MARYLAND DEPARTMENT OF TRANSPORTATION

STATE HIGHWAY ADMINISTRATION

VISSIM Modeling Guidance

This document outlines MDOT SHA best practice methodologies for VISSIM related microsimulation operational analyses and recommended modeling techniques.

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Purpose

The purpose of this document is to outline best practice modeling techniques of a typical transportation operational analysis using VISSIM microsimulation modeling software and to provide guidance on specific details of VISSIM modeling for the Maryland Department of Transportation State Highway Administration (MDOT SHA), Travel Forecasting and Analysis Division (TFAD). The use of 'should' or 'will' are suggestive, not mandatory (i.e. not a legal requirement).

This document is not a tutorial for VISSIM; rather it provides guidance on specific concerns previously noted by the TFAD staff. Engineers applying these methodologies should already be familiar with the latest VISSIM software package, currently at version 9.0 (as of 9/12/2017).

Users should also be familiar with the latest Highway Capacity Manual (HCM), Maryland Manual on Uniform Traffic Control Devices (MD MUTCD), and general transportation vernacular to ensure accurate engineering judgment during the modeling process.

Quality Review and Schedule

All VISSIM modeling should be created with a set schedule in place for (1) the existing year calibrated models, (2) the future year no build calibrated models, and (3) the future year build conditions models. Each additional Build condition, or alternative, requires additional schedule consideration.

A minimum of one week must be taken into consideration for TFAD staff to review and confirm the VISSIM models are acceptable **at each stage of the modeling effort** (i.e. a minimum of three review periods with additional review periods if more than one Build condition is modeled).

Additional time may be required and must be discussed with the TFAD staff to ensure project schedule adherence. TFAD staff will review the models for accuracy per the VISSIM checklist.

Modeling Techniques

Vehicle Inputs

Vehicle inputs must reflect current vehicular composition and speeds using existing vehicle traffic counts and travel data. At a minimum, Vehicle Inputs will take into consideration automobiles and trucks as two separate vehicle classes (exception: routes with no truck access). Additional breakdown of vehicle classes are appropriate if data is available (i.e. motorcycles, medium trucks vs. heavy trucks etc).

For all project studies multiple Vehicle Input types must be created for all roadways entering the project area. For example, side streets with no trucks might use 100% automobiles, whereas mainline streets might use 90% automobiles and 10% trucks.

If the project is a transit oriented study, bus volumes should **not** be included in the Vehicle Input. Bus "volumes" will be input as Public Transit (PT) frequencies. If the study allows for a mix of known and unknown transit, the modeler can consider the unknown bus volume as a Vehicle Input and the known bus "volume" as a PT frequency.

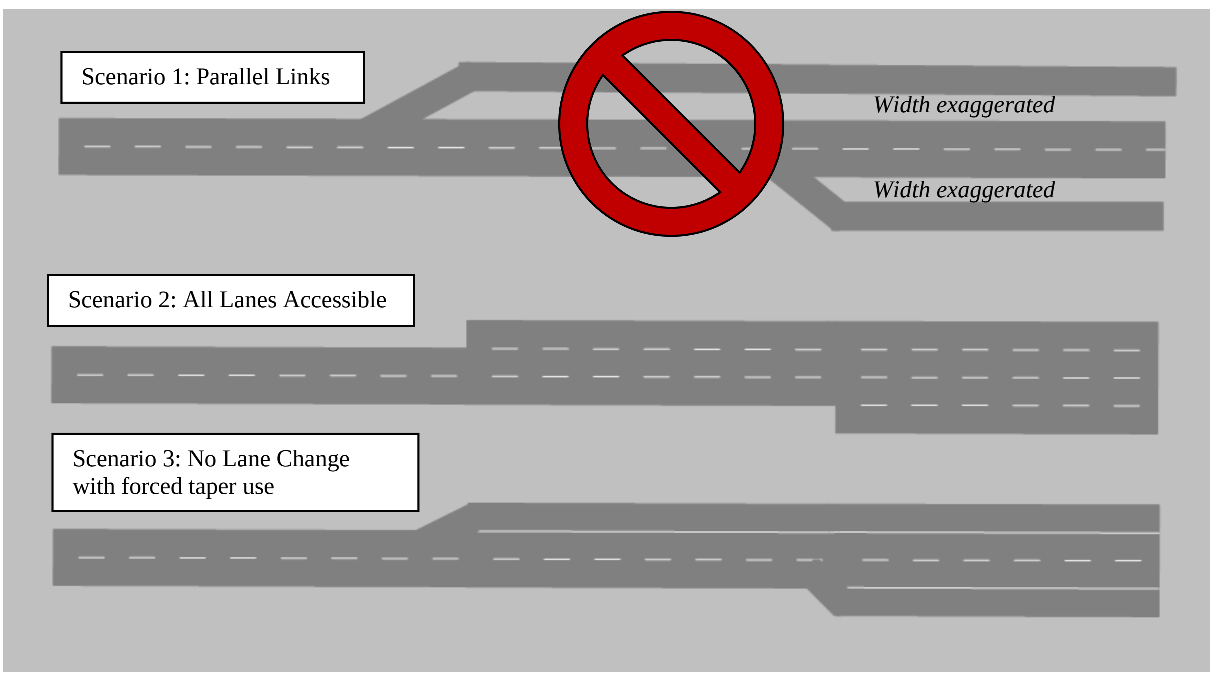
Note that using PT will affect your traffic count and must be taken into consideration carefully. Traffic volumes need to be reduced based on the known number of buses passing through the corridor in a given hour.

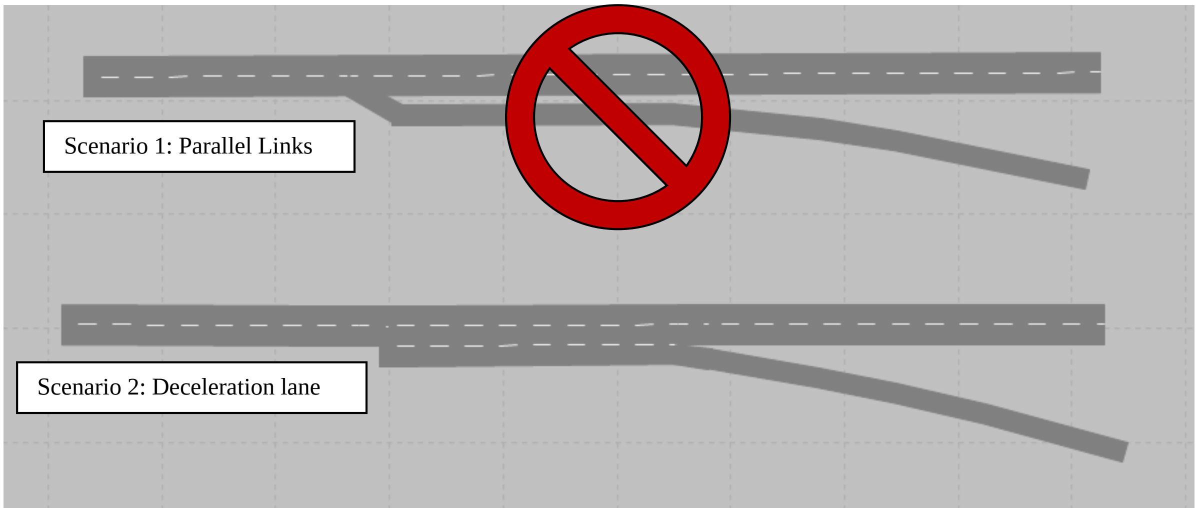
Links and Connectors

Network links should be modeled per existing lane geometry. Note that **Google or Bing** imagery (from Google Maps/Earth or Bing Maps for example) may not be accepted as a background image for large project areas due to scaling problems noted in past projects. Ensure scaling is accurate throughout the entire corridor if you use these images.

Segments of roadway with turning bays should be modeled as links with all lanes accessible, rather than multiple parallel links (Scenario 1) each associated to a turning movement, as shown below, unless the existing conditions include a physical barrier between turn lanes. TFAD recognizes this approach differs from the PTV modeling technique. However, this approach allows users to then model forced lane use (with the use of no lane change options) through connectors **if necessary** (Scenario 3) or allow vehicles to merge smoothly into the turning bay (Scenario 2). Generally, this approach works best for longer turning bays, but for consistency, all models should use the "one link-all lanes" approach and adapt as needed.

Merges and diverges with acceleration and deceleration lanes should be modeled similarly (one link-all lanes), one link with the acceleration or deceleration lane included as part of the mainline link, as shown below, unless the existing conditions include a physical barrier between the mainline and the ramp lanes (ex. Collector-Distributor lane).





In general, parallel link modeling is not an accepted methodology for TFAD operational analysis using VISSIM software unless specific roadway geometry prohibits movement along the lane (ex. solid barriers), ramp design allows for single on/off access from the freeway (ex. tapered diverge/merge), or the modeler can provide field data to show that all drivers merge/diverge using the taper only. There may be case by case exceptions, but the modeler should consider the above one link-all lanes approach unless the conditions suggest otherwise.

All connectors should be short and should not significantly overlap over the two links it connects.

Driver Behavior Parameters

Modelers are encouraged to develop driver behavior models in addition to the default VISSIM driver behavior models. Each corridor is unique and driver behavior models should reflect these patterns; however, TFAD recently performed a Driving Behavior assessment, discussed below, which could help modelers during the VISSIM calibration process. Recommended ranges for behavior models are also discussed in this section.

The purpose of this section is to provide VISSIM modelers with a set of baseline driving behaviors, which can be applied to different link segments, in order to more effectively help with the calibration process of VISSIM models for the Maryland Department of Transportation State Highway Administration (MDOT SHA). The driving behaviors defined below were compiled, evaluated, and summarized from a pool of most frequently used VISSIM driving behavior models obtained from industry experts who frequently perform VISSIM analyses for MDOT SHA.

The goal of this compilation is to assist VISSIM modelers. All base behaviors can still be modified to better reflect the specific corridors being analyzed; however, this list could aid in beginning the calibration process and the Travel Forecasting and Analysis Division (TFAD) recommends utilizing the suggested ranges of parameters defined within the document.

PTV VISSIM's Baseline Behavior Models and Parameters

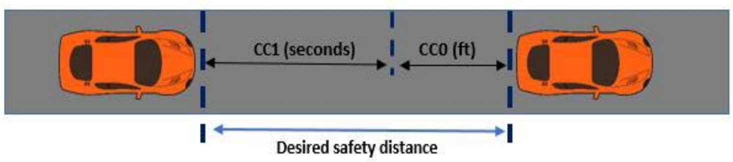
PTV VISSIM uses a psycho-physical car following model which is stochastic and discrete developed by Wiedemann nameed **Wiedemann 74** and **Wiedemann 99**, further discussed below**.**

A. Baseline Behavior Models

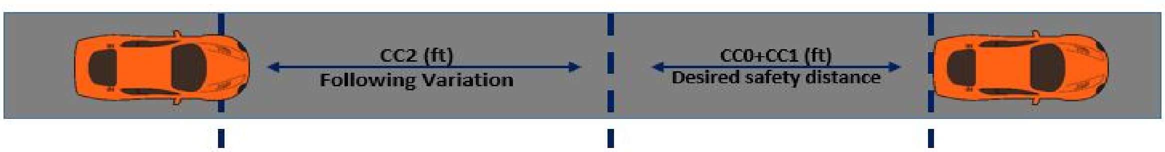
Wiedemann 99 model
Wiedemann 99 car following model is applicable to freeway links and connectors. It consists of 10 calibration parameters which are all labeled with a prefix "CC". From several research papers and guideline documents, cited at the end of this document, three of the ten CC parameters, CC0, CC1 and CC2 have the most impact on driving behavior:

- **CC0 Standstill distance**: Desired distance between the rear-bumper to front bumper of the stopped cars. This parameter has greater impact to maximum flow rate when the traffic is in jam conditions.
- **CC1 Headway time:** The distance in seconds that the following driver desires to maintain with the lead vehicle. Note: this parameter is defined as a time distribution starting from VISSIM 9.0. Model versions prior to 9.0 will result in conversions of the time distribution to a static value that may impact your overall model.

  Note that desired safety distance=CC0+(CC1* speed)



- **CC2 (Following variation):** How much more distance than the desired safety distance (CC0+CC1) before the lagging driver intentionally moves closer to the lead vehicle.



Wiedemann 74 model
The Wiedemann 74 car following model is most frequently applied to arterial segments. It has three parameters which can be modified to simulate real world traffic conditions:

- **Average standstill distance**: Average desired distance between two stopped cars.
- **Additive part of safety distance:** this value affects the computation of desired safety distance.
- **Multiplicative part of safety distance:** both the additive value and multiplicative value are used for computation of the desired safety distance. The greater this value, the greater the distribution of safety distances increases.

B. Baseline Behavior Parameters

Driving behavior parameters in VISSIM control the driver behavior characteristics of individual vehicles in the model. Driving behavior in VISSIM is primarily affected by two categories:

- Car following model
- Lane changing behavior

These categories include the parameters discussed below, which TFAD found to be effective in impacting driver behavior for calibration purposes.

Advanced merging

When this option is selected vehicles change lanes upstream of a congested on-ramp to allow more vehicles from the ramp to merge to the mainline, thus increasing capacity and reducing the likelihood of stopped vehicles waiting for a gap.

Safety Distance Reduction Factor SDRF for lane changes

A safety distance reduction factor is taken into consideration for each lane change. It affects the following parameters:

1. The safety distance of the trailing vehicle on the new lane, which determines whether a lane change will be carried out.
2. The safety distance of the lane changing vehicle itself.
3. The distance to the preceding, slower lane changing vehicle.

During the lane change VISSIM reduces the safety distance of the vehicle to the value that is calculated by multiplying **original safety distance** with the **safety distance reduction factor.** For instance, the default value of 0.6 reduces the safety distance value by 40% and then after the lane change occurs the value is changed to the original safety distance.

Note: For arterial behaviors, when changing the safety distance reduction factor value, modelers should also change the value of "safety distance close to a stop line factor". If not the behavior of the vehicles will be different when compared to behavior 'between the intersections' to behaviors 'when approaching the intersections'.

Consider combining static routing decisions

With this option selected in the driving behavior model, the vehicles choosing a lane will identify and only take into account the next downstream routing decision. Ideally, the modeler will have coded static routes to avoid intermediate routes (i.e. short routes), but we recognize this is not always feasible.

Note: For the vehicle to identify the downstream routing decision points, the option "**Combine Static Routing Decision**" located under "**Static Vehicles Routes**" must also be selected.

Cooperative Lane Change

It is recommended this option be selected for all behaviors, as it smooths transitions into more realistic driving behaviors.

Waiting time before diffusion

This time is the maximum amount of time a vehicle will wait or stop for a necessary lane change before it is removed from the network. If the vehicle is removed from the network, a warning message will be written in the .err file denoting that the vehicle was removed. TFAD recommends the value be kept the same as suggested below to ensure volume balancing consistency. Other methods of analysis replace this value with low values (e.g. 30 seconds or less), thus removing traffic volume from the network when vehicles cannot enter the desired facility. This method was developed due to PTV's software limitations and accurately suggests that vehicles should not stop and queue to merge into traffic for long periods of time. However, TFAD suggests that should vehicles stop or wait in an unrealistic fashion, the modeler should revisit the behavior model of that link, the positioning distance of the connector and the downstream behavior the vehicle is attempting to connect to. If this value is reduced and TFAD notices frequent vehicle removals for the network, the reviewers will likely reject the model because it does not realistically represent how queues will form and disperse at that location within the network. If documentation is provided showing calibration of vehicle throughput, queuing and travel times are still met, reducing waiting time before diffusion will be permitted.

Maximum deceleration for cooperative braking

This value denotes to what extent the trailing vehicle is braking cooperatively in order to allow the preceding vehicle in the adjacent lane to perform a lane change and enter the lane in which the trailing vehicle is traveling. The default value for the maximum deceleration for cooperative braking is -9.84 feet/sec^2 (or -3m/ sec^2 as defaulted in VISSIM).

During cooperative braking, a vehicle decelerates with the following values:

1. 0% to 50% of the desired deceleration, until the vehicle in front begins to change lanes.
2. 50% of the desired deceleration to the maximum deceleration of 100% specified in the 'Maximum deceleration field'. The deceleration during the lane change will be considerably less than the maximum deceleration, because the preceding vehicle, which changes lanes, does not expect such a high deceleration from the trailing vehicle.

Additional Factors

Additional factors that influence driver behaviors include the look back distance at connectors, the roadway grade combined with truck vehicle compositions (if used), and general vehicle fleet with their associated desired speeds. These factors are all considerations for additional "tweaking" to enhance calibration accuracy during VISSIM modeling.

Suggested Ranges of Driving Behavior Parameters (DBP)

Car following parameters

Default values of car following models are an essential starting point for calibrating VISSIM models. Due to frequent edits of these values for various projects throughout MDOT, TFAD listed a suggested range of values for the parameters, shown in Tables 1 and 2, which can be used as a guideline when calibrating VISSIM models. The parameter ranges provided in this section reflect typical traffic conditions and were derived after consulting several stakeholders and considering different VISSIM protocols for state Department of Transportations around the nation, including VDOT, WSDOT, and ODOT.

Table 1: Wiedemann 99 car following parameters

Freeway Car Following Parameters Suggested Range – Wiedemann 99 model					
	Parameter	**Default Value**	**Unit**	**Suggested Range**	
				Basic Segment	**Weave/Merge/Diverge Segment**
CC0	Standstill distance	4.92	feet	4.5-5.5	>4.92
CC1	Headway time	0.9	sec	0.85 to 1.05	0.8 to 1.5
CC2	'Following' variation	13.12	feet	6.56 to 22.97	13.12 to 39.27
CC3	Threshold for entering 'following'	-8		Use Default	
CC4	Negative 'following' threshold	-0.35		Use Default	
CC5	Positive 'following' threshold	0.35		Use Default	
CC6	Speed dependency of oscillation	11.44		Use Default	
CC7	Oscillation acceleration	0.82	feet/sec^2	Use Default	
CC8	Standstill acceleration	11.48	feet/sec^2	Use Default	
CC9	Acceleration at 50mph	4.92	feet/sec^2	Use Default	

Table 2: Wiedemann 74 car following parameters

Arterial Car Following Model Parameters Suggested Range -Wiedemann 74 model			
Parameter	**Default value**	**Unit**	**Suggested Range**
Average standstill distance	6.56	feet	3.28 to 6.56
Additive part of safety distance	2.00	-	2.0 to 2.2
Multiplicative part of safety distance	3.00	-	2.8 to 3.3

Lane changing parameters

Lane changing parameters shown in Table 3 are the same for both of the car following models and can be used for both freeways and arterials. The parameter for general behavior should be selected as 'Free lane selection'.

Table 3: Lane changing parameters

General Lane changing behavior: Free lane selection				
Necessary Lane Change(route)	**Own**	**Unit**	**Trailing Vehicle**	**Unit**
Maximum deceleration	-15 to -12	feet/sec^2	-15 to -8	feet/sec^2
-1 feet/sec^2 per distance	100 to 250	meters*	100 to 250	meters
Accepted deceleration	-12 to -2.5	feet/sec^2	-12 to -1.5	feet/sec^2
Waiting time before diffusion		200 s		
Min. Headway (front/rear)		1.5 to 2 feet		
To slower lane if collision time above		0 to 0.5 sec		
Safety distance reduction factor		0.10 to 1.0		
Maximum deceleration for cooperative braking		-8 to-20 feet/sec^2		
Overtake reduced speed areas		unchecked		

*The unit for this parameter is in meters by default and does not change.

Driving Behavior Summary

The driving behaviors summarized below were sorted based on their application to different facility types such as freeways, arterial and merge/weaving segments. Each driving behavior summarized below is associated with a number that reflects the same number present in the "DRIVING BEHAVIOR. inpx" VISSIM file. There are two basic categories considered under Freeways and Arterials:

- Conservative driving: this condition generally increases headway
- Aggressive driving: this condition generally reduces headway

Both categories can be used in rural, urban, congested, or uncongested situations, depending on the facility's driving population.

Reminder: the goal of this compilation is to aid VISSIM modelers in the calibration process. The parameters of the driving behaviors listed in Table 4 below can be changed to better reflect specific corridors. It is recommended, however, that the driving behavior values changed fall within the suggested ranges previously discussed in Tables 1 through 3. Driving behaviors should be visually verified within the simulation to ensure the behavior represents realistic operations.

Table 4: Driver Behavior Model Names

Freeway	
101	**Freeway Basic Conservative I**
102	**Freeway Basic Conservative II**
103	**Freeway Merge Conservative**
104	**Freeway Weave Conservative**
105	**Freeway Aggressive I**
106	**Freeway Aggressive II**
107	**Freeway Merge Aggressive**
108	**Freeway Weave Aggressive**
Arterial	
201	**Arterial Basic Conservative I**
202	**Arterial Basic Conservative II**
203	**Merge Arterial Conservative**
204	**Weave Arterial Conservative**
205	**Arterial Aggressive I**
206	**Arterial Aggressive II**

DRIVING BEHAVIOR SUMMARY TABLE

CONSERVATIVE						AGGRESSIVE
			FREEWAY			
Description	Name	#	LINK TYPE	#	Name	Description
Model can be used at segments where reduction in throughput is required. Throughput reduction observed was 20%. Significant factors include increased CC1 value whereas the lane change parameter values are kept low.	**Freeway Basic Conservative I**	**101**	**BASIC**	**105**	**Freeway Aggressive I**	Throughput achieved is higher than the above model. Significant factors include SDRF at 0.10, high lane change parameter values and a high value for Maximum deceleration for cooperative braking (-20.00 ft/s2)
Throughput reduction is greater compared to the first model. Observed throughput reduction was nearly 30%. Significant factor is the CC2 value of 27 ft.	**Freeway Basic Conservative II**	**102**		**106**	**Freeway Aggressive II**	Model can be used where desired throughputs are high. Model simulates aggressive behavior. Lane change parameter values are high. Significant factors include low CC1 value, SDRF at 0.20 and high Cooperative braking deceleration rate.
Model simulates merge segments with reduced throughput of around 15%. Model's significant factors include a low CC1 value and reduced value for lane change parameters. This makes the vehicle change lanes with reduced deceleration rate but travel with reduced headway	**Freeway Merge Conservative**	**103**	**MERGE**	**107**	**Freeway Merge Aggressive**	Model is suitable for simulating aggressive merging traffic. Higher throughput was observed. Model has a low CC1 value of 0.9 and increased lane change parameter values enabling the car to change lanes aggressively. Safety distance reduction factor is 0.20
The model can be used at segments where reduced throughput is desired at weaving segments. Throughput reduction observed was around 25%. The model has reduced values for 'Lane change' parameters. Look back and look ahead distance values are high.	**Freeway Weave Conservative**	**104**	**WEAVE**	**108**	**Freeway Weave Aggressive**	This model simulates aggressive weaving and diverging with high deceleration rate and reduced headway. Model has increased look back distance. Accepted deceleration rate is high, results in fast deceleration of the vehicles. Higher throughput achieved. Significant factors are SDRF at 0.20 and cooperative braking being -20 ft/s2.

			ARTERIAL			
Description	Name	#	LINK TYPE	#	Name	Description
Model is used for simulating conservative driving on arterial segments. Throughput reduction observed was around 15%. The lane change parameters values are kept low and SDRF is 0.60	**Arterial Basic Conservative I**	**201**	**BASIC**	**205**	**Arterial Aggressive I**	Model can be used for simulating Aggressive arterial segments. Significant factors include SDRF at 0.10, car following model parameter values are low and maximum cooperative braking value is also high
Throughput reduction is higher than the above model (around 18%). Maximum deceleration is kept high and look ahead distance value is high	**Arterial Basic Conservative II**	**202**		**206**	**Arterial Aggressive II**	Higher throughput is achieved when compared to the above model. Model simulates aggressive behavior with values of lane change parameters being high.
Model can be used for conservative driving on arterial segments where reduced throughput is desired. Throughput reduction observed was around 13% Additive and multiplicative part of safety distance values are 2.30 and 3.4 respectively	**Merge Arterial Conservative**	**203**	**MERGE**	**-**	***Note*: Arterial Aggressive I & II above are also suitable for arterial merge/weave segments to increase throughputs and simulate aggressive lane changing.**	
Model can be used for conservative driving on weaving arterial segments. Model provides low throughput, around 18% with high weaving.	**Weave Arterial Conservative**	**204**	**WEAVE**	**-**		

All percent changes by behavior types are estimates and may vary depending on the scenario they are applied to.

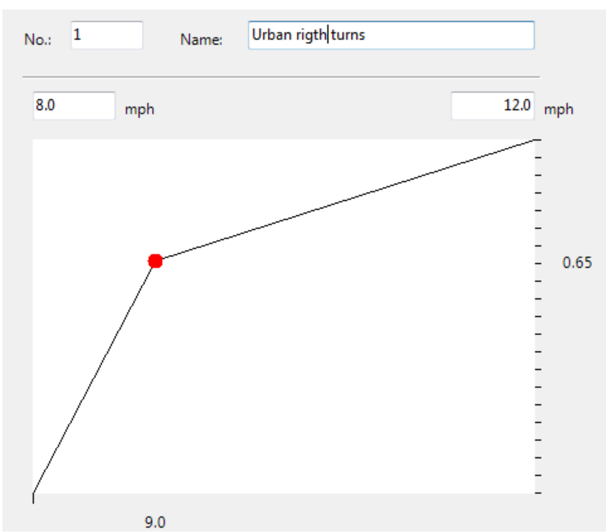
Pedestrian Models
TFAD currently models pedestrians as a Vehicle Input instead of using the pedestrian module. If the modeler expects more than 30 pedestrians within the model, then the above Vehicle Input method must be used due to software limitations. Pedestrians should always be modeled where appropriate, unless specified otherwise.

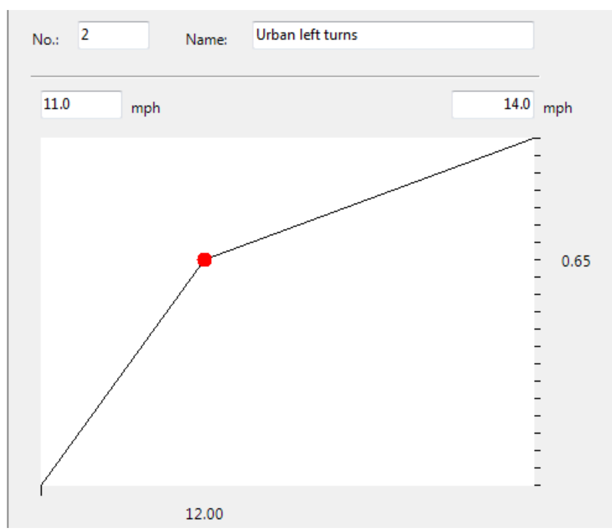
Transit
For all Transit, bus alighting and boarding should be considered in addition to bus travel times, schedules, capacity (vehicle types), all stop locations, etc. TFAD currently models an on street bus stop as 50 feet to 100 feet depending on urban density. An alternative to boarding/alighting data is to use dwell time information, though this must be supported with field verified information.

Speeds

Turning Speeds

Turning speeds for intersection movements, or tight left/right turning vehicles, should be modeled using the speed distributions provided below. These speeds differ from the Synchro defaults and are based on MDOT SHA data.





Speed reduction zones should be placed at the sharpest point on the curve of the link or connector. The speed reduction zones for turning movements should be short, usually within 5-15 feet depending on the curve length. Excessively long reduced speed zones will reduce the turning movement volume capacity and should only be used if the turning movement excessively reduces vehicle throughput.

Wide left turning movements or free right movements where vehicles can travel faster are especially susceptible to this condition and can be modeled with higher turning speed distributions with longer speed reduction zones (e.g. 5-30 feet at 25mph), if appropriate.

Speed reduction zones for ramps, specifically loop ramps, should use a distribution of the ramp caution speed limit, usually within the 30-45 mph range. These can span the entire ramp (ex. tight loops) or only the sharpest curve of the ramp (ex. slip ramps) depending on field data.

All speed distributions above may be replaced with field based data, which must be documented.

Mainline Speeds

Mainline desired speeds should be modeled as a distribution of existing speeds along the corridor, **not** as the posted speed limit. Vehicles modeled in VISSIM must reflect existing conditions as accurately as possible. Scenario analysis may be performed after the base calibration in complete; however, existing conditions must be reflected in the models.

When first opening a VISSIM model, care should be taken when converting from KPH to MPH (i.e. when converting from metric to imperial). Do not switch to imperial units and keep the speed as-is; this will result in unrealistic speed distributions.

Currently, TFAD uses the default VISSIM Maximum Acceleration and Deceleration distributions. Make note should these be altered in the modeling effort.

Conflict Areas and Priority Rules

Conflict areas should be modeled for all conflicting movements that might occur. Specifically, permissive left turns, right-turn-on-red, and pedestrian conflicts. Not all movements must be coded, but those occurring in the field and specifically under congested conditions where an intersection might spillback should be coded. Roundabouts should use a 4.2 to 5.5 seconds gap based on field data collected by the Office of Traffic and Safety (OOTS), or provide supporting documentation otherwise.

Note that conflict zones work most efficiently for non-congested locations and tight conflict areas. For wide turns, congested networks, and other complex facilities, priority rules may be more appropriate to allow for smoother traffic flow.

Signals

Signal timings should use RBC NEMA phasing standards or VAP for complex/innovative signals. All signal timings must use MDOT SHA, County, or City timing sheets. New signals must meet MDOT SHA standard practice and the RBC timing sheet must be supplied to TFAD for review.

Permissive left turn signal heads can be coded as an “Overlap” with parent phases as the through and left movement combined due to vehicles in Maryland operating as though left turn yellows are permissive. This movement can also be coded through the “Or signal group” option in the Signal Head tool, but vehicle throughput should be evaluated to make sure the capacity of the turn is maintained (i.e. vehicles in Maryland tend to turn on yellow arrow, which operates more like the overlap condition than the “Or signal” condition).

Right Turn On Red (RTOR) conditions must be coded into the networks where vehicles are permitted to turn if the signal is red. To code RTOR, use the stop sign tool and under the “RTOR” tab, select the “Only on Red” option for the appropriate Signal Controller and Signal Group. The stop sign should be positioned on the link/connector performing the right turn while a signal head for the through movement should still be coded in on the through link.

Caution: Import of Synchro files into VISSIM can lead to multiple errors and should be done with caution. Always confirm Synchro timings with actual controller timing sheets when possible – TFAD staff is trained in reviewing signal controller timing sheets and will request corrections to signal timings if they do not match the controller outputs.

Routing

<u>Static Routing</u>

TFAD currently uses Static Routing for most VISSIM simulation models. This requires a balanced network of traffic volumes to input in the VISSIM model that must be approved by TFAD. Routes should start at the farthest point from a “split” or volume change location to ensure the most distance for vehicles to make a decision.

Caution is advised for interchange locations where routing might cause “loop” conditions where a vehicle will be removed from the highway only to return in the opposing direction. To avoid these conditions, push highway traffic at interchanges through the following intersections rather than stopping a route right after the end of the ramp movement, as shown below.

Route end points **must** be on the same link as the following route’s start point.

Breakdown of truck routes versus automobile routes, or route combinations will be left at the discretion of the modeler. However, methodologies are expected to be submitted to TFAD for review.

<u>Dynamic Routing</u>

Dynamic routing should be discussed on a case by case basis with the TFAD staff as this requires an additional macroscopic modeling effort.

Calibration

Two calibration metrics are required of all VISSIM models submitted to TFAD:

- Travel time and/or speed
- Vehicle throughput

Additionally, engineering judgment will be required for locations with existing queues and overall network operations. All calibration must consider the following:

- Seeding time must allow a car to travel from one end of the network to the other; customary simulation seeding times span from 900 seconds (15 minutes) to 1,800 seconds (30 minutes). Longer seeding times should be considered for excessively large networks or high congestion.
- A minimum of 5 simulation runs must be completed before average outputs of all runs can be used for analysis. Additional runs may be necessary, up to 15 runs or by showing convergence of the model.

Calibration of the network using travel times or speed must report short segment data in addition to overall corridor travel time/speed. TFAD requires a ± 10 percent travel time variation for small segments (no more than 1 mile long) and ± 5 percent travel time variation over the entire corridor analyzed. Exceptions permitted on a case by case basis with justification.

For a facility spanning more than 1 mile, it is recommended to break the facility into segments based on obvious breakpoints (ex. between signalized intersections, or at ramps). These new smaller segments would then be calibrated at ± 10 percent variation with an overall corridor calibration of ± 5 percent.

To calibrate to travel times or speeds, floating car runs or collected speed data may be used (ex. RITIS.org probe data). This may result in two separate data sets: one from floating car runs, and one from an outside source. Do **not** mix the calibration of travel times from floating car runs with speeds collected from an outside source. Two options are available if multiple data sets are available:

1. Average the speed data with the travel time runs into one data set (i.e. convert speeds into travel time runs or vice versa and calibrate the VISSIM outputs to the average of the two),
2. Use only one data set, either travel time runs from the floating car runs, or the speed data from an outside source, and keep the other data source for validation.

The volume calibrations should not exceed 10% of the **count traffic volume** and/or GEH<5.

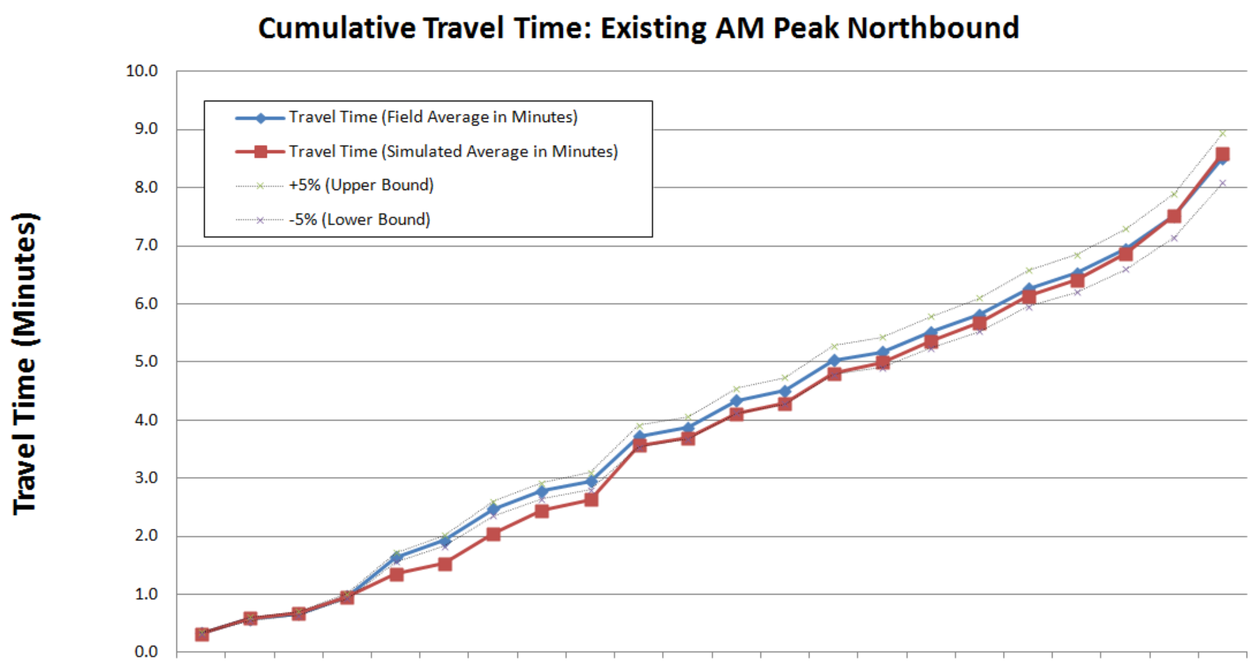
Caution: A frequent error noted is the use of the balanced traffic volume network for calibration of a VISSIM model. This is an incorrect calibration method. Calibration should not be made using the demand volume (i.e. the balanced volume network), rather they should meet the throughput measured in the field (i.e. raw data count).

Calibration sheets are required for review and must be presented with the start of stage (2) of the VISSIM schedule (See Quality Review and Schedule). Example calibration tables are provided below.

Segment	Table 5: Volume Calibration						
	1.Demand Volume (vehicles)	2.Count Volume (vehicles)	3.Simulated Volume (vehicles)	4.Difference (% of 2&3)	5.Difference <10%?	6. GEH	7.GEH <5?
Corridor							
A-B	2,765	2,620	2,628	0%	Yes	0.2	Yes
B-C	4,050	3,500	4,086	-17%	No	9.5	No

Travel Segments	Distance (miles)	Table 6: Travel Time Calibration					
		Speeds (MPH)		Travel Times (sec)		Difference	
		Field (mph)	Simulated (mph)	Field (sec)	Simulated (sec)	Difference (sec)	Difference (%)
Corridor	**2**	**51**	**56.3**	**141.2**	**128.5**	**12.7**	**10%**
A-B	**1**	60	59.7	**60**	**60.3**	**0.3**	**1%**
B-C	**1**	30	52.8	**120**	**68.2**	**-51.8**	**-43%**

Calibration threshold not met.



Measures of Effectiveness

Outputs of the VISSIM models requested for project studies include (as appropriate):

- Travel times and speeds for each corridor segment and associated cross streets,
- Average and Maximum Queue lengths on each approach
- Node delays for intersection level of service (LOS)
- Diverge, merge, and weave density outputs for LOS
- Network performance measures of effectiveness (MOEs)
    - Network Overall Delays
    - Network Overall Travel Times
    - Latent Vehicles ("vehicles denied entry")

Tables clearly labeling all results must be submitted to TFAD for review and will be included in the final report.

Travel Times & Speed

Travel time collection points should span the same distances and locations as the floating car runs. For example, if a segment in the floating car run extends 524 feet, the travel time collection point should be equal or almost equal to 524 feet. Alternatively, if the modeler wishes to extend or reduce that distance, an appropriate travel time needs to be calculated for the new distance.

Speeds may be calculated from the travel time collection points.

Transit oriented studies must include transit travel times separate from automobile travel times (ex. bus/tram/light-rail).

Queues

Maximum and average queue lengths should be collected at the stop bar locations for signalized intersections or stop signs. Queues occurring on freeways should be measured from the start of the queue by observing the simulation and determining the start point. Networks should be modeled such that the maximum queue length measurements are encompassed by the network and queues do not extend past the end of the link.

Intersection Levels of Service (Nodes)

Intersection delays should be collected via the Node tool to determine Level of Service (LOS). Different modeling techniques may be used – each edge of the node may sit solely at the stop bars for each approach resulting in a small node, or each edge of the node may sit outside of the farthest turning bay resulting in wider nodes.

Measuring delay per vehicle should consider the HCM categories for LOS grade. Node delays at unsignalized versus signalized intersections are different and must be evaluated correctly.

Node "start of delay segment" should consider the length of the queues at that node. Alternatively, this may be zeroed out if the edges of nodes from nearby intersections are bordering the node (i.e. back to back node systems).

Once data is collected from the VISSIM model, total intersection delays should be translated from the latest Highway Capacity Manual (HCM) to a letter grade LOS.

Diverge, Merge, and Weave Levels of Service

Diverge, merge, and weave lane density outputs must be collected for all freeway analyses and converted to a level or service letter grade based on the latest HCM.

For all studies the link(s) on which the merge, diverge, or weave occurs must be evaluated for density output. Note that the modeler should use HGV and auto densities to translate to a LOS, and must not solely translate the VISSIM "All Vehicle" density to a LOS grade. TFAD allows for the use of a 2.5 factor to convert HGV density to passenger car per mile per lane (pcpmpl), which is added to the auto density, and then converted to a LOS grade per the HCM breakdowns. Similar to intersection LOS categories, freeway segments have different breakdowns for weaves, diverges and merges, which must be considered when reporting LOS.

Delays at the diverge/merge/weave may be considered in addition to the density; however, a delay estimation using node or travel times may not be translated to a LOS using HCM delay tables.

Benefit Cost Analysis

Benefit cost analysis (BCA) may be considered for VISSIM models that consider Build scenarios. Each Build scenario would include a change in the network, resulting in changes to vehicular delay.

TFAD's current approach is to determine the delay variation at the location of the Build change using either travel time segments or nodes. Due to the software limitations, some node systems may be too large to encompass an entire interchange, for example, and thus travel times may be used.

TFAD does not currently use network wide delay as a means for BCA due to scale of projects; however, this MOE may be considered for very small networks (independent intersections, single interchange etc) and is needed for the Network Performance Measures, below.

Network Performance Measures of Effectiveness (MOEs)

Network wide MOEs should be collected for the following:

- System wide average delay (seconds per vehicle)
- Averaged stopped delay (seconds per vehicle)
- Vehicles denied entry (Delay Latent)

Additional MOEs that might be considered:

- Average number of stops
- Average speed (miles per hour)
- Total travel time (seconds per vehicle)
- Total vehicle-miles (miles)

Deliverables

The required deliverables of a VISSIM modeling effort to MDOT SHA's TFAD include:

- All VISSIM models and associated VISSIM files (ex. RBC and VAP files), for each stage of the schedule (see Quality Review and Schedule)
- Calibration tables (see Calibration)
- A Calibration and Methodologies Memorandum including version of VISSIM used and detailed volume diagrams used in the network,
- MOEs of final (i.e. not the base model) VISSIM networks (see Measures of Effectiveness)
- Full technical memorandum with all results.

References

1. VDOT- Traffic Operations and Safety Manual Appendix E – Microsimulation calibration Parameters-Traffic operations and safety analysis manual- http://www.virginiadot.org/business/resources/TOSAM.pdf
2. WSDOT – VISSIM Protocol- http://www.wsdot.wa.gov/NR/rdonlyres/378BEAC9-FE26-4EDA-AA1F-B3A55F9C532F/0/VissimProtocol.pdf
3. ODOT- VISSIM calibration parameters- http://www.oregon.gov/ODOT/Planning/Documents/APMv2_Add15A.pdf
4. Tony Woody - 'Calibrating freeway simulation models in VISSIM'-University of Washington, Seattle, WA-2006-courses.washington.edu/cee500/VISSIMCalibration_FinalReport.doc
5. PTV VISSIM version 9 manual -2016

-end-

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