NORTH CAROLINA
Department of Transportation

NCSITE Traffic Engineering Council "Back to Basics" Series

Online Webinar

April 14, 2020

Synchro Planning Level Analysis per the NCDOT Capacity Analysis Guidelines

Michael P. Reese, PE, CPM

NCDOT Congestion Management Section

NCDOT Congestion Management

The mission of the NCDOT Congestion Management Section is the statewide application of cost-effective traffic engineering based operational and safety improvement strategies which mitigate the impacts of traffic congestion, improve system efficiency, enhance traveler safety, and improve economic vitality.

The vision of the NCDOT Congestion Management Section is optimal system-wide mobility.

Congestion Management Resources

- NCDOT Guidelines Resources - Effective 10-01-2016
- NCDOT CONGESTION MANAGEMENT SIMULATION GUIDELINES - Effective 10-01-2016
- NCDOT Traffic Engineering Suite
- NCDOT TIA Checklist
- NCDOT TIA Checklist Instructions
- Capacity Analysis Guidelines
  Congestion Management has revised the Department's Traffic Analysis Guidelines effective July 1, 2015, replacing the previous edition dated January 1, 2012. Revisions cover Trip Generation and Links sections only.
- Congestion Management Consultant Prequalification Requirements
- ITS and Signals Unit - Design Manual
- NCDOT Congestion Management Driveway Permit Review General Comments Current Edition 2008-11-21
- North Carolina Median Crossover Guidelines Current Edition 2004-01-01
- Policy on Street and Driveway Access to North Carolina Highways Current Edition July 2003
- RW Disposal and CA Checklist
  Right-of-Way Disposal and Control of Access Review Committee Operating Procedures and Checklist - Revised 2010-07-09 (For more information, contact Robert Barrier, Field Support Staff Engineer, 919-707-2507)

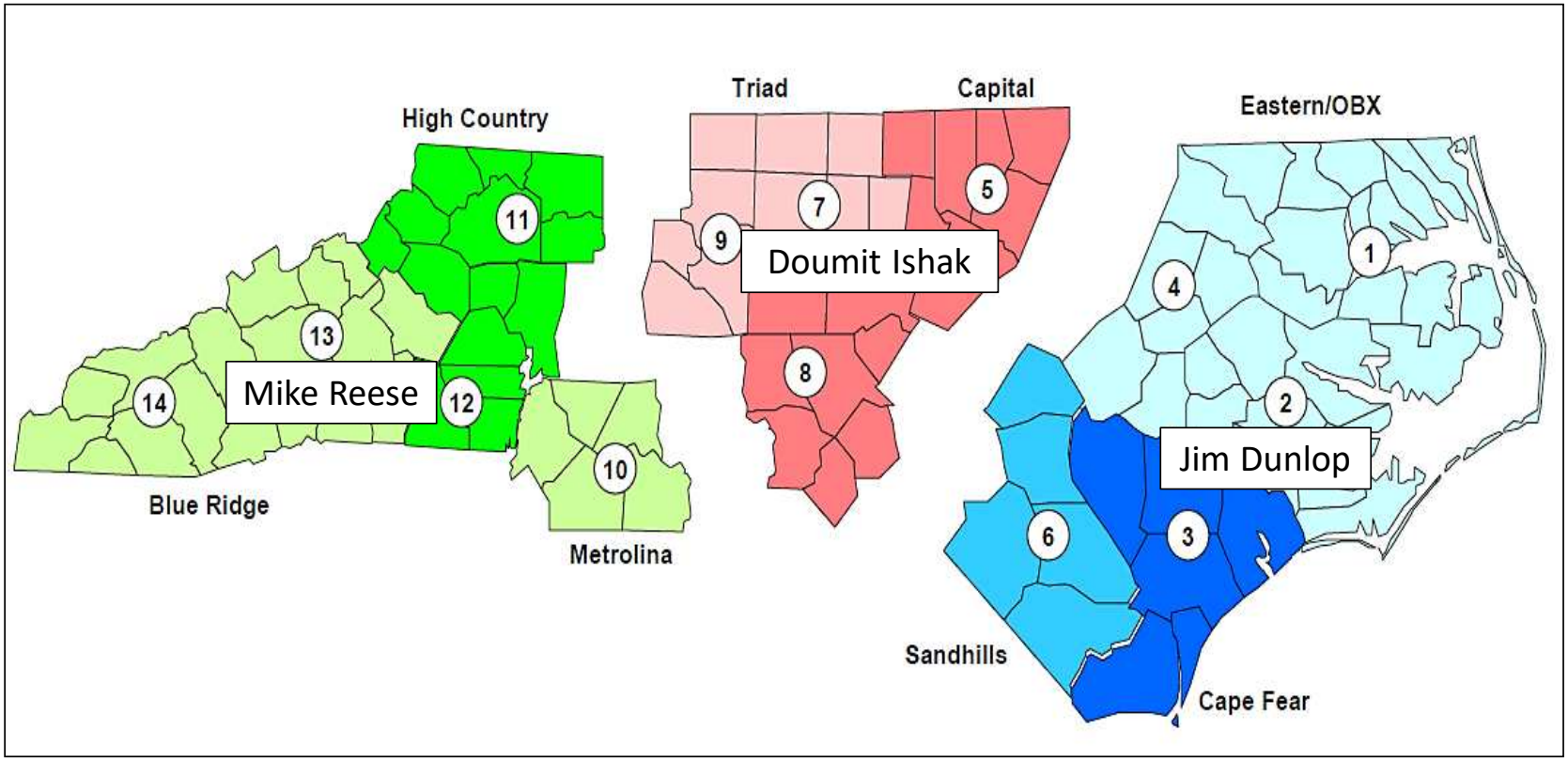
Congestion Management Website

https://connect.ncdot.gov/resources/safety/Pages/Congestion-Management.aspx

Being Updated!

- RW Disposal and CA Procedures
  The Surplus Right-of-Way Disposal and Control of Access Review Committee Operating Procedures - Revised 2017-05-03. (For more information, contact Robert Barrier, Field Support Staff Engineer, (919) 707-2507)
- Spreadsheet to assist in the interpolation of traffic volumes
- Trip Generation Rate Equation Recommendations
  The "Rate versus Equation" table provides specific trip generation recommendations per land use including pass-by percentage data and when to use trip generation equations, rates, or local data.
- Sample Internal Capture Spreadsheet
- Workshop - Site Development and Highway Access - What you need to know
- TEPPL C60 – Congestion Management - SaFID Chart

Congestion Management Regions



NCDOT Capacity Analysis Guidelines

https://connect.ncdot.gov/resources/safety/Pages/Congestion-Management.aspx

NCDOT Congestion Management Capacity Analysis Guidelines

Introduction/Purpose

This document provides standard values to ensure consistent traffic analysis. Deviation from these practices requires justification. By reviewing reports, plans, and submittals, the North Carolina Department of Transportation (NCDOT) in no way relieves the analyst of possible claims or additional work resulting from errors or omissions.

In other words, use the defaults or explain and justify prior to submitting analysis

Pre-Analysis

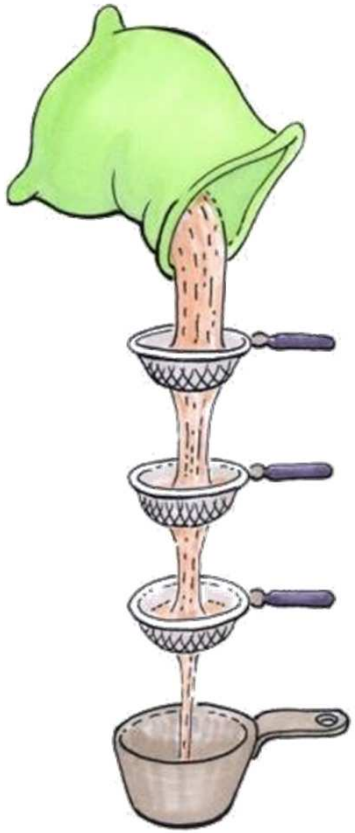
Submittal Document Requirements

The submitted traffic analysis document should include, but is not limited to: a summary of the analysis and results, site plans, traffic counts and forecasts, volume generation, any assumptions used in the analysis, and any variations from these guidelines.

TIA	TIP
Summary of Results	Summary of Results
Site Plan	Traffic Forecasts
Traffic Counts and Forecasts	Traffic Breakouts (Existing, No Build, Build
Existing Lane Diagram	Traffic Adjustments and Reroutes)

Capacity Analysis Tool Selection Guidance

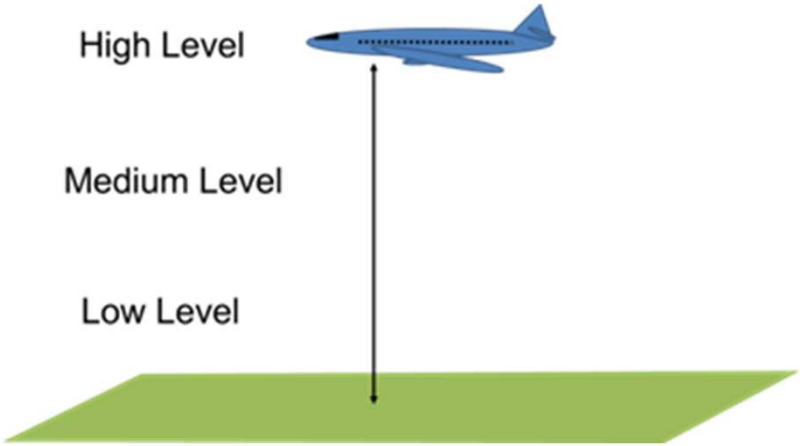
- Planning-level analysis
  - results provide estimates of expected performance and are useful in informing the initial feasibility and high-level design features.
- HCM analysis
  - balances operational detail with reasonable data input needs and analysis resource requirements.
  - may provide insight on additional geometric design and signal timing details
- Microsimulation analysis
  - allows for flexible customization and configuration of geometry, signal timing, and other operational parameters.
  - provides visualization of traffic patterns and roadway geometry



Slide Data Courtesy Kittelson & Associates, Inc.

Levels of Planning Analysis from HCM

- High level
  - Large analysis area
  - Low detail
- Medium level
  - Focus on a single roadway facility, segment, or intersection
  - Greater detail
- Low level
  - Highly focused and highly detailed



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Intersection Capacity Analysis Tools

Planning Analysis vs. Operations Analysis

Highway Capacity Manual

CAP-X

U.S.Department of Transportation
Federal Highway Administration

CAPX
Capacity Analysis for Planning of Junctions

Version 3.0
October 2018

Synchro plus SimTraffic

Highway Capacity Software

Caliper
TransModeler
Traffic Simulation Software

TransModeler

SIDRA

Others???

Levels of Intersection Analysis

Planning-level Tools

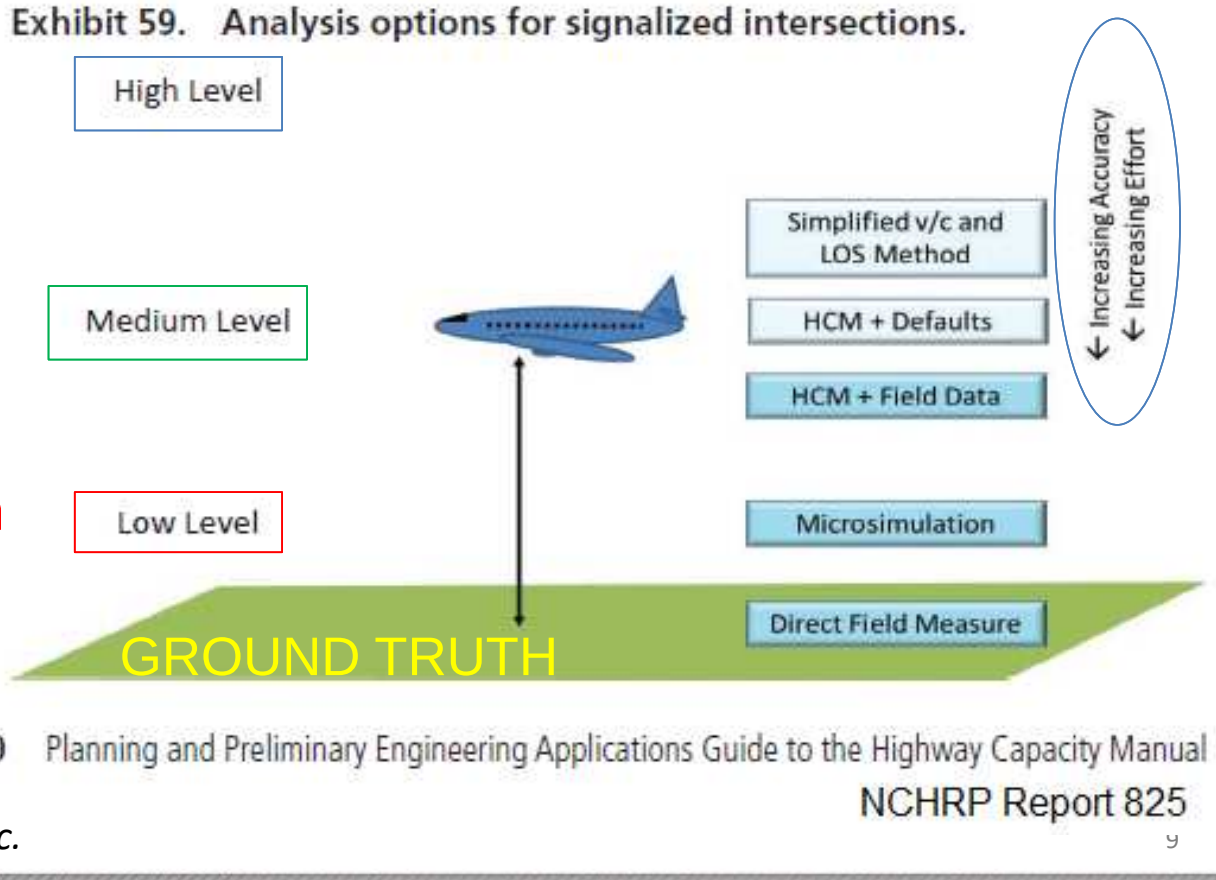
e.g. CAP-X, Vjust, etc.

HCM Analysis Methods

e.g. HCM, HCS, Synchro, Sidra, etc.

Microsimulation

e.g. TransModeler, VISSIM, etc.



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Levels of Intersection Analysis

Planning-level Tools
e.g. CAP-X, Vjust, etc.

HCM Analysis Methods
e.g. HCM, HCS, Synchro, Sidra, etc.

Microsimulation
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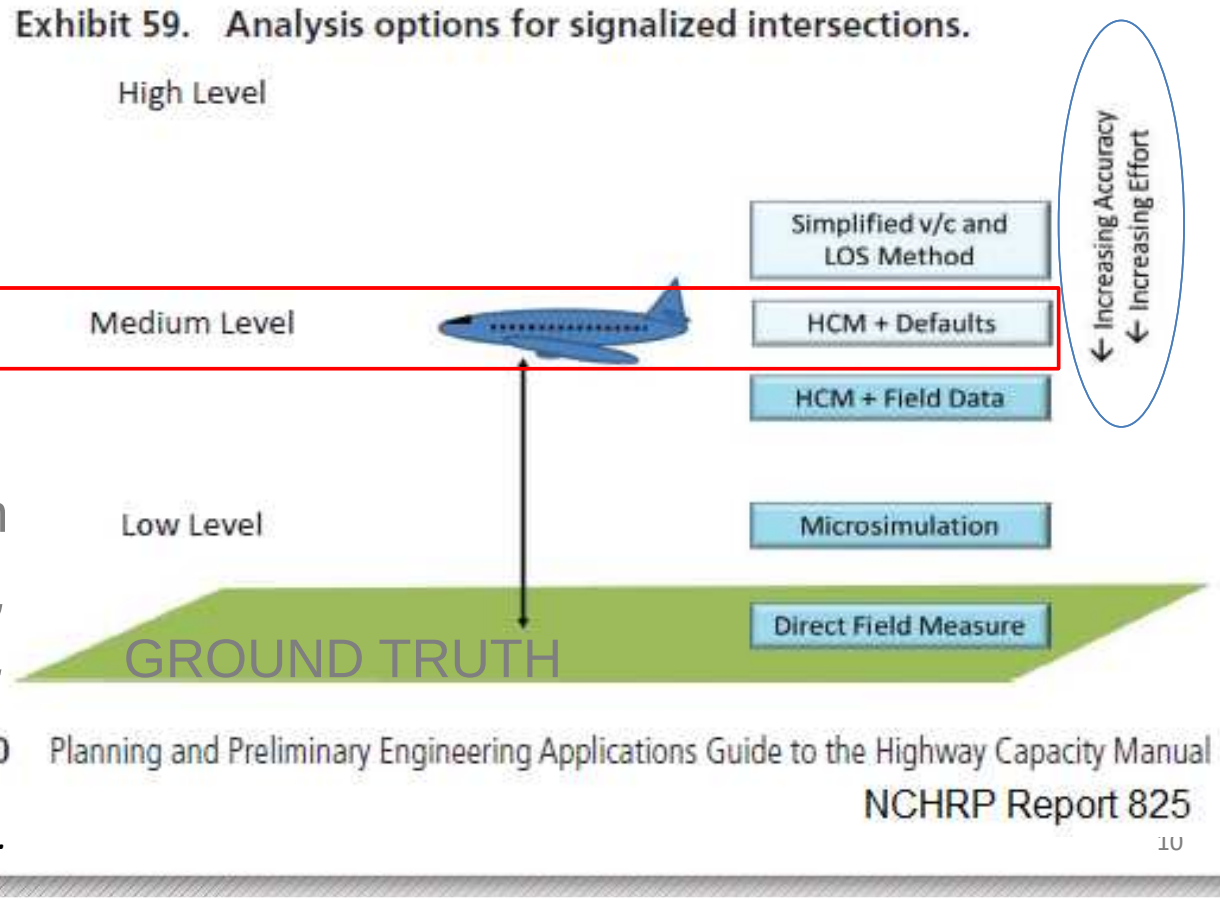

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Seven Step Process of Synchro and SimTraffic Planning Level Analysis

Step 1: Model Network

- Include all study intersections
- Accurately model distance between intersections
- Include future lane/intersection improvements from other developments or projects
- Y-Line lengths should be close to 1000’ in order to view full queue lengths
- Code storage lengths correctly
  - Use 100’ tapers
- Use cardinal directions (N, S, E, W, not NW, SE, etc.)
- Reduced Conflict Intersections (RCUT) in Synchro should be modeled using one-way pairs (check with CMS for guidance)

Step 2: Follow Analysis Guidelines

- Use NCDOT Capacity Analysis Guidelines Provided by Congestion Management, for example…
- Turn Lane Treatment
  - No protected-permitted lefts
  - No right turns on red
- Recommended Timing Settings
  - Minimum initial green time, yellow time, all-red time, lost time adjustment, minimum split
- Minimum Cycle Length
  - Based on number of phases in the signal
- Use a Peak Hour Factor (phf) of 0.9 except for near schools where 0.5 to 0.75 is commonly used (check with MSTA or CMS)

Step 3: Create Synchro File for Each Scenario

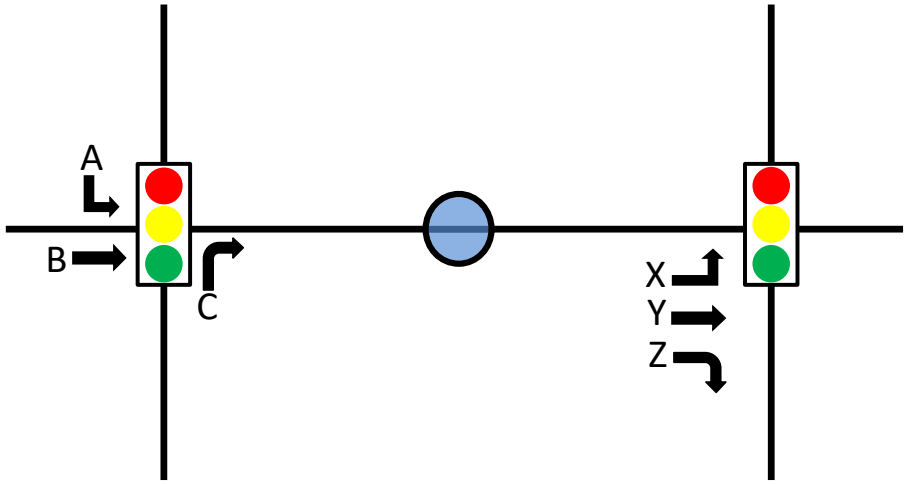
- A separate file should be created for both AM and PM peak hours for each scenario
  - Existing No Build
  - Future Year No Build
  - Future Year Build
  - Others as Needed
- Each file should have matching corridor and Y-line lengths or else simulations will not match!

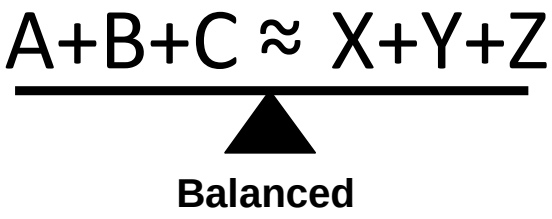
Step 4: Input Volumes

- Input turning movement volumes into the corresponding file for each scenario
- In Synchro, use 4 vph as a minimum turning movement volume for any permitted movement

Step 4: Input Volumes

- Balance volumes and/or explain discrepancies between intersections within reason (check with CMS)
  - Look at what's between the intersections
    - More development = More volume drops or gains
    - Less development = Less volume drops or gains





Step 5: Optimize Signal Timing

- Optimize Signal Cycle Lengths
  - Make sure to stay above minimums in Guidelines
- Optimize Splits
- If There are Multiple Signals within the network:
  - Should be coordinated if appropriate
  - If coordinated:
    - Optimize network cycle lengths, all cycle lengths should be the same or half cycle
    - Optimize network offsets
- Ensure analysis matches Capacity Analysis Guidelines
- Run “Coding Error Check” in Synchro before Simulation

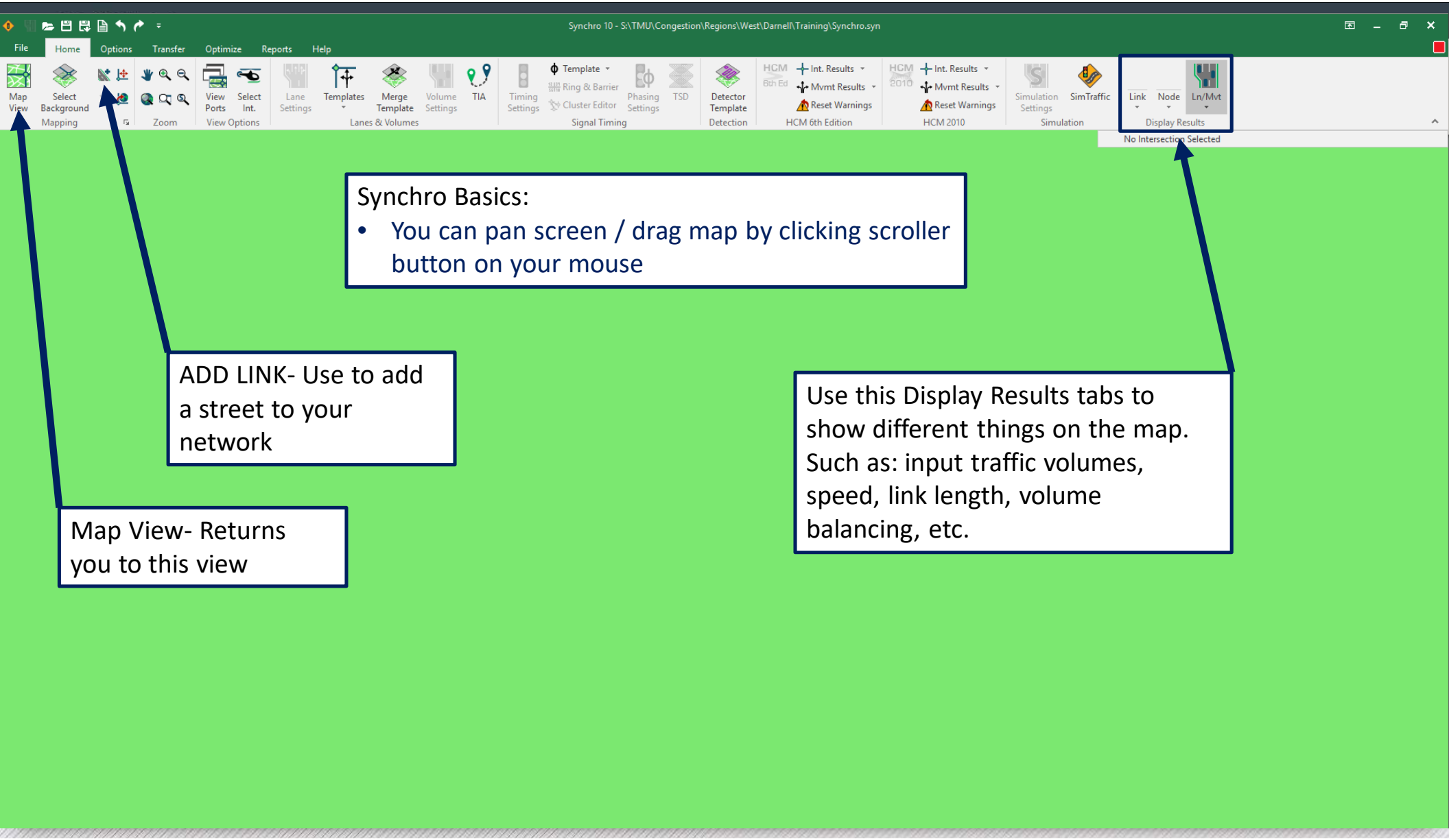
Step 6: Take Note of MOEs

- Synchro Analysis:
  - Record overall intersection LOS and delay for signalized intersections
  - Record approach, and/or movement, LOS and delay for each leg of the intersection
  - Record 95th percentile queue lengths for each approach
- Create a table showing MOEs (Measures of Effectiveness e.g. LOS, delay, queuing, v/c, etc.)

Step 7: Run SimTraffic Simulation

- SimTraffic should always be run when using Synchro as an analysis tool
- Set seeding time to at least 10 minutes and recording time to 60 minutes
- Record simulation (10 runs is recommended)
- Print queuing and blocking report for the whole network
  - Should be included with analysis document appendix
  - Make a table recording SimTraffic maximum queue lengths
- **Lanes and storage recommendations should be higher of Synchro 95th and SimTraffic Maximum Queues (iteration may be necessary). Ensure recommended lanes and storage are coded.**

Planning Level Capacity Analysis of Existing Intersection in Synchro and SimTraffic



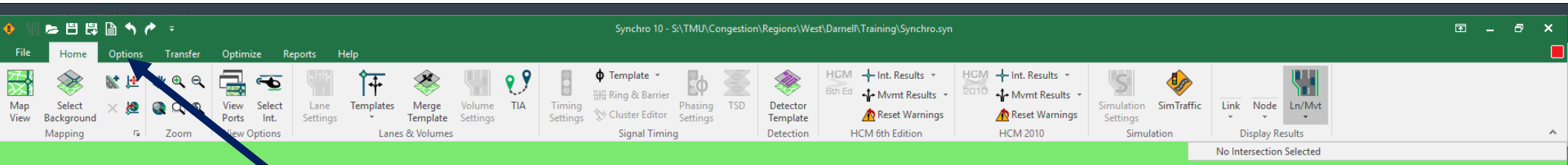
Synchro Basics:

- You can pan screen / drag map by clicking scroller button on your mouse

ADD LINK- Use to add a street to your network

Map View- Returns you to this view

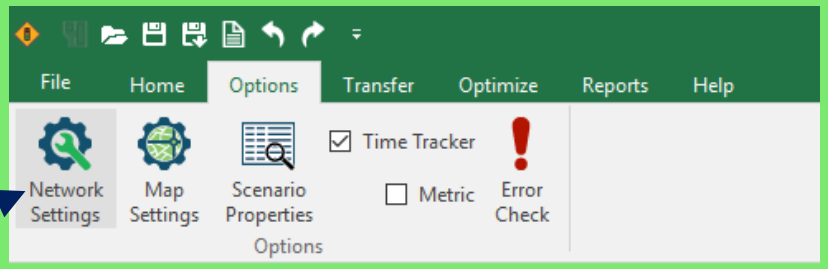
Use this Display Results tabs to show different things on the map. Such as: input traffic volumes, speed, link length, volume balancing, etc.



1

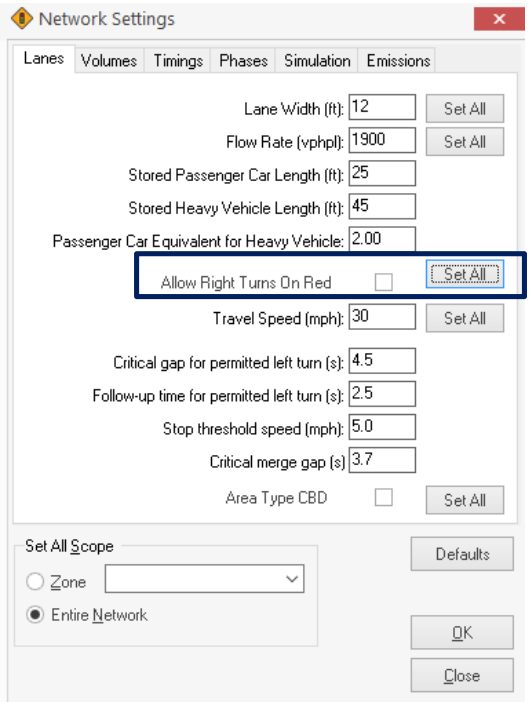
Start by changing network settings to match our guidelines

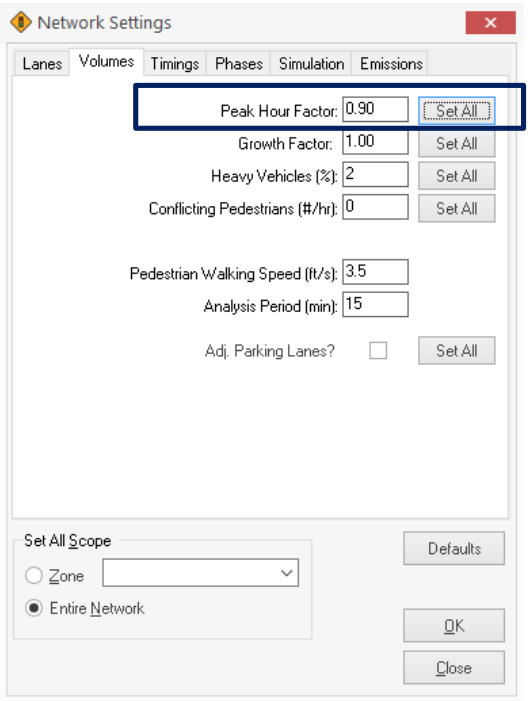
1. Go to Options
2. Click Network Settings

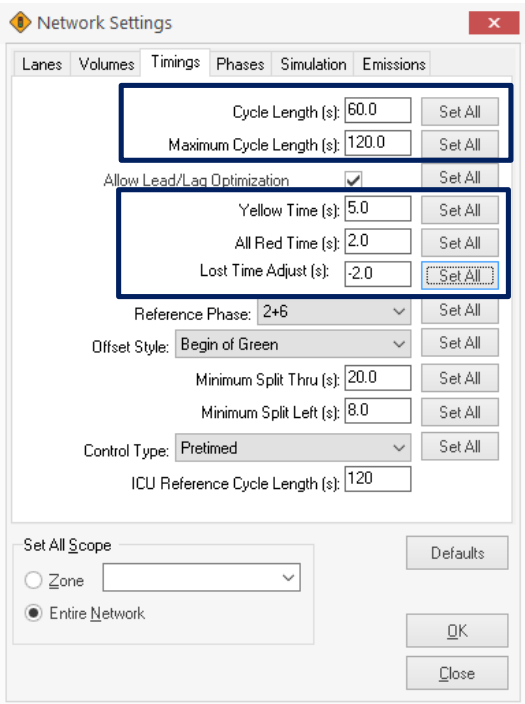


2

Change Default Settings for These:







***MUST CLICK "SET ALL" FOR EACH THEN "OK"*

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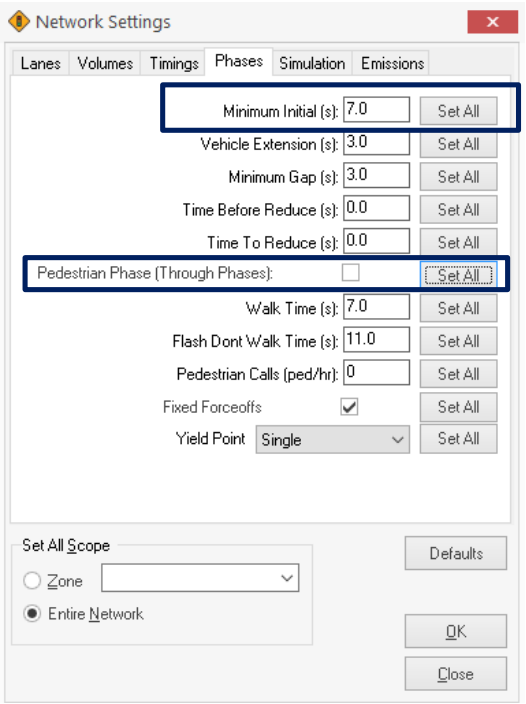

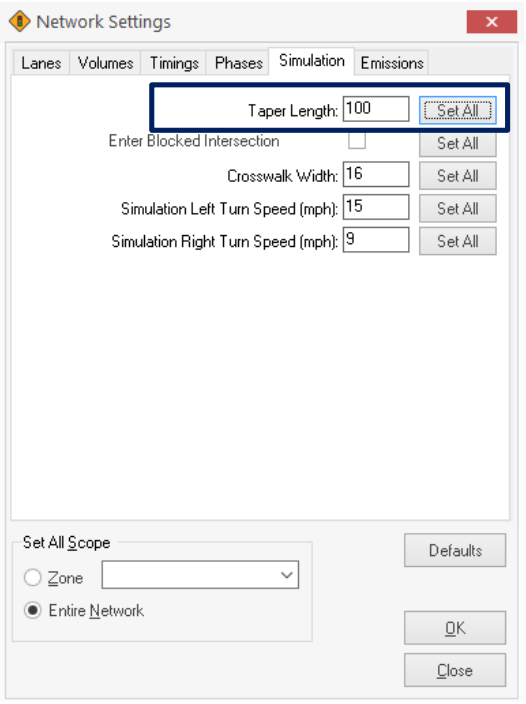

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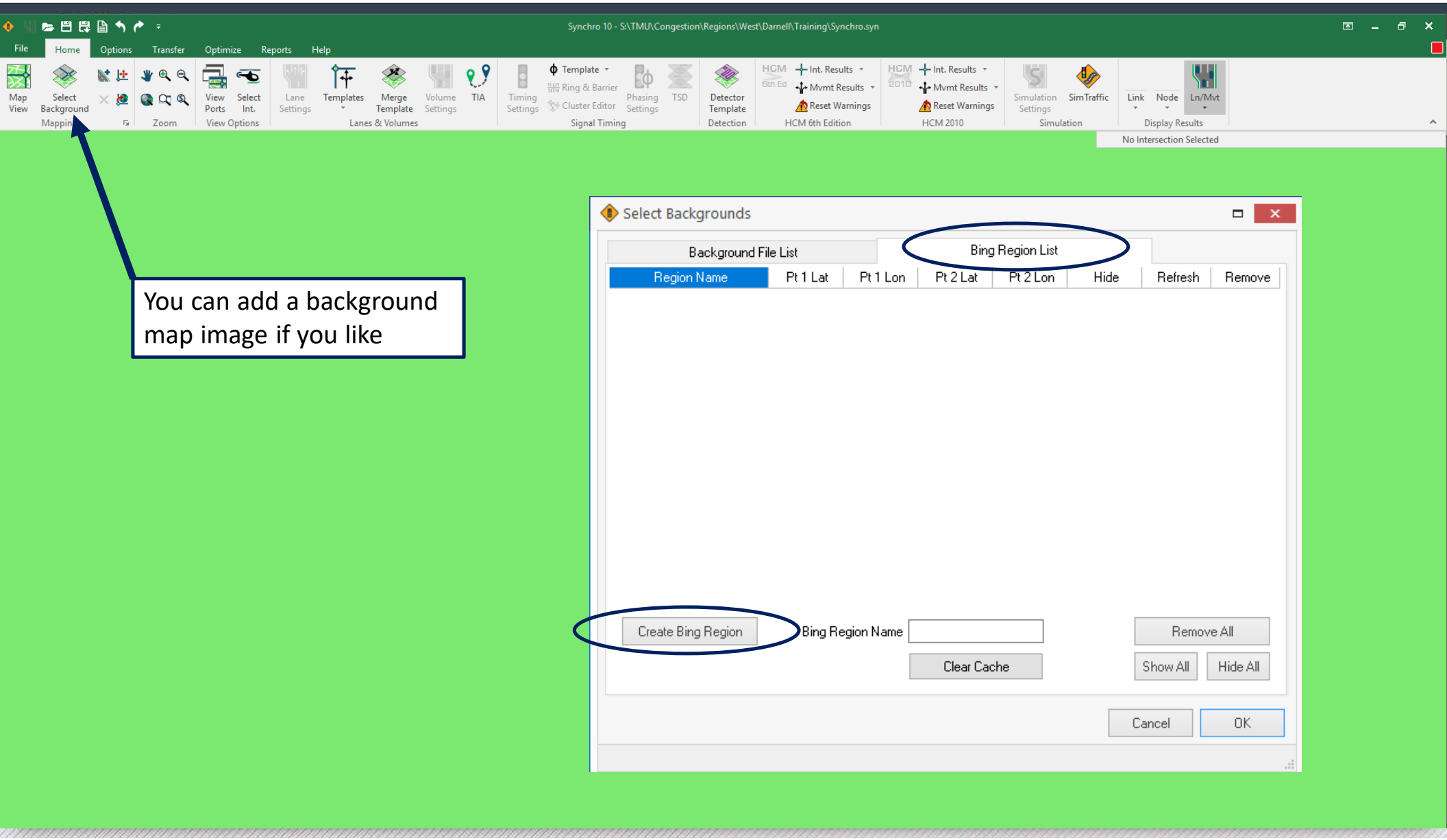
Synchro 10 - S:\TMU\Congestion\Regions\West\Darnell\Training\Synchro.syn
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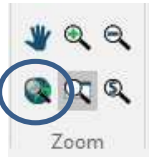
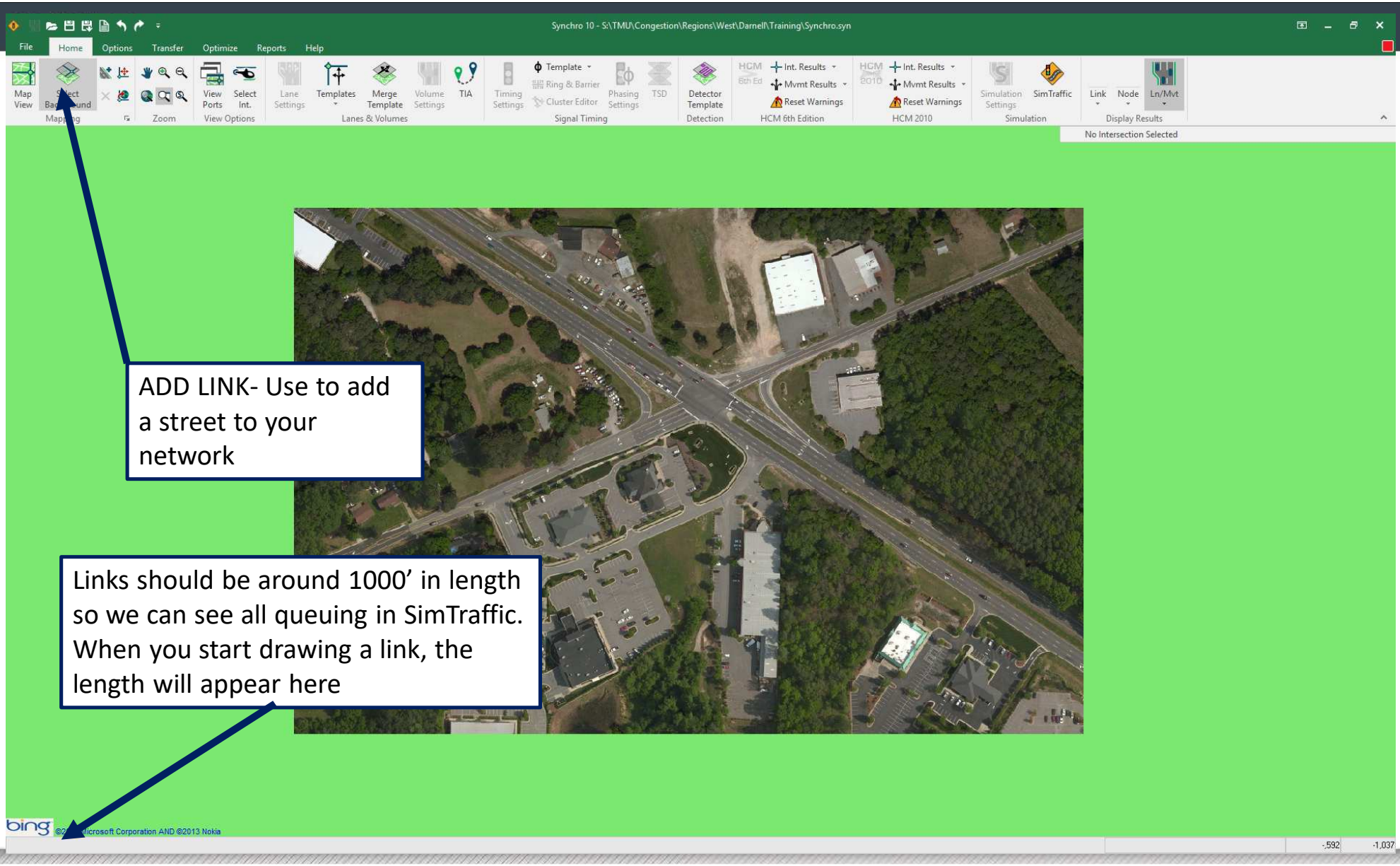
Display Results
No Intersection Selected
You can add a background map image if you like
Select Backgrounds
Background File List
Bing Region List
Region Name
Pt 1 Lat
Pt 1 Lon
Pt 2 Lat
Pt 2 Lon
Hide
Refresh
Remove
Create Bing Region
Bing Region Name
Clear Cache
Remove All
Show All
Hide All
Cancel
OK

Find your wanted location:

- Drag to area or use search bar to type in an address
- Once you find your wanted background image, click “Select Region”
- Draw a box around wanted region then click on a reference point (a reference point helps when the Synchro network is already drawn). Click “Next”
- If no network is already drawn, then leave world coordinates at 0,0 and click “Ok”
- Now you have a map as a background
- If you don’t see your map, click this button:

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Mvmt Results
Reset Warnings
HCM 2010
Simulation Settings
SimTraffic
Simulation
Link
Node
Ln/Mvt
Display Results
No Intersection Selected
ADD LINK- Use to add a street to your network
Links should be around 1000’ in length so we can see all queuing in SimTraffic. When you start drawing a link, the length will appear here
bing
©2013 Microsoft Corporation AND ©2013 Nokia
-592
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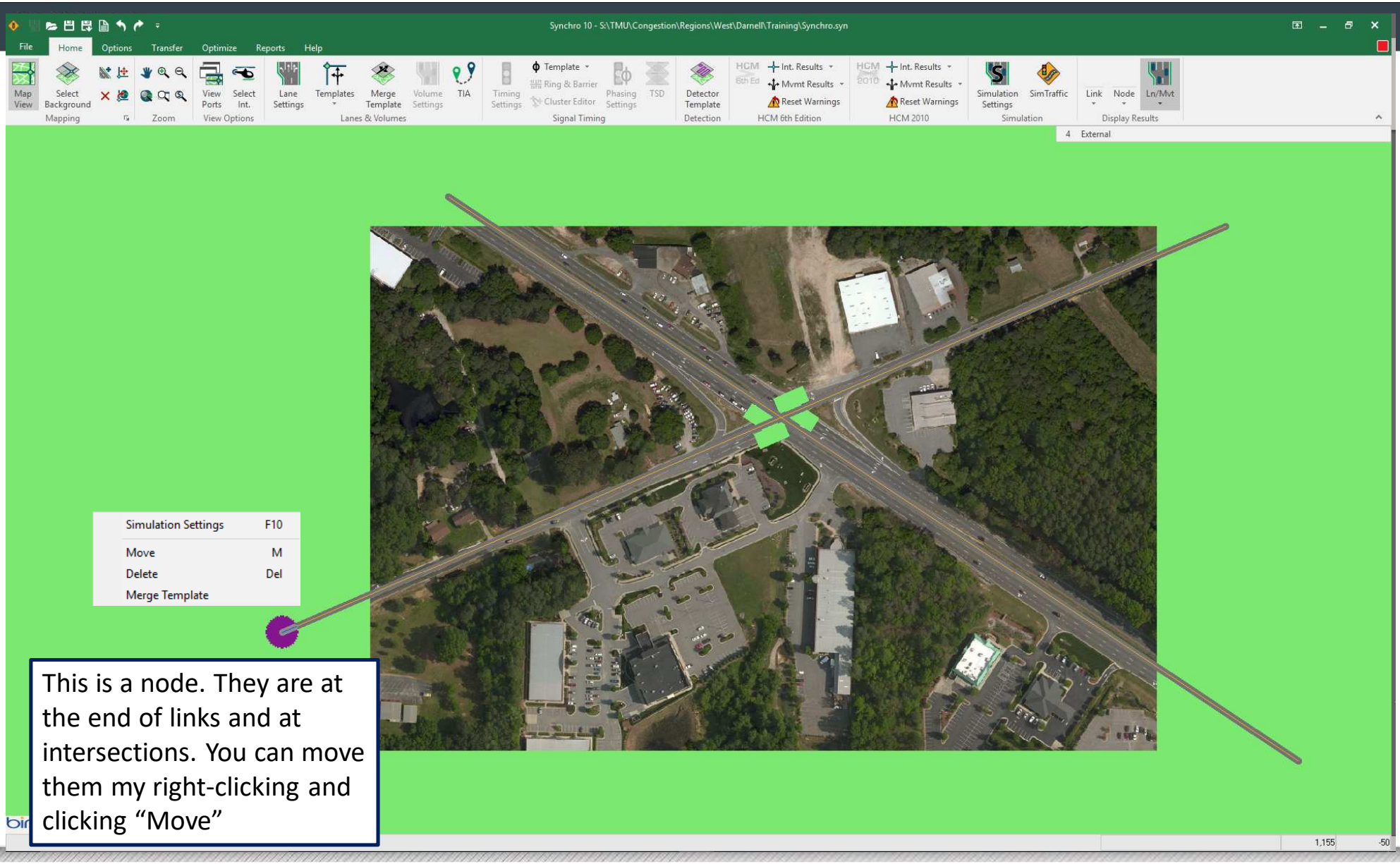
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This is a node. They are at the end of links and at intersections. You can move them my right-clicking and clicking “Move”
1,155
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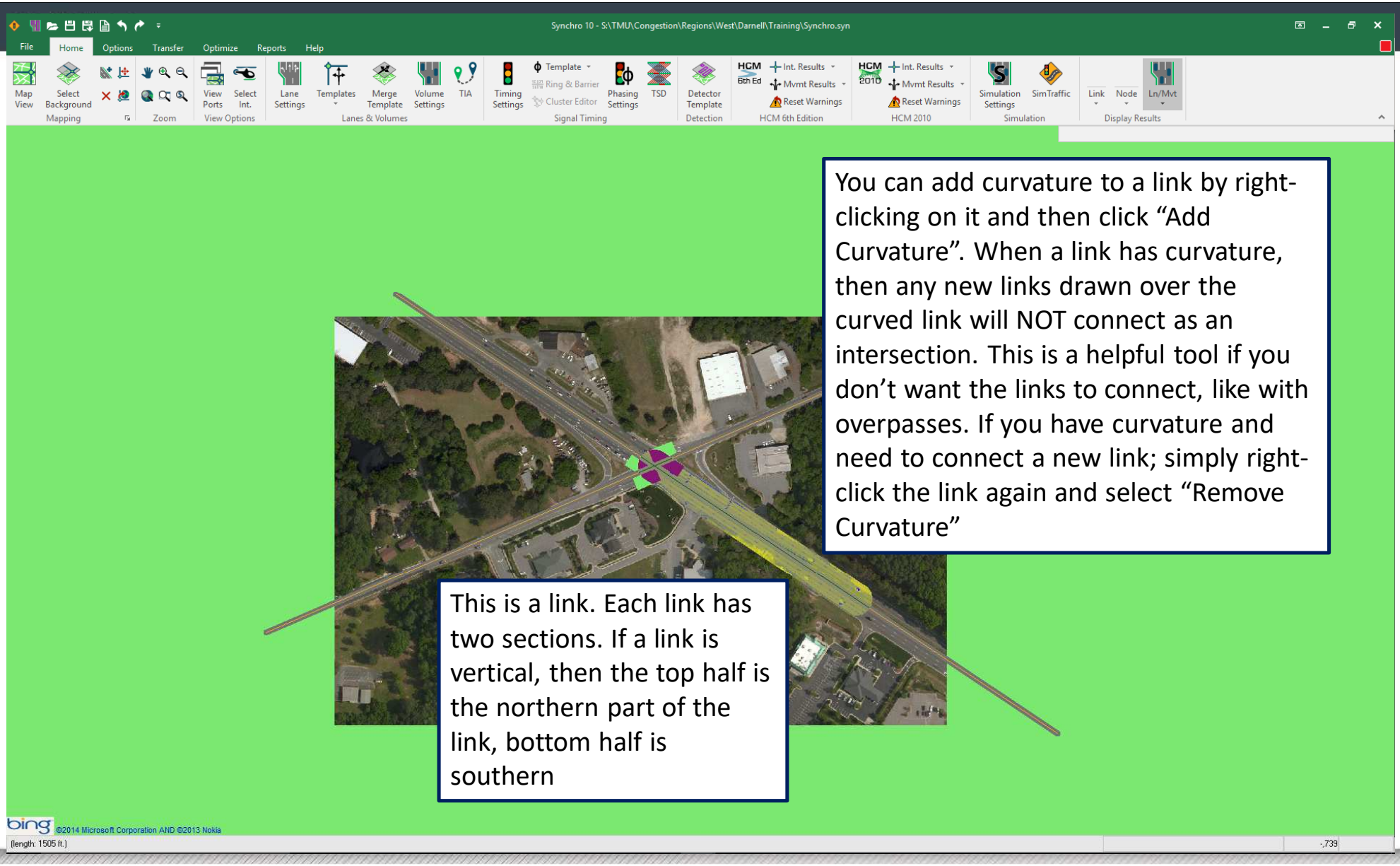
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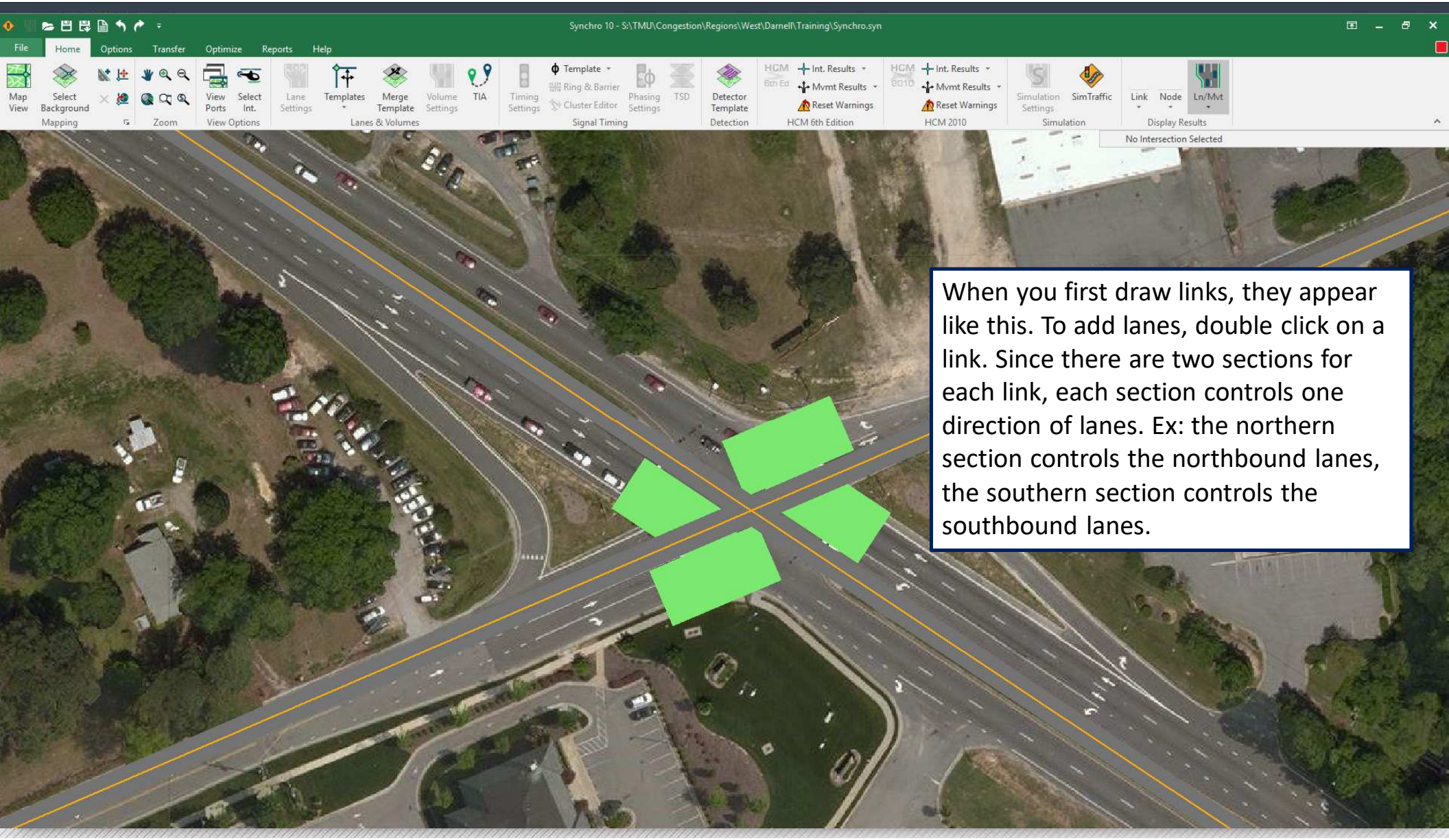
HCM 2010
Int. Results
Mvmt Results
Reset Warnings
HCM 2010
Simulation Settings
SimTraffic
Simulation
Link
Node
Ln/Mvt
Display Results
You can add curvature to a link by right-clicking on it and then click “Add Curvature”. When a link has curvature, then any new links drawn over the curved link will NOT connect as an intersection. This is a helpful tool if you don’t want the links to connect, like with overpasses. If you have curvature and need to connect a new link; simply right-click the link again and select “Remove Curvature”
This is a link. Each link has two sections. If a link is vertical, then the top half is the northern part of the link, bottom half is southern
bing
©2014 Microsoft Corporation AND ©2013 Nokia
(length: 1505 ft.)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Simulation
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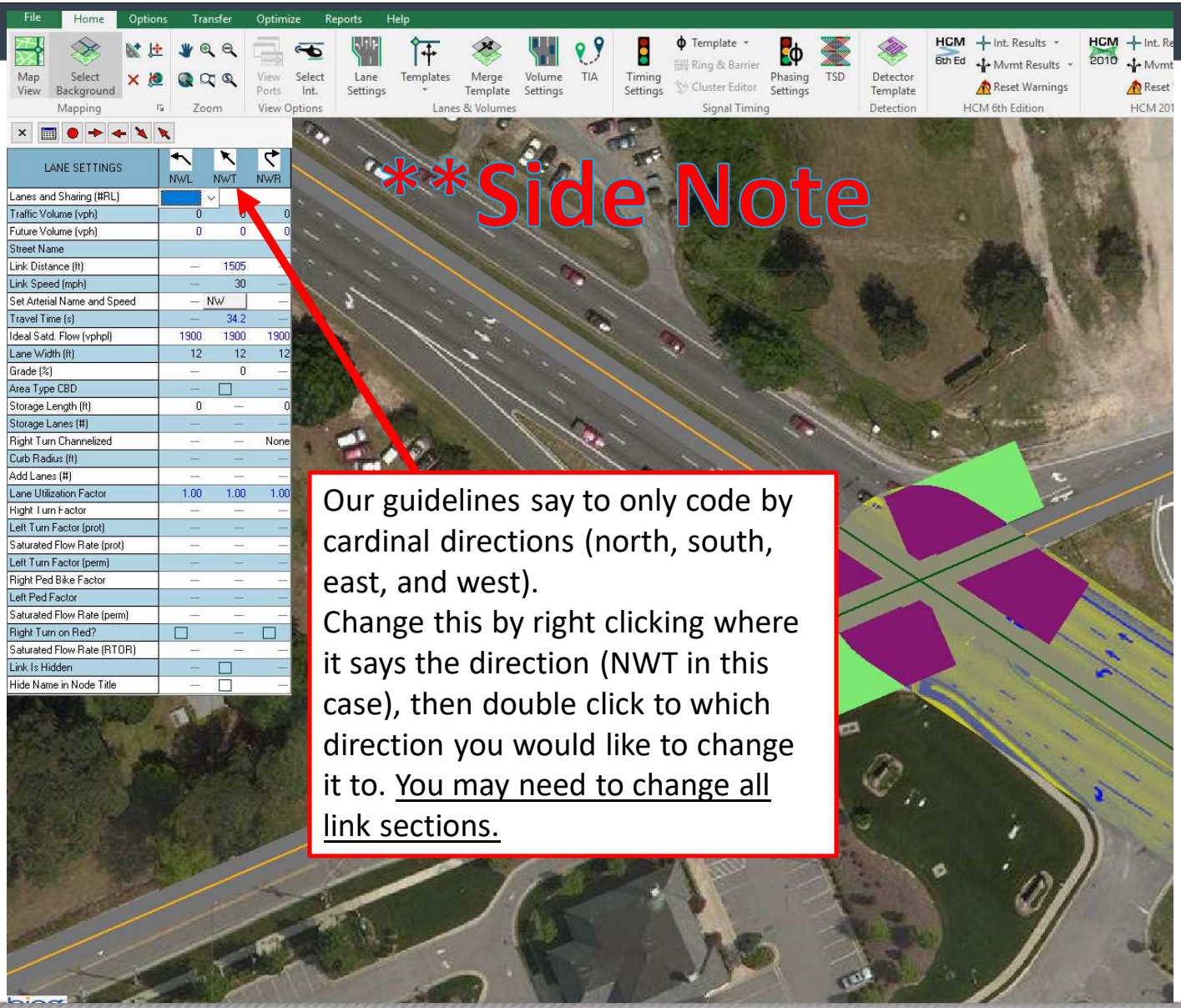
Display Results
No Intersection Selected
When you first draw links, they appear like this. To add lanes, double click on a link. Since there are two sections for each link, each section controls one direction of lanes. Ex: the northern section controls the northbound lanes, the southern section controls the southbound lanes.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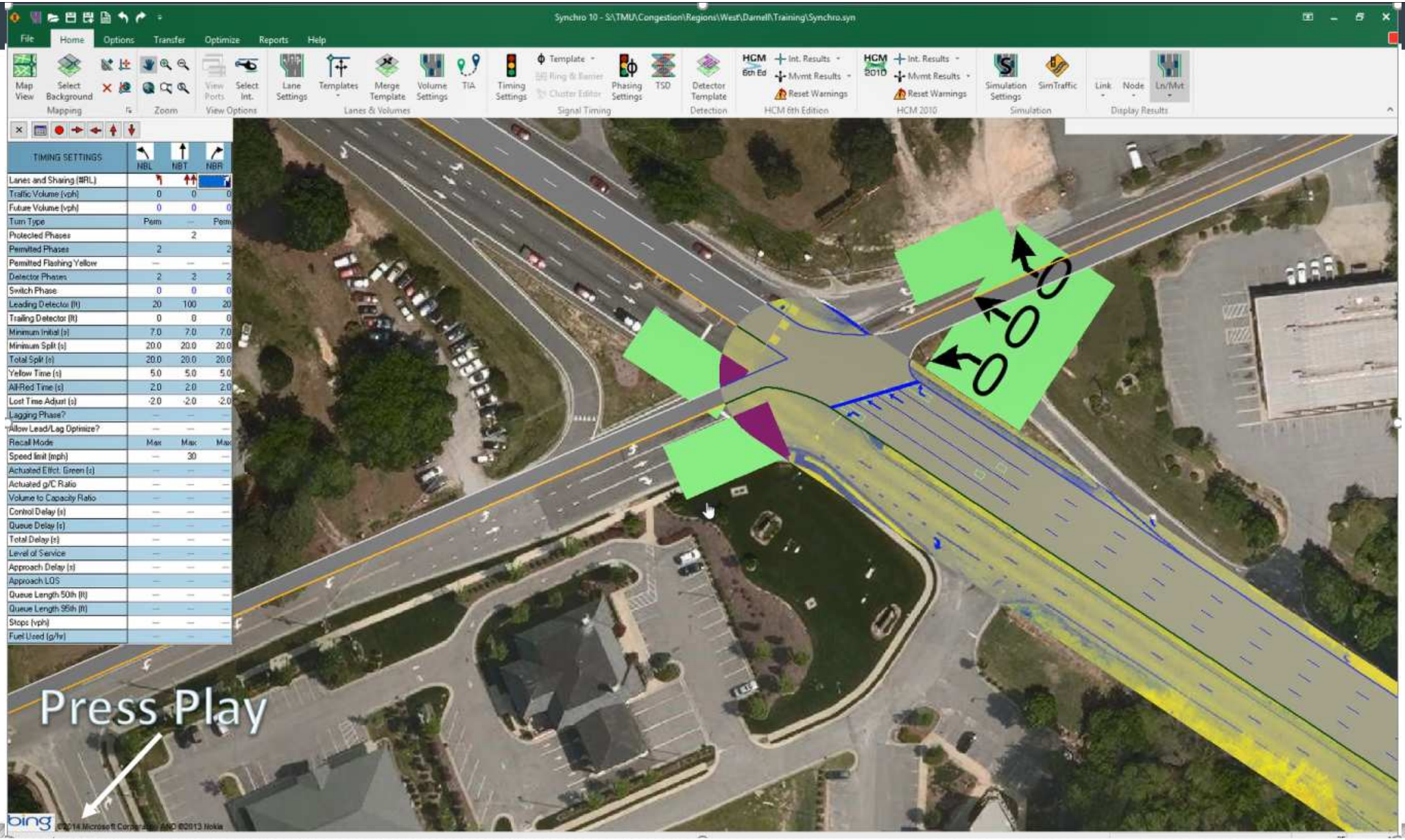
HCM 6th Ed
Int. Results
Mvmt Results
Reset Warnings
HCM 6th Edition
HCM 2010
HCM 201
LANE SETTINGS
NWL
NWT
NWR
Lanes and Sharing (#RL)
Traffic Volume (vph)
Future Volume (vph)
Street Name
Link Distance (ft)
Link Speed (mph)
Set Arterial Name and Speed
Travel Time (s)
Ideal Satd. Flow (vphpl)
Lane Width (ft)
Grade (%)
Area Type CBD
Storage Length (ft)
Storage Lanes (#)
Right Turn Channelized
Curb Radius (ft)
Add Lanes (#)
Lane Utilization Factor
Right Turn Factor
Left Turn Factor (prot)
Saturated Flow Rate (prot)
Left Turn Factor (perm)
Right Ped Bike Factor
Left Ped Factor
Saturated Flow Rate (perm)
Right Turn on Red?
Saturated Flow Rate (RTOR)
Link Is Hidden
Hide Name in Node Title
1505
30
NW
34.2
None
**Side Note
Our guidelines say to only code by cardinal directions (north, south, east, and west).
Change this by right clicking where it says the direction (NWT in this case), then double click to which direction you would like to change it to. You may need to change all link sections.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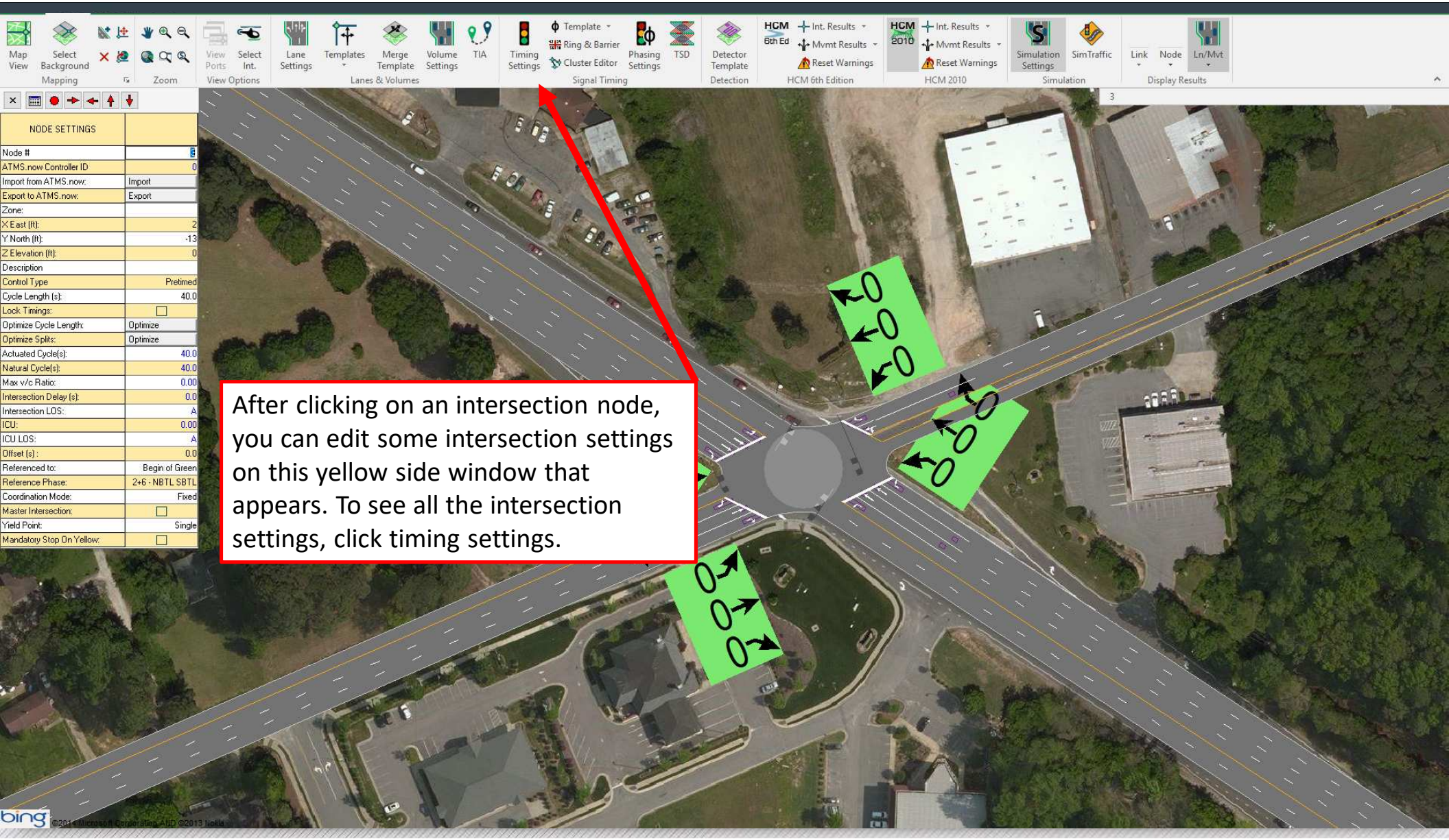
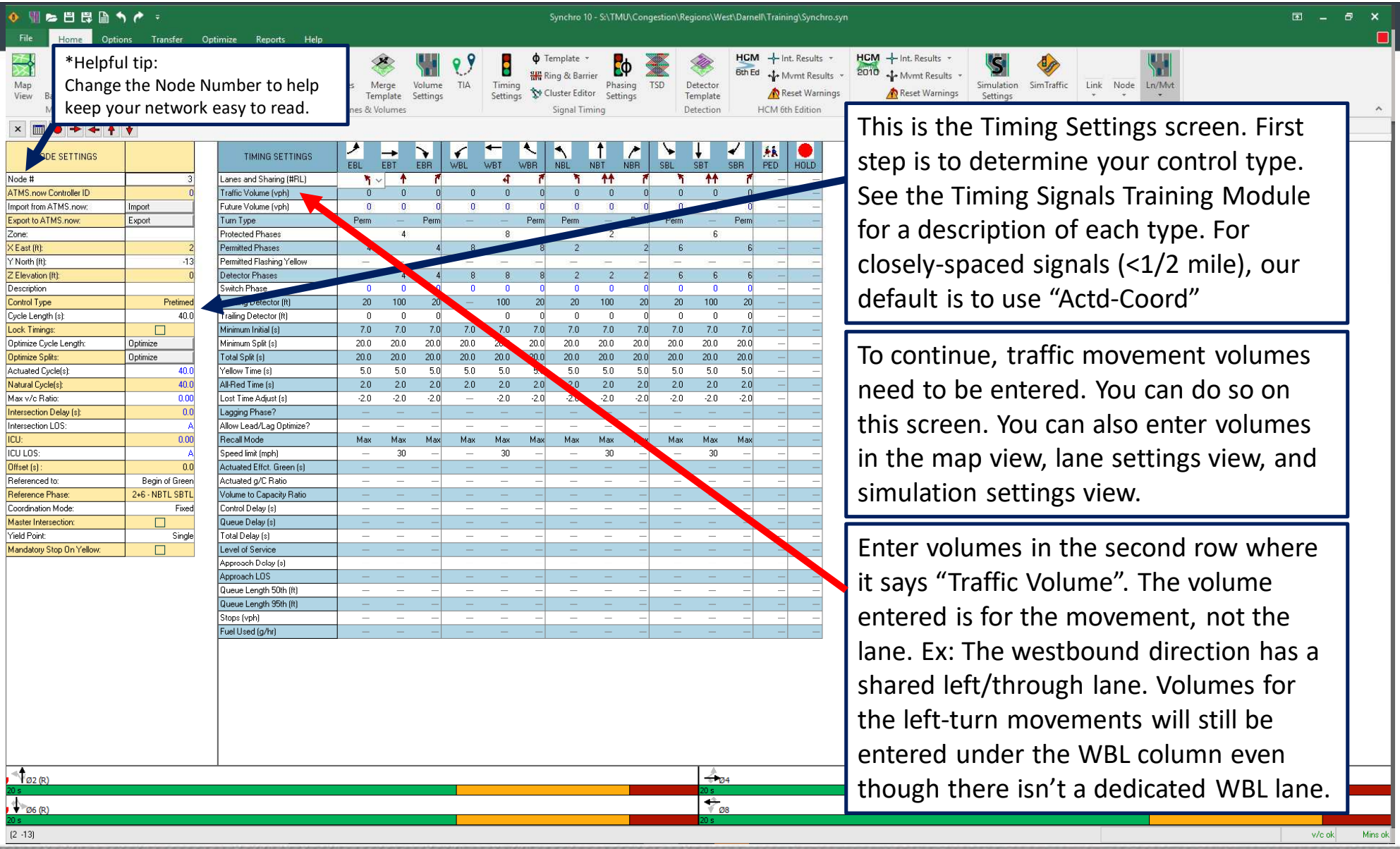
Lanes and Sharing (#RL)
Traffic Volume (vph)
Future Volume (vph)
Turn Type
Protected Phases
Permitted Phases
Permitted Flashing Yellow
Detector Phases
Switch Phase
Leading Detector (ft)
Trailing Detector (ft)
Minimum Initial (s)
Minimum Split (s)
Total Split (s)
Yellow Time (s)
All-Red Time (s)
Lost Time Adjust (s)
Lagging Phase?
Allow Lead/Lag Optimize?
Recall Mode
Speed limit (mph)
Actuated Effct. Green (s)
Actuated g/C Ratio
Volume to Capacity Ratio
Control Delay (s)
Queue Delay (s)
Total Delay (s)
Level of Service
Approach Delay (s)
Approach LOS
Queue Length 50th (ft)
Queue Length 95th (ft)
Stops (vph)
Fuel Used (g/hr)
Press Play
bing

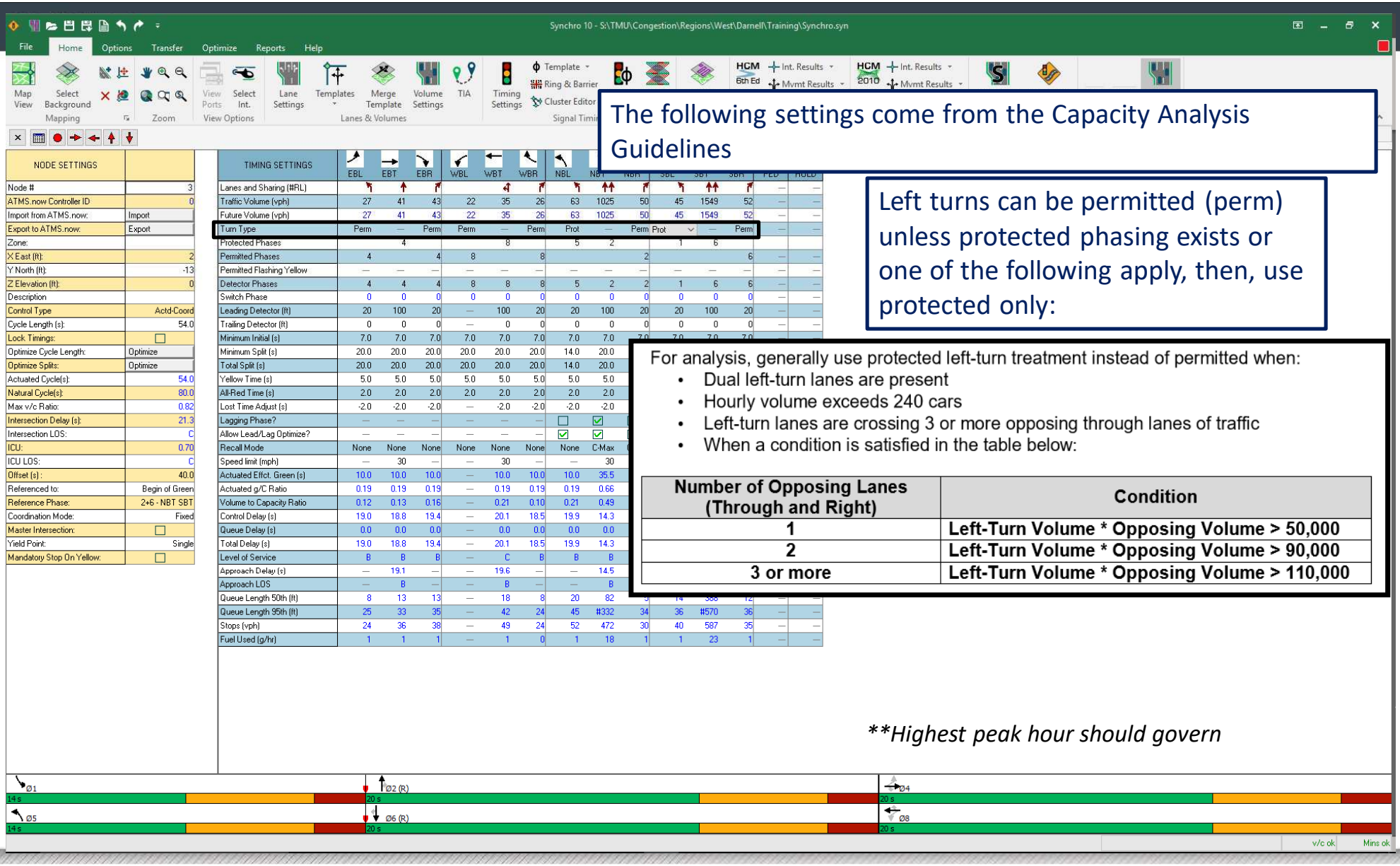

Map View
Select Background
Mapping
Zoom
View Ports
Select Int.
View Options
Lane Settings
Templates
Merge Template
Volume Settings
TIA
Lanes & Volumes
Timing Settings
Template
Ring & Barrier
Cluster Editor
Phasing Settings
TSD
Signal Timing
Detector Template
Detection
HCM 6th Ed
Int. Results
Mvmt Results
Reset Warnings
HCM 6th Edition
HCM 2010
Int. Results
Mvmt Results
Reset Warnings
HCM 2010
Simulation Settings
SimTraffic
Simulation
Link
Node
Ln/Mvt
Display Results
NODE SETTINGS
Node #
ATMS.now Controller ID
Import from ATMS.now:
Import
Export to ATMS.now:
Export
Zone:
X East (ft):
Y North (ft):
Z Elevation (ft):
Description
Control Type
Pretimed
Cycle Length (s):
40.0
Lock Timings:
Optimize Cycle Length:
Optimize
Optimize Splits:
Optimize
Actuated Cycle(s):
40.0
Natural Cycle(s):
40.0
Max v/c Ratio:
0.00
Intersection Delay (s):
0.0
Intersection LOS:
A
ICU:
0.00
ICU LOS:
A
Offset (s):
0.0
Referenced to:
Begin of Green
Reference Phase:
2+6 - NBTL SBTL
Coordination Mode:
Fixed
Master Intersection:
Yield Point:
Single
Mandatory Stop On Yellow:
After clicking on an intersection node, you can edit some intersection settings on this yellow side window that appears. To see all the intersection settings, click timing settings.
bing

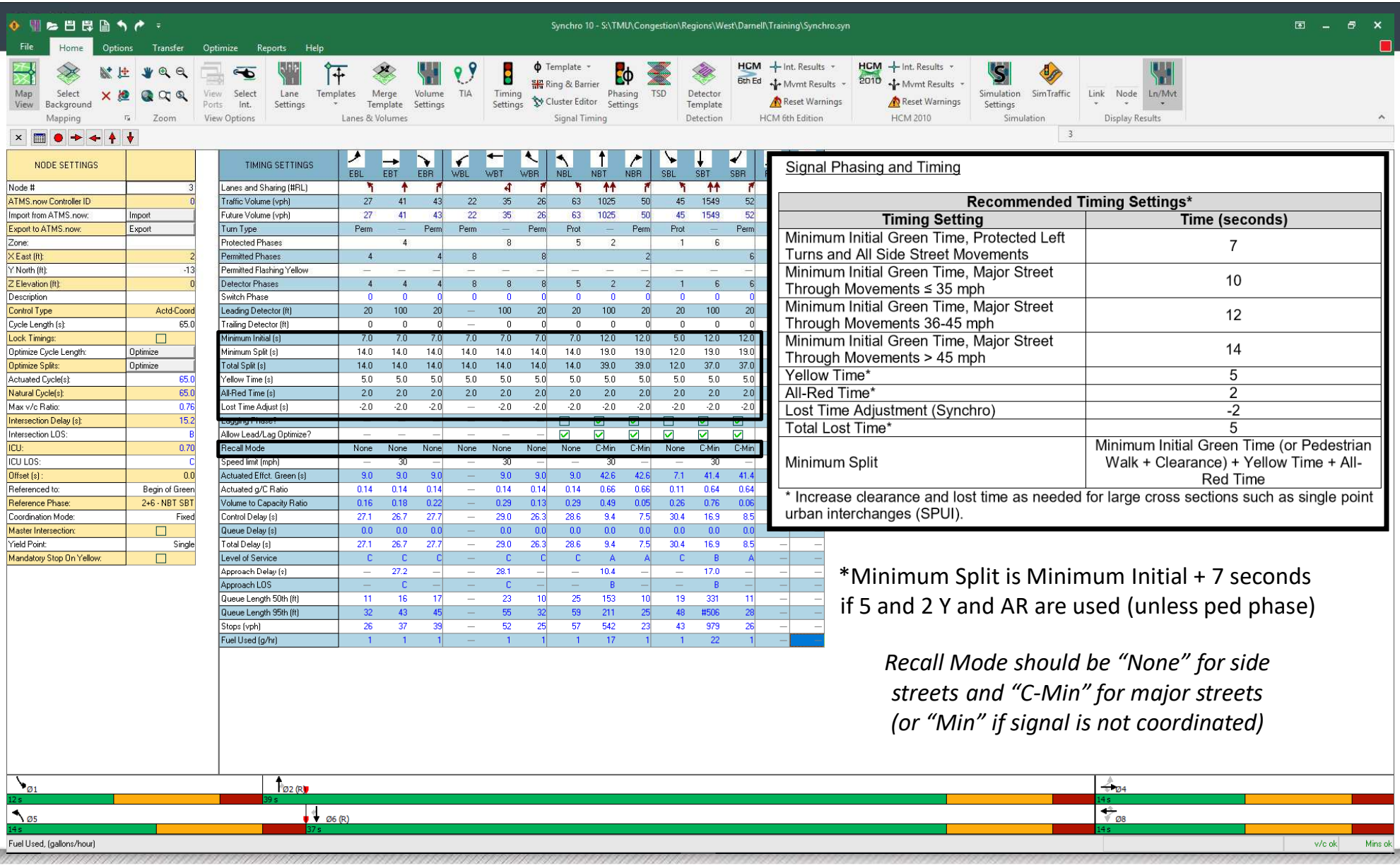


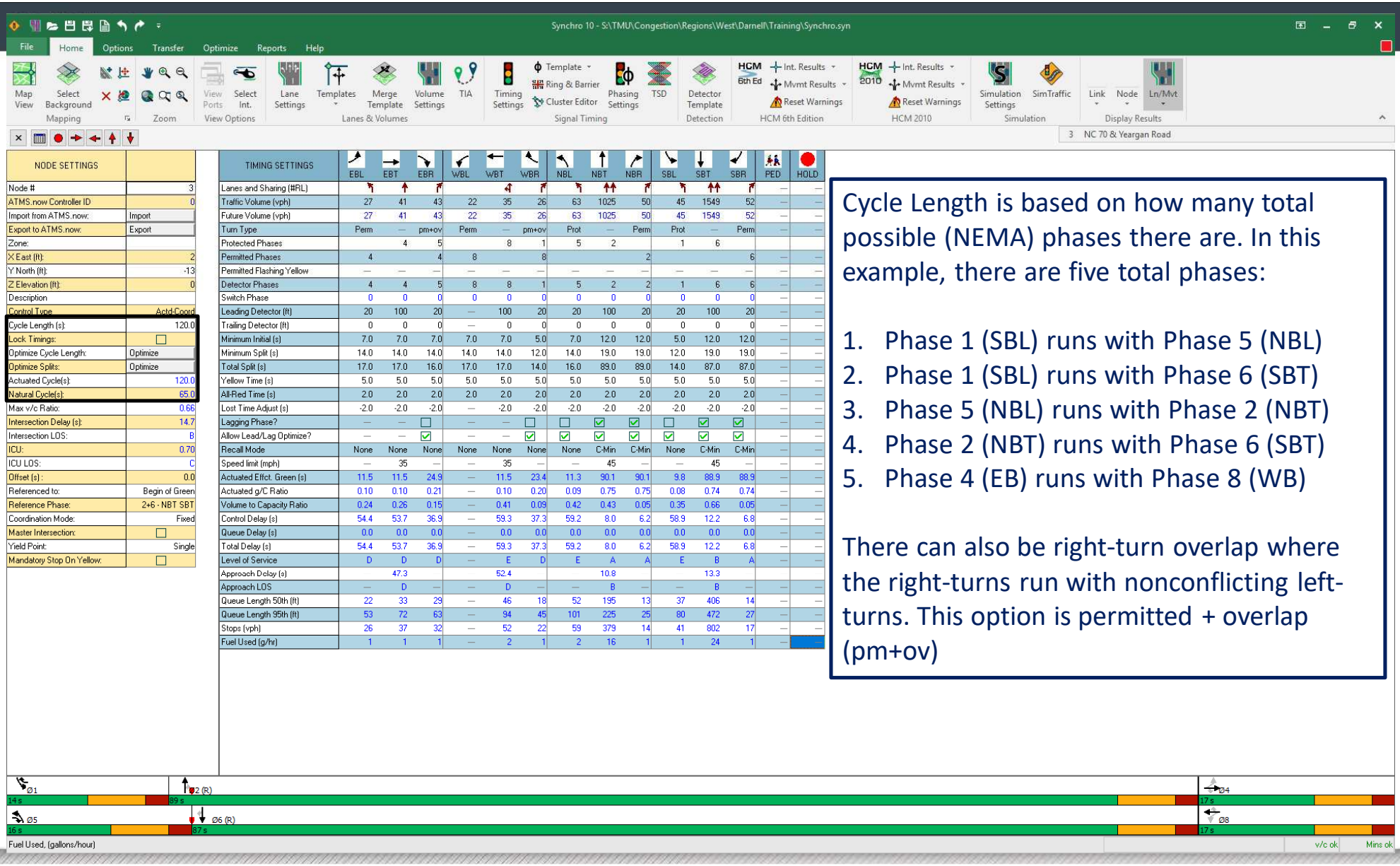
This is the Timing Settings screen. First step is to determine your control type. See the Timing Signals Training Module for a description of each type. For closely-spaced signals (<1/2 mile), our default is to use “Actd-Coord”

To continue, traffic movement volumes need to be entered. You can do so on this screen. You can also enter volumes in the map view, lane settings view, and simulation settings view.

Enter volumes in the second row where it says “Traffic Volume”. The volume entered is for the movement, not the lane. Ex: The westbound direction has a shared left/through lane. Volumes for the left-turn movements will still be entered under the WBL column even though there isn’t a dedicated WBL lane.


Synchro 10 - S:\TMU\Congestion\Regions\West\Darnell\Training\Synchro.syn
The following settings come from the Capacity Analysis Guidelines
Left turns can be permitted (perm) unless protected phasing exists or one of the following apply, then, use protected only:
For analysis, generally use protected left-turn treatment instead of permitted when:
Dual left-turn lanes are present
Hourly volume exceeds 240 cars
Left-turn lanes are crossing 3 or more opposing through lanes of traffic
When a condition is satisfied in the table below:
Number of Opposing Lanes (Through and Right)
Condition
1
Left-Turn Volume * Opposing Volume > 50,000
2
Left-Turn Volume * Opposing Volume > 90,000
3 or more
Left-Turn Volume * Opposing Volume > 110,000
**Highest peak hour should govern


Synchro 10 - S:\TMU\Congestion\Regions\West\Darnell\Training\Synchro.syn
File
Home
Options
Transfer
Optimize
Reports
Help
Map View
Select Background
Mapping
Zoom
View Ports
Select Int.
View Options
Lane Settings
Templates
Merge Template
Volume Settings
TIA
Lanes & Volumes
Timing Settings
Template
Ring & Barrier
Cluster Editor
Phasing Settings
TSD
Signal Timing
Detector Template
Detection
HCM 6th Ed
Int. Results
Mvmt Results
Reset Warnings
HCM 6th Edition
HCM 2010
HCM 2010
Simulation Settings
SimTraffic
Simulation
Link
Node
Ln/Mvt
Display Results
NODE SETTINGS
Node # 3
ATMS.now Controller ID 0
Import from ATMS.now: Import
Export to ATMS.now: Export
Zone:
X East (ft): 2
Y North (ft): -13
Z Elevation (ft): 0
Description
Control Type Actd-Coord
Cycle Length (s): 65.0
Lock Timings:
Optimize Cycle Length: Optimize
Optimize Splits: Optimize
Actuated Cycle(s): 65.0
Natural Cycle(s): 65.0
Max v/c Ratio: 0.76
Intersection Delay (s): 15.2
Intersection LOS: B
ICU: 0.70
ICU LOS: C
Offset (s): 0.0
Referenced to: Begin of Green
Reference Phase: 2+6 - NBT SBT
Coordination Mode: Fixed
Master Intersection:
Yield Point: Single
Mandatory Stop On Yellow:
TIMING SETTINGS
EBL EBT EBR WBL WBT WBR NBL NBT NBR SBL SBT SBR
Lanes and Sharing (#RL)
Traffic Volume (vph) 27 41 43 22 35 26 63 1025 50 45 1549 52
Future Volume (vph) 27 41 43 22 35 26 63 1025 50 45 1549 52
Turn Type Perm — Perm Perm — Perm Prot — Perm Prot — Perm
Protected Phases 4 8 5 2 1 6
Permitted Phases 4 4 8 8 2 6
Permitted Flashing Yellow — — — — — — — — — — — —
Detector Phases 4 4 4 8 8 8 5 2 2 1 6 6
Switch Phase 0 0 0 0 0 0 0 0 0 0 0 0
Leading Detector (ft) 20 100 20 — 100 20 20 100 20 20 100 20
Trailing Detector (ft) 0 0 0 — 0 0 0 0 0 0 0 0
Minimum Initial (s) 7.0 7.0 7.0 7.0 7.0 7.0 7.0 12.0 12.0 5.0 12.0 12.0
Minimum Split (s) 14.0 14.0 14.0 14.0 14.0 14.0 14.0 19.0 19.0 12.0 19.0 19.0
Total Split (s) 14.0 14.0 14.0 14.0 14.0 14.0 14.0 39.0 39.0 12.0 37.0 37.0
Yellow Time (s) 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0
All-Red Time (s) 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0
Lost Time Adjust (s) -2.0 -2.0 -2.0 — -2.0 -2.0 -2.0 -2.0 -2.0 -2.0 -2.0 -2.0
Lagging Phase?
Allow Lead/Lag Optimize? — — — — — —
Recall Mode None None None None None None None C-Min C-Min None C-Min C-Min
Speed limit (mph) — 30 — — 30 — — 30 — — 30 —
Actuated Effct. Green (s) 9.0 9.0 9.0 — 9.0 9.0 9.0 42.6 42.6 7.1 41.4 41.4
Actuated g/C Ratio 0.14 0.14 0.14 — 0.14 0.14 0.14 0.66 0.66 0.11 0.64 0.64
Volume to Capacity Ratio 0.16 0.18 0.22 — 0.29 0.13 0.29 0.49 0.05 0.26 0.76 0.06
Control Delay (s) 27.1 26.7 27.7 — 29.0 26.3 28.6 9.4 7.5 30.4 16.9 8.5
Queue Delay (s) 0.0 0.0 0.0 — 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
Total Delay (s) 27.1 26.7 27.7 — 29.0 26.3 28.6 9.4 7.5 30.4 16.9 8.5
Level of Service C C C — C C C A A C B A
Approach Delay (s) — 27.2 — — 28.1 — — 10.4 — — 17.0 —
Approach LOS — C — — C — — B — — B —
Queue Length 50th (ft) 11 16 17 — 23 10 25 153 10 19 331 11
Queue Length 95th (ft) 32 43 45 — 55 32 59 211 25 48 #506 28
Stops (vph) 26 37 39 — 52 25 57 542 23 43 979 26
Fuel Used (g/hr) 1 1 1 — 1 1 1 17 1 1 22 1
Signal Phasing and Timing
Recommended Timing Settings*
Timing Setting | Time (seconds)
Minimum Initial Green Time, Protected Left Turns and All Side Street Movements | 7
Minimum Initial Green Time, Major Street Through Movements ≤ 35 mph | 10
Minimum Initial Green Time, Major Street Through Movements 36-45 mph | 12
Minimum Initial Green Time, Major Street Through Movements > 45 mph | 14
Yellow Time* | 5
All-Red Time* | 2
Lost Time Adjustment (Synchro) | -2
Total Lost Time* | 5
Minimum Split | Minimum Initial Green Time (or Pedestrian Walk + Clearance) + Yellow Time + All-Red Time
* Increase clearance and lost time as needed for large cross sections such as single point urban interchanges (SPUI).
*Minimum Split is Minimum Initial + 7 seconds if 5 and 2 Y and AR are used (unless ped phase)
Recall Mode should be "None" for side streets and "C-Min" for major streets (or "Min" if signal is not coordinated)
Ø1 12 s
Ø2 (R) 39 s
Ø4 14 s
Ø5 14 s
Ø6 (R) 37 s
Ø8 14 s
Fuel Used, (gallons/hour)
v/c ok
Mins ok


Synchro 10 - S:\TMU\Congestion\Regions\West\Darnell\Training\Synchro.syn
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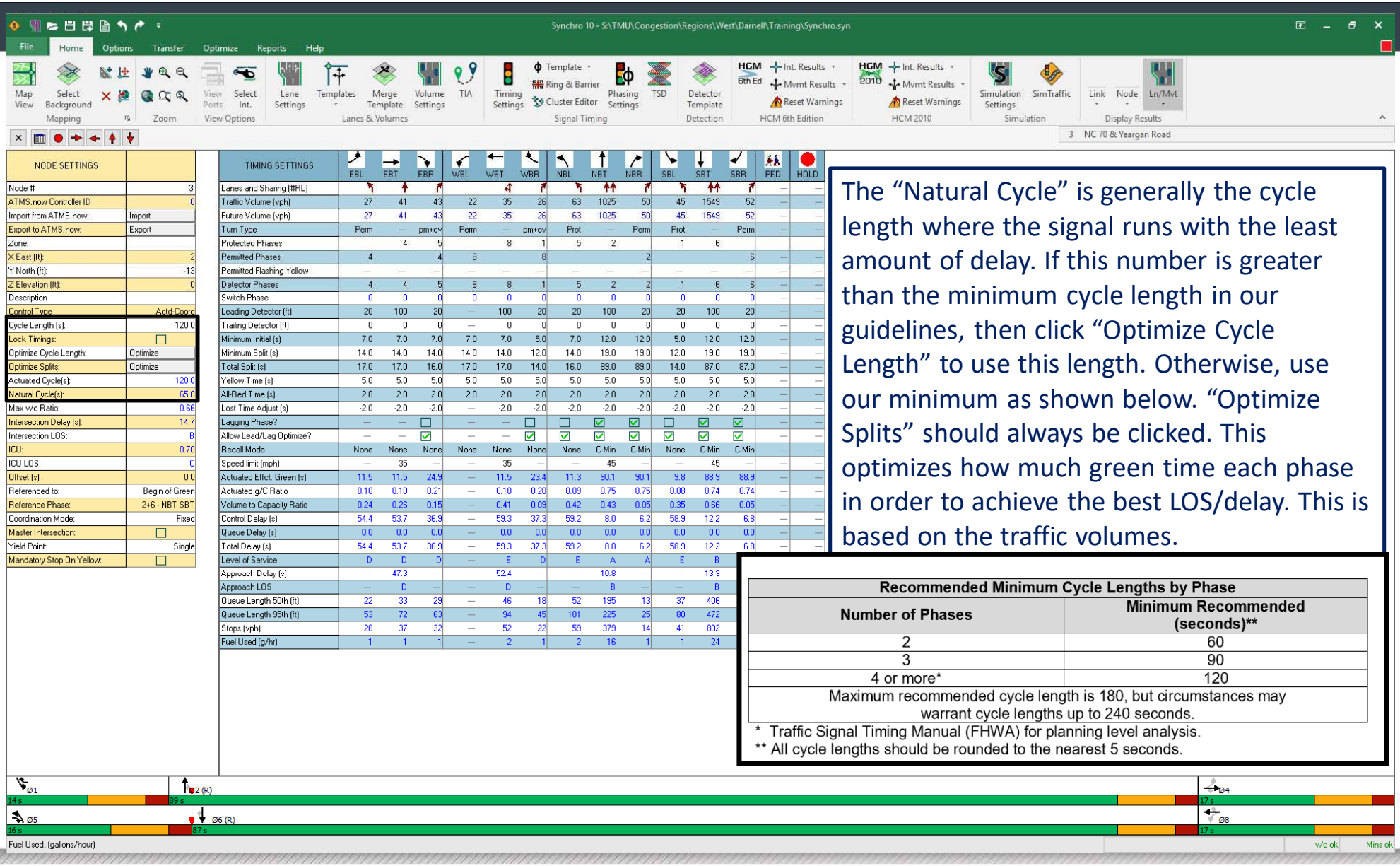
Mvmt Results
Reset Warnings
HCM 2010
Simulation Settings
SimTraffic
Simulation
Link
Node
Ln/Mvt
Display Results
3 NC 70 & Yeargan Road
NODE SETTINGS
Node # 3
ATMS.now Controller ID 0
Import from ATMS.now: Import
Export to ATMS.now: Export
Zone:
X East (ft): 2
Y North (ft): -13
Z Elevation (ft): 0
Description
Control Type Actd-Coord
Cycle Length (s): 120.0
Lock Timings:
Optimize Cycle Length: Optimize
Optimize Splits: Optimize
Actuated Cycle(s): 120.0
Natural Cycle(s): 65.0
Max v/c Ratio: 0.66
Intersection Delay (s): 14.7
Intersection LOS: B
ICU: 0.70
ICU LOS: C
Offset (s): 0.0
Referenced to: Begin of Green
Reference Phase: 2+6 - NBT SBT
Coordination Mode: Fixed
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) 27 41 43 22 35 26 63 1025 50 45 1549 52
Future Volume (vph) 27 41 43 22 35 26 63 1025 50 45 1549 52
Turn Type Perm pm+ov Perm pm+ov Prot Perm Prot Perm
Protected Phases 4 5 8 1 5 2 1 6
Permitted Phases 4 4 8 8 2 6
Permitted Flashing Yellow
Detector Phases 4 4 5 8 8 1 5 2 2 1 6 6
Switch Phase 0 0 0 0 0 0 0 0 0 0 0 0
Leading Detector (ft) 20 100 20 100 20 20 100 20 20 100 20
Trailing Detector (ft) 0 0 0 0 0 0 0 0 0 0 0 0
Minimum Initial (s) 7.0 7.0 7.0 7.0 7.0 5.0 7.0 12.0 12.0 5.0 12.0 12.0
Minimum Split (s) 14.0 14.0 14.0 14.0 14.0 12.0 14.0 19.0 19.0 12.0 19.0 19.0
Total Split (s) 17.0 17.0 16.0 17.0 17.0 14.0 16.0 89.0 89.0 14.0 87.0 87.0
Yellow Time (s) 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0
All-Red Time (s) 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0
Lost Time Adjust (s) -2.0 -2.0 -2.0 -2.0 -2.0 -2.0 -2.0 -2.0 -2.0 -2.0 -2.0 -2.0
Lagging Phase?
Allow Lead/Lag Optimize?
Recall Mode None None None None None None None C-Min C-Min None C-Min C-Min
Speed limit (mph) 35 35 45 45
Actuated Effct. Green (s) 11.5 11.5 24.9 11.5 23.4 11.3 90.1 90.1 9.8 88.9 88.9
Actuated g/C Ratio 0.10 0.10 0.21 0.10 0.20 0.09 0.75 0.75 0.08 0.74 0.74
Volume to Capacity Ratio 0.24 0.26 0.15 0.41 0.09 0.42 0.43 0.05 0.35 0.66 0.05
Control Delay (s) 54.4 53.7 36.9 59.3 37.3 59.2 8.0 6.2 58.9 12.2 6.8
Queue Delay (s) 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
Total Delay (s) 54.4 53.7 36.9 59.3 37.3 59.2 8.0 6.2 58.9 12.2 6.8
Level of Service D D D E D E A A E B A
Approach Delay (s) 47.3 52.4 10.8 13.3
Approach LOS D D B B
Queue Length 50th (ft) 22 33 29 46 18 52 195 13 37 406 14
Queue Length 95th (ft) 53 72 63 94 45 101 225 25 80 472 27
Stops (vph) 26 37 32 52 22 59 379 14 41 802 17
Fuel Used (g/hr) 1 1 1 2 1 2 16 1 1 24 1
Cycle Length is based on how many total possible (NEMA) phases there are. In this example, there are five total phases:
1. Phase 1 (SBL) runs with Phase 5 (NBL)
2. Phase 1 (SBL) runs with Phase 6 (SBT)
3. Phase 5 (NBL) runs with Phase 2 (NBT)
4. Phase 2 (NBT) runs with Phase 6 (SBT)
5. Phase 4 (EB) runs with Phase 8 (WB)
There can also be right-turn overlap where the right-turns run with nonconflicting left-turns. This option is permitted + overlap (pm+ov)
Ø1
14 s
Ø2 (R)
39 s
Ø4
17 s
Ø5
16 s
Ø6 (R)
87 s
Ø8
17 s
Fuel Used, (gallons/hour)
v/c ok
Mins ok

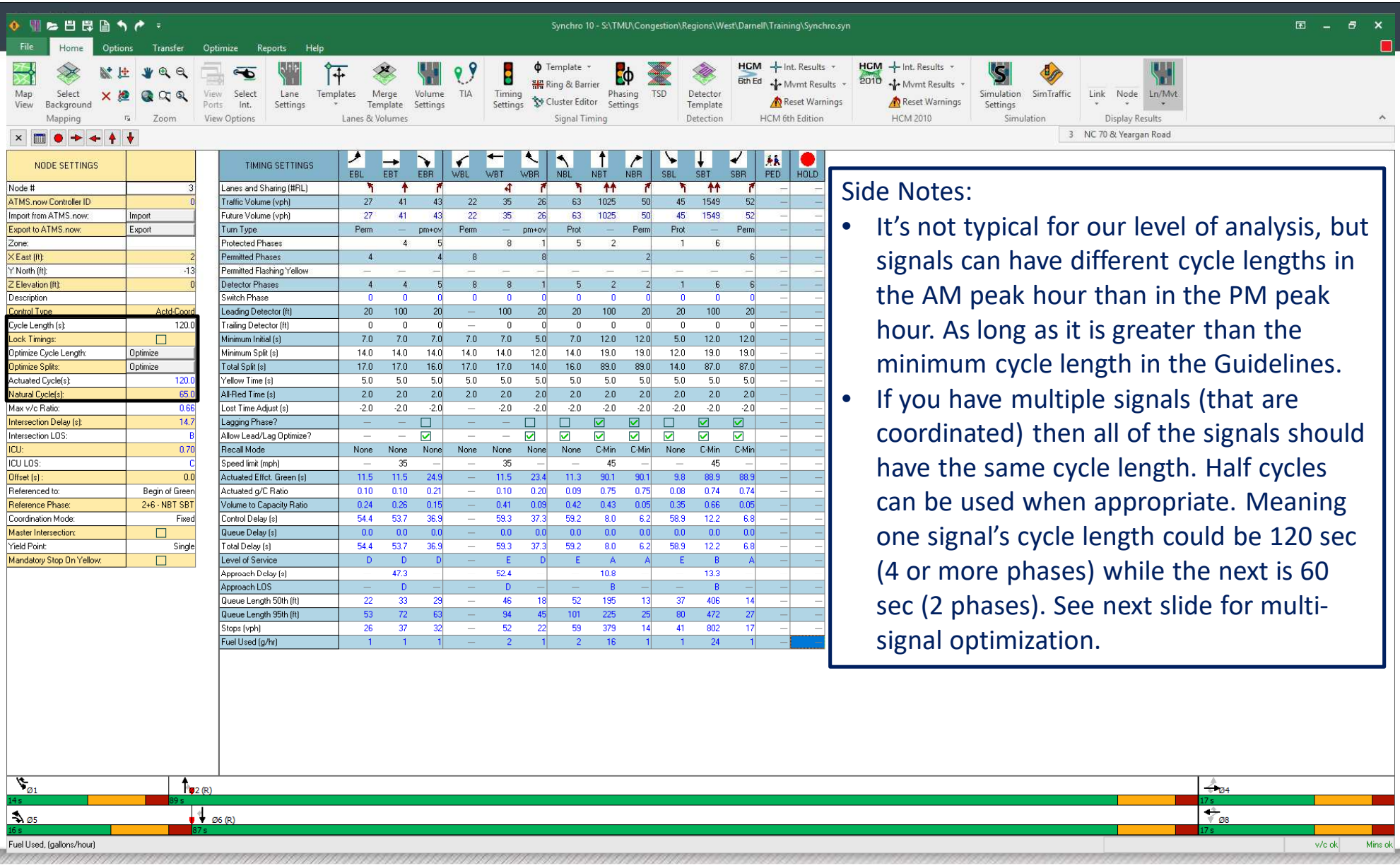


The "Natural Cycle" is generally the cycle length where the signal runs with the least amount of delay. If this number is greater than the minimum cycle length in our guidelines, then click "Optimize Cycle Length" to use this length. Otherwise, use our minimum as shown below. "Optimize Splits" should always be clicked. This optimizes how much green time each phase in order to achieve the best LOS/delay. This is based on the traffic volumes.

Recommended Minimum Cycle Lengths by Phase	
Number of Phases	**Minimum Recommended (seconds)****
2	60
3	90
4 or more*	120
Maximum recommended cycle length is 180, but circumstances may warrant cycle lengths up to 240 seconds.	

* Traffic Signal Timing Manual (FHWA) for planning level analysis.

** All cycle lengths should be rounded to the nearest 5 seconds.


Synchro 10 - S:\TMU\Congestion\Regions\West\Darnell\Training\Synchro.syn
File
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Simulation Settings
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Simulation
Link
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Display Results
3 NC 70 & Yeargan Road
NODE SETTINGS
Node # 3
ATMS.now Controller ID 0
Import from ATMS.now: Import
Export to ATMS.now: Export
Zone:
X East (ft): 2
Y North (ft): -13
Z Elevation (ft): 0
Description
Control Type Actd-Coord
Cycle Length (s): 120.0
Lock Timings:
Optimize Cycle Length: Optimize
Optimize Splits: Optimize
Actuated Cycle(s): 120.0
Natural Cycle(s): 65.0
Max v/c Ratio: 0.66
Intersection Delay (s): 14.7
Intersection LOS: B
ICU: 0.70
ICU LOS: C
Offset (s): 0.0
Referenced to: Begin of Green
Reference Phase: 2+6 - NBT SBT
Coordination Mode: Fixed
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) 27 41 43 22 35 26 63 1025 50 45 1549 52
Future Volume (vph) 27 41 43 22 35 26 63 1025 50 45 1549 52
Turn Type Perm pm+ov Perm pm+ov Prot Perm Prot Perm
Protected Phases 4 5 8 1 5 2 1 6
Permitted Phases 4 4 8 8 2 6
Permitted Flashing Yellow
Detector Phases 4 4 5 8 8 1 5 2 2 1 6 6
Switch Phase 0 0 0 0 0 0 0 0 0 0 0 0
Leading Detector (ft) 20 100 20 100 20 20 100 20 20 100 20
Trailing Detector (ft) 0 0 0 0 0 0 0 0 0 0 0 0
Minimum Initial (s) 7.0 7.0 7.0 7.0 7.0 5.0 7.0 12.0 12.0 5.0 12.0 12.0
Minimum Split (s) 14.0 14.0 14.0 14.0 14.0 12.0 14.0 19.0 19.0 12.0 19.0 19.0
Total Split (s) 17.0 17.0 16.0 17.0 17.0 14.0 16.0 89.0 89.0 14.0 87.0 87.0
Yellow Time (s) 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0
All-Red Time (s) 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0
Lost Time Adjust (s) -2.0 -2.0 -2.0 -2.0 -2.0 -2.0 -2.0 -2.0 -2.0 -2.0 -2.0 -2.0
Lagging Phase?
Allow Lead/Lag Optimize?
Recall Mode None None None None None None None C-Min C-Min None C-Min C-Min
Speed limit (mph) 35 35 45 45
Actuated Effct. Green (s) 11.5 11.5 24.9 11.5 23.4 11.3 90.1 90.1 9.8 88.9 88.9
Actuated g/C Ratio 0.10 0.10 0.21 0.10 0.20 0.09 0.75 0.75 0.08 0.74 0.74
Volume to Capacity Ratio 0.24 0.26 0.15 0.41 0.09 0.42 0.43 0.05 0.35 0.66 0.05
Control Delay (s) 54.4 53.7 36.9 59.3 37.3 59.2 8.0 6.2 58.9 12.2 6.8
Queue Delay (s) 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
Total Delay (s) 54.4 53.7 36.9 59.3 37.3 59.2 8.0 6.2 58.9 12.2 6.8
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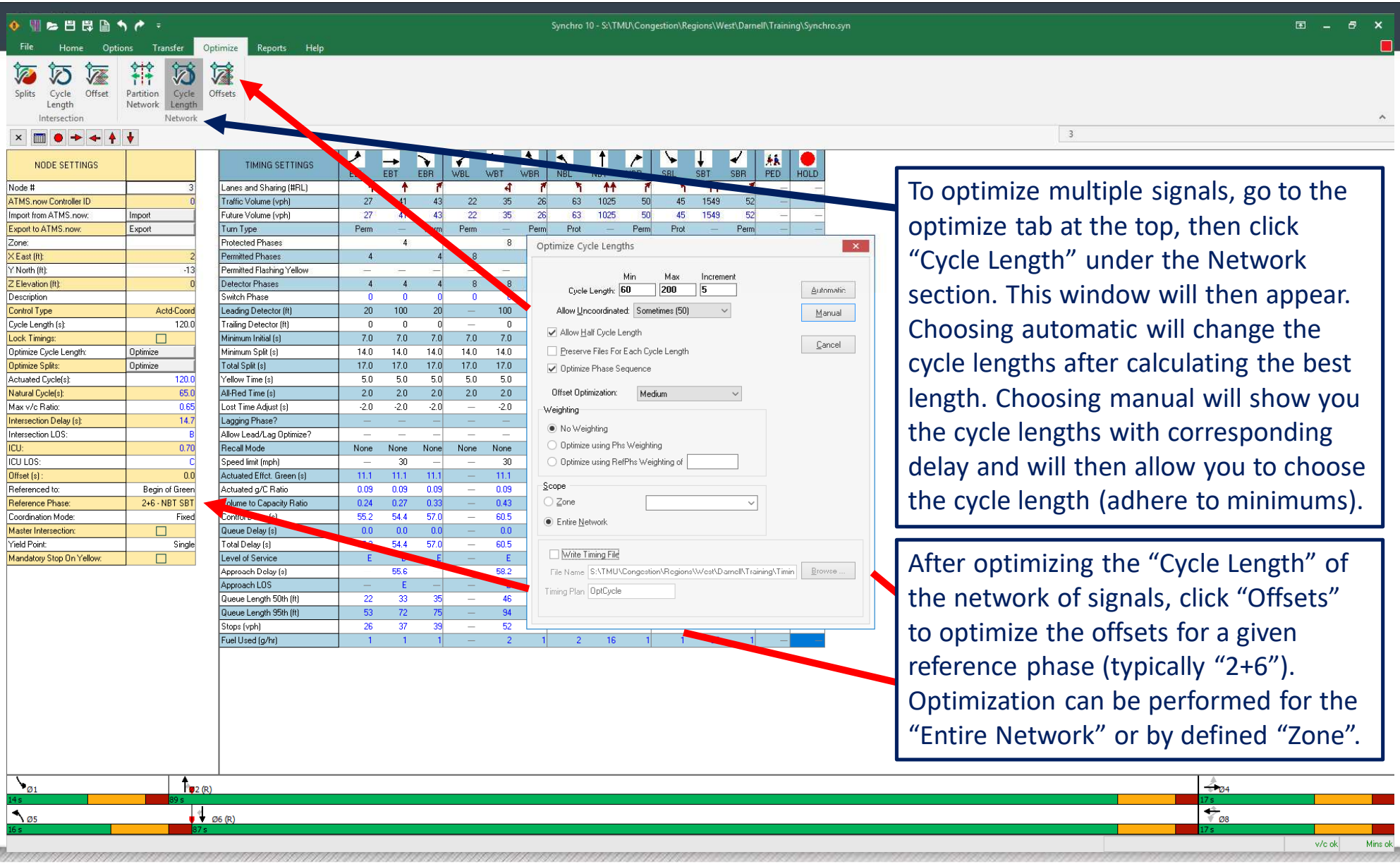
Queue Length 50th (ft) 22 33 29 46 18 52 195 13 37 406 14
Queue Length 95th (ft) 53 72 63 94 45 101 225 25 80 472 27
Stops (vph) 26 37 32 52 22 59 379 14 41 802 17
Fuel Used (g/hr) 1 1 1 2 1 2 16 1 1 24 1
Side Notes:
• It's not typical for our level of analysis, but signals can have different cycle lengths in the AM peak hour than in the PM peak hour. As long as it is greater than the minimum cycle length in the Guidelines.
• If you have multiple signals (that are coordinated) then all of the signals should have the same cycle length. Half cycles can be used when appropriate. Meaning one signal's cycle length could be 120 sec (4 or more phases) while the next is 60 sec (2 phases). See next slide for multi-signal optimization.
Ø1
14 s
Ø2 (R)
89 s
Ø4
17 s
Ø5
16 s
Ø6 (R)
87 s
Ø8
17 s
Fuel Used, (gallons/hour)
v/c ok
Mins ok


Synchro 10 - S:\TMU\Congestion\Regions\West\Darnell\Training\Synchro.syn
File
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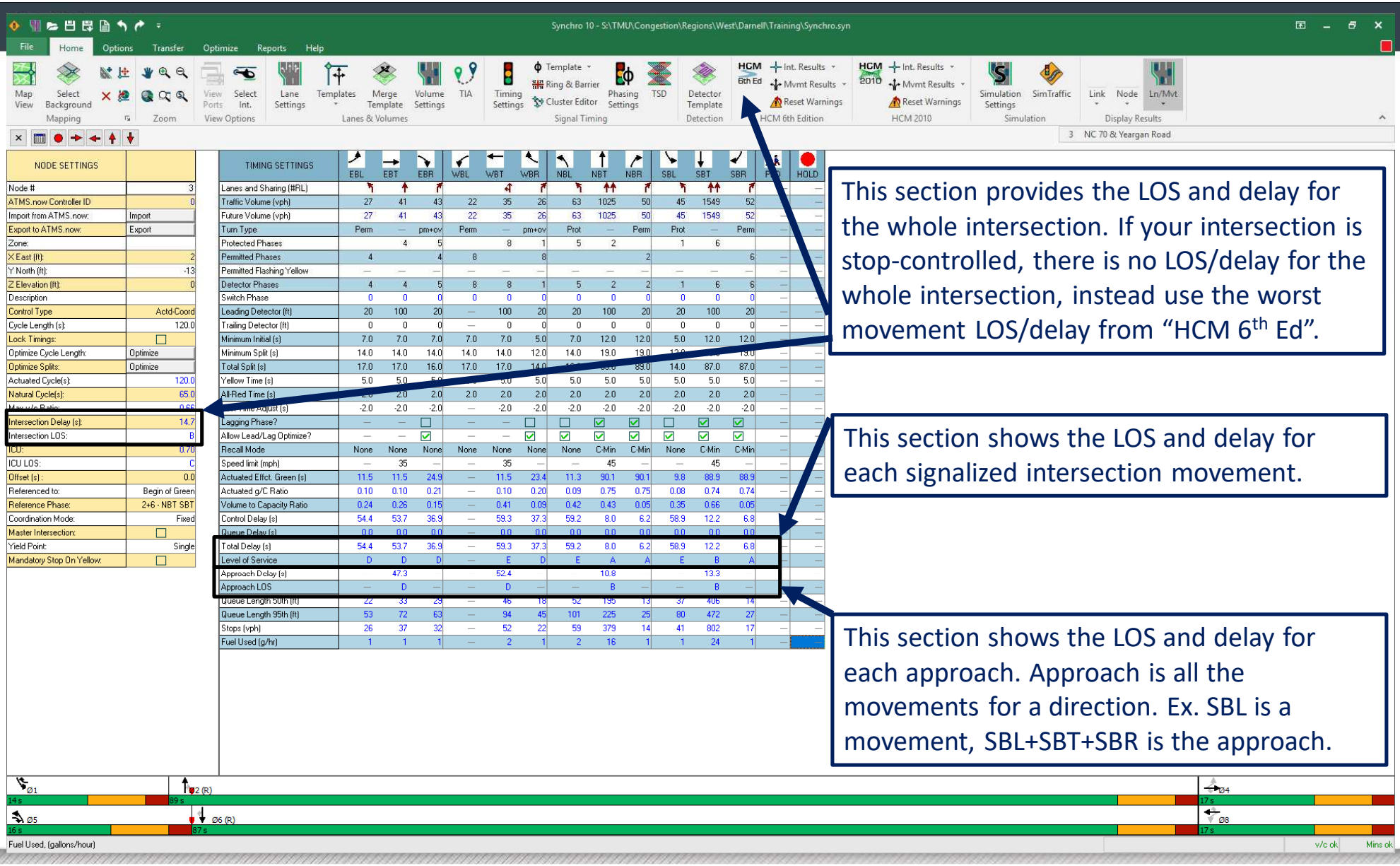
Cycle Length
Offsets
Network
NODE SETTINGS
TIMING SETTINGS
Optimize Cycle Lengths
Min
Max
Increment
Cycle Length: 60 200 5
Automatic
Allow Uncoordinated: Sometimes (50)
Manual
Allow Half Cycle Length
Cancel
Preserve Files For Each Cycle Length
Optimize Phase Sequence
Offset Optimization: Medium
Weighting
No Weighting
Optimize using Phs Weighting
Optimize using RefPhs Weighting of
Scope
Zone
Entire Network
Write Timing File
File Name
Timing Plan: OptCycle
Browse ...
To optimize multiple signals, go to the optimize tab at the top, then click “Cycle Length” under the Network section. This window will then appear. Choosing automatic will change the cycle lengths after calculating the best length. Choosing manual will show you the cycle lengths with corresponding delay and will then allow you to choose the cycle length (adhere to minimums).
After optimizing the “Cycle Length” of the network of signals, click “Offsets” to optimize the offsets for a given reference phase (typically “2+6”). Optimization can be performed for the “Entire Network” or by defined “Zone”.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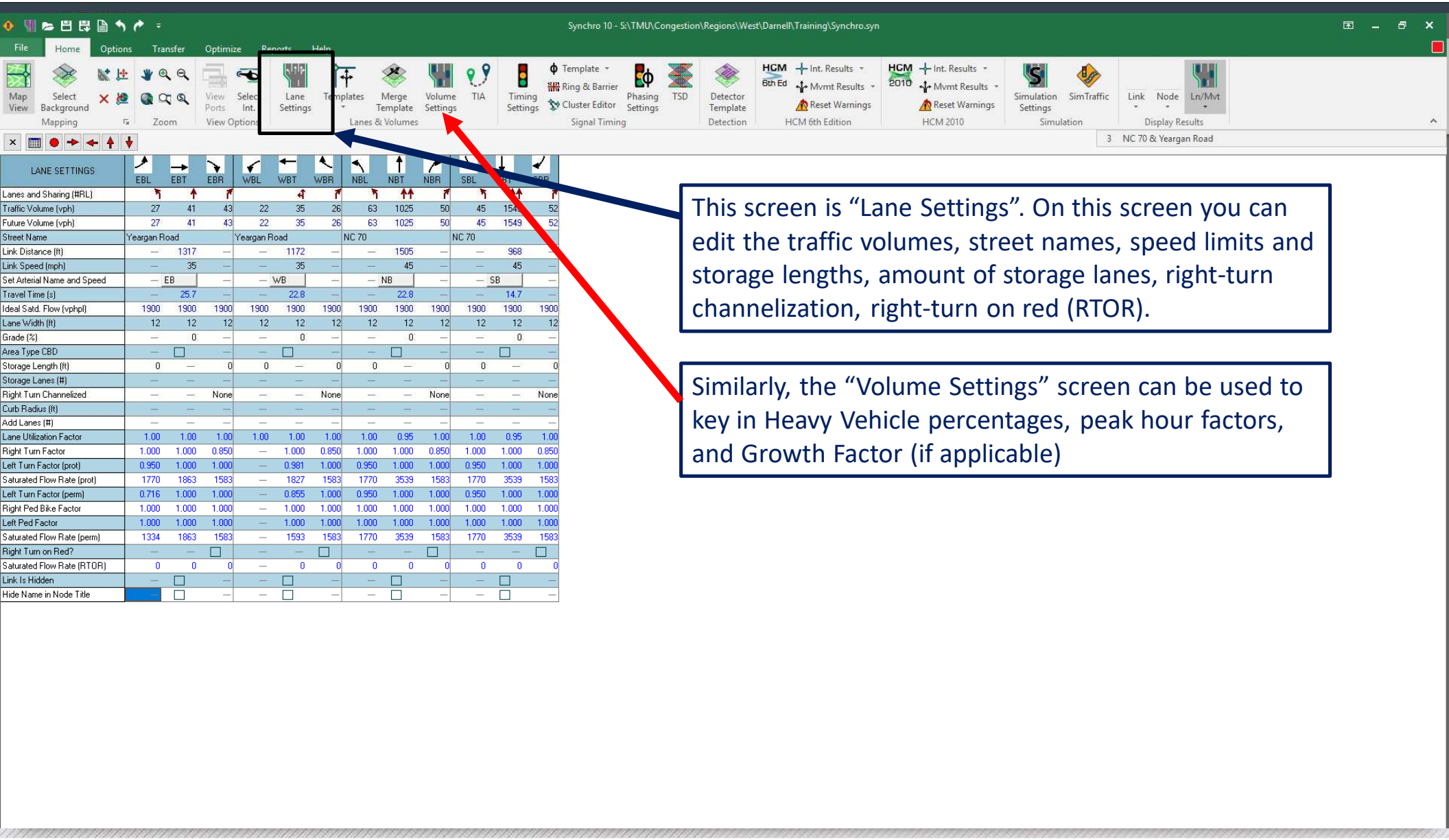
3 NC 70 & Yeargan Road
NODE SETTINGS
Node #
ATMS.now Controller ID
Import from ATMS.now:
Export to ATMS.now:
Zone:
X East (ft):
Y North (ft):
Z Elevation (ft):
Description
Control Type
Cycle Length (s):
Lock Timings:
Optimize Cycle Length:
Optimize Splits:
Actuated Cycle(s):
Natural Cycle(s):
Intersection Delay (s):
Intersection LOS:
ICU:
ICU LOS:
Offset (s):
Referenced to:
Reference Phase:
Coordination Mode:
Master Intersection:
Yield Point:
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)
Future Volume (vph)
Turn Type
Protected Phases
Permitted Phases
Permitted Flashing Yellow
Detector Phases
Switch Phase
Leading Detector (ft)
Trailing Detector (ft)
Minimum Initial (s)
Minimum Split (s)
Total Split (s)
Yellow Time (s)
All-Red Time (s)
Lagging Phase?
Allow Lead/Lag Optimize?
Recall Mode
Speed limit (mph)
Actuated Effct. Green (s)
Actuated g/C Ratio
Volume to Capacity Ratio
Control Delay (s)
Queue Delay (s)
Total Delay (s)
Level of Service
Approach Delay (s)
Approach LOS
Queue Length 50th (ft)
Queue Length 95th (ft)
Stops (vph)
Fuel Used (g/hr)
This section provides the LOS and delay for the whole intersection. If your intersection is stop-controlled, there is no LOS/delay for the whole intersection, instead use the worst movement LOS/delay from “HCM 6th Ed”.
This section shows the LOS and delay for each signalized intersection movement.
This section shows the LOS and delay for each approach. Approach is all the movements for a direction. Ex. SBL is a movement, SBL+SBT+SBR is the approach.
Ø1
Ø2 (R)
Ø4
Ø5
Ø6 (R)
Ø8
Fuel Used, (gallons/hour)
v/c ok
Mins ok



LANE SETTINGS	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lanes and Sharing (#RL)												
Traffic Volume (vph)	27	41	43	22	35	26	63	1025	50	45	1549	52
Future Volume (vph)	27	41	43	22	35	26	63	1025	50	45	1549	52
Street Name	Yeargan Road			Yeargan Road			NC 70			NC 70		
Link Distance (ft)	—	1317	—	—	1172	—	—	1505	—	—	968	—
Link Speed (mph)	—	35	—	—	35	—	—	45	—	—	45	—
Set Arterial Name and Speed	—	EB	—	—	WB	—	—	NB	—	—	SB	—
Travel Time (s)	—	25.7	—	—	22.8	—	—	22.8	—	—	14.7	—
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)	0	—	0	0	—	0	0	—	0	0	—	0
Storage Lanes (#)	—	—	—	—	—	—	—	—	—	—	—	—
Right Turn Channelized	—	—	None	—	—	None	—	—	None	—	—	None
Curb Radius (ft)	—	—	—	—	—	—	—	—	—	—	—	—
Add Lanes (#)	—	—	—	—	—	—	—	—	—	—	—	—
Lane Utilization Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Right Turn Factor	1.000	1.000	0.850	—	1.000	0.850	1.000	1.000	0.850	1.000	1.000	0.850
Left Turn Factor (prot)	0.950	1.000	1.000	—	0.981	1.000	0.950	1.000	1.000	0.950	1.000	1.000
Saturated Flow Rate (prot)	1770	1863	1583	—	1827	1583	1770	3539	1583	1770	3539	1583
Left Turn Factor (perm)	0.716	1.000	1.000	—	0.855	1.000	0.950	1.000	1.000	0.950	1.000	1.000
Right Ped Bike Factor	1.000	1.000	1.000	—	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	1.000	1.000	1.000
Saturated Flow Rate (perm)	1334	1863	1583	—	1593	1583	1770	3539	1583	1770	3539	1583
Right Turn on Red?	—	—	☐	—	—	☐	—	—	☐	—	—	☐
Saturated Flow Rate (RTOR)	0	0	0	—	0	0	0	0	0	0	0	0
Link Is Hidden	—	☐	—	—	☐	—	—	☐	—	—	☐	—
Hide Name in Node Title	—	☐	—	—	☐	—	—	☐	—	—	☐	—

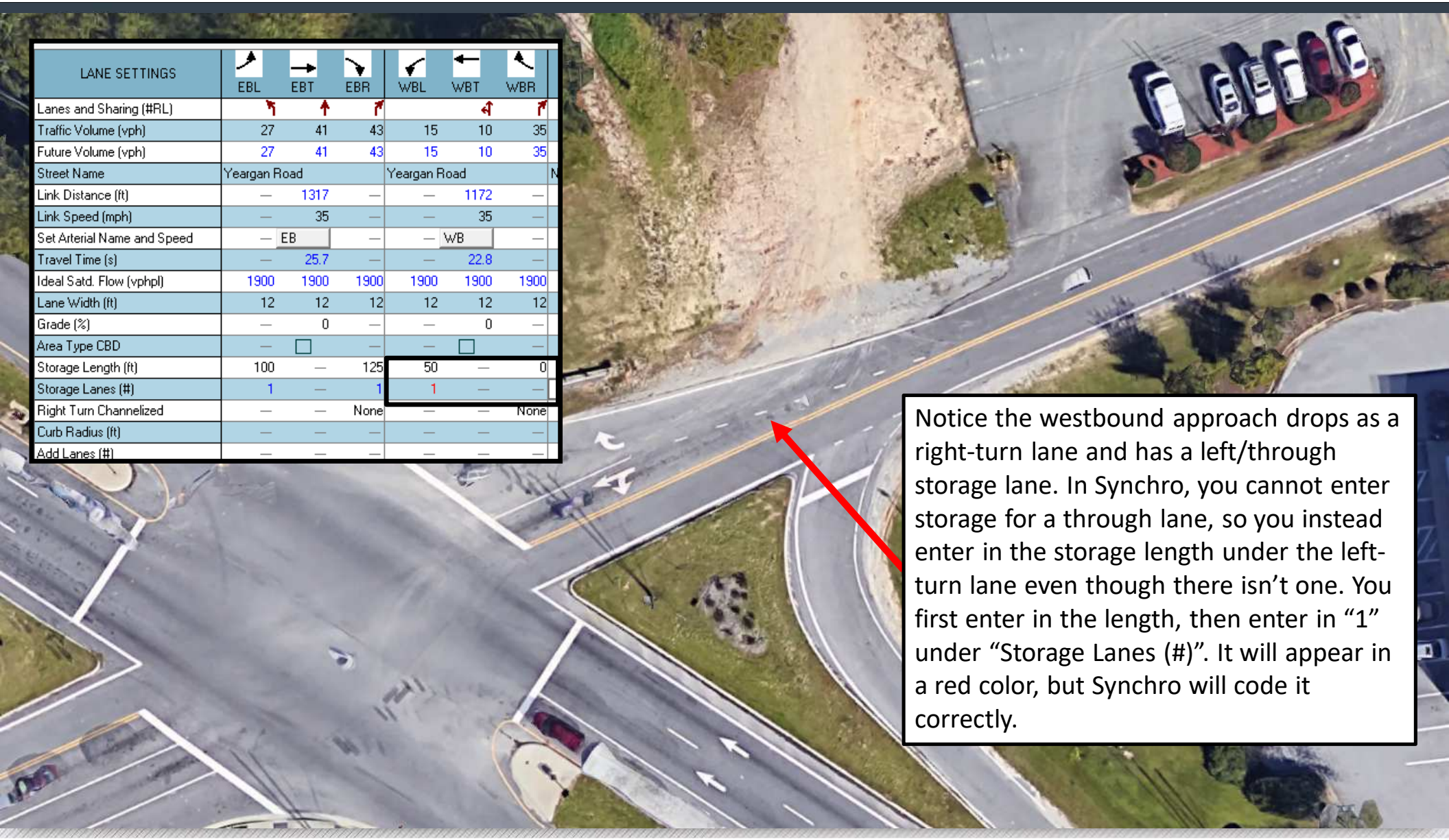
This screen is “Lane Settings”. On this screen you can edit the traffic volumes, street names, speed limits and storage lengths, amount of storage lanes, right-turn channelization, right-turn on red (RTOR).

Similarly, the “Volume Settings” screen can be used to key in Heavy Vehicle percentages, peak hour factors, and Growth Factor (if applicable)

Storage lengths do not affect Synchro outputs, however, it does effect SimTraffic simulation. Storage lengths can be measured using Google Maps. Storage lanes have the storage length and a taper length. We use a default taper length of 100 ft. Storage length is generally the length of the full width lane (before taper begins) or solid white line, however, sometimes the white skip lines can be included within storage. The length should be rounded to the nearest multiple of 25.
250’

This is called a channelized right-turn. Synchro has an option in the “Lane Settings” tab to enter in channelization. These right-turn lanes will still have storage length. Channelization will only affect SimTraffic.

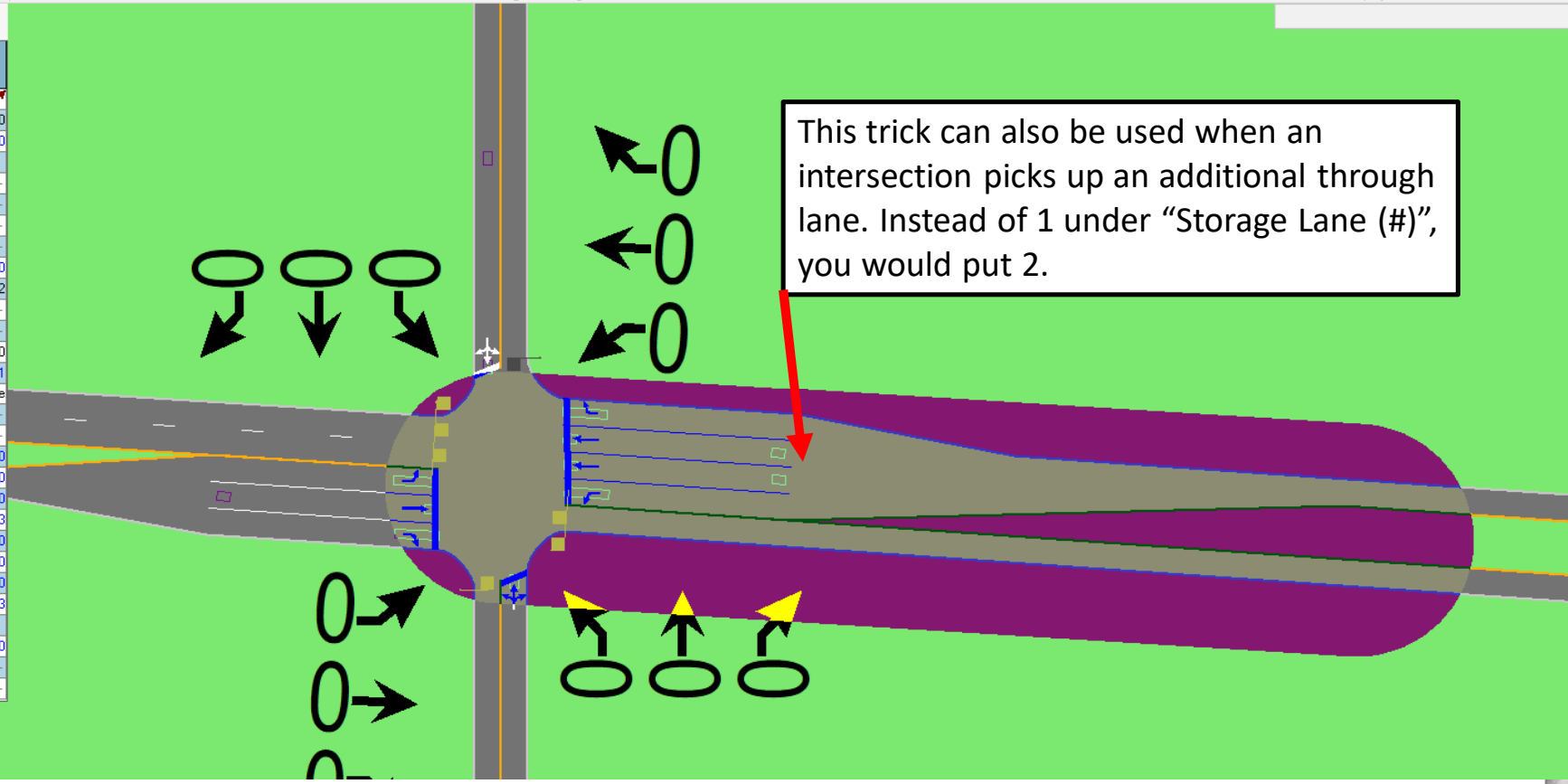
LANE SETTINGS	NBL	NBT	NBR
Lanes and Sharing (#RL)			
Traffic Volume (vph)	63	1025	50
Future Volume (vph)	63	1025	50
Street Name	NC 70		
Link Distance (ft)	—	1505	—
Link Speed (mph)	—	45	—
Set Arterial Name and Speed	—	NB	—
Travel Time (s)	—	22.8	—
Ideal Satd. Flow (vphpl)	1900	1900	1900
Lane Width (ft)	12	12	12
Grade (%)	—	0	—
Area Type CBD	—	☐	—
Storage Length (ft)	250	—	300
Storage Lanes (ft)	1	—	1
Right Turn Channelized	—	—	Stop
Curb Radius (ft)	—	—	50
Add Lanes (#)	—	—	0
Lane Utilization Factor	1.00	0.95	1.00
Right Turn Factor	1.000	1.000	0.850
Left Turn Factor (prot)	0.950	1.000	1.000
Saturated Flow Rate (prot)	1770	3539	1583
Left Turn Factor (perm)	0.950	1.000	1.000
Right Ped Bike Factor	1.000	1.000	1.000
Left Ped Factor	1.000	1.000	1.000
Saturated Flow Rate (perm)	1770	3539	1583
Right Turn on Red?	—	—	☐
Saturated Flow Rate (RTOR)	0	0	0
Link Is Hidden	—	☐	—
Hide Name in Node Title	—	☐	—



LANE SETTINGS	EBL	EBT	EBR	WBL	WBT	WBR
Lanes and Sharing (#RL)						
Traffic Volume (vph)	27	41	43	15	10	35
Future Volume (vph)	27	41	43	15	10	35
Street Name	Yeargan Road			Yeargan Road		
Link Distance (ft)	—	1317	—	—	1172	—
Link Speed (mph)	—	35	—	—	35	—
Set Arterial Name and Speed	—	EB	—	—	WB	—
Travel Time (s)	—	25.7	—	—	22.8	—
Ideal Satd. Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12
Grade (%)	—	0	—	—	0	—
Area Type CBD	—	☐	—	—	☐	—
Storage Length (ft)	100	—	125	50	—	0
Storage Lanes (#)	1	—	1	1	—	—
Right Turn Channelized	—	—	None	—	—	None
Curb Radius (ft)	—	—	—	—	—	—
Add Lanes (#)	—	—	—	—	—	—

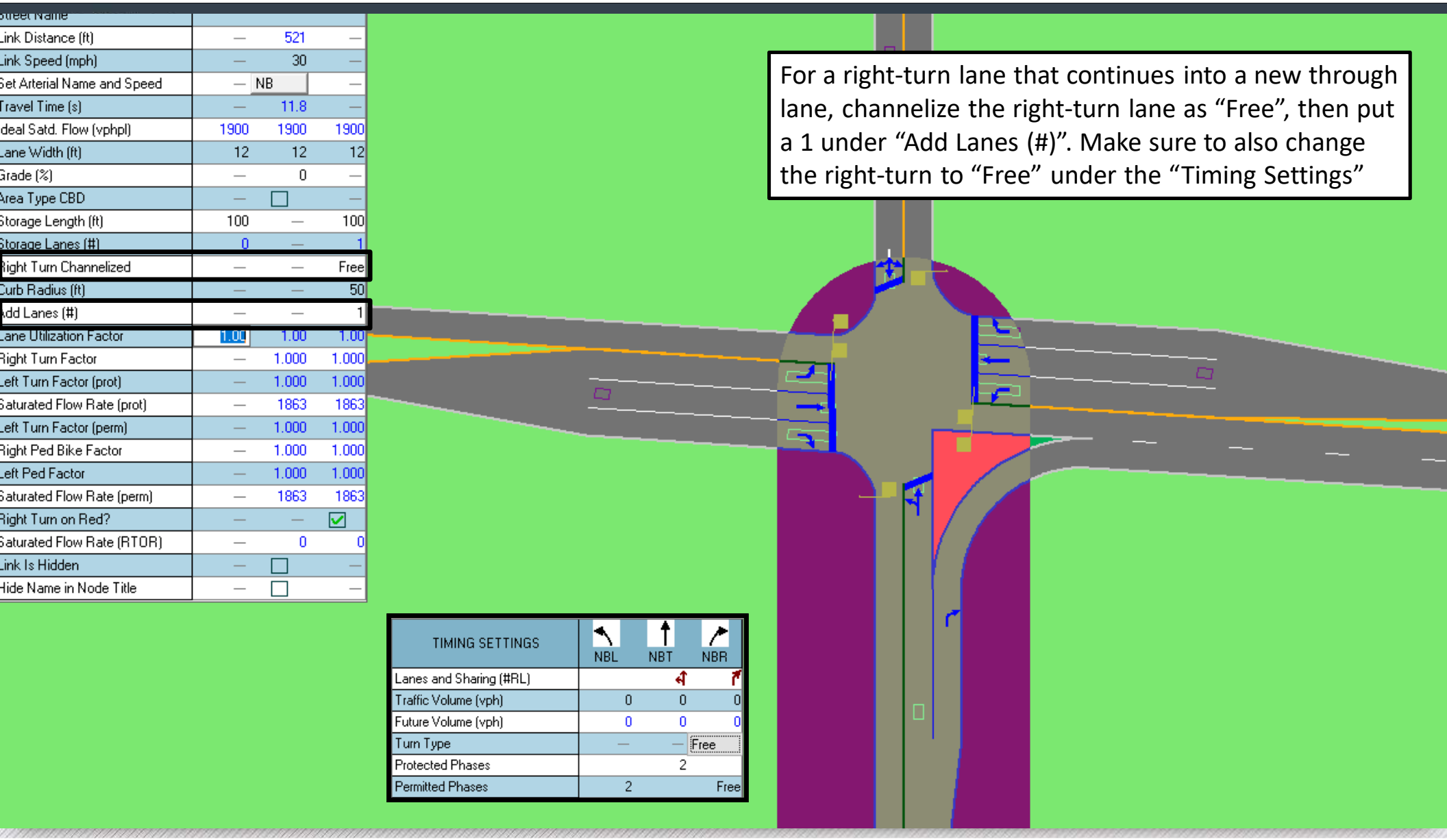
Notice the westbound approach drops as a right-turn lane and has a left/through storage lane. In Synchro, you cannot enter storage for a through lane, so you instead enter in the storage length under the left-turn lane even though there isn't one. You first enter in the length, then enter in "1" under "Storage Lanes (#)". It will appear in a red color, but Synchro will code it correctly.

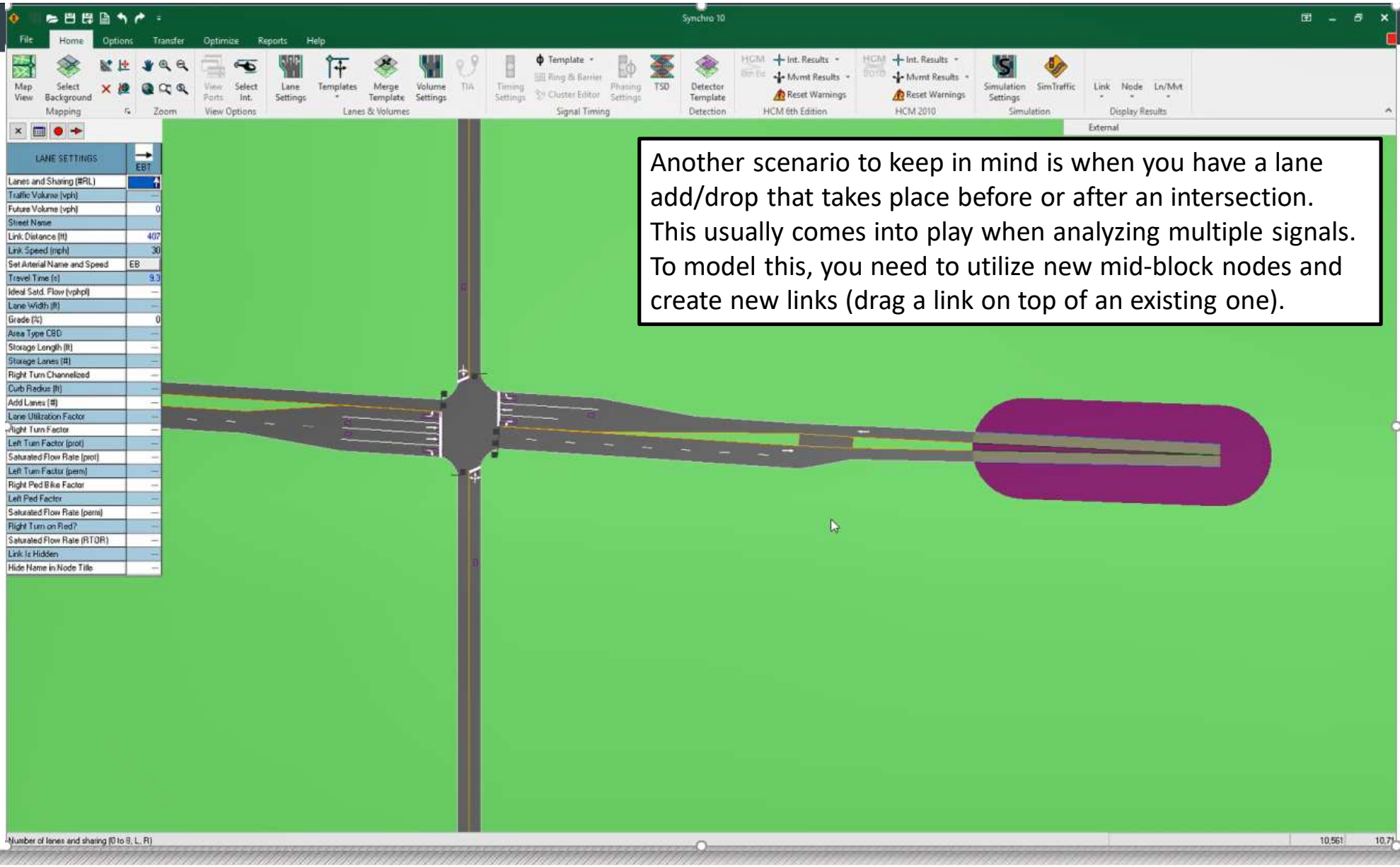
LANE SETTINGS	WBL	WBT	WBR
Lanes and Sharing (#RL)			
Traffic Volume (vph)	0	0	0
Future Volume (vph)	0	0	0
Street Name			
Link Distance (ft)	—	776	—
Link Speed (mph)	—	30	—
Set Arterial Name and Speed	—	WB	—
Travel Time (s)	—	17.6	—
Ideal Satd. Flow (vphpl)	1900	1900	1900
Lane Width (ft)	12	12	12
Grade (%)	—	0	—
Area Type CBD	—	☐	—
Storage Length (ft)	100	—	100
Storage Lanes (#)	2	—	1
Right Turn Channelized	—	—	None
Curb Radius (ft)	—	—	—
Add Lanes (#)	—	—	—
Lane Utilization Factor	1.00	0.95	1.00
Right Turn Factor	1.000	1.000	1.000
Left Turn Factor (prot)	1.000	1.000	1.000
Saturated Flow Rate (prot)	1863	3539	1863
Left Turn Factor (perm)	1.000	1.000	1.000
Right Ped Bike Factor	1.000	1.000	1.000
Left Ped Factor	1.000	1.000	1.000
Saturated Flow Rate (perm)	1863	3539	1863
Right Turn on Red?	—	—	☑
Saturated Flow Rate (RTOR)	0	0	0
Link Is Hidden	—	☐	—
Hide Name in Node Title	—	☐	—

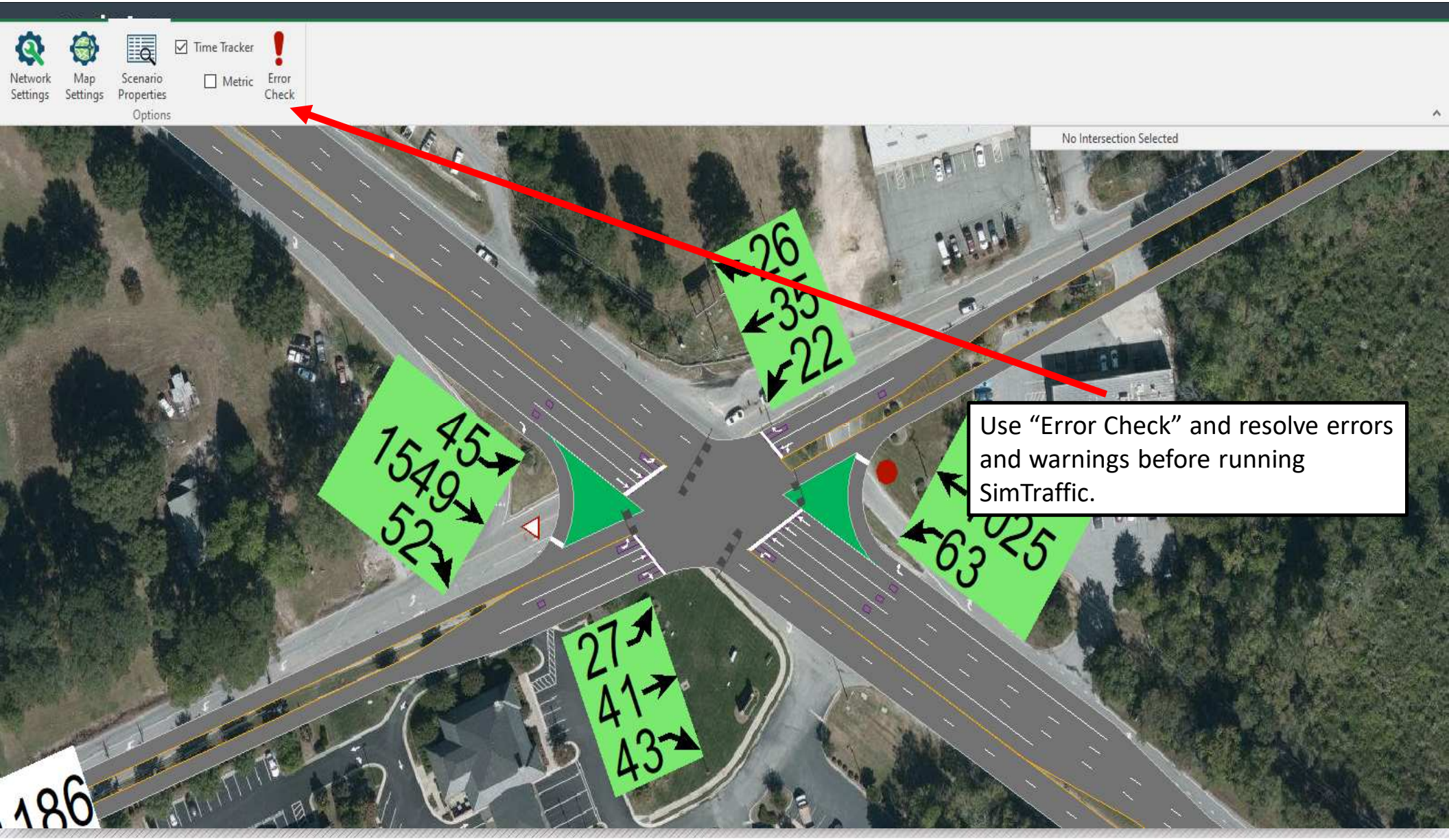


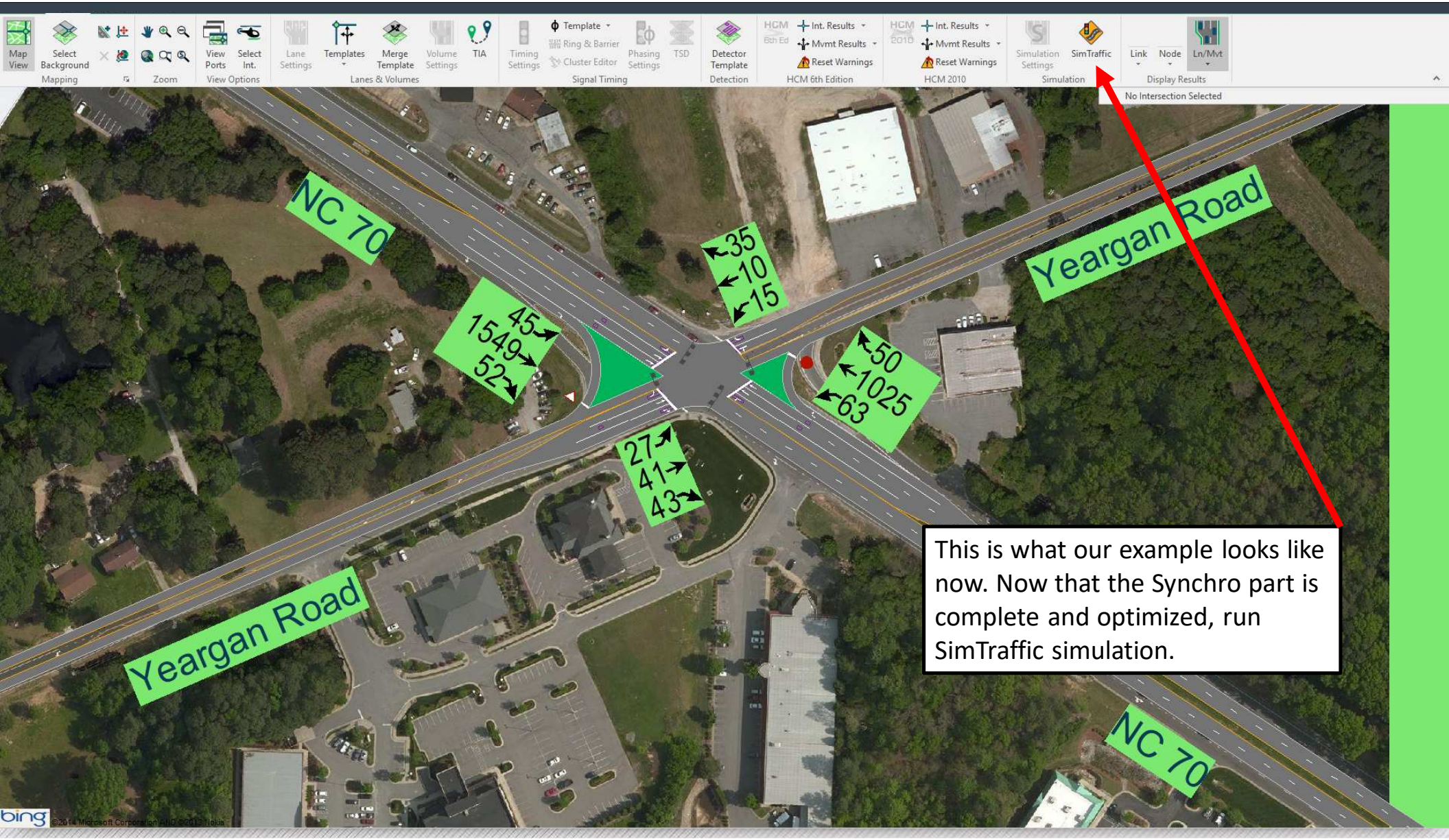
This trick can also be used when an intersection picks up an additional through lane. Instead of 1 under “Storage Lane (#)”, you would put 2.

Another scenario is having a channelized right-turn lane that then continues on as its own lane.


Street Name
Link Distance (ft) — 521 —
Link Speed (mph) — 30 —
Set Arterial Name and Speed — NB —
Travel Time (s) — 11.8 —
Ideal Satd. Flow (vphpl) 1900 1900 1900
Lane Width (ft) 12 12 12
Grade (%) — 0 —
Area Type CBD — — —
Storage Length (ft) 100 — 100
Storage Lanes (#) 0 — 1
Right Turn Channelized — — Free
Curb Radius (ft) — — 50
Add Lanes (#) — — 1
Lane Utilization Factor 1.00 1.00 1.00
Right Turn Factor — 1.000 1.000
Left Turn Factor (prot) — 1.000 1.000
Saturated Flow Rate (prot) — 1863 1863
Left Turn Factor (perm) — 1.000 1.000
Right Ped Bike Factor — 1.000 1.000
Left Ped Factor — 1.000 1.000
Saturated Flow Rate (perm) — 1863 1863
Right Turn on Red? — — ☑
Saturated Flow Rate (RTOR) — 0 0
Link Is Hidden — — —
Hide Name in Node Title — — —
TIMING SETTINGS NBL NBT NBR
Lanes and Sharing (#RL)
Traffic Volume (vph) 0 0 0
Future Volume (vph) 0 0 0
Turn Type — — Free
Protected Phases 2
Permitted Phases 2 Free
For a right-turn lane that continues into a new through lane, channelize the right-turn lane as “Free”, then put a 1 under “Add Lanes (#)”. Make sure to also change the right-turn to “Free” under the “Timing Settings”


Synchro 10
File
Home
Options
Transfer
Optimize
Reports
Help
Map View
Select Background
Mapping
Zoom
View Ports
Select Int.
View Options
Lane Settings
Templates
Merge Template
Volume Settings
TIA
Lanes & Volumes
Timing Settings
Template
Ring & Barrier
Cluster Editor
Phasing Settings
TSD
Signal Timing
Detector Template
Detection
Int. Results
Mvmt Results
Reset Warnings
HCM 6th Edition
HCM 2010
Simulation Settings
SimTraffic
Simulation
Link
Node
Ln/Mvt
Display Results
External
LANE SETTINGS
EBT
Lanes and Sharing (#RL)
Traffic Volume (vph)
Future Volume (vph)
Street Name
Link Distance (ft)
Link Speed (mph)
Set Arterial Name and Speed
Travel Time (s)
Ideal Satd. Flow (vphpl)
Lane Width (ft)
Grade (%)
Area Type CBD
Storage Length (ft)
Storage Lanes (#)
Right Turn Channelized
Curb Radius (ft)
Add Lanes (#)
Lane Utilization Factor
Right Turn Factor
Left Turn Factor (prot)
Saturated Flow Rate (prot)
Left Turn Factor (perm)
Right Ped Bike Factor
Left Ped Factor
Saturated Flow Rate (perm)
Right Turn on Red?
Saturated Flow Rate (RTOR)
Link Is Hidden
Hide Name in Node Title
Another scenario to keep in mind is when you have a lane add/drop that takes place before or after an intersection. This usually comes into play when analyzing multiple signals. To model this, you need to utilize new mid-block nodes and create new links (drag a link on top of an existing one).
Number of lanes and sharing (0 to 9, L, R)


Network Settings
Map Settings
Scenario Properties
Time Tracker
Metric
Error Check
Options
No Intersection Selected
Use “Error Check” and resolve errors and warnings before running SimTraffic.


Map View
Select Background
Mapping
Zoom
View Ports
Select Int.
View Options
Lane Settings
Templates
Merge Template
Volume Settings
TIA
Lanes & Volumes
Timing Settings
Template
Ring & Barrier
Cluster Editor
Phasing Settings
TSD
Signal Timing
Detector Template
Detection
HCM 6th Ed
Int. Results
Mvmt Results
Reset Warnings
HCM 6th Edition
HCM 2010
Int. Results
Mvmt Results
Reset Warnings
HCM 2010
Simulation Settings
SimTraffic
Simulation
Link
Node
Ln/Mvt
Display Results
No Intersection Selected
NC 70
Yeargan Road
35
10
15
45
1549
52
50
1025
63
27
41
43
Yeargan Road
NC 70
This is what our example looks like now. Now that the Synchro part is complete and optimized, run SimTraffic simulation.
bing
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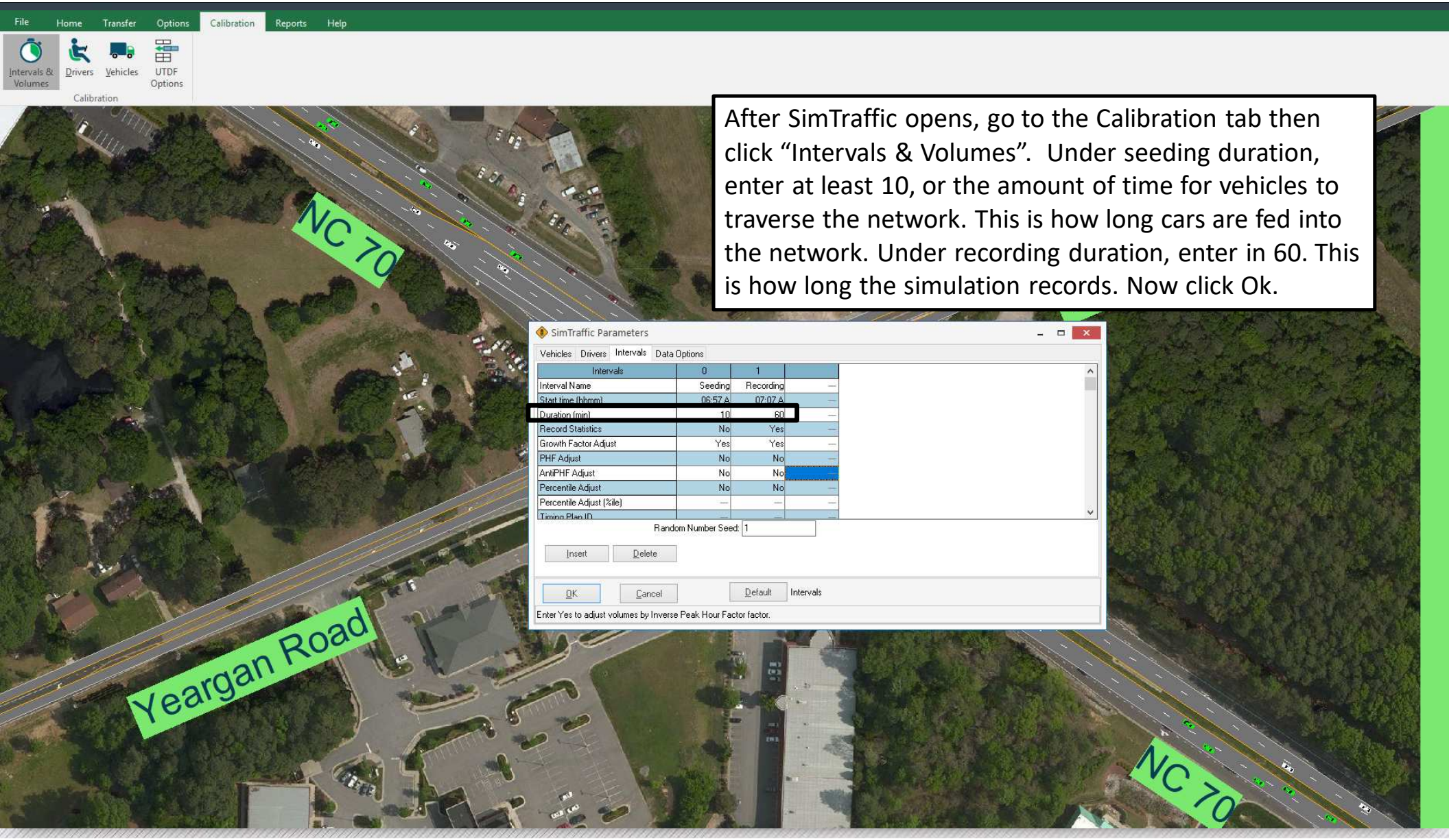
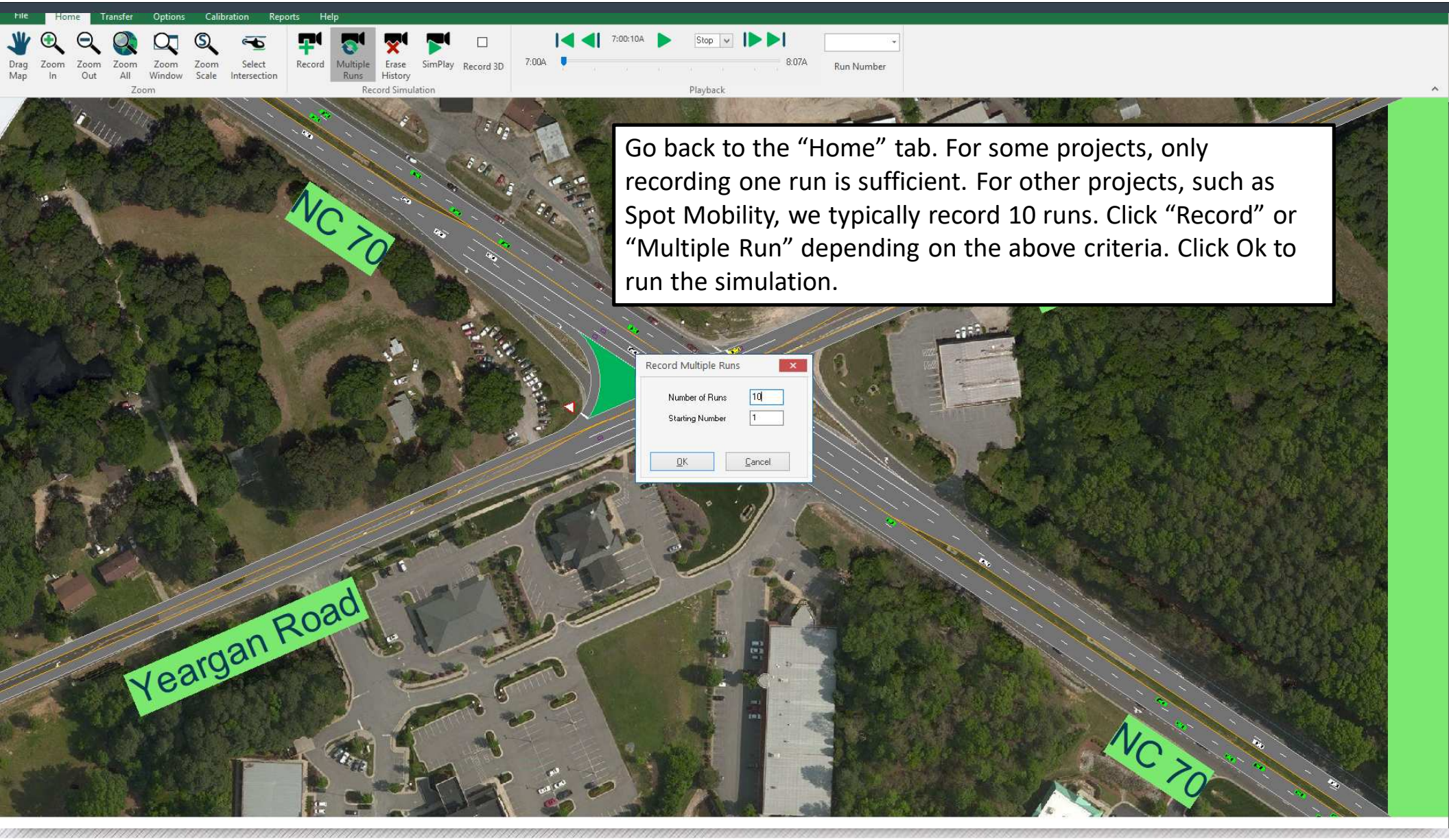
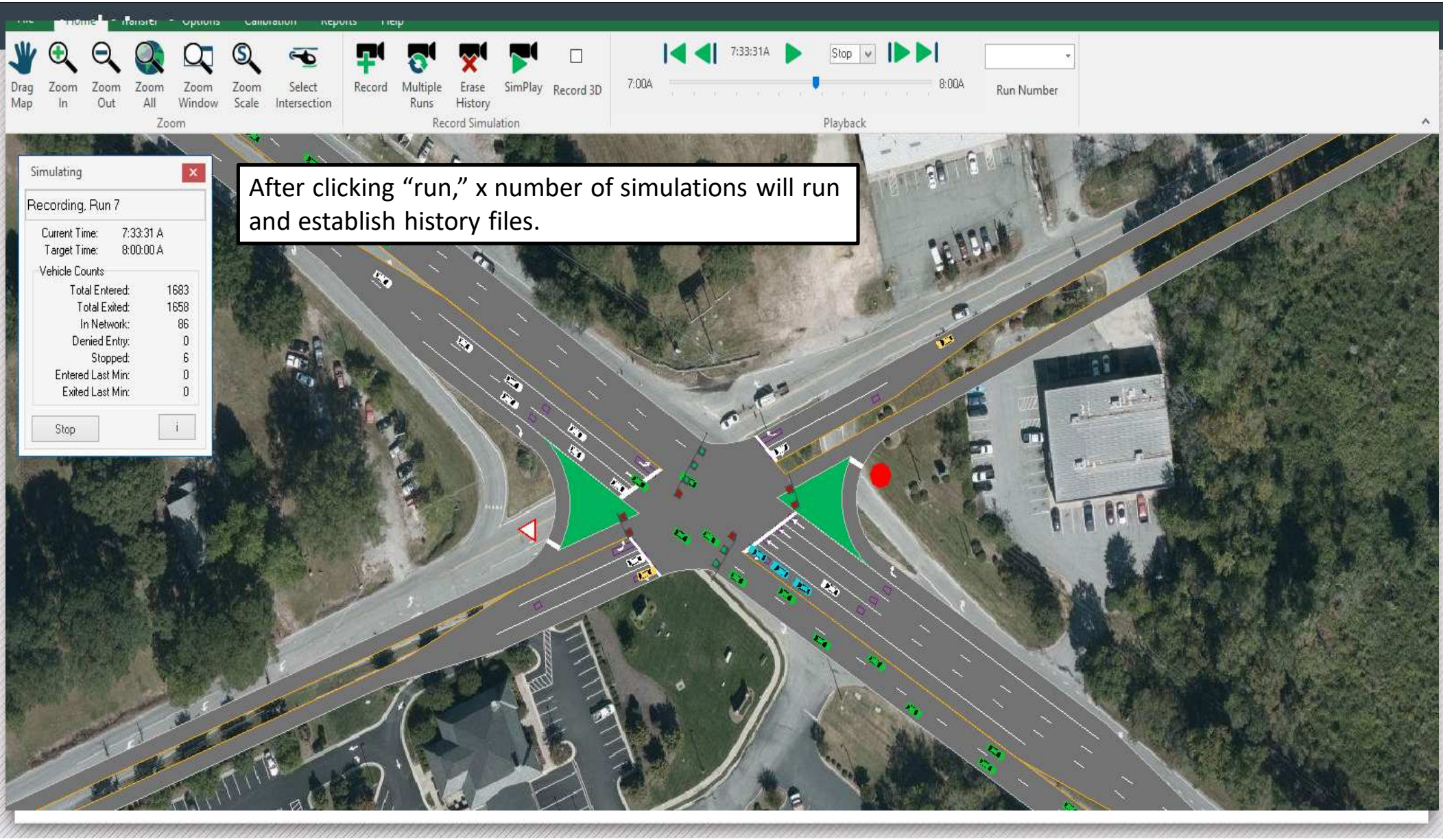
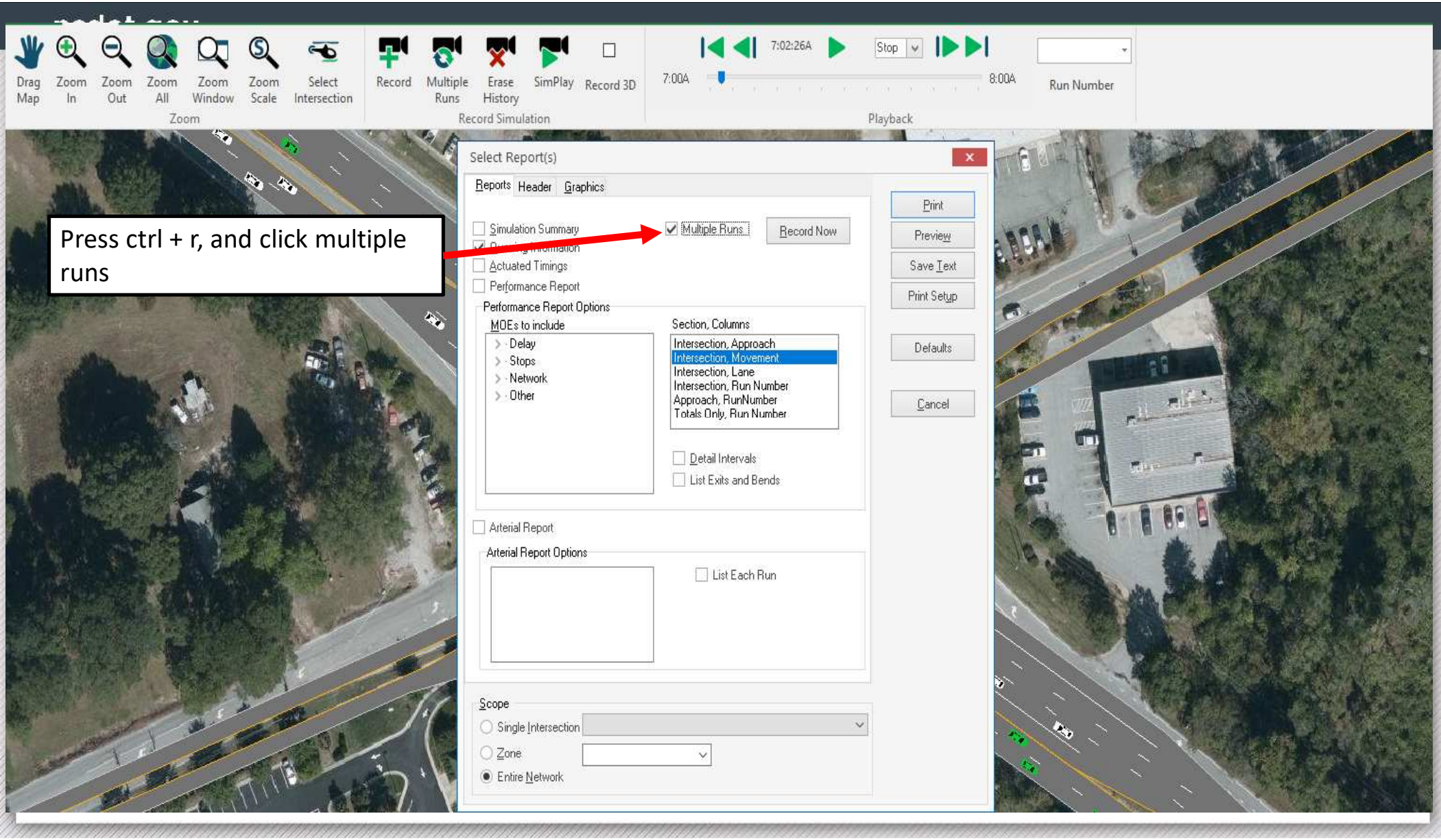
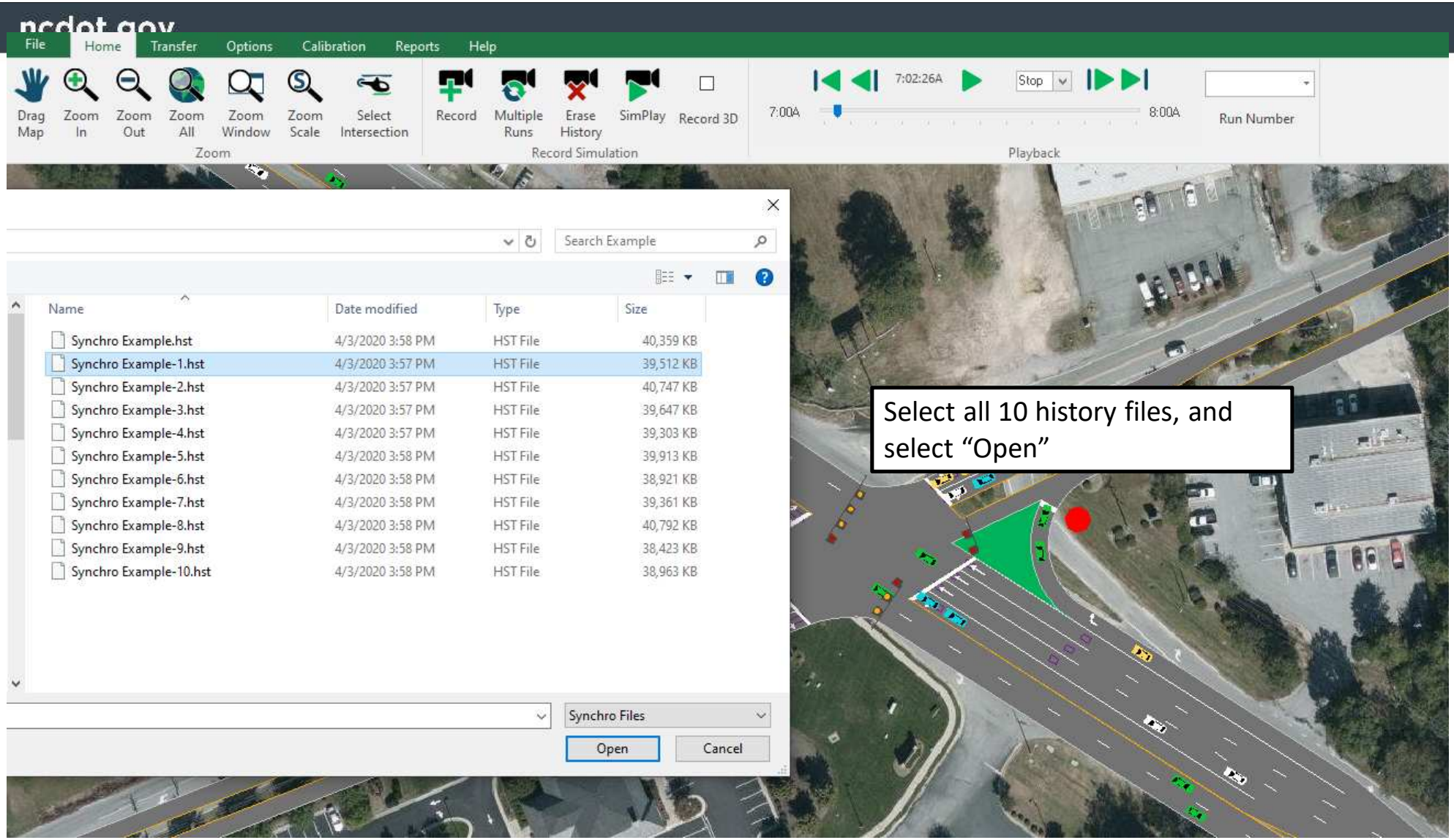


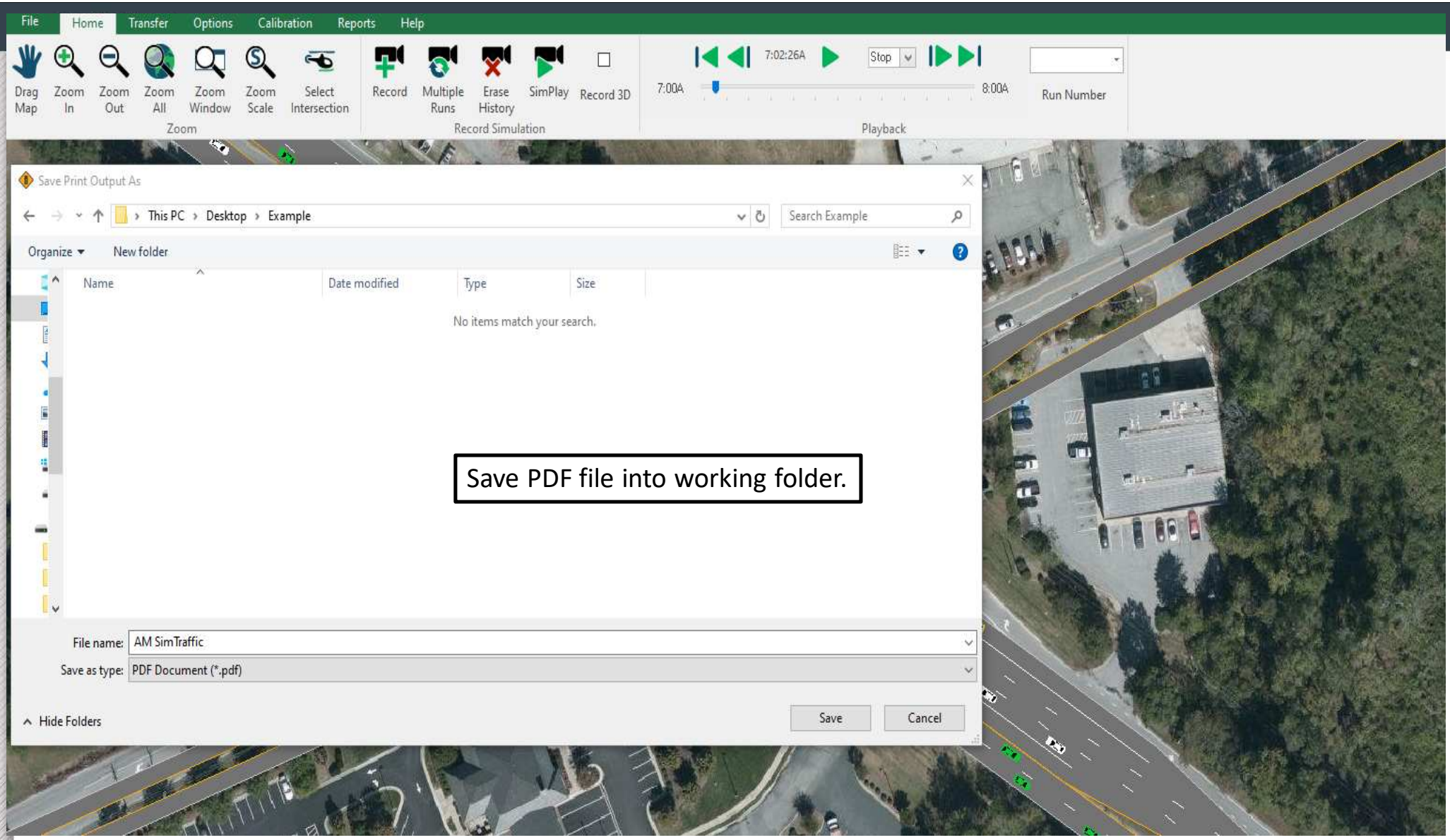
After SimTraffic opens, go to the Calibration tab then click “Intervals & Volumes”. Under seeding duration, enter at least 10, or the amount of time for vehicles to traverse the network. This is how long cars are fed into the network. Under recording duration, enter in 60. This is how long the simulation records. Now click Ok.


File
Home
Transfer
Options
Calibration
Reports
Help
Drag Map
Zoom In
Zoom Out
Zoom All
Zoom Window
Zoom Scale
Select Intersection
Zoom
Record
Multiple Runs
Erase History
SimPlay
Record 3D
Record Simulation
7:00:10A
Stop
7:00A
8:07A
Playback
Run Number
Go back to the “Home” tab. For some projects, only recording one run is sufficient. For other projects, such as Spot Mobility, we typically record 10 runs. Click “Record” or “Multiple Run” depending on the above criteria. Click Ok to run the simulation.
Record Multiple Runs
Number of Runs
10
Starting Number
1
OK
Cancel
NC 70
Yeargan Road
NC 70


Drag Map
Zoom In
Zoom Out
Zoom All
Zoom Window
Zoom Scale
Select Intersection
Zoom
Record
Multiple Runs
Erase History
SimPlay
Record 3D
Record Simulation
7:33:31A
Stop
7:00A
8:00A
Run Number
Playback
Simulating
Recording, Run 7
Current Time: 7:33:31 A
Target Time: 8:00:00 A
Vehicle Counts
Total Entered: 1683
Total Exited: 1658
In Network: 86
Denied Entry: 0
Stopped: 6
Entered Last Min: 0
Exited Last Min: 0
Stop
After clicking “run,” x number of simulations will run and establish history files.


Drag Map
Zoom In
Zoom Out
Zoom All
Zoom Window
Zoom Scale
Select Intersection
Zoom
Record
Multiple Runs
Erase History
SimPlay
Record 3D
Record Simulation
7:02:26A
Stop
7:00A
8:00A
Playback
Run Number
Press ctrl + r, and click multiple runs
Select Report(s)
Reports
Header
Graphics
Simulation Summary
Multiple Runs
Record Now
Actuated Timings
Performance Report
Performance Report Options
MOEs to include
Delay
Stops
Network
Other
Section, Columns
Intersection, Approach
Intersection, Movement
Intersection, Lane
Intersection, Run Number
Approach, RunNumber
Totals Only, Run Number
Detail Intervals
List Exits and Bends
Arterial Report
Arterial Report Options
List Each Run
Scope
Single Intersection
Zone
Entire Network
Print
Preview
Save Text
Print Setup
Defaults
Cancel


ncdot.gov
File
Home
Transfer
Options
Calibration
Reports
Help
Drag Map
Zoom In
Zoom Out
Zoom All
Zoom Window
Zoom Scale
Select Intersection
Zoom
Record
Multiple Runs
Erase History
SimPlay
Record 3D
Record Simulation
7:02:26A
Stop
7:00A
8:00A
Run Number
Playback
Search Example
Name
Date modified
Type
Size
Synchro Example.hst 4/3/2020 3:58 PM HST File 40,359 KB
Synchro Example-1.hst 4/3/2020 3:57 PM HST File 39,512 KB
Synchro Example-2.hst 4/3/2020 3:57 PM HST File 40,747 KB
Synchro Example-3.hst 4/3/2020 3:57 PM HST File 39,647 KB
Synchro Example-4.hst 4/3/2020 3:57 PM HST File 39,303 KB
Synchro Example-5.hst 4/3/2020 3:58 PM HST File 39,913 KB
Synchro Example-6.hst 4/3/2020 3:58 PM HST File 38,921 KB
Synchro Example-7.hst 4/3/2020 3:58 PM HST File 39,361 KB
Synchro Example-8.hst 4/3/2020 3:58 PM HST File 40,792 KB
Synchro Example-9.hst 4/3/2020 3:58 PM HST File 38,423 KB
Synchro Example-10.hst 4/3/2020 3:58 PM HST File 38,963 KB
Synchro Files
Open
Cancel
Select all 10 history files, and select “Open”


File
Home
Transfer
Options
Calibration
Reports
Help
Drag Map
Zoom In
Zoom Out
Zoom All
Zoom Window
Zoom Scale
Select Intersection
Zoom
Record
Multiple Runs
Erase History
SimPlay
Record 3D
Record Simulation
7:02:26A
Stop
7:00A
8:00A
Run Number
Playback
Save Print Output As
This PC › Desktop › Example
Search Example
Organize
New folder
Name
Date modified
Type
Size
No items match your search.
Save PDF file into working folder.
File name: AM SimTraffic
Save as type: PDF Document (*.pdf)
Hide Folders
Save
Cancel

SimTraffic Queuing and Blocking Report

Compare SimTraffic Max. Queue to Synchro 95th Queue to determine storage length needs

Queuing and Blocking Report
Baseline

04/03/2020

Intersection: 1: US 70 & Yeargan Rd

Movement	EB	EB	EB	WB	WB	NB	NB	NB	NB	NB	SB	SB
Directions Served	L	T	R	LT	R	L	T	T	T	R	L	T
Maximum Queue (ft)	73	86	90	115	84	108	186	178	139	22	152	376
Average Queue (ft)	22	26	26	42	16	37	99	88	43	1	32	214
95th Queue (ft)	55	61	64	86	49	84	168	161	112	22	90	339
Link Distance (ft)		1120			1649		1419	1419	1419			1497
Upstream Blk Time (%)												
Queuing Penalty (veh)												
Storage Bay Dist (ft)	100		125	100		250				300	200	
Storage Blk Time (%)	0	0	0	2	0							8
Queuing Penalty (veh)	0	0	0	0	0							4

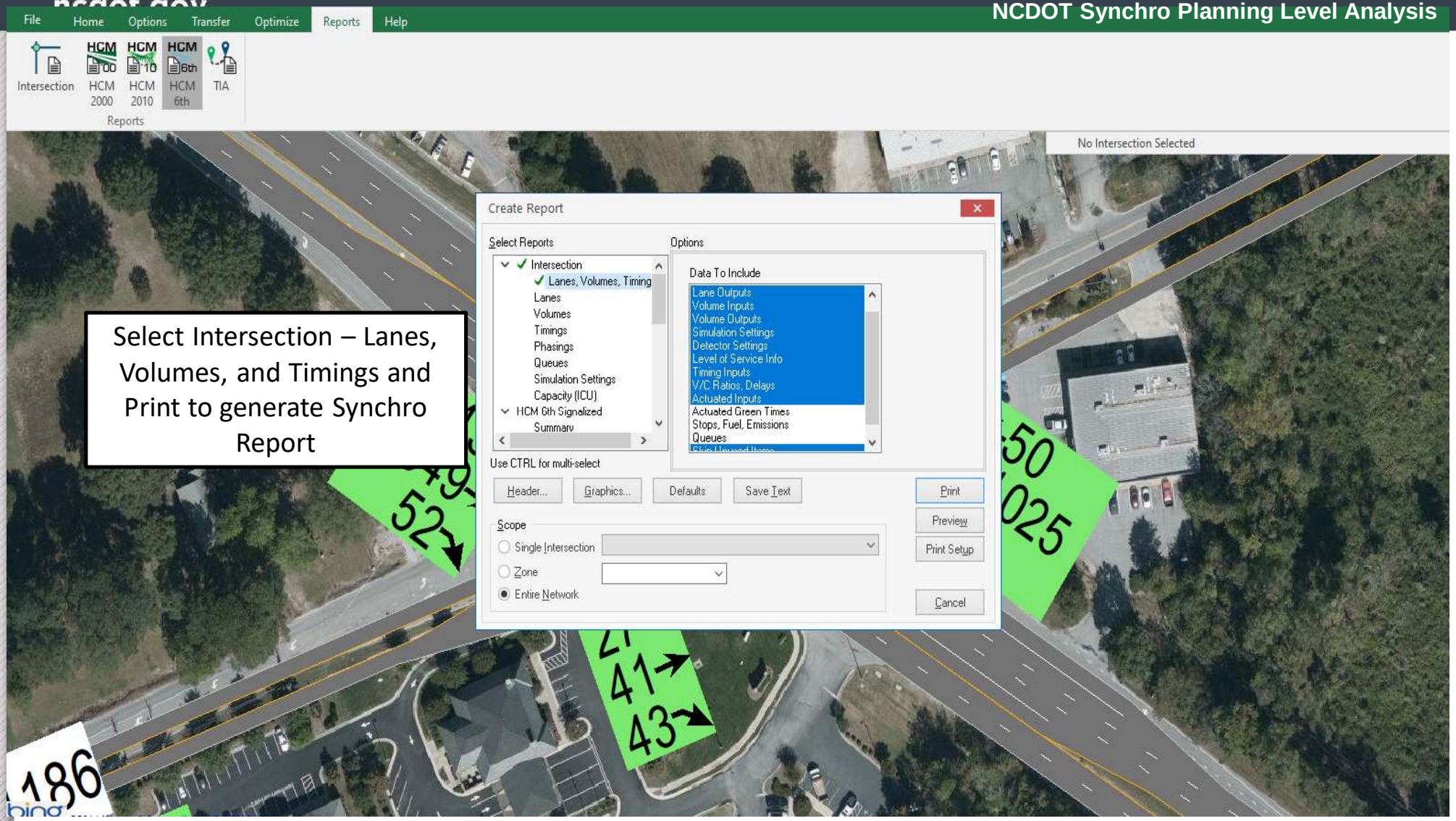
Intersection: 1: US 70 & Yeargan Rd

Movement	SB	SB
Directions Served	T	R
Maximum Queue (ft)	374	59
Average Queue (ft)	212	3
95th Queue (ft)	341	51
Link Distance (ft)	1497	
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		200
Storage Blk Time (%)	7	
Queuing Penalty (veh)	4	

Beware of cases where the Maximum Queue extends beyond the Storage Bay Distance. Additional analysis may be necessary extending Storage Bay Distances.

Network Summary

Network wide Queuing Penalty: 8


File
Home
Options
Transfer
Optimize
Reports
Help
Intersection
HCM 2000
HCM 2010
HCM 6th
TIA
Reports
No Intersection Selected
Create Report
Select Reports
Intersection
Lanes, Volumes, Timing
Lanes
Volumes
Timings
Phasings
Queues
Simulation Settings
Capacity (ICU)
HCM 6th Signalized
Summary
Options
Data To Include
Lane Outputs
Volume Inputs
Volume Outputs
Simulation Settings
Detector Settings
Level of Service Info
Timing Inputs
V/C Ratios, Delays
Actuated Inputs
Actuated Green Times
Stops, Fuel, Emissions
Queues
Use CTRL for multi-select
Header...
Graphics...
Defaults
Save Text
Print
Preview
Print Setup
Cancel
Scope
Single Intersection
Zone
Entire Network
Select Intersection – Lanes, Volumes, and Timings and Print to generate Synchro Report

Synchro
Lanes, Volumes, Timings
Report

Lanes, Volumes, Timings
1: US 70 & Yeargan Rd

04/03/2020

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Detector Phase	4	4	5	8	8	1	5	2	2	1	6	6
Switch Phase												
Minimum Initial (s)	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Minimum Split (s)	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0
Total Split (s)	17.0	17.0	16.0	17.0	17.0	14.0	16.0	89.0	89.0	14.0	87.0	87.0
Total Split (%)	14.2%	14.2%	13.3%	14.2%	14.2%	11.7%	13.3%	74.2%	74.2%	11.7%	72.5%	72.5%
Maximum Green (s)	10.0	10.0	9.0	10.0	10.0	7.0	9.0	82.0	82.0	7.0	80.0	80.0
Yellow Time (s)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	-2.0	-2.0	-2.0		-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0
Total Lost Time (s)	5.0	5.0	5.0		5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Lead/Lag			Lead			Lead	Lead	Lag	Lag	Lead	Lag	Lag
Lead-Lag Optimize?			Yes			Yes	Yes	Yes	Yes	Yes	Yes	Yes
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Recall Mode	None	None	None	None	None	None	None	C-Min	C-Min	None	C-Min	C-Min
Act Effct Green (s)	11.1	11.1	24.0		11.1	22.7	10.7	91.1	91.1	9.4	89.8	89.8
Actuated g/C Ratio	0.09	0.09	0.20		0.09	0.19	0.09	0.76	0.76	0.08	0.75	0.75
v/c Ratio	0.24	0.27	0.15		0.43	0.10	0.44	0.30	0.05	0.36	0.65	0.05
Control Delay	55.2	54.4	38.0		60.5	38.4	61.0	6.2	5.8	60.3	11.5	6.3
Queue Delay	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	55.2	54.4	38.0		60.5	38.4	61.0	6.2	5.8	60.3	11.5	6.3
LOS	E	D	D		E	D	E	A	A	E	B	A
Approach Delay		48.2			53.5			9.2			12.7	
Approach LOS		D			D			A			B	

Intersection Summary			
Area Type:	Other		
Cycle Length: 120			
Actuated Cycle Length: 120			
Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBT, Start of Green			
Natural Cycle: 65			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 0.65			
Intersection Signal Delay: 13.8		Intersection LOS: B	
Intersection Capacity Utilization 70.4%		ICU Level of Service C	
Analysis Period (min) 15			

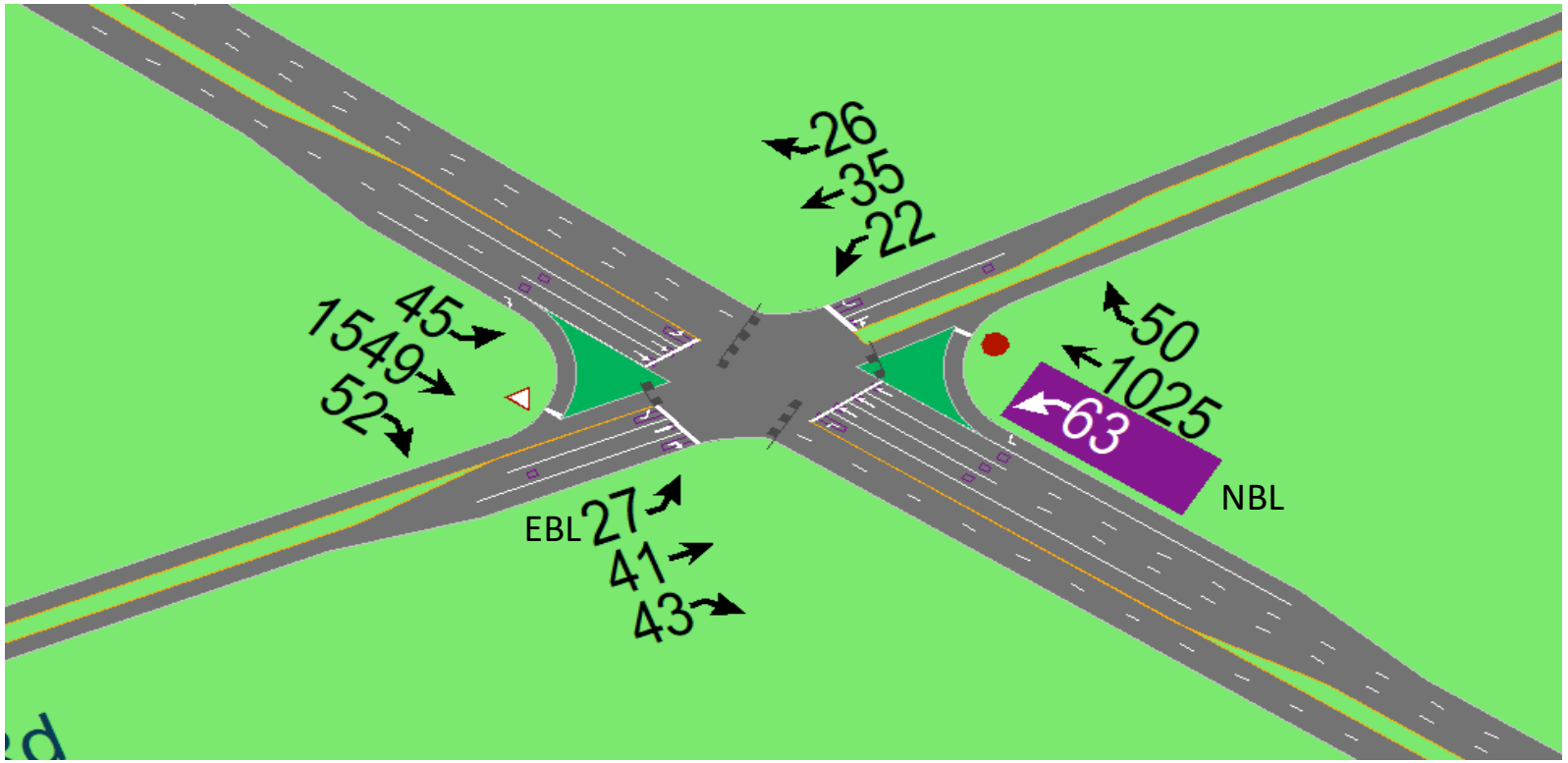
Splits and Phases: 1: US 70 & Yeargan Rd

Making Recommendations from Synchro and SimTraffic

What if…
the NBL and EBL movements had volumes that approach capacity at this intersection

New NBL volume: 100 vph

New EBL volume: 70 vph



Therefore, the Synchro 95th queue will be…

TIMING SETTINGS	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lanes and Sharing (#RL)												
Traffic Volume (vph)	70	41	43	22	35	26	100	1025	50	45	1549	52
Future Volume (vph)	70	41	43	22	35	26	100	1025	50	45	1549	52
Turn Type	Perm	—	pm+ov	Perm	—	pm+ov	Prot	—	Perm	Prot	—	Perm
Protected Phases		4	5		8	1	5	2		1	6	
Permitted Phases	4		4	8		8			2			6
Permitted Flashing Yellow	—	—	—	—	—	—	—	—	—	—	—	—
Detector Phases	4	4	5	8	8	1	5	2	2	1	6	6
Switch Phase	0	0	0	0	0	0	0	0	0	0	0	0
Leading Detector (ft)	20	100	20	—	100	20	20	100	20	20	100	20
Trailing Detector (ft)	0	0	0	—	0	0	0	0	0	0	0	0
Minimum Initial (s)	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Minimum Split (s)	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0
Total Split (s)	17.0	17.0	16.0	17.0	17.0	14.0	16.0	89.0	89.0	14.0	87.0	87.0
Yellow Time (s)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	-2.0	-2.0	-2.0	—	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0
Lagging Phase?	—	—	☐	—	—	☐	☐	☑	☑	☐	☑	☑
Allow Lead/Lag Optimize?	—	—	☑	—	—	☑	☑	☑	☑	☑	☑	☑
Recall Mode	None	None	None	None	None	None	None	C-Min	C-Min	None	C-Min	C-Min
Speed limit (mph)	—	30	—	—	30	—	—	30	—	—	30	—
Actuated Effct. Green (s)	11.9	11.9	26.3	—	11.9	23.6	12.1	90.2	90.2	9.4	83.7	83.7
Actuated g/C Ratio	0.10	0.10	0.22	—	0.10	0.20	0.10	0.75	0.75	0.08	0.70	0.70
Volume to Capacity Ratio	0.59	0.25	0.14	—	0.40	0.09	0.62	0.30	0.05	0.36	0.70	0.05
Control Delay (s)	70.0	53.2	36.5	—	58.3	37.9	67.7	6.6	6.0	60.3	13.6	6.9
Queue Delay (s)	0.0	0.0	0.0	—	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay (s)	70.0	53.2	36.5	—	58.3	37.9	67.7	6.6	6.0	60.3	13.6	6.9
Level of Service	E	D	D	—	E	D	E	A	A	E	B	A
Approach Delay (s)	—	56.2	—	—	51.9	—	—	11.7	—	—	14.7	—
Approach LOS	—	E	—	—	D	—	—	B	—	—	B	—
Queue Length 50th (ft)	57	33	27	—	45	17	81	127	14	37	473	16
Queue Length 95th (ft)	#121	72	63	—	94	45	#167	133	25	80	472	27
Stops (vph)	66	37	33	—	52	22	92	323	15	41	885	16
Fuel Used (g/hr)	2	1	1	—	2	1	3	15	1	1	28	1

What do the # and ~ symbols mean?

These indicate possible underestimation of the queuing results, and further information or study is needed.

Therefore, we will need to take a closer look at the SimTraffic Maximum Queue. Nevertheless, we look at the Maximum Queue for all of the lanes.

SimTraffic Maximum Queue

Intersection: 1: US 70 & Yeargan Rd

Movement	EB	EB	EB	WB	WB	NB	NB	NB	NB	SB	SB	SB
Directions Served	L	T	R	LT	R	L	T	T	T	L	T	T
Maximum Queue (ft)	115	116	82	104	71	160	197	183	141	195	476	474
Average Queue (ft)	51	27	24	37	13	63	104	96	46	33	258	253
95th Queue (ft)	96	71	62	81	44	125	176	167	116	107	415	409
Link Distance (ft)		1120			1649		1419	1419	1419		1497	1497
Upstream Blk Time (%)												
Queuing Penalty (veh)												
Storage Bay Dist (ft)	100		125	100		250				200		
Storage Blk Time (%)	2	0	0	1	0		0				12	11
Queuing Penalty (veh)	2	0	0	0	0		0				5	6

Intersection: 1: US 70 & Yeargan Rd

Movement	SB
Directions Served	R
Maximum Queue (ft)	208
Average Queue (ft)	15
95th Queue (ft)	122
Link Distance (ft)	
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	200
Storage Blk Time (%)	
Queuing Penalty (veh)	

Recommendations Summary

	Synchro 95th Queue (ft)	SimTraffic Max Queue (ft)	Number of lanes	Existing Storage length (ft)	Proposed Storage length (ft)
NBL (US 70)	#167	160	1	250	250
EBL (Yeargan Rd)	#121	115	1	100	125

Feed These Storages Back Into SimTraffic

New 95th Queue and SimTraffic Queue

	Synchro 95th Queue (ft)	SimTraffic Max Queue (ft)	Number of lanes	Old Storage length (ft)	New Storage length (ft)
NBL (US 70)	#167	168	1	250	250
EBL (Yeargan Rd)	#121	119	1	100	125

*Note: One passenger vehicle is approximately 25 feet
Per Guidelines, minimum turn lane storage length is 100 feet

Site Development and Highway Access Classes

https://itre.ncsu.edu/training/highways/

Spring 2020 Classes to be rescheduled due to COVID-19

2020 Classes planned for Charlotte, Raleigh (2), and Winston-Salem

Site Development and Highway Access - What You Need to Know

Day One: Site Development & Highway Access - Introduction: This introductory one-day class is meant to be a comprehensive overview to conventional and modern site development and highway access principles discussed in the NCDOT Driveway Access Manual and associated manuals and policies. **This class is intended to serve as a prerequisite and foundation to the practitioner level class.**

Day Two: Site Development and Highway Access - Practitioner: This advanced one-day class is meant to familiarize engineers, planners, developers, and local authorities with basic to complex highway access principles, traffic analyses, traffic mitigation recommendations, and the driveway permitting processes, including new details on how to develop/review TIAs based on new legislation, policy, standards, and guidelines. **For best class attendee results, it is strongly recommended the introductory level site development and highway access class should have been attended within the last two years.**

Course Fee: $100 per day. Classes can be taken separately or concurrently. Registration is separate for each course offering above!
PDHs: Each participant will receive 7.0 Professional Development Hours (PDHs) per day which will be noted on his or her training certificate(s).

Intro. Classes:	Practitioner Classes:	Who should attend:
• Charlotte–Apr. 21, 2020	• Charlotte–Apr. 29, 2020	• Public and private sector traffic engineers and planners
• Raleigh–June 24, 2020	• Raleigh–July 14, 2020	• NCDOT District and traffic engineering staff
• Winston-Salem–Sep. 22	• Winston-Salem–Oct. 13	• Local government, planning, transportation and traffic staff
• Raleigh–Nov. 17, 2020	• Raleigh–Dec. 8, 2020	• TIA preparers and site developers

Course Instructors:

Mike Reese, PE, CPM is a Congestion Management Regional Engineer in the NCDOT Transportation Mobility and Safety Division. Mike's extensive experience reviewing and performing traffic impact analyses and traffic studies in the Traffic Management Unit provides insight and clear expectations when reviewing permits and TIAs.

Chuck Edwards, PE is currently a District Engineer in the NCDOT Field Operations for Division 7, District 1 responsible for the greater Burlington and Chapel Hill areas. Chuck's extensive field experience within the Division provides a unique perspective to those participating in the workshop.

Locations and Directions will be given by confirmation via e-mail one month prior to the workshop!

For registration, future classes, and complete information visit **https://itre.ncsu.edu/training/highways/** or contact: **Walt Thomas at wthomas@ncsu.edu or (919) 515-8893.**

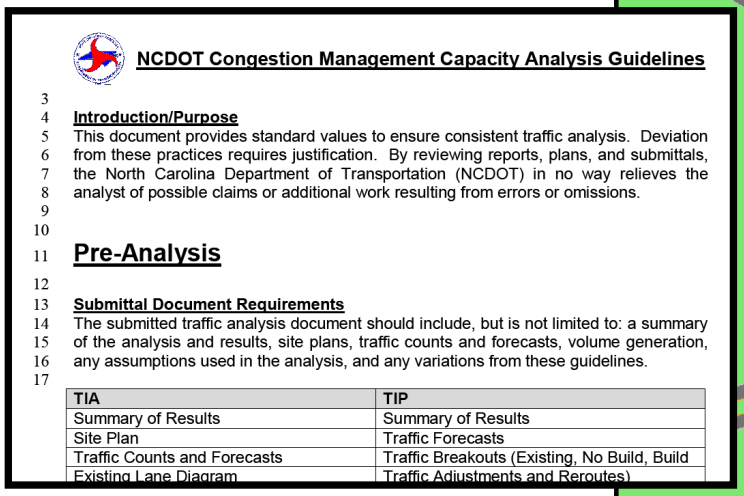
Sponsored by Institute for Transportation Research and Education (ITRE) NC State University • Centennial Campus • Raleigh, NC
NCDOT employees must register through their training coordinators

Acknowledgements

Synchro and SimTraffic graphics and other content developed in this presentation courtesy of:

- **Trevor Darnell**, Formerly Congestion Management
- **Robert Gallo**, Congestion Management
- **Kittelson & Associates, Inc.**

Questions?



NCDOT Congestion Management Capacity Analysis Guidelines

Introduction/Purpose

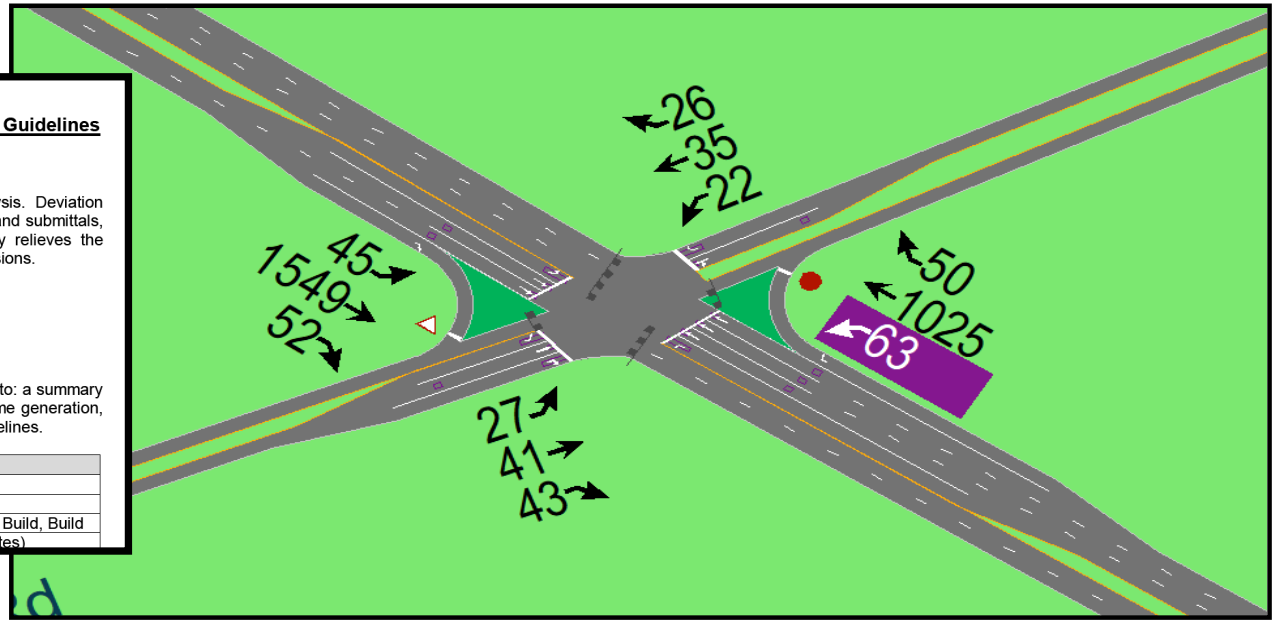
This document provides standard values to ensure consistent traffic analysis. Deviation from these practices requires justification. By reviewing reports, plans, and submittals, the North Carolina Department of Transportation (NCDOT) in no way relieves the analyst of possible claims or additional work resulting from errors or omissions.

Pre-Analysis

Submittal Document Requirements

The submitted traffic analysis document should include, but is not limited to: a summary of the analysis and results, site plans, traffic counts and forecasts, volume generation, any assumptions used in the analysis, and any variations from these guidelines.

TIA	TIP
Summary of Results	Summary of Results
Site Plan	Traffic Forecasts
Traffic Counts and Forecasts	Traffic Breakouts (Existing, No Build, Build
Existing Lane Diagram	Traffic Adjustments and Reroutes)



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919-814-4938