacent intersections. Can be used to reduce or eliminate certain turn combinations.
Traffic in Shared Lane (%)	Traffic volumes assigned to exclusive and shared lane are proportioned to each lane.
Lane Group Flow (vph)	Combines the Adjusted Flow and Traffic in Shared Lane (%) values to assign net volumes to each lane group.
NODE SETTINGS [F5/F6]	
Control Type	Indicates the type of controller you are using. The choices are: Pretimed, Semi-Actuated-Uncoordinated, Actuated-Uncoordinated, Actuated-Coordinated, Unsignalized, and Roundabouts. Description for each signal Control Type are as follows: • Pretimed – Has no detector actuations and all phases are set to Maximum Recall. The signal is considered coordinated because the cycle length is fixed each cycle. • Semi-Actuated-Uncoordinated – Signal recalls the main street through phases to their Maximum values. Other assigned phases may skip or gap-out based on vehicle direction. This signal is not considered coordinated because the cycle length can vary each cycle (i.e. no offset). • Actuated-Uncoordinated – All phases are fully actuated, and no recalls are set. The cycle length can vary each cycle (based on detection), so the intersection is considered uncoordinated (i.e. no offset). • Actuated-Coordinated – All phases other than the assigned coordinated phases are fully actuated. The signal operates on a fixed cycle length and any unused time in the cycle is added to the assigned coordinated phases. • Unsignalized – Control Type used when traffic movements at unsignalized intersections are free flow or controlled by stop or yield signs. • Roundabouts – Control Type used when a roundabout is placed at an intersection, instead of a signal. Note 1: In general, an Actuated Control Type means that all approaches are vehicle demand actuated via the presence of vehicles on loop detectors. Note 2: In general, a Coordinated Control Type means that the intersection signal has an offset time (time that ensures the intersections along a corridor remain green). The converse is true with an Uncoordinated Control Type.
Cycle Length (s)	The total time required to service all competing traffic movements at a signalized or unsignalized intersection. Note: The minimum value allowed in Synchro is 3s, although Coordinated Cycle Lengths are typically between 30-180s depending on the number of competing phases serviced.
Lock Timings	Parameter that prevents the signal timing from changing. Note: If you optimize the network, these intersections' timing plans will not change, but the other intersections will be optimized around them.
Optimize Cycle Length	Parameter used to optimize the selected intersection cycle length.

<table>
<tr><th>PARAMETER</th><th>DESCRIPTION</th></tr>
<tr><td>Optimize Splits</td><td>Parameter used to optimize the selected intersection splits.</td></tr>
<tr><td>Actuated Cycle (s)</td><td>The Actuated Cycle Length (CL) is the average cycle length for an actuated signal and is calculated using the following formula:

$$C' = \frac{\sum Ci}{5}$$
where:
C' = Actuated CL (and C = Pretimed and Coordinated Signal CL)
Ci = Percentile Scenario Cycle Length

Note: C' may not equal the sum of the actuated splits due to skipped phases and dwell time.</td></tr>
<tr><td>Actuated Cycle XXth (s)</td><td>Parameter describing the expected Actuated Cycle (cycle length based on the sum of the actuated splits for each phase) for five different traffic volume percentile scenarios: 90th, 70th, 50th, 30th, and 10th percentiles. Traffic volumes for each approach are adjusted up or down to model these percentile scenarios. By adjusting the traffic for different scenarios, the actuated signals can be modelled under a range of conditions. If traffic is observed for 100 cycles, the:
90th percentile would be the 90th busiest;
10th percentile would be the 10th busiest; and
50th percentile would represent average traffic.</td></tr>
<tr><td>Natural Cycle (s)</td><td>The shortest cycle length that will give acceptable capacity. The Natural Cycle Length is the cycle length an intersection would operate at if it were to operate independently of all other intersections.</td></tr>
<tr><td>Max v/c Ratio</td><td>The highest individual movement or lane group v/c ratio. During peak hours, V/C ratios at or above 1.0 can be expected at major intersections throughout the City.</td></tr>
<tr><td>Intersection Delay (s)</td><td>The average Total Delay for the signalized intersection and it is calculated by taking a volume weighted average of all the Total Delays (including Queue Delay plus Control Delay).</td></tr>
<tr><td>Intersection LOS</td><td>Qualitative measure used to analyze roadways by categorizing traffic flow and assigning quality levels of traffic based on performance measure such as vehicle speed, density, congestion, etc. The Level of Service (LOS) for an intersection is calculated by taking the total Intersection Delay and converting it to a letter, between A and F, based on the length of the delay. During peak hours, LOS E or even F can be expected at major intersections throughout the City.

<table>
<tr><th rowspan="2">LOS</th><th rowspan="2">Description</th><th colspan="2">Control Delay (s)</th></tr>
<tr><th>Signalized Int</th><th>Unsignalized Int</th></tr>
<tr><td>A</td><td>Free Flow</td><td>≤10</td><td>≤10</td></tr>
<tr><td>B</td><td>Reasonably Free Flow</td><td>10-20</td><td>10-15</td></tr>
<tr><td>C</td><td>Stable Flow</td><td>20-35</td><td>15-25</td></tr>
<tr><td>D</td><td>Approaching Unstable Flow</td><td>35-55</td><td>25-35</td></tr>
<tr><td>E</td><td>Unstable Flow/At Capacity</td><td>55-80</td><td>35-50</td></tr>
<tr><td>F</td><td>Forced/Breakdown Flow</td><td>>80</td><td>>50</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>PARAMETER</th><th>DESCRIPTION</th></tr>
<tr><td>ICU</td><td>
Intersection Capacity Utilization (ICU) is only shown for unsignalized intersections and represents the potential capacity for the intersection if it were to be signalized. The ICU is the sum of time required to serve all movements at saturation given a reference cycle length, divided by the reference cycle length:

$$ICU = \frac{\sum(Max(tMin, \frac{v}{si}) \times CL + tLi)}{CL}$$

where:
tMin = Minimum Green Time, Critical Movement i
v/si = Volume to Saturation Flow Rate, Critical Movement i
CL = Reference Cycle Length
tLi = Lost Time for Critical Movement i
</td></tr>
<tr><td>ICU LOS</td><td>
Intersection Capacity Utilization Level of Service (ICU LOS) is only shown for unsignalized intersections and gives insight into how an intersection is functioning and how much extra capacity is available to handle traffic fluctuations. This parameter gives a good reading on the conditions that can be expected at the intersection if it were to be signalized. The ICU LOS for an intersection is calculated using the ICU formula and converting it to a letter, between A and H.
<table>
<tr><th>ICU LOS</th><th>Intersection Description</th><th>ICU (%)</th></tr>
<tr><td>A</td><td>No Congestion</td><td><55</td></tr>
<tr><td>B</td><td>Very Little Congestion</td><td>55-64</td></tr>
<tr><td>C</td><td>No Major Congestion</td><td>64-73</td></tr>
<tr><td>D</td><td>Normally Has No Congestion</td><td>73-82</td></tr>
<tr><td>E</td><td>Verge of Congested Conditions</td><td>82-91</td></tr>
<tr><td>F</td><td>Over Capacity and Likely Experiences Congestion Periods of 15-60 Minutes Per Day</td><td>91-100</td></tr>
<tr><td>G</td><td>10-20% Over Capacity and Likely Experiences Congestion Periods of 60-12 Minutes Per Day</td><td>100-109</td></tr>
<tr><td>H</td><td>20% Over Capacity and Could Experience Congestion Periods of Over 120 Minutes Per Day</td><td>>109</td></tr>
</table>
</td></tr>
<tr><td>Offset (s)</td><td>
The amount of time, in seconds, that the reference phase lags the master reference (or arbitrary reference if no master reference is specified) to synchronize the intersections sharing a common cycle length to provide a coordinated system. This parameter allows for vehicles to travel without periodically stopping due to downstream signalized intersections' All-Red intervals.
</td></tr>
<tr><td>Offset Reference To</td><td>
Parameter describing the point at which the Offset is referencing to. Each intersection is given one Offset that is typically referenced to the beginning of green in the City of Vancouver. Special reference points include TS2-1st Green or 170 Style.
<table>
<tr><th>Reference To</th><th>Reference Point</th></tr>
<tr><td>Begin of Green</td><td>Referenced to last of phases to turn green</td></tr>
<tr><td>Begin of Yellow</td><td>Referenced to first of phases to turn yellow</td></tr>
<tr><td>Begin of Red</td><td>Referenced to first of phases to turn red</td></tr>
<tr><td>TS2-1st Green</td><td>Referenced to first of phases to turn green</td></tr>
<tr><td>170 Style</td><td>Referenced to start of FDW or start of yellow</td></tr>
</table>
</td></tr>
</table>

PARAMETER	DESCRIPTION
Offset Reference Phase	Parameter describing the phase at which the Offset is referencing to. The Offset Reference Phase(s) are typically the coordinated phases associated with the arterial street and controls which phases are the coordinated phases for an actuated-coordinated signal. Note: The red indicator/marker is displayed on the phasing diagram to indicate the Reference Phase(s).
Master Intersection	The Master Intersection is used in Synchro to reference offsets to the cycle counter at that intersection. Note: The Offset value for Master Intersection is typically zero (0).
Yield Point	Parameter that determines when the Coordinated Phases will “yield” to side street phases. This setting affects whether there is a single yield point for all phases or multiple yield points. See *Synchro Studio 10 User Guidelines* for additional information.
Mandatory Stop On Yellow	By default, Synchro will allow at least two vehicles to proceed during a signal phase. This parameter will allow only one simulated vehicle to pass through a short green signal and no sneaker vehicles will be allowed during the yellow interval.
TIMING SETTINGS [F5]	
Turn Type	Parameter describing the level of turn protection for both left and right turns and assigns default phase and detector numbers to the dedicated turn lane. There are two turn types: Left Turn Type and Right Turn Type, each having different turn protections. Refer to Table 4.7 in Section 4.5 for descriptions of all turn types.
Protected Phases	Phase rows are used to assign one or more phases for each movement. During protected phases, traffic can move without conflict. Protected phases are automatically assigned to through movements and are assigned to left or right Turn Types that have a protected turn protection.
Permitted Phases	Phase rows are used to assign one or more phases for each movement. During permitted phases, left turning traffic must yield to oncoming traffic and right turn turning traffic must yield to pedestrians. Permitted phases are automatically assigned to left or right Turn Types that have a permitted turn protection.
Permitted Flashing Yellow	Parameter that ensures the traffic signal display will flash yellow during the permitted phase of a prot+perm left turn. Note: Selecting this parameter is only used if a simulation within SimTraffic is conducted and does not affect the analysis results.
Detector Phases	Detector Phase are automatically assigned depending on the assigned phases of each approach. Detectors in the subject lane group will call and/or extend the Detector Phases. Detectors call a protected phase by default or a permitted phase if a protected phase does not exist. Note: If there is no detector for a lane group, code a value of zero (0) in the setting for Detector Phase and ensure that his is either the coordinated phase, is a pretimed signal, or “maximum” is coded for the recall mode.
Switch Phase	Secondary phase that extends the entered phase when it is green. This setting does not place a call and does not call the primary Detector Phase when the entered switch phase is green. This setting can be used for the permitted phase of a permitted plus protected left turn.
Leading Detector (m)	Distance from the leading edge of the most advanced detector to the respective stop bar of an intersection.
Trailing Detector (m)	Distance from the respective stop bar of an intersection to the trailing edge of the most advanced detector.

PARAMETER	DESCRIPTION
Lost Time Adjust (s)	The start-up lost time minus extension of effective green time. Lost Time Adjust (tLA) formula is as follows: $$tLA = L1 - e$$ where: L1 = Startup Lost Time (s) = 2.5s (by default) e = Extension of Effective Green (s) = 2.5s (by default) Note: The Lost Time Adjust is set to 0s by default. The Total Lost Time (tL) is calculated as the sum of the yellow time, all-red time, and Lost Time Adjust: $$tL = Yi + tLA$$ where: Yi = Yellow + All-Red Time (s) tLA = Lost Time Adjust (s)
Actuated Effct. Green (s)	The average green time observed while the signal is operating in actuated mode. The Actuated Effective Green (g') time is an average of the five percentile green times, considers the yellow plus all-red time, and subtracts the total lost time: $$g' = \sum \left[\frac{gi+YAR}{Ci}\right] \times \frac{\sum Ci}{25} - tL$$ (Percentile Method) $$g' = \sum \left[\frac{gi}{Ci}\right] \times \frac{\sum Ci}{25} + YAR - tL$$ (Webster Method) where: gi = Percent Green Time Ci = Percentile Cycle Length YAR = Yellow + All-Red Time (s) tL = Total Lost Time (s) Note 1: This value may be less than maximum green time if the phase is skipped or gapped out. The effective green may be higher than maximum green during coordination depending on the Floating Force Off setting and Yield method selected. Note 2: Effective green for left-turns is also dependent on whether the left-turn is protected, permitted, or both (pm+pt).
Actuated g/C Ratio	The average actuated green time (g) divided by the actuated cycle length (C): $$\frac{g}{C} = \frac{\sum(\frac{gi}{Ci})}{5}$$ where: g = Effective Green Time (s) (split minus lost time) C = Cycle Length (s) gi = Percentile Green Time Ci = Percentile Scenario Cycle Length

<table>
<tr><th>PARAMETER</th><th>DESCRIPTION</th></tr>
<tr><td>Volume to Capacity Ratio</td><td>Indicated the amount of congestion for each lane group. Volume to Capacity Ratio (v/c Ratio) value of:

Less than one (<1) indicates the approach is operating below capacity.
One (1) indicates the approach is operating at capacity.
Greater than one (>1) indicates the approach is operating above capacity.

v/c Ratio is calculated using the formula:

$$X = \frac{v}{s \times (\frac{g}{C})}$$

where:
X = Volume to Capacity Ratio
v = Adjusted Lane Group Volume
s = Saturated Flow Rate
g = Effective Green Time (s) (split minus total lost time)
C = Cycle length (s)</td></tr>
<tr><td>Control Delay (s)</td><td>Signal Delays that are equivalent to the Stopped Delay multiplied by a constant of 1.3. Control Delay is the component of delay caused by the downstream control device and does not include Queue Delay. Note: Used for analyzing the effects of coordination, actuation, and congestion.</td></tr>
<tr><td>Queue Delay (s)</td><td>Parameter that analyzes the effects of queues and blocking on short links and short turning bays. This delay includes the analysis of spillback, starvation, and storage blocking.</td></tr>
<tr><td>Total Delay (s)</td><td>The sum of the lane group Control Delay and the Queue Delay.</td></tr>
<tr><td>Level of Service</td><td>Qualitative measure used to analyze roadways by categorizing traffic flow and assigning quality levels of traffic based on performance measure such as vehicle speed, density, congestion, etc. The Level of Service (LOS) for each turning movement of an intersection is calculated by taking the signalized Intersection Delay and converting it to a letter, between A and F, based on the length of the delay.
<table>
<tr><th rowspan="2">LOS</th><th rowspan="2">Description</th><th colspan="2">Control Delay (s)</th></tr>
<tr><th>Signalized Int</th><th>Unsignalized Int</th></tr>
<tr><td>A</td><td>Free Flow</td><td>≤10</td><td>≤10</td></tr>
<tr><td>B</td><td>Reasonably Free Flow</td><td>10-20</td><td>10-15</td></tr>
<tr><td>C</td><td>Stable Flow</td><td>20-35</td><td>15-25</td></tr>
<tr><td>D</td><td>Approaching Unstable Flow</td><td>35-55</td><td>25-35</td></tr>
<tr><td>E</td><td>Unstable Flow/At Capacity</td><td>55-80</td><td>35-50</td></tr>
<tr><td>F</td><td>Forced/Breakdown Flow</td><td>>80</td><td>>50</td></tr>
</table></td></tr>
<tr><td>Approach Delay (s)</td><td>Volume weighted average of the Total Delays for each lane group.</td></tr>
</table>

<table>
<tr><th>PARAMETER</th><th>DESCRIPTION</th></tr>
<tr><td>Approach LOS</td><td>Qualitative measure used to analyze roadways by categorizing traffic flow and assigning quality levels of traffic based on performance measure such as vehicle speed, density, congestion, etc. The Level of Service (LOS) for each approach of an intersection is calculated by taking the signalized Intersection Delay and converting it to a letter, between A and F, based on the length of the delay.

<table>
<tr><th rowspan="2">LOS</th><th rowspan="2">Description</th><th colspan="2">Control Delay (s)</th></tr>
<tr><th>Signalized Int</th><th>Unsignalized Int</th></tr>
<tr><td>A</td><td>Free Flow</td><td>≤10</td><td>≤10</td></tr>
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</table></td></tr>
<tr><td>Queue Length 50th (m)</td><td>50th percentile maximum queue is the maximum back of queue on a typical cycle.</td></tr>
<tr><td>Queue Length 95th (m)</td><td>95th percentile queue is the maximum back of queue with 95th percentile traffic volumes.</td></tr>
<tr><td>Stops (vph)</td><td>The number of vehicle stops per hour for a lane group.</td></tr>
<tr><td>Fuel Used (g/hr)</td><td>Parameter describing the fuel consumption of vehicles for a lane group. Note: The fuel used in each time slice is determined by the vehicle’s fleet (car, truck, or bus), speed, and deceleration.</td></tr>
<tr><td colspan="2">PHASE SETTINGS [F6]</td></tr>
<tr><td>Minimum Initial (s)</td><td>Shortest green time that is guaranteed if a phase is serviced for a specific approach/turning movement of an intersection. Note: The minimum Synchro value allowed is 1s and the maximum Synchro value allowed is 840s. Refer to Section 2.5 for details on City of Vancouver standard.</td></tr>
<tr><td>Minimum Split (s)</td><td>Shortest amount of time allowed for a phase. If the phase does not have a pedestrian phase, then the Minimum Split must at least be long enough to accommodate the Minimum Initial interval plus the Yellow and All-Red Time. If the phase has a pedestrian phase, then the Minimum Split must be the maximum of either the vehicle phase (Sum of Minimum Initial interval, Yellow Time, and All-Red Time) or the pedestrian phase (Sum of Walk Time, Flash Don’t Walk Time, Yellow Time, and All-Red Time):

$$Min\ Split = Max(Min\ Green + Y + AR, Walk + FDW + Y + AR)$$

Note: The minimum Synchro value allowed is 3s and the maximum Synchro value allowed is 840s. Refer to Section 2.5 for details on City of Vancouver standard.</td></tr>
<tr><td>Maximum Split (s)</td><td>Longest amount of split time for actuated movements. If the phase does not have a pedestrian phase, then the Maximum Split must at least be long enough to accommodate the Maximum Green interval plus the Yellow and All-Red Time. If the phase has a pedestrian phase, then the Maximum Split must be the maximum of either the vehicle phase (Sum of Maximum Green interval, Yellow Time, and All-Red Time) or the pedestrian phase (Sum of Walk Time, Flash Don’t Walk Time, Yellow Time, and All-Red Time):

$$Max\ Split = Max(Max\ Green + Y + AR, Walk + FDW + Y + AR)$$

Note: The Synchro minimum value is 3s. Refer to Section 2.5 for details on City of Vancouver standard.</td></tr>
</table>

PARAMETER	DESCRIPTION
Yellow Time (s)	Amount of time given for the yellow (amber) interval. Value typically set between 3 and 5s, depending on the approach speed, the cross-street width, and local standards. Note: The minimum Synchro value allowed is 2s and maximum Synchro value allowed is 10s. Refer to Section 2.5 for details on City of Vancouver standard.
All-Red Time (s)	Amount of time for the all red interval that proceeds the yellow interval. The all red time should be of sufficient duration to permit the intersection to clear before cross traffic is released. Note: The minimum Synchro value allowed is 0s and the maximum Synchro value is 120s. Refer to Section 2.5 for details on City of Vancouver standard.
Lagging Phase?	Parameter that swaps the order of phase partners. The first two phases within a ring-barrier sequence are considered phase partners. The third and fourth phases within a ring-barrier sequence, if used, are also phase partners. Eight phase dual ring operation normally provides the following phase partners: 1-2 and 3-4 in ring 1 and phase partners: 5-6 and 7-8 in ring 2. If Phase Lagging is set to "on" for a phase, it will follow the phase it normally proceeds. If Phase lagging is set to "off" for an even phase, it will precede the odd phase that normally comes before the even phase.
Allow Lead/Lag Optimize?	Parameter allows for the optimization of phases based on the order between leading and lagging phases. When optimizing offsets, Synchro will check all combinations of leading and lagging phasing to improve traffic flow. This is accomplished by looking at all combinations of the Lagging Phase setting. Note: You may use this parameter if it is okay for the phase to be either leading or lagging.
Optimize Phs Weights - Delays	Parameter optimizes a network by applying a weight factor for individual phases to prioritize/give precedence to an approach. Note: The weighting range is from 0.1 to 5. A value of 1 indicates no weighting and therefore would be the same as performing a basic operation.
Vehicle Extension (s)	Time at which the minimum green time is extended due to vehicle actuations to ensure there is sufficient time for vehicles to cross/clear an intersection. Vehicle Extension time only applies at the end of the minimum green time interval and if vehicles cross a loop detector. Vehicle Extension time terminates once the phase has either: • Gapped Out – A type of actuated operation for a given phase where the phase terminates due to a lack of vehicle calls within a specific period of time. • Maxed out – A type of actuated operation for a given phase where the phase terminates due to reaching the designated maximum green time for the phase.
Minimum Gap (s)	Minimum Gap is used with actuated phases for volume-density operation and is the minimum time between vehicle actuations before a phase gap out.
Time Before Reduce (s)	Time Before Reduce is used with actuated phases for volume-density operation and is the amount of time before gap reduction begins.
Time to Reduce (s)	Time to Reduce is used with actuated phases for volume-density operation and is the amount of time to reduce the gap from Vehicle Extension (or maximum gap) to Minimum Gap.
Recall Mode	Parameter tells when and how a phase will be served. There are six different types of Recall Modes: • No Recall (None) – The phase can be skipped. The phase will only be serviced when it is actuated by a field input. The phase will be called for its minimum green time and then extended by the passage time to the maximum green time. The extension of the phase to the maximum green time is dependent upon vehicle activations. An actuated phase may be skipped in absence of vehicular or pedestrian calls. • Minimum Recall (Min) – The phase will always be serviced each cycle for the minimum green time and cannot be skipped. The phase will be extended by the passage time to

PARAMETER	DESCRIPTION
	the maximum green time dependent upon vehicle actuations. If there are no calls to other phases after the Minimum Recall phase has gapped out, then the controller will rest in green in this phase. Note: The lane being analyzed with a Minimum Recall Mode typically will have loops detectors. • Maximum Recall (Max) – The phase will always be serviced each cycle for its Maximum Green time, has not detection, cannot be skipped, gapped out, and extended. Field inputs has no effect. After the phase has maxed out, then it will rest in green unless there are other phases with calls. Note: The lane being analyzed with a Maximum Recall Mode typically will not have loop detectors. • Pedestrian Recall (Ped) – The pedestrian times (i.e. Walk + Flash Don't Walk) are always serviced and cannot be skipped or gapped out until the Walk and Flash Don't Walk intervals have passed. • Coordinated Minimum (C-Min) – Used with coordinated signals only. This option is available for phases selected as the reference phase in the Offset settings. Phase shows for its minimum time starting at its scheduled start time. Note: Coordinated movements for minimum time must have loop detectors for vehicle actuation to extend the minimum green time to maximum green time. • Coordinated Maximum (C-Max) – Used with coordinated signals only. This option is available for phases selected as the reference phase in the Offset settings. Phase shows for its maximum time starting at its scheduled start time. Coordinated movements for maximum time do not have loop detectors.
Pedestrian Phase	Parameter describing if a pedestrian phase exists for an intersection approach. Note: Checking the box indicates there is a Pedestrian Phase for the intersection approach. Unchecking the box indicates there is no Pedestrian Phase for the intersection approach and the Pedestrian Phase, Walk Time, Flash Don't Walk, and Pedestrian calls are disabled.
Walk Time (s)	The amount of time given for a pedestrian walk phase for pedestrians to cross the intersection.
Flash Don't Walk (s)	The amount of time given for a pedestrian Flash Don't Walk phase for pedestrians to clear the intersection.
Pedestrian Calls (#/hr)	The number of pedestrian push button calls for a phase. Note 1: This value is only needed if this phase has a pedestrian push button. Note 2: When counting pedestrians, people travelling in groups can be counted as a single pedestrian call.
Dual Entry	Parameter is used in dual-ring operation to specify whether a phase is to be activated (green) even though it has not received a call for service. Two entry modes are possible: dual entry and single entry. This mode is input for each actuated signal phase.
Fixed Force Off	Parameter is used for Actuated-Coordinated signals only to give extra time to either side streets or main streets. When this parameter is set to: • On – Extra time is given to side streets; and • Off – Extra time is given to main streets. Note when set to 'ON", maximum green for uncoordinated phase can be exceeded if the phase starts early. If set to 'OFF" time will be added to the coordinated phase instead. The default is the coordinated phase.
XXth %ile Green Time (s)	Parameter describing the green time for each phase and for five different traffic volume percentile scenarios: 90th, 70th, 50th, 30th, 10th percentiles. Traffic volumes for each approach are adjusted up or down to model these percentile scenarios. By adjusting the traffic for different scenarios, the actuated signals can be modelled under a range of traffic conditions.

PARAMETER	DESCRIPTION
	If traffic is observed for 100 cycles, the: • 90^{th} percentile would be the 90^{th} busiest; • 10^{th} percentile would be the 10^{th} busiest; and • 50^{th} percentile would represent average traffic. Note: The range of green times for each phase gives an indication of how often the phase will max-out, gap-out, or skipped.