# HOW TO SYNCHRO

**ADD AERIAL PHOTO FROM BING**

- Go to File → Select Backgrounds, then click on "Bing Region List", click on "Create Bing Region" button.
- Navigate or search to get to the location of your study.
- Pan and zoom to get the aerial view you would like in the window, then click on the "set reference" button. Click on the middle of the intersection and then a view of your synchro model will appear and ask you to select the reference point in there as well. (If this is a new project you can put the Synchro reference point at X:0 Y:0). Then click OK
- Click the "Set Region Boundaries" button then click "Set 1st boundary point". Click the red pin somewhere on the lower left side of the aerial photo. Then "Set 2nd boundary point" on the upper right side of the aerial photo. After you set the two boundary points it will shade the area in red, this will be the aerial photo view that will be downloaded into your Synchro model.
- Click the "Save Region" button, then "Close" button
- Now it will show a "Region 1" under the Bing Region List tab, click OK to exit the select backgrounds window.
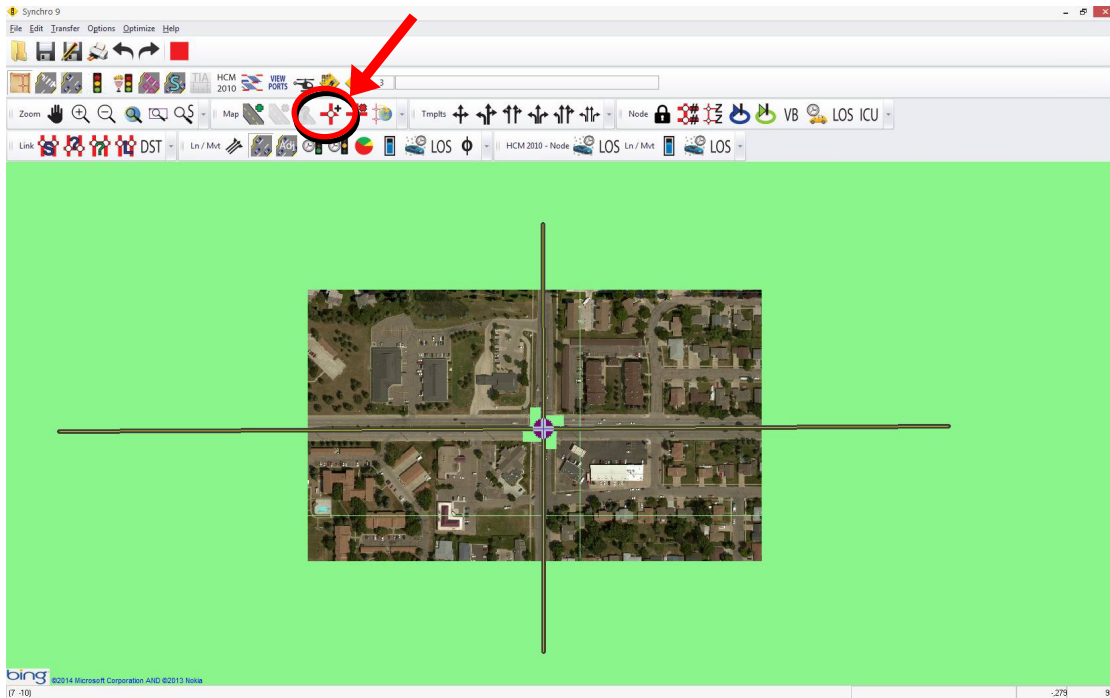- The aerial should appear in your Synchro model:
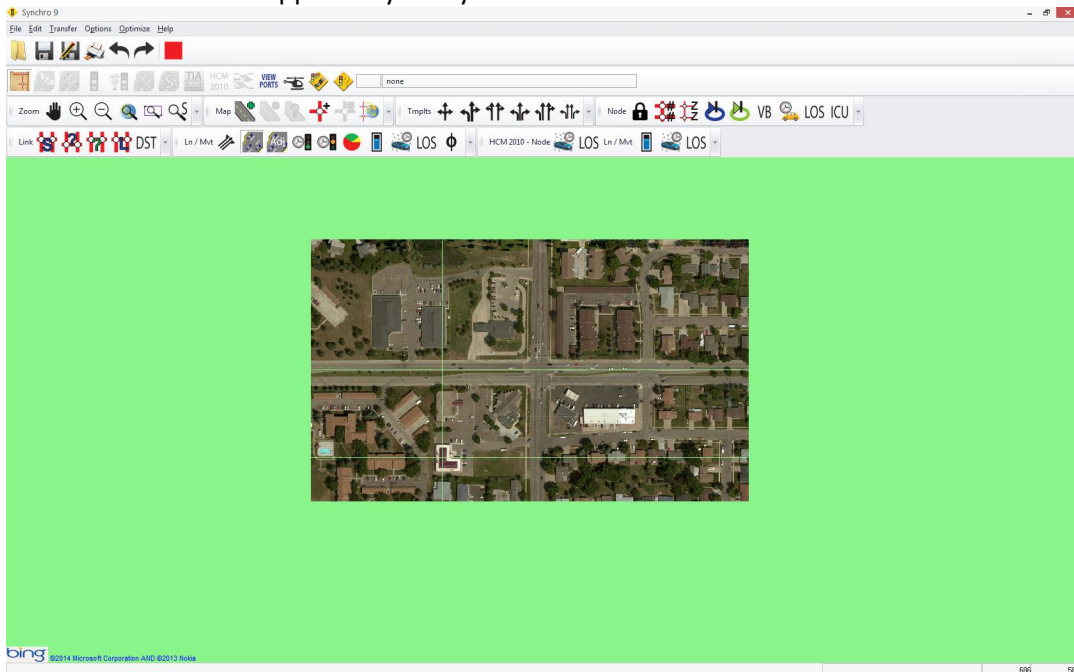
ADD LINKS
- Click on the add link button:
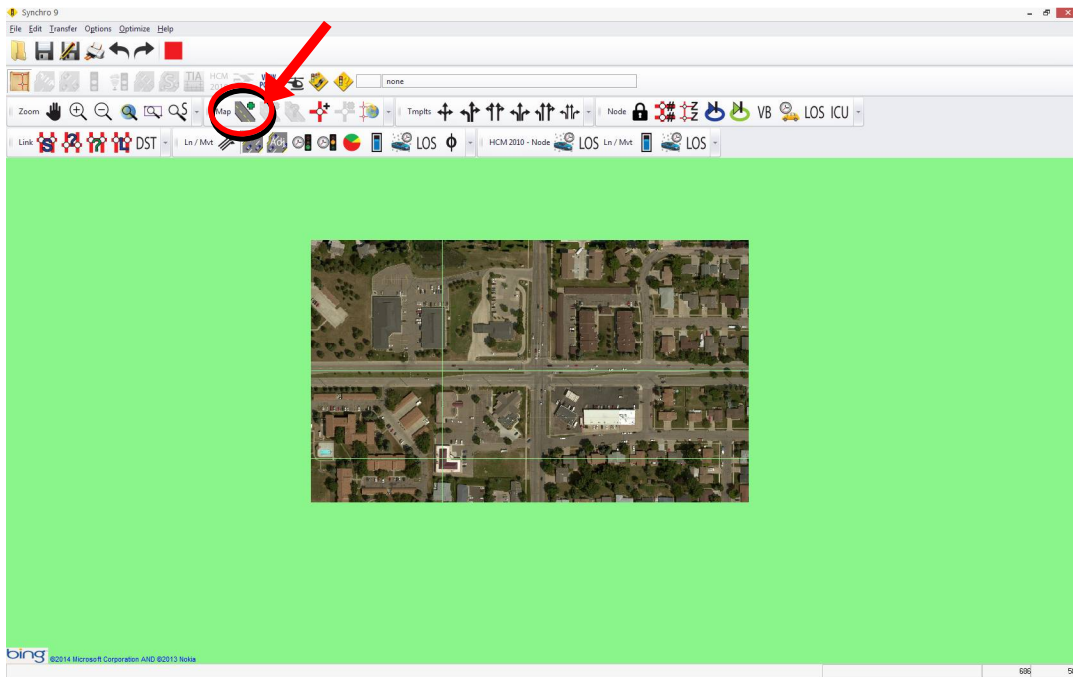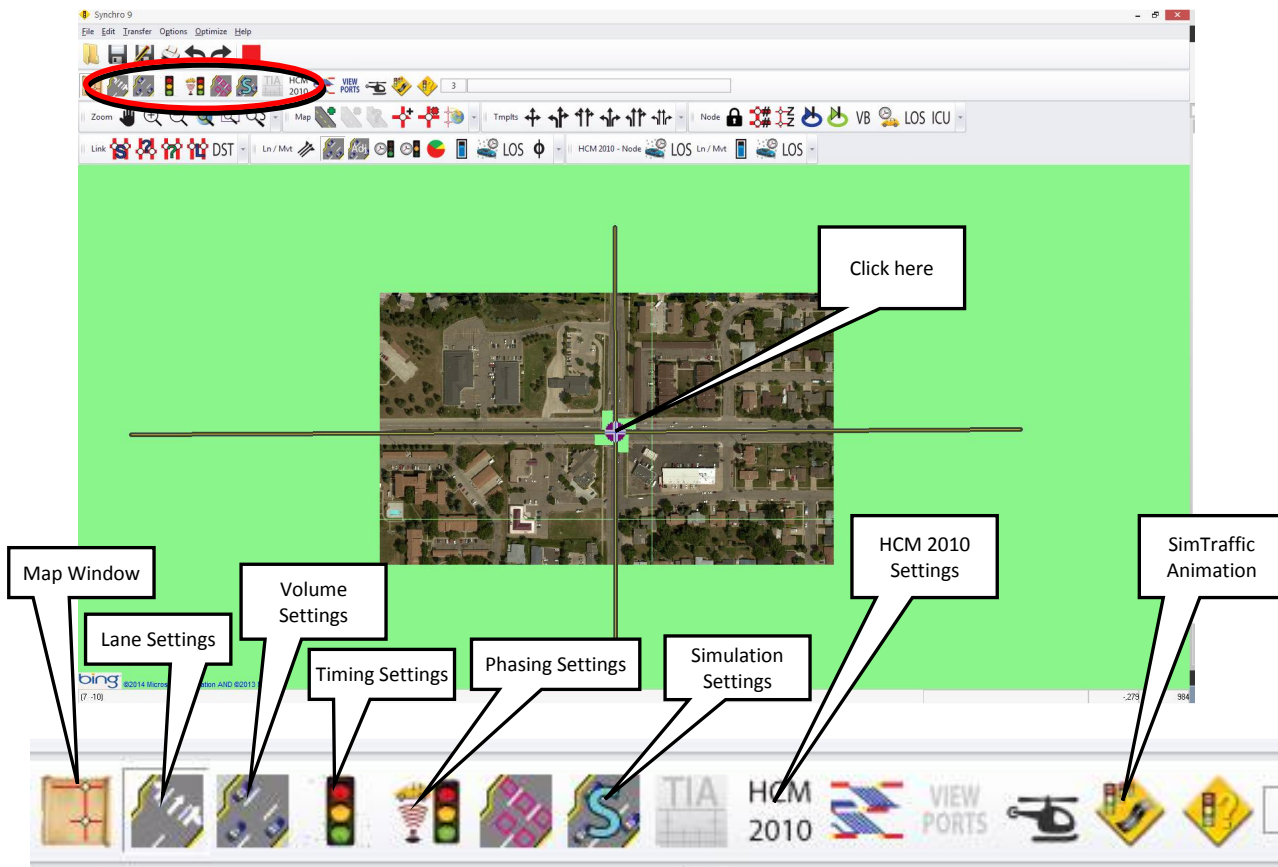

- Click on the screen at the approximate end points of your roads. It is okay to go outside of the aerial photo.
- After drawing two links that cross, the program will create a node at the point where the links intersect. To move the location of nodes (including end points), click this button:

- Note that when the intersection node is selected, more buttons become available:

LANE SETTINGS

This screen is used to enter in the lane arrangement on each approach of your intersection. At a minimum, enter the data for the rows marked with the yellow star.

LANE SETTINGS	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
⭐ Lanes and Sharing (#RL)	↰	↑↑↱		↰	↑↑↱		↰	↑↑↱		↰	↑↑↱	
Traffic Volume (vph)	10	125		29	138	12	66	122	84	12	80	12
Future Volume (vph)	10	125	25	29		12	66	122	84	12	80	12
⭐ Street Name												
Link Distance (ft)	—	1829	—								773	—
⭐ Link Speed (mph)	—	30	—								30	—
Set Arterial Name and Speed	—	EB	—	—	WB	—	—	NB	—	—	SB	—
Travel Time (s)	—	41.6	—	—	34.8	—	—	19.1	—	—	17.6	—
⭐ Ideal Satd. Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)	—	0	—	—	0	—	—	0	—	—	0	—
Area Type CBD	—	☐	—	—		—	—	☐	—	—	☐	—
⭐ Storage Length (ft)	210	—	0							155	—	0
Storage Lanes (#)	1		—							1	—	—
Right Turn Channelized	—		None	—	—	None	—	—	None	—	—	None
Curb Radius (ft)	—	—	—	—	—	—	—	—	—	—	—	—
Add Lanes (#)	—	—	—	—	—	—	—	—	—	—	—	—
Lane Utilization Factor	1.00	0.95	0.95		0.95	0.95	1.00	0.95	0.95	1.00	0.95	0.95
Right Turn Factor	1.000	0.975							—	1.000	0.980	—
Left Turn Factor (prot)	0.950	1.000							—	0.950	1.000	—
Saturated Flow Rate (prot)	1770	3423	—	1787	3407	—	1770	3317	—	1787	3415	—
Left Turn Factor (perm)	0.649	1.000	—	0.649	1.000	—	0.689	1.000	—	0.612	1.000	—
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)	1209	3423	—	1221	3407	—	1283	3317	—	1151	3415	—
Right Turn on Red?	—	—	☑	—	—	☑	—	—	☑	—	—	☑
Saturated Flow Rate (RTOR)	0	27	—	0	13	—	0	91	—	0	13	—
Link Is Hidden	—	☐	—	—	☐	—	—	☐	—	—	☐	—
Hide Name in Node Title	—	☐	—	—	☐	—	—	☐	—	—	☐	—

Callout: Clicking in this area allows a drop down menu. Select the lane geometry for each traffic movement in this row.

Callout: Default is 1900, change to 1750. See notes below.

Callout: Enter storage length for any dedicated turn lanes. This is the full-width distance of the turn lane.
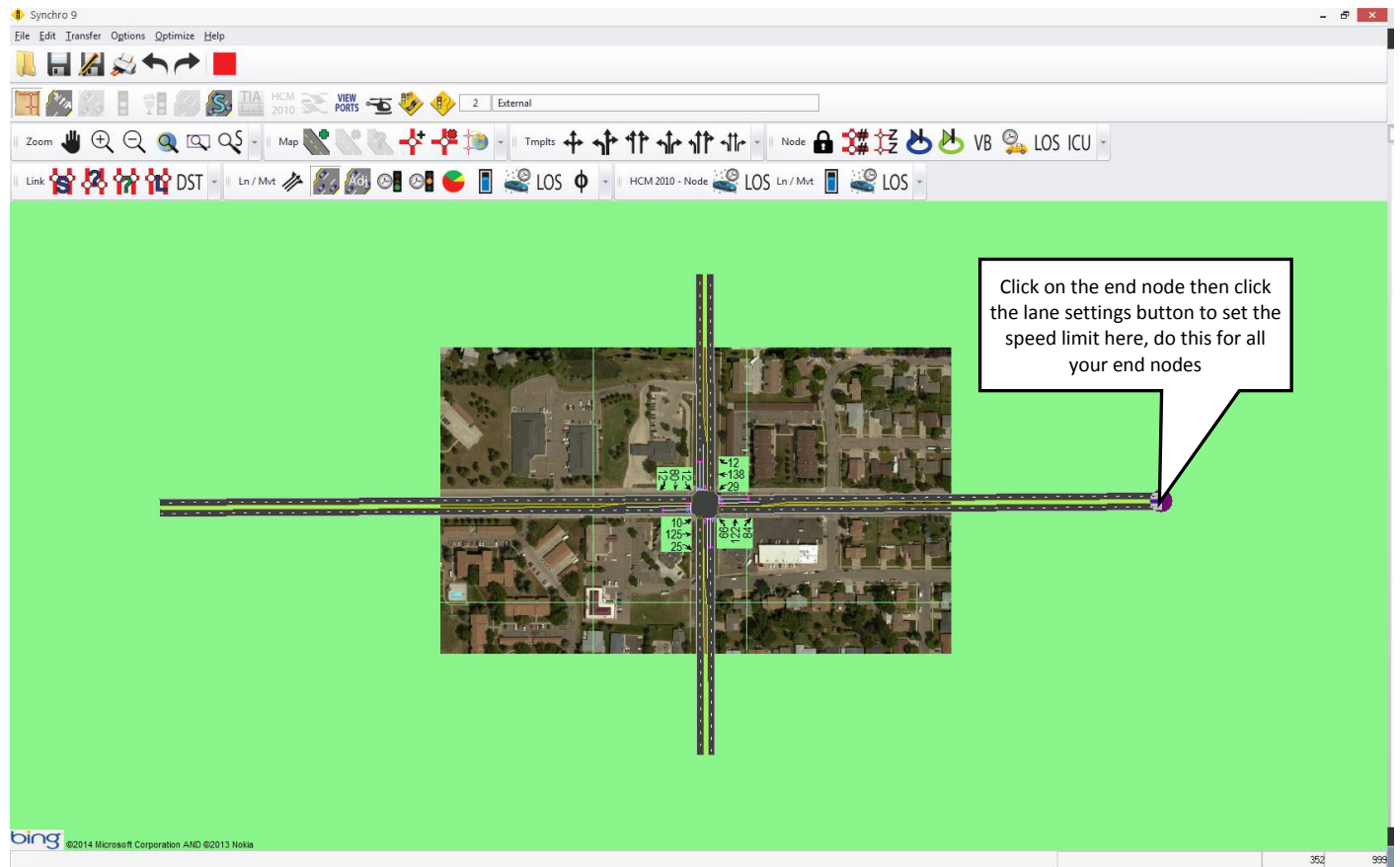
Ideal saturated flow should be 1750 for NDDOT projects. Go to Options → Network Settings → Lanes
Flow Rate (vphpl) [which shows up as "Ideal Satd. Flow" in the Lane Settings button] From NCHRP Report 599 page 6 item 5 and also 2010 HCM page 18-76.

If you are working on a proposed scenario to determine lengths of turn lanes, you may want to set the storage length as 1000 ft or leave it blank as a test run. Several test runs may be needed to fine tune the ideal storage lengths of turn lanes before making the final recommendation in your traffic study.

MAP WINDOW

Go back to the map window to verify if the lane geometry is correct. After you get your lane geometry entered it should appear something like this:

Click on the end node then click the lane settings button to set the speed limit here, do this for all your end nodes

VOLUME SETTINGS

Use this screen to enter in your traffic volumes, truck percentages and peak hour factor.

VOLUME SETTINGS	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lanes and Sharing (#RL)												
Traffic Volume (vph)	10	125	25	29	138	12	66	122	84	12	80	12
Development Volume (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Combined Volume (vph)	10					12		122	84	12	80	12
Future Volume (vph)	10					12			84	12	80	12
Conflicting Peds. (#/hr)	0											0
Conflicting Bicycles (#/hr)	—	—	0	—	—							0
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)	11	136	27	32	150	13	72	133	91	13	87	13
Heavy Vehicles (%)	2	3	2	1	5	1	2	3	1	1	4	1
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Adj. Parking Lane?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Parking Maneuvers (#/hr)	—	—					—	—	—	—	—	—
Traffic from mid-block (%)	—	0					0	—	—	0	—	
Link OD Volumes	—	—	—	—	—	—	—	—	—	—	—	—
Traffic in shared lane (%)	—	—	—	—	—	—	—	—	—	—	—	—
Lane Group Flow (vph)	11	163	0	32	163	0	72	224	0	13	100	0

Callout notes in figure:
- Enter the peak hour factor. Note that it should be the same value for the entire row.
- Enter the hourly volume for each movement in this row
- Enter the percentage of heavy vehicles
- See notes below

For the Peak Hour Factor (PHF) – if you have actual hourly counts, use may use that PHF to enter into this screen. If you are using TMC's use the default values of 0.88 for rural areas, 0.92 for urban.

Link OD Volumes: Typically only change this at interchange ramps, to prevent off-ramp vehicles from turning onto the crossroad and then immediately turning back onto the interstate in the other direction. For example, if interstate runs E/W, go to the WB off-ramp intersection (a.k.a. north ramp), click "Link OD Volumes" for the NB lanes, go under the NB L column, and set the "From EBL Weight" to zero. Then flip-flop these steps for the EB off-ramp intersection (a.k.a. south ramp). You may also want to use this when modeling J-Turn intersections – to prevent mainline thru vehicles from using the U-Turn areas.

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TIMING SETTINGS

NODE SETTINGS	
Node #	3
Zone:	
X East (ft):	7
Y North (ft):	-10
Z Elevation (ft):	0
Description	
Control Type	Pretimed
Cycle Length (s):	45.0
Lock Timings:	☐
Optimize Cycle Length:	Optimize
Optimize Splits:	Optimize
Actuated Cycle(s):	45.0
Natural Cycle(s):	45.0
Max v/c Ratio:	0.16
Intersection Delay (s):	7.4
Intersection LOS:	A
ICU:	0.30
ICU LOS:	A
Offset (s) :	0.0
Referenced to:	Begin of Green
Reference Phase:	2+6 - NBTL SBTL
Master Intersection:	☐
Yield Point:	Single
Mandatory Stop On Yellow:	☐

TIMING SETTINGS	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	PED	HOLD
Lanes and Sharing (#RL)	⬏	↑↱		⬏	↑↱		⬏	↑↱		⬏	↑↱		—	—
Traffic Volume (vph)	10	125	25	29	138	12	66	122	84	12	80	12	—	—
Future Volume (vph)	10	125	25	29	138	12	66	122	84	12	80	12	—	—
Turn Type	Perm	—	—	Perm	—	—	Perm	—	—	Perm	—	—	—	—
Protected Phases		4	—		8	—								
Permitted Phases	4		—	8		—	2							
Detector Phases														
Switch Phase	0	0	—	0	0									
Leading Detector (ft)	20	100	—	20	100	—	20							
Trailing Detector (ft)	0	0	—	0	0	—	0							
Minimum Initial (s)	5.0	5.0	—	5.0	5.0	—	5.0							
Minimum Split (s)	22.5	22.5	—	22.5	22.5	—	22.5							
Total Split (s)	22.5	22.5	—	22.5	22.5	—	22.5							
Yellow Time	3.5	3.5	—	3.5	3.5	—	3.5							
All-Red Time	1.0	1.0	—	1.0	1.0	—	1.0	1.0	1.0					
Lost Time				0.0	0.0	—	0.0	0.0	—	0.0	0.0	—	—	—
Lagging				—	—	—	—	—	—	—	—	—	—	—
Allow Lead/Lag Optimize?	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Recall Mode	Max	Max	—	Max	Max	—	Max	Max	—	Max	Max	—	—	—
Speed limit (mph)	—	30	—	—	30	—	—	30	—	—	30	—	—	—
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	0.02	0.12	—	0.07	0.12	—	0.14	0.16	—	0.03	0.07	—	—	—
Control Delay (s)	8.4	7.5	—	8.9	8.1	—	9.5	5.7	—	8.5	7.7	—	—	—
Queue Delay (s)	0.0	0.0	—	0.0	0.0	—	0.0	0.0	—	0.0	0.0	—	—	—
Total Delay (s)	8.4	7.5	—	8.9	8.1	—	9.5	5.7	—	8.5	7.7	—	—	—
Level of Service	A	A	—	A	A	—	A	A	—	A	A	—	—	—
Approach Delay (s)	—	7.5	—	—	8.2	—	—	6.6	—	—	7.8	—	—	—
Approach LOS	—	A	—	—	A	—	—	A	—	—	A	—	—	—
Queue Length 50th (ft)	2	11	—	5	12	—	11	10	—	2	6	—	—	—
Queue Length 95th (ft)	8	24	—	17	25	—	30	26	—	9	16	—	—	—
Stops (vph)	8	72	—	21	79	—	41	74	—	9	48	—	—	—

Select the type of intersection control here.

- **Pretimed** – traffic signal without detectors, typically downtown areas
- **Act-Uncrd** – traffic signal in "free" mode
- **Semi Act-Uncrd** – traffic signal with detectors on the side street only, normally not used in ND
- **Actd-Coord** – traffic signal with coordination with other nearby traffic signals
- **Unsig** – stop signs on one or more approaches, skip to page 11
- **Roundabout**

Normally between 60 sec & 120 sec

Ø2 (R)   Ø4

22.5 s   22.5 s

Ø6 (R)   Ø8

22.5 s   22.5 s

Options → Network Settings → Timings: Offset Style = "TS2 – 1st Green" rather than "Begin of Green". This greatly impacts time-space diagrams and coordination when one direction turns green before the other! "TS2 – 1st Green" references the first coordinated movement to turn green, similar to controllers in the field. "Begin of Green" references when both coordinated movements are green.

TIMING SETTINGS (CONTINUED)

Go to Options → Phase Templates → Edit Template Phases. This window will appear, edit these numbers so that the signal phase numbers match with NDDOT practice. The correct numbers are shown below:

Phase Template Editor	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
North South Arterial	7	4	3	8	1	6	5	2
East West Arterial	5	2	1	6	7	4	3	8
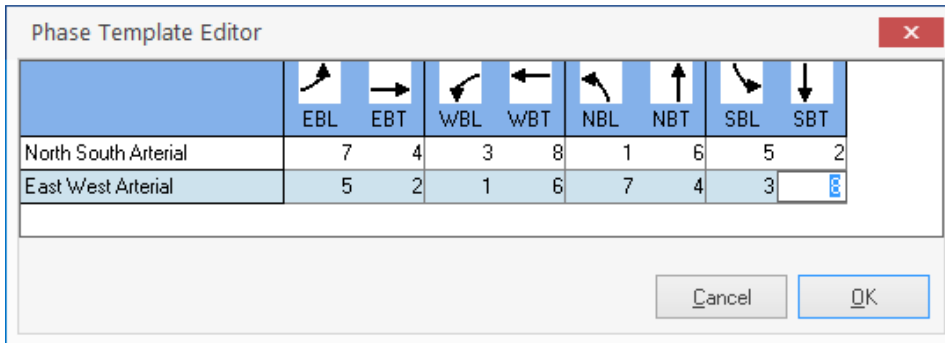
Next, go to Options → Phase Templates → then select "Intersection to East-West" or "Intersection to North-South", depending on your intersection. Then click OK.

PHASING SETTINGS

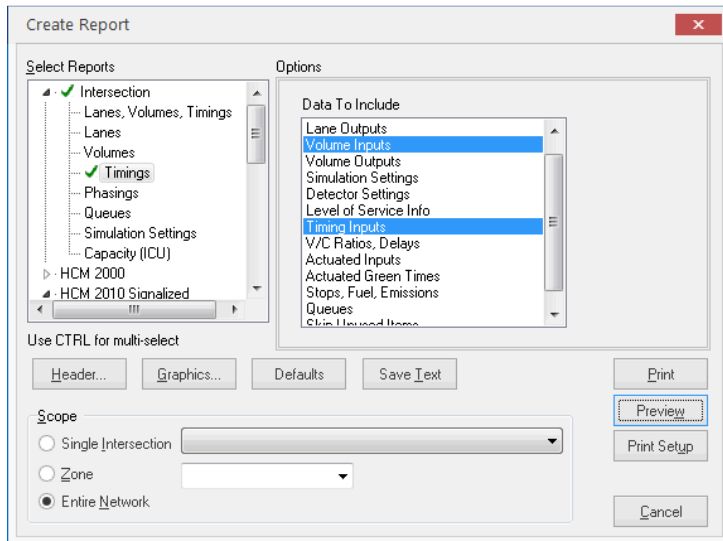| NODE SETTINGS	
Node #	3
Zone:	
X East (ft):	7
Y North (ft):	-10
Z Elevation (ft):	0
Description	
Control Type	Pretimed
Cycle Length (s):	45.0
Lock Timings:	☐
Optimize Cycle Length:	Optimize
Optimize Splits:	Optimize
Actuated Cycle 90th (s):	45.0
Actuated Cycle 70th (s):	45.0
Actuated Cycle 50th (s):	45.0
Actuated Cycle 30th (s):	45.0
Actuated Cycle 10th (s):	45.0
Natural Cycle(s):	45.0
Max v/c Ratio:	0.16
Intersection Delay (s):	7.4
Intersection LOS:	A
ICU:	0.30
ICU LOS:	A
Offset (s) :	22.5
Referenced to:	Begin of Green
Reference Phase:	2+6 - EBTL WBTL
Master Intersection:	☐
Yield Point:	Single
Mandatory Stop On Yellow:	☐

PHASING SETTINGS	2-EBTL	4-NBTL	6-WBTL	8-SBTL
Minimum Initial (s)	5.0	5.0	5.0	5.0
Minimum Split (s)	22.5	22.5	22.5	22.5
Maximum Split (s)	22.5	22.5	22.5	22.5
Yellow Time (s)	3.5	3.5	3.5	3.5
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
Vehicle Extension (s)	3.0	3.0	3.0	3.0
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
Recall Mode	Max	Max	Max	Max
Pedestrian Phase	☑	☑	☑	☑
Walk Time (s)	7.0	7.0	7.0	7.0
Flash Dont Walk (s)	11.0	11.0	11.0	11.0
Pedestrian Calls (#/hr)	0	0	0	0
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

At a minimum, the yellow and all-red times should be entered on this screen.

SYNCHRO REPORTS
Depending on the type of study you are doing, you may want to include some Synchro reports to provide more details of the timing and phasing as shown below:

SIGNING WINDOW

If unsignalized is selected as the control type, the button's appearance will look like this:

NODE SETTINGS	
Node #	1
Zone:	
X East (ft):	8574
Y North (ft):	10548
Z Elevation (ft):	0
Description	
Control Type	Unsig
Max v/c Ratio:	0.17
Intersection Delay (s):	0.8
Intersection LOS:	A
ICU:	0.33
ICU LOS:	A

HCM 2000 SIGNING SETTINGS	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lanes and Sharing (#RL)		↑↑			↰↑	↱		⊕			↰	↱
Traffic Volume (vph)	26	385	3	2	385	10	3	0	2	10	0	26
Future Volume (vph)	26	385	3	2	385	10	3	0	2	10	0	26
Sign Control	—	Free	—	—	Free	—	—	Stop	—	—	Stop	—
Median Width (ft)	—	60	—	—	60	—	—	0	—	—	0	—
TWLTL Median	—	☐	—		☐	—	—	☐	—	—	☐	—
Right Turn Channelized	—	—	None	—		None	—	—	None	—	—	None
Critical Gap, tC (s)	4.5	—	—							8.3	—	7.3
Follow Up Time, tF (s)	2.4	—	—							3.9	—	3.5
Volume to Capacity Ratio	0.03	0.17	0.09							0.04	—	0.04
Control Delay (s)	8.7	0.0	0.0							11.2	—	11.2
Level of Service	A	A	A	A	A	A	B	—	B	B	—	B
Queue Length 95th (ft)	2	0	0	0	0	0	1	—	1	3	—	3
Approach Delay (s)	—	0.6	—	—	0.0	—	—	11.8	—	—	11.2	—

If your intersection is a two-way stop, be sure to set your major road approaches as "free"

SIMULATION SETTINGS

SIMULATION SETTINGS	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lanes and Sharing (#RL)	↖	↑↑↘		↖	↑↑↘		↖	↑↑↘		↖	↑↑↘	
Traffic Volume (vph)	10	125	25	29	138	12	66	122	84	12	80	12
Future Volume (vph)	10	125	25	29	138	12	66	122	84	12	80	12
Storage Length (ft)	216	—	0	133	—	0	200		0	155	—	0
Storage Lanes (#)	1	—	—	1	—	—	1	—	—	1	—	—
Taper Length (ft)	100	—	—	100	—	—	100	—	—	100	—	—
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Median Width (ft)	—	12	—	—	12	—	—	12	—	—	12	—
Link Offset (ft)	—	0	—	—		—	—	0	—	—	0	—
Crosswalk Width (ft)	—	16	—	—		—	—	16	—	—	16	—
TWLTL Median	—	☐	—	—	☐	—	—	☐	—	—	☐	—
Headway 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
Turning Speed (mph)	15	—	9	15	—	9	15	—	9	15	—	9
Mandatory Distance (ft)	—	200	—	—	200	—	—	200	—	—	200	—
Positioning Distance (ft)	—	1320	—	—	1320	—	—	1320	—	—	1320	—
Mandatory Distance 2 (ft)	—	880	—	—	880	—	—	880	—	—	880	—
Positioning Distance 2 (ft)	—	1760	—	—	1760	—	—	1760	—	—	1760	—

Note on Median Width: Normally 12 ft, edit this if you are studying a divided highway.

This screen repeats some of the same information as the Lane Settings screen.

Enter taper length here or go to Options → Network Settings → Simulation. Set to 100 ft rather than the default of 25 ft. This makes the maps appear more realistic. In SimTraffic this allows vehicles to slide over into the turn lane when thru queues are backed-up all the way to the taper area.

If your major road is a divided highway, enter the median width in the appropriate columns.

Go to Options → Maps Settings. These settings may be adjusted to control the appearance of the map view in Synchro. Check on the "Intersection Paths" to see the centerline of vehicle and pedestrian paths through the intersection. This may help you identify errors in the model.

SIMTRAFFIC ANIMATION

If your Synchro file has been saved, a SimTraffic animation of your model can be created. Click this button:

General Notes to Consider:
- In SimTraffic simulations, vehicles are not able to make two-stage left turns at unsignalized divided highway intersections. The vehicles wait for a gap in both directions of traffic prior to turning (they won't cross into the median and wait in the median). However, the results in Synchro, **do** account for two-stage left turns if the median is wide enough to store a vehicle. See Version 7 user guide page 7-19.
- Typically use an average of 10 runs for SimTraffic simulation results.
- Synchro and SimTraffic queue lengths can be quite different. See Version 7 user guide page 23-13 and 7-27. For studies, typically use SimTraffic 95th percentile length or SimTraffic maximum length, whichever is shorter, rounded to 25ft increment. However, use Synchro (not SimTraffic) queue lengths for unsignalized divided highway intersections.
- Delete the simulation .HST files when finished with study. These have HUGE file sizes.
- Go to Options → Intervals and Volumes: Change start time and duration if needed. Typical seeding = 5 minutes. Typical Duration [analysis period] = 15 minutes. From 2010 HCM page 18-76 and Synchro Version 7 user guide page 13-29. Switch "PHF Adjust" to "yes" rather than "no". This incorporates the PHF values that were originally entered in Synchro.

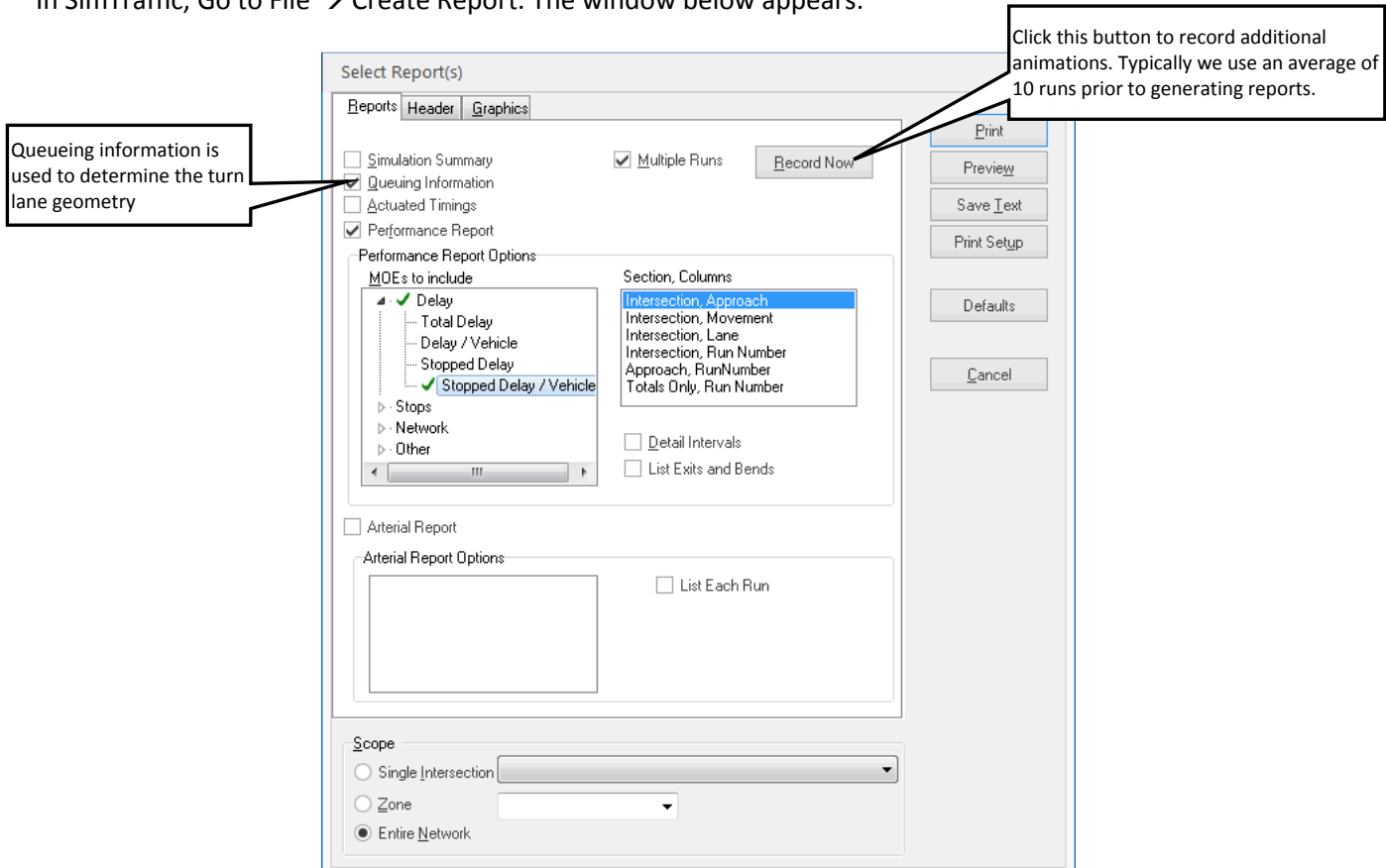| Intervals	0	1	
Interval Name	Seeding	Recording	—
Start time (hhmm)	04:40 P	04:45 P	—
Duration (min)	5	15	—
Record Statistics	No	Yes	—
Growth Factor Adjust	Yes	Yes	—
PHF Adjust	Yes	Yes	—
AntiPHF Adjust	No	No	—
Percentile Adjust	No	No	—
Percentile Adjust (%ile)	—	—	—
Timing Plan ID	—	—	—
Data Start Time (hhmm)	—	—	—

- Go to Options → Vehicle Parameters: Adjust the occurrence and length as appropriate for your situation. An example is below. Typically change Carpool1 and Carpool2 occurrence to zero.

Vehicles Types	1	2	3	4	5	6	7	8	9	10
Vehicle Name	Car1	Car2	Truck SU	SemiTrk1	SemiTrk2	Truck DB	Bus	Carpool1	Carpool2	
Vehicle Occurence (%)	0.80	0.20	0.10	0.10	0.55	0.20	0.05	0.00	0.00	0.00
Acceleration	File	File	File	File	File	File	File	File	File	File
Vehicle Length (ft)	20.0	16.0	30.0	55.0	75.0	114.0	40.0	20.0	14.0	16.0
Vehicle Width (ft)	6.0	6.0	8.0	8.0	8.0	8.0	8.0	6.0	6.0	6.0
Vehicle Fleet	Car	Car	Trk	Trk	Trk	Trk	Bus	Pool	Pool	Car
Occupancy (# people)	1.3	1.3	1.2	1.2	1.2	1.2	20.0	2.8	2.8	1.3
Graphics Shape	Car	Car	Truck	SemiTrk	SemiTrk	DBTruck	Bus	Car	Car	Car
Table Index (1 to 7)	1	2	3	4	5	6	7	1	2	1

Watch the animation to see if there are any errors while coding the model in Synchro.

SIMTRAFFIC REPORT

Once you are satisfied with your Synchro/SimTraffic model, you are ready to generate a report.
In SimTraffic, Go to File → Create Report. The window below appears:

Click this button to record additional animations. Typically we use an average of 10 runs prior to generating reports.

Queueing information is used to determine the turn lane geometry

At a minimum, a report should be generated showing the information shown in the window above. Other measures of effectiveness (MOEs) can be generated as the author sees fit.