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Definitions of “Shall”, “Direction”, “Should”, “Guidance”, and “May”

The following definitions apply to the use of these terms in this manual:

**Shall:** A mandatory condition. Any deviation from a shall condition requires approval from the Regional Traffic Engineer (RTE) or his/her designee supplemented by documentation of the decision in the project files.

**Direction:** A mandatory condition. Any deviation from a direction requires approval from the RTE or his/her designee supplemented by documentation of the decision in the project files.

**Should:** An advisory condition. A should condition is recommended but not mandatory. Any deviation from a should condition requires approval from the VDOT project manager supplemented by documentation of the decision in the project files.

**Guidance:** An advisory condition. A guidance condition is recommended but not mandatory. Any deviation from a guidance condition requires approval from the VDOT project manager supplemented by documentation of the decision in the project files.

**May:** A permissive condition. A may condition is optional.
Technical Advisory Committee

VDOT created a technical advisory committee (TAC) to collaborate in the development of this manual. The TAC consisted of traffic engineers, designers, transportation planners, and researchers from throughout the state from both the public and private sectors, including representatives from the Virginia Department of Transportation (VDOT), Virginia Transportation Research Council (VTRC), and Federal Highway Administration (FHWA). Development of this manual was based on current VDOT policies and guidelines; industry best practices; and research findings. The TAC was responsible for discussing and vetting issues throughout the manual development process. TAC members for both the TOSAM, Version 1.0 and the Traffic Operations Analysis Tool Guidebook (TOATG), Version 1.1, are listed in the following sections.

TRAFFIC OPERATIONS AND SAFETY ANALYSIS MANUAL, VERSION 1.0
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Glossary of Terms

Access management: The systematic control of the location, spacing, design, and operation of entrances, median openings, traffic signals, and interchanges for the purpose of providing vehicular access to land development in a manner that preserves the safety and efficiency of the transportation system.

Active traffic management (ATM): A type of ITS solution that includes an integrated set of operating strategies and technologies for managing transportation demand, such as advanced lane control signal systems, variable speed limits, dynamic junction control, speed harmonization, and automated signs.

Adaptive signal control technology (ASCT): Technology that uses algorithms within traffic signal controllers to adjust signal timings every few minutes based on real-time traffic information to reduce congestion.

American Association of State Highway and Transportation Officials (AASHTO): An organization that advocates transportation-related policies and provides technical services to support states in their efforts to efficiently and safely move people and goods.

Area: An interconnected set of transportation facilities serving movements within a specified geographic space, as well as movements to and from adjoining areas.

Automated Traffic Recorder (ATR): A traffic counter that collects volume, speed, and/or vehicle classification data over a period of time using an electronic device, such as count tubes, cameras, radar, or detectors.

Average travel speed (ATS): Speed (expressed in mph) on a segment computed by the length of a highway segment divided by the average travel time of all vehicles traversing this segment. This speed is equivalent to space mean speed.

Bus rapid transit (BRT): A permanent, integrated transportation system that uses buses or specialized vehicles on roadways or dedicated lanes to transport passengers more quickly and efficiently than traditional bus service.

Calibration parameter: Parameter used to fine-tune the base microsimulation model to reflect local, existing traffic operational behavior. For example, calibration parameters consist of queue lengths, travel time, saturation flow rate, start-up lost time, queue discharge headway, etc. Some of the information to perform calibration is collected from the field and others are user-adjustable values within the microsimulation models.

Central Business District (CBD): An urban area, typically characterized by narrow street rights-of-way, frequent parking maneuvers, vehicle blockages, taxi and bus activity, small-radius turns, limited use of exclusive turn lanes, high pedestrian activity, dense population, and midblock curb cuts.

Collector-distributor road (C-D road): A roadway parallel to the mainline facility designed to separate mainline travel lanes from merges, diverges, weaves, and access points. On arterials, C-D roads are also known as collector roads or frontage roads and primarily serve commercial or residential properties to reduce the number of access points on the arterial.

Conflict point: A location in which two or more road users approach each other in time and space to such an extent that there is risk of collision if their movements remain unchanged.

Congestion mapping: A graphical representation of traffic flow in over-capacity conditions based on collected speed data for a particular area.
Continuous-flow intersection (CFI): An alternative intersection configuration whereby left-turning cross vehicles at upstream intersections to allow left-turn signal phases to be served simultaneously with through movement signal phases. CFIs are also known as “Displaced Left-Turn” (DLT) or “Crossover Displaced Left-Turn” (XDL) intersections.

Continuous green-T intersection (CGT): An alternative intersection configuration that features a signalized three-approach intersection (T-intersection) where the mainline approach on the opposite side of the minor-street approach operates in a free-flow condition. Left-turning vehicles from the minor approach are provided an auxiliary lane in the median to merge onto the mainline. CGTs are also known as “Turbo-T” or “High-T” intersections.

Control delay: Delay associated with vehicles passing through an intersection, including slowing in advance of an intersection, the time spent on an intersection approach, the time spent as vehicles advance in a queue, and the time needed for vehicles to accelerate to their desired speed (expressed in seconds per vehicle).

Corridor: A set of parallel transportation facilities, such as a freeway and one or more parallel arterial streets.

Crash modification factor (CMF): Multiplicative factor used to compute the expected number of crashes after implementing a given countermeasure at a site.

Critical links/movements/routes: A critical link, movement, or route represents a portion of a roadway network that is of decisive importance to the recommendations made as a result of a traffic operations analysis.

Cycle: A complete sequence of traffic signal indications.

Cycle length: The time required for one complete sequence of signal phases such that all of the movements at the intersection (that have not been omitted) have been served at least once (expressed in seconds).

Delay: Travel time experienced by a driver, passenger, bicyclist, or pedestrian beyond that required to travel at the desired speed (expressed in seconds per vehicle). See control delay or microsimulation delay for more information.

Density: The number of vehicles occupying a given length of lane at a particular instant (expressed in either passenger cars per mile per lane (pcpmpl) for deterministic traffic tools or vehicles per mile per lane (vpmpl) for stochastic traffic tools).

Deterministic traffic tools: Traffic analysis tools in which there is no variability in driver-vehicle characteristics (e.g., HCS 2010).

Diverging diamond interchange (DDI): An interchange configuration that is a diamond interchange where the directions of travel on the arterial cross over to the left side of the road at each ramp terminal. This configuration allows for left- and right-turn movements to operate as unsignalized intersections on the arterial. A two-phased traffic signal controls the intersections at the crossover points. A traffic signal phase can be provided for the ramp approaches when the opposing movement is not served, when applicable. A DDI is also known as a “double crossover diamond interchange” (DCDI).

Dynamic traffic assignment: A modeling approach that simulates vehicles making alternative route choices based on factors, such as congestion and travel time, within a network.

Effective auxiliary lane length: The length of the auxiliary lane plus two-thirds of the auxiliary lane taper length (expressed in feet).

Effective turn lane storage length: The full with turn lane storage length plus one half of the taper length (expressed in feet).
Empirical Bayes (EB) method: A statistical method used to improve the reliability of determining the number of crashes produced from a predictive model by combining the model prediction with observed crash data.

Engineering judgment: The evaluation of available information and the application of appropriate principles, provisions, and practices for the purpose of deciding upon the applicability and proper use of traffic operations and safety analysis tools and related methodologies.

Expected crashes: The estimate of long-term expected average crash frequency of a site, facility, or network under a given set of geometric conditions and traffic volumes (AADT) in a given period of years. In the Empirical Bayes (EB) method, this frequency is calculated from observed crash frequency at the site and predicted crash frequency at the site based on crash frequency estimates at similar sites.

Facility: A roadway, bike path, or pedestrian walkway composed of a connected series of points and segments and are defined by two endpoints.

Federal Highway Administration (FHWA): An agency within the U.S. Department of Transportation that supports state and local governments in the design, construction, and maintenance of the nation’s highway system (Federal Aid Highway Program) and various federal- and tribal-owned lands (Federal Lands Highway Program).

Flow rate: The equivalent hourly rate at which vehicles or other roadway users pass over a given point or section of a lane or roadway during a given time interval of less than one hour, usually 15 minutes (expressed in vehicles per hour).

Free-flow speed: The prevailing speed on highways at flow rates between 0 and 1,000 passenger cars per hour per lane (expressed in mph).

High-occupancy vehicle (HOV) lane: A restricted travel lane reserved for the exclusive use of vehicles with a driver and one or more passengers.

Highway Capacity Manual (HCM): The HCM is a publication produced and maintained by TRB that contains concepts, guidelines, and computation procedures for calculating the capacity and quality of service of highway facilities.

Highway Safety Manual (HSM): The HSM is a publication produced and maintained by AASHTO that contains a variety of methods for quantitatively estimating crash frequency and severity on various facility types.

Input parameter: Parameter that is collected and/or measured directly in the field and is used to build the base model. For example, input parameters consist of the number of lanes, lane widths, traffic volume, free-flow speed, etc. It is not customary to change input parameters; however, if there is a need for an adjustment, then the VDOT project manager should be consulted along with documented justification.

Intelligent Transportation Systems (ITS): Transportation infrastructure that is used collect, store, process and distribute information relating to the movement of people and goods.

Interchange Justification Report (IJR): An operational analysis prepared in accordance with both VDOT and FHWA guidelines for a proposed new interchange. The IJR process applies to all access additions and FHWA’s approval is required on all interstate projects greater than or equal to $1.0 million in construction costs.
**Interchange Modification Report (IMR):** An operational analysis prepared in accordance with both VDOT and FHWA guidelines for access modifications that are needed to improve operations and safety of an existing interchange. The IMR process applies to access modifications on the Interstate system, non-interstate National Highway System (NHS), and non-NHS.

**Interrupted-flow facilities:** Facilities that have fixed causes of periodic delay or interruption to the traffic stream, such as traffic signals and stop signs.

**Level of service (LOS):** Stratification of a performance measure(s) that represent quality of service, measured in an A-F scale with LOS A representing the best.

**Light-rail transit (LRT):** An electric railway system that operates single or multiple car trains along a fixed guideway. LRT guideways can be located in streets, on elevated platforms, or along exclusive rights-of-way.

**Macroscopic analysis tools:** Tools used to analyze traffic flow, taking into account aggregated traffic stream characteristics (speed, flow, and density) and their relationships (e.g., HCS 2010, SIDRA Intersection, and Synchro).

**Managed lanes:** Highway facilities or a set of lanes where operational strategies, such as ramp metering or variable speed limits, are proactively implemented and managed in response to changing conditions.

**Maximum queue length:** The longest queue length (see queue length) that is observed or simulated during a given analysis period (expressed in feet).

**Measure of effectiveness (MOE):** Factor that quantifies operational and safety objectives and provides a basis for evaluating the performance of the transportation network.

**Microsimulation:** Modeling of individual vehicle movements on a second or sub-second basis to assess the traffic performance of a transportation node, segment, or network.

**Microscopic analysis tools:** Tools used to simulate the characteristics and interactions of individual vehicles. These tools include algorithms and rules describing how vehicles move and interact within the transportation network, including acceleration, deceleration, and lane changing (e.g., CORSIM, SimTraffic, and VISSIM).

**Microsimulation delay:** The difference (expressed in seconds per vehicle) between the simulated travel time and the theoretical travel time if the vehicle was operating at the desired speed calculated by a microsimulation tool.

**Model calibration:** Modeling process where the modeler modifies calibration parameters that cause the model to best replicate field-measured and observed traffic volumes, speeds, travel times, and queues.

**Multimodal facility:** A place where at least two or more modes of transportation interface, such as bus and rail.

**National Cooperative Highway Research Program (NCHRP):** A program for coordinated and collaborative transportation research administered by the TRB and sponsored by FHWA, AASHTO and individual state departments of transportation.

**Network link:** A link connecting two nodes in a microsimulation model.

**Node:** An intersection of two or more roadway segments in a traffic model. A node may represent an actual intersection or point where roadway characteristics or geometry change.
Parameter: Any value assigned or input into an analysis tool by a user to configure the analysis tool to produce results.

Peak hour factor (PHF): The hourly volume during maximum volume hour of the day divided by the peak 15-minute flow rate within the peak hour. PHF is a measure of traffic demand fluctuation within the analysis hour.

Peak hour spreading (PHS): PHS occurs when the peak hour traffic demand exceeds the available traffic capacity throughout the entire peak hour. This excess traffic then “spreads” to either side of the computed peak hour, which creates a peak period of two or more hours as opposed to just one hour.

Percent of free-flow speed (PFFS): The average travel speed (see average travel speed) divided by the free-flow speed (see free-flow speed).

Percent time spent following (PTSF): The average percent of total travel time that vehicles must travel in platoons behind slower vehicles because of the inability to pass on a two-lane highway.

Phase: The part of a traffic signal cycle allocated to any combination of traffic movements receiving the right-of-way simultaneously during one or more intervals. A phase includes green, yellow change, and red clearance intervals.

Predicted crashes: The estimate of future average crash frequency that is forecast to occur at a site using a predictive model.

Point: A place along a facility where (a) conflicting traffic streams cross, merge, or diverge; (b) a single traffic stream is regulated by a traffic control device; or (c) there is significant change in the segment capacity (e.g., lane drop, lane addition, narrow bridge, significant upgrade, start or end of a ramp influence area).

Potential for safety improvement (PSI): Factor that indicates a higher historical crash rate than the rate predicted by the HSM methodology, which is based on national averages. A positive PSI value indicates a location in need of safety improvement.

Public transit facilities: Roadway infrastructure that accommodates public transit modes such as buses, trolleys, and trains.

Quality control (QC): Measures taken within a project to produce work to acceptable standards that meet project requirements.

Queue length: The distance between the upstream and downstream ends of a traffic queue (expressed in feet).

Ramp metering: A traffic signal that regulates the flow of traffic entering a freeway from a ramp.


Roadway safety assessment (RSA): A formal examination of an existing roadway or project design in which a team of independent and multidisciplinary examiners report on the past safety performance and/or the project’s crash potential performance to recommend safety treatments to mitigate crashes in the future.

Safety performance function (SPF): A statistical model used to estimate the average crash frequency for a specific site type, with specified base conditions, based on traffic volume and roadway segment length.

Segment: For interrupted-flow facilities, a segment is defined as a link and its boundary points. For uninterrupted-flow facilities, a segment is defined as the portion of a facility between two points.
Single-point urban interchange (SPUI): Interchange configuration consisting of a diamond interchange that combines both ramp terminals into one intersection to allow left turns to operate simultaneously. A SPUI is also known as a “single-point interchange” (SPI), “single-point diamond interchange” (SPDI), or “single point urban diamond” (SPUD) interchange.

Space mean speed: Average speed based on the average travel time of vehicles to traverse a length of roadway (expressed in mph).

Speed: Rate of motion expressed as distance per unit of time (expressed in mph).

Stochastic traffic tools: Traffic microsimulation tools that assign driver-vehicle characteristics from statistical distributions using random numbers (e.g., CORSIM, SimTraffic, VISSIM).

Stopped delay: Amount of time that a vehicle is slowed to 5 mph or less (expressed in seconds).

Superstreet intersection: Intersection configuration where left-turning vehicles on the minor road must turn right onto the major road and make a U-turn at a designated location a short distance upstream. After completing the U-turn, the drivers may continue straight or make a right turn at the original intersection.

System: All transportation facilities and modes within a particular region.

Time mean speed: Average speed of vehicles observed passing a point on a highway (expressed in mph).

Toll plazas: An area on a facility where fares are collected in exchange for passage through a roadway network. Fares can be collected via toll booth or through electronic toll collection.

Traffic and safety project delivery process: All activities that occur within a traffic operations and safety analysis project between initiating a project scope and a completed project deliverable.

Traffic impact analysis (TIA): A traffic operations analysis that assesses the effect of a proposed land development project on a transportation system and recommends improvements to reduce the impacts.

Traffic operations analysis: An evaluation of how a roadway or a set of roadways functions under existing and/or projected traffic and geometric conditions.

Traffic safety analysis: An evaluation of safety components on a roadway or a set of roadways under existing and/or projected traffic and geometric conditions.

Transportation demand management (TDM): Strategies that increase system efficiency by focusing on traffic demand. TDM provides travelers with travel choices, such as work location, route, time and mode. TDM is also known as “traffic demand management.”

Transportation Research Board (TRB): A major division of the National Research Council. The mission of the TRB is to promote innovation and progress in transportation through research.

Travel time: The average time spent by vehicles traversing a highway segment, including control delay (expressed in seconds).

Travel time routes: Routes taken to traverse a set of contiguous links and connectors that is part of a vehicle path, which may be wholly or partially within a full vehicle route. Travel time routes are defined based on project needs and goals.

Turning movement count (TMC): The process of collecting vehicle movement information data at an intersection. Data can be collected either manually or using technology such as video cameras.
Uninterrupted-flow facilities: Facilities that have no fixed causes of delay or interruption external to the traffic stream.

Model validation: Modeling process where the modeler checks the overall model-predicted traffic performance for a network against field measurements of traffic performance not using data from the calibration process.

VDOT project manager: Individual responsible for overseeing and directing the project from scoping through project delivery. The VDOT project manager is responsible for ensuring the direction and guidance presented in this manual are followed and should consult with technical specialists, as needed, throughout the project process.

VDOT Sample Size Determination Tool: Tool used to determine the appropriate number of microsimulation runs for a given traffic analysis based on the FHWA sample size determination methodology.

VDOT Software Selection Tool (SST): A self-guided decision matrix that allows a user to select from a range of traffic analysis criteria and MOEs to determine the appropriate traffic analysis tool(s) for a specific study.

Volume to capacity (v/c) ratio: The ratio of the flow rate to the theoretical maximum capacity for a system component.

Work zone: An area of a roadway network with highway construction, maintenance, or utility work activities.

95th percentile queue length: The queue length that has only a 5% probability of being exceeded during a given analysis period (expressed in feet).
# List of Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>AADT</td>
<td>Annual Average Daily Traffic</td>
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<tr>
<td>AASHTO</td>
<td>American Association of State Highway and Transportation Officials</td>
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<tr>
<td>ATM</td>
<td>Active Traffic Management</td>
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<tr>
<td>ATR</td>
<td>Automated Traffic Recorder</td>
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<td>ATS</td>
<td>Average Travel Speed</td>
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<td>ASCCT</td>
<td>Adaptive Signal Control Technology</td>
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<tr>
<td>ALDOT</td>
<td>Alabama Department of Transportation</td>
</tr>
<tr>
<td>AWSC</td>
<td>All-Way Stop Control</td>
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<tr>
<td>BRT</td>
<td>Bus-Rapid Transit</td>
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<tr>
<td>CBD</td>
<td>Central Business District</td>
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<tr>
<td>C-D</td>
<td>Collector-Distributor</td>
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<tr>
<td>CFI</td>
<td>Continuous-Flow Intersection</td>
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<tr>
<td>CFSM</td>
<td>Car Following Sensitivity Multiplier</td>
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<td>CGT</td>
<td>Continuous Green-T</td>
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<tr>
<td>CMF</td>
<td>Crash Modification Factor</td>
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<td>CORSIM</td>
<td>CORSridor SIMulation</td>
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<tr>
<td>DCDI</td>
<td>Double Crossover Diamond Interchange</td>
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<tr>
<td>DDI</td>
<td>Diverging Diamond Interchange</td>
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<tr>
<td>DLT</td>
<td>Displaced Left-Turn</td>
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<tr>
<td>DRPT</td>
<td>Department of Rail and Public Transit</td>
</tr>
<tr>
<td>DTA</td>
<td>Dynamic Traffic Assignment</td>
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<tr>
<td>EB</td>
<td>Empirical Bayes</td>
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<tr>
<td>FFS</td>
<td>Free-Flow Speed</td>
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<td>FHWA</td>
<td>Federal Highway Administration</td>
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<tr>
<td>GIS</td>
<td>Geographic Information System</td>
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<tr>
<td>HOT</td>
<td>High-Occupancy Toll</td>
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<td>HOV</td>
<td>High-Occupancy Vehicle</td>
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<tr>
<td>HCM</td>
<td>Highway Capacity Manual</td>
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<td>HCS</td>
<td>Highway Capacity Software</td>
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<td>HSIP</td>
<td>Highway Safety Improvement Program</td>
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<td>HSM</td>
<td>Highway Safety Manual</td>
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<tr>
<td>ICU</td>
<td>Intersection Capacity Utilization</td>
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<tr>
<td>IHSDM</td>
<td>Interactive Highway Safety Design Model</td>
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<td>IJR</td>
<td>Interchange Justification Report</td>
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<tr>
<td>IMR</td>
<td>Interchange Modification Report</td>
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<tr>
<td>ITS</td>
<td>Intelligent Transportation System</td>
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<tr>
<td>LOS</td>
<td>Level of Service</td>
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<tr>
<td>LRT</td>
<td>Light-Rail Transit</td>
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<tr>
<td>MOE</td>
<td>Measure of Effectiveness</td>
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<tr>
<td>NCHRP</td>
<td>National Cooperative Highway Research Program</td>
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<tr>
<td>NHS</td>
<td>National Highway System</td>
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<tr>
<td>O-D</td>
<td>Origin-Destination</td>
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<tr>
<td>PFFS</td>
<td>Percent of Free-Flow Speed</td>
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<tr>
<td>PHF</td>
<td>Peak Hour Factor</td>
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<td>PHS</td>
<td>Peak Hour Spreading</td>
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<tr>
<td>PSI</td>
<td>Potential for Safety Improvement</td>
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<tr>
<td>PTSF</td>
<td>Percent Time Spent Following</td>
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<td>QC</td>
<td>Quality Control</td>
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<tr>
<td>RBC</td>
<td>Ring-Barrier Controller</td>
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<td>RNS</td>
<td>Roadway Network System</td>
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<td>RSA</td>
<td>Roadway Safety Assessment</td>
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<td>RTE</td>
<td>Regional Traffic Engineer</td>
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<td>SPF</td>
<td>Safety Performance Function</td>
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<td>SPI</td>
<td>Single-Point Interchange</td>
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<tr>
<td>SPDI</td>
<td>Single-Point Diamond Interchange</td>
</tr>
<tr>
<td>SPF</td>
<td>Safety Performance Function</td>
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<tr>
<td>SPUD</td>
<td>Single-Point Urban Diamond</td>
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<tr>
<td>SPUI</td>
<td>Single-Point Urban Interchange</td>
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<tr>
<td>SSAM</td>
<td>Surrogate Safety Assessment Model</td>
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<td>SST</td>
<td>Software Selection Tool</td>
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<td>TAC</td>
<td>Technical Advisory Committee</td>
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<td>TIA</td>
<td>Traffic Impact Analysis</td>
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<td>TDM</td>
<td>Transportation Demand Management</td>
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<td>TED</td>
<td>VDOT Traffic Engineering Division</td>
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<tr>
<td>TMC</td>
<td>Turning Movement Count</td>
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<tr>
<td>TMS</td>
<td>Traffic Monitoring System</td>
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<tr>
<td>TOATG</td>
<td>Traffic Operations Analysis Tool Guidebook</td>
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<tr>
<td>TOSAM</td>
<td>Traffic Operations and Safety Analysis Manual</td>
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<tr>
<td>TRB</td>
<td>Transportation Research Board</td>
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<tr>
<td>TWSC</td>
<td>Two-Way Stop Control</td>
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<tr>
<td>VCTIR</td>
<td>Virginia Center for Transportation Innovation and Research</td>
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<tr>
<td>VDOT</td>
<td>Virginia Department of Transportation</td>
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<tr>
<td>VISSIM</td>
<td>Verkehr In Städten – SIMulationmodel</td>
</tr>
<tr>
<td>VTRC</td>
<td>Virginia Transportation Research Council</td>
</tr>
<tr>
<td>V/C</td>
<td>Volume to Capacity</td>
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<tr>
<td>XDL</td>
<td>Crossover Displaced Left-Turn</td>
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1 Introduction

1.1 BACKGROUND

Traffic and safety analysis tools help transportation professionals analyze the operational and safety components of transportation networks under both existing and future conditions. As a result, these tools play an important role in the decision-making process that lead to transportation solutions. As the complexity of potential improvement concepts increases, it is important for transportation professionals to choose the most appropriate traffic and safety analysis tool(s).

1.2 PURPOSE OF THIS MANUAL

There are several types of traffic and safety analysis tools designed to fit projects of different sizes, scopes, and objectives. Depending on the project type, there may be more than one suitable traffic or safety analysis tool, or the project may require more than one traffic or safety analysis tool be used simultaneously. Furthermore, the selection of traffic and safety analysis tools for a project may vary depending on the analyst or VDOT project manager preference. For these reasons, the VDOT developed this manual, the Traffic Operations and Safety Analysis Manual (TOSAM), to provide direction to VDOT project managers in selecting the most appropriate traffic and safety analysis tool(s) during the project scoping phase; understanding the data requirements and standard assumptions related to each analysis tool; and producing consistent output from these tools for traffic operations and safety analyses. This manual supersedes the VDOT Traffic Operations Analysis Tool Guidebook (TOATG), Version 1.1.

The TOSAM establishes consistent and uniform direction and guidance for scoping, conducting, and reporting traffic and safety analyses in Virginia. Statewide uniformity across traffic and safety analyses is intended to improve the quality of deliverables for traffic and safety analyses and accelerate the review process for VDOT project managers. This document provides both direction, which is required, and guidance, which is recommended, for all applicable study types, which are defined in Section 1.3. The direction and guidance provided herein are intended to be used by both VDOT personnel, localities, and consultants working on projects that will ultimately be submitted to VDOT for review. This document will help to standardize the evaluation of various design, traffic operations, planning, and safety analyses. To most effectively use this manual, VDOT project managers should consult with technical specialists (traffic engineers, transportation planners, safety specialists, and/or traffic microsimulation modelers), as needed, to obtain assistance in scoping the project; selecting the most appropriate traffic and safety analysis tool(s); and conducting and/or reviewing traffic and safety analyses.

The primary products of this manual are:

- Direction and guidance for the acceptable range of conditions under which various traffic and safety analysis tool(s) may be used to evaluate transportation conditions for analyses either conducted by or for VDOT, or ones that require VDOT review, comment, and/or approval;
- Direction and guidance for data collection types and methods for traffic operations and safety analyses;
- Standard assumptions to be used for each traffic and safety analysis tool;
- Standard output summary templates and requirements for each traffic and safety analysis tool; and
- Direction and guidance on the traffic and safety project process from scoping through reporting.
1.3 POTENTIAL USES OF THIS MANUAL

There is an unlimited array of geometric and operational conditions that could be addressed in this manual. Since it is impractical to address all possible combinations of traffic and geometric conditions, this manual provides direction and guidance on the selection of traffic and safety analysis tools for the following four types of analysis scenarios, which are defined and discussed in more detail in Chapter 2.

- Interrupted-flow operations analyses
- Uninterrupted-flow operations analyses
- Miscellaneous analyses
- Safety analyses

If a scenario is encountered that varies from these four types of analysis scenarios, VDOT personnel will provide direction and guidance on which scenario to use, on a case-by-case basis, based on VDOT policies and engineering judgment. This direction and guidance shall be documented for future reference. Supplemental direction and guidance may be developed and incorporated into future versions of this manual.

This manual provides direction and guidance for operational and safety analyses for studies that focus on short-term and long-term conditions. The following study types, as well as measures of effectiveness (MOEs), are covered in this manual:

- Study types, including but not limited to:
  - Traffic operations analyses
    - Traffic signal timing
    - Freeway weaving and ramp analyses
    - Congestion mitigation studies
  - Access management studies (traffic operations only)
  - Traffic Impact Analyses (TIAs) not covered under VDOT TIA Regulations Administrative Guidelines (Chapter 527 of the 2006 Acts of Assembly)
  - Design-related analyses
    - Interchange justification/ modification (IMR/IJR) studies
    - Roadway design analyses (turn-bay length, number of lanes, etc.)
    - Maintenance of traffic analyses (work zone analysis)
  - Safety analyses
    - Access management studies (safety analysis only)
    - Safety improvement alternatives evaluation
    - Design alternatives evaluation including design exceptions and waivers assessments
- Measures of Effectiveness (MOEs)
  - Maximum queue length (feet)
  - 95th percentile queue length (feet)
  - Microsimulation delay (seconds per vehicle)
  - Control delay (seconds per vehicle)
  - Volume-to-capacity ratio
  - Density (passenger cars per lane per mile or vehicles per lane per mile)
  - Space mean speed (miles per hour)
  - Time mean speed (miles per hour)
Chapter 1 – Introduction

- Travel time (seconds)
- Percent time spent following (percentage)
- Percent of free-flow speed (percentage)
- Predicted crashes or predicted average crash frequency (crashes or crashes per year)
- Expected crashes or expected average crash frequency (crashes or crashes per year)
- Conflicts (number)

The following study types are **not** covered in this manual; however, this manual may be used as a guidance document for these study types when applying the traffic operations and safety analysis tools detailed in the manual.

- Planning data-based studies
  - Studies requiring the use of sketch planning tools (e.g., spreadsheets, GIS) that are used to produce order-of-magnitude estimates of transportation and land use demand and impacts
  - Studies requiring the use of travel demand models as the main means for analysis or to determine general traffic volume based improvements (e.g., “2,000 vehicles per hour (vph) requires two travel lanes”)
  - Annual Average Daily Traffic (AADT) based operations analyses
  - First- and second-tier NEPA studies

- Safety studies
  - Sight distance evaluations
  - Guardrail assessments
  - Signing and marking evaluations
  - Roadway safety assessments
  - VDOT Highway Safety Improvement Program (HSIP) Studies
  - Systematic safety evaluations

- Other studies
  - Speed studies
  - Signal warrant analyses

For the study types covered in this manual, direction and guidance are provided to assist VDOT project managers with the selection of appropriate traffic and safety analysis tool(s). The direction and guidance on tool selection provided in this manual are based on the functionality of the tools, roadway congestion levels, type of study to be conducted, and required MOEs.

This manual does not address other considerations such as the cost of analysis, time to conduct an analysis, data availability, and training requirements for different tools. VDOT project managers should weigh these considerations in conjunction with the direction and guidance provided in this manual when selecting traffic and safety analysis tools.

### 1.3.1 Role of the VDOT Project Manager

The VDOT project manager is responsible for overseeing and directing the project from scoping through project delivery. The VDOT project manager is responsible for ensuring the direction and guidance presented in this manual are followed and should consult with technical specialists, as needed, throughout the project process. Refer to the following VDOT policy documents regarding the role of the VDOT project manager:

- Department Policy Memoranda (DPM) “VDOT Project Management” - DPM Number: 1-21
- Project Management Procedures (PMO) “Initiate Project Scope” - PMO-1.4
- Project Management Procedures (PMO) “Final Project Scope” - PMO-4.2
The VDOT project manager is responsible for reviewing the direction and guidance in this manual and determining if any deviations are necessary, except for direction and guidance specified in VDOT policy. If the VDOT project manager, in coordination with his/her technical project team, decides to use an alternate traffic or safety analysis tool or deviate from the direction outlined in this manual, the Regional Traffic Engineer (RTE), or his/her designee, shall be required to approve the deviation. Justification for deviations from any direction or guidance shall be documented in the technical report. Information such as the overall goal(s) of the project; the required MOE(s); functionality of the traffic or safety analysis tools; and available budget, schedule, and resources should be considered when determining the most appropriate traffic or safety analysis tool to use.

1.4 **TRAFFIC AND SAFETY PROJECT DELIVERY PROCESSES**

This manual is intended to be used throughout the traffic and safety project delivery processes. The project delivery process include all activities that occur within a traffic and safety project between initiating a project scope and completing the project deliverable. The following sections of the manual address the role of the VDOT project manager, as well as the use of this manual in the scoping, reporting, and quality control review processes.

Federal and/or state requirements govern the project development process and reporting requirements for traffic and safety studies. When applicable, the latest versions of the federal and/or state requirements shall be followed. In cases where direction provided in this manual conflicts with federal requirements, the federal requirements shall take precedence. Federal or state administrative requirements include, but are not limited to, the following:

- Interchange Justification Report (IJR) or Interchange Modification Report (IMR), VDOT Location and Design Division Instructional and Informational Memorandum (IIM-LD-200.7, or latest version)
- VDOT Road Design Manual

### 1.4.1 Traffic and Safety Analysis Scoping Processes

This manual shall be used during both the traffic analysis and safety analysis scoping processes. The traffic analysis scoping process and the safety analysis scoping process are two separate processes that may be performed independently of each other, but may also be performed together. The traffic and safety analysis tools and methodologies agreed upon during the scoping process will be applied during the analysis phase of the project. The VDOT project manager shall be involved in the scoping process and supported by technical specialists familiar with the methods and tools associated with operational and/or safety analyses. The following topics are recommended for discussion during the scoping process and should be agreed upon and documented during the traffic and safety analysis scoping processes.

- **Purpose:** Define the project purpose, need, and objective(s).
- **Project Management:** Establish the project schedule, milestone dates, and number and purpose of meetings.
- **Study Limits:** Define the physical study area and time of day limits of the study.
• **Measures of Effectiveness**: Identify the MOE(s) to be used in the analysis and acceptable thresholds for each MOE. MOE(s) should be selected based on the purpose of the project. A minimum of two MOEs shall be identified, when possible.

• **Analysis Tool Selection**: Determine the traffic and safety analysis tool(s) to be used, along with the specific versions, based on the analysis category, location type, saturation conditions, and microsimulation requirements. The VDOT Software Selection Tool, which is one of the companion macro tools to this manual, shall be used to help the study team to select and document the traffic and safety analysis tool selection.

• **Data Collection**: Determine the sources and collection methods for roadway geometry, traffic volumes, traffic signal data, traffic microsimulation model calibration data, and safety data. The methodology for selecting peak hour(s); determining and applying seasonal adjustment factors; and volume balancing, if applicable, should be decided.

• **Microsimulation**: Define calibration thresholds and determine the calibration methodology for projects using microsimulation. Direct the study team to use the VDOT Sample Size Determination Tool that accompanies this manual to determine the number of microsimulation runs required.

• **Alternatives Analysis**: Establish the analysis years, number of analysis scenarios, and the alternatives screening criteria. The traffic forecasting methodology should be approved by the VDOT project manager.

• **Output/Reporting**: Establish the depictive and tabular output format(s) and the reporting documentation requirements.

The traffic analysis and safety analysis project scoping processes should include a discussion on the estimated level of effort to complete the project. This discussion should include all subject matter experts and should consider the schedule, budget, and available resources. In addition, the complexity of the analysis area, number of alternatives, congestion levels, and type of analysis tools should also be taken into account. Time for microsimulation, calibration, and model review are additional factors to consider for projects involving microsimulation analyses.

When considering whether or not a safety analysis should be conducted, consider the following questions:

• Is the project funded using federal dollars?
• Are multiple alternatives being evaluated?
• Are significant geometric changes being made to a roadway?
• Is a safety analysis required by state regulations?

In addition, the safety analysis project scoping process shall include a review of VDOT’s safety planning data to identify locations with high potential for safety improvement (PSI). PSI indicates a higher historical crash rate than the rate predicted by the HSM methodology, which is based on national averages. Listings and maps of roadway segments and intersections with the highest ranked PSI values in each VDOT district are published by TED each year. All PSI locations in the project limits shall be included in the safety analysis.
1.4.2 Reporting Guidelines

Traffic and safety analysis reports are used to document the project purpose, analysis results, and conclusions. Report formats and level of detail will vary depending on the type of project, complexity of the project, and the intended audience. Project specific reporting guidelines should be determined on a case-by-case basis and agreed upon by the VDOT project manager. The following list of basic report sections should be considered:

- Title Page
- Executive Summary
- Table of Contents
- Introduction
  - Purpose and Need
  - Project Background
  - Project Location Map
  - Analysis Objective(s)
- Analysis Methodology
  - Assumptions
  - Identification of Analysis Years/Scenarios
  - Analysis Tools
  - Measures of Effectiveness
- Existing Conditions Analysis
  - Data Collection
  - Field Review
  - Analysis Tool Calibration and Validation
  - Analysis Approach and Results
  - Microsimulation Approach and Results
  - Crash Analysis
- Future Alternatives Analysis
  - Traffic Forecasting
  - No-Build Analysis Results
  - Development of Alternatives
  - Build Alternatives Analysis Results
  - Summary of Results
- Conclusions and Recommendations
- References
- Appendix

It is important that appropriate documentation be submitted with the report to support the traffic and safety analyses. Traffic and safety analysis reports shall be submitted in electronic format and shall contain the complete report, documentation of any deviation(s) from direction and guidance in this manual, and the analysis files from all tools used, so the VDOT project manager and/or his/her designee, may review the results using the appropriate traffic or safety analysis tool. In addition, any requirements for hard copies of the report shall
be determined by the VDOT project manager on a case-by-case basis. Recommended output formats for each traffic and safety analysis tool to be used in reporting are addressed in Chapter 8.

1.4.3 Quality Control

Quality control (QC) is a critical part of all traffic and safety analyses. Quality control reviews shall be performed throughout the life of the project and time for these reviews shall be included in the project budget and schedule. The purpose of quality control reviews is to verify that parameters and assumptions match the study requirements, analyses are performed appropriately, models are properly calibrated, and results are reasonable. Independent reviewers with experience in traffic and safety analyses commensurate with the scope of the project shall complete the quality control reviews.

The Traffic and Safety Operations Analysis Reviewers Prompt List, which is provided in Appendix B, should be used during the quality control review process.

1.5 MANUAL ORGANIZATION

This manual consists of the following chapters:

- **Chapter 1 – Introduction**
  
  This chapter provides an overview of the manual, including the background, purpose, and applications of the document. A summary of the project development process, with discussion on the use of the manual from scoping through reporting, is also included.

- **Chapter 2 – Common Analysis Scenarios**
  
  This chapter defines study area characteristics, the types of traffic and safety analysis scenarios considered in this manual, and the difference between oversaturated and undersaturated conditions.

- **Chapter 3 – Traffic and Safety Analysis Tools**
  
  This chapter provides a brief description of each traffic and safety analysis tool included in this manual:
  - VDOT Work Zone Spreadsheets
  - HCS (Highway Capacity Software) 2010
  - SIDRA Intersection
  - Vistro
  - Synchro
  - SimTraffic
  - CORSIM
  - VISSIM
  - VDOT Extended HSM Spreadsheets (Highway Safety Manual Part C: Predictive Methods)
  - IHSDM (Interactive Highway Safety Design Model)
  - ISATe (Enhanced Interchange Safety Analysis Tool)
  - SSAM (Surrogate Safety Assessment Model)

- **Chapter 4 – Measures of Effectiveness (MOEs)**
  
  This chapter defines the MOEs used to interpret traffic and safety analysis results considered in this manual. Direction and guidance on applying level of service (LOS), determining acceptable thresholds for MOEs, and using sensitivity testing is also provided.
• **Chapter 5 – Microsimulation**
  This chapter provides direction and guidance on the use of microsimulation tools for traffic operations and safety analyses. The direction and guidance covers scenarios where microsimulation analysis may be needed, base model development methodology, acceptable calibration thresholds, and the selection of the appropriate number of microsimulation runs.

• **Chapter 6 – Standard Requirements for Analyses**
  This chapter describes the standard requirements for different types of traffic and safety analyses. Standard requirements addressed in this chapter include geometric data, traffic count data, traffic signal operations data, calibration data, and safety data. Direction and guidance on acceptable sources of data are also provided.

• **Chapter 7 – Standard Input Parameter Assumptions for Tools**
  This chapter provides direction and guidance on appropriate parameters for each traffic and safety analysis tool addressed in this manual. Direction and guidance are not provided for every parameter, but rather for parameters that require additional clarification or where modification of default values is recommended.

• **Chapter 8 – Output**
  This chapter describes the approved, standardized output formats to be used for reporting results from each of the traffic and safety analysis tools.
Chapter 2 – Common Analysis Scenarios

2 Common Analysis Scenarios

There are many analysis scenarios that may be evaluated on any given project. In many cases, the use of multiple traffic analysis tools will be required to meet the project requirements. It is important to understand the differences between the various analysis scenarios, so the appropriate traffic analysis tool may be selected. The TOSAM considers the following four types of analysis scenarios:

- Interrupted-Flow Operations Analyses
- Uninterrupted-Flow Operations Analyses
- Miscellaneous Analyses
- Safety Analyses

This chapter includes a description of each of these analysis scenarios in more detail, a description of the study area classifications (e.g., points, segments), and the definition of oversaturated and undersaturated conditions.

2.1 STUDY AREA CLASSIFICATIONS

This document references the following six roadway system components to define the scope of the project, as defined by the Transportation Research Board (TRB) *Highway Capacity Manual 2010* (HCM) or the American Association of State Highway and Transportation Officials (AASHTO) *Highway Safety Manual* (HSM).

- **Point:** A point is the smallest roadway system components. The *HCM 2010* defines a “Point” as follows:
  - “Points are places along a facility where (a) conflicting traffic streams cross, merge, or diverge; (b) a single traffic stream is regulated by a traffic control device; or (c) there is a significant change in the segment capacity (e.g., lane drop, lane addition, narrow bridge, significant upgrade, start or end of a ramp influence area).”
  - Intersections, whether they are unsignalized, signalized, or roundabouts, are considered points. An intersection is defined by the *HSM* as a “general area where two or more roadways or highways meet, including the roadway, and roadside facilities for pedestrian and bicycle movements within the area.”

- **Segment:** A segment consists of two points and is defined as follows:
  - *HCM:* “A segment is the length of roadway between two points. Traffic volumes and physical characteristics generally remain the same over the length of a segment, although small variations may occur (e.g., changes in traffic volumes on a segment resulting from a low-volume driveway). Segments may or may not be directional.”
  - *HSM:* “A portion of a facility on which a crash analysis is performed. A segment is defined by two endpoints.”
  - Example segments include urban street segments, weaving segments, freeway diverge/merge segments, and basic freeway segments.

- **Facility:** Facilities are made up of more than two points and segments. A facility is defined as follows:
  - *HCM:* “Facilities are lengths of roadways, bicycle paths, and pedestrian walkways composed of a connected series of points and segments. Facilities may or may not be directional and are defined by two endpoints.”
  - *HSM:* “A length of highway that may consist of connected sections, segments, and intersections.”

- **Corridor:** A corridor is comprised of multiple facilities. The facilities must be parallel and may be an assortment of freeway, urban street, transit, or pedestrian/bicycle facilities. The *HCM 2010* defines a corridor as follows:
“Corridors are generally a set of parallel transportation facilities designed to move people between two locations.”

**Area:** An area consists of numerous facilities. Within an area, facilities do not need to be parallel to one another. The HCM 2010 defines areas as follows:

“Areas consist of an interconnected set of transportation facilities serving movements within a specified geographic space, as well as movements to and from adjoining areas. The primary factor distinguishing areas from corridors is that the facilities within an area need not be parallel to each other. Area boundaries may be set by significant transportation facilities, political boundaries, or topographical features such as ridgelines or major bodies of water.”

**System:** A system is a larger version of an area. The HCM 2010 defines a system as follows:

“Systems are composed of all the transportation facilities and modes within a particular region. A large metropolitan area typically has multiple corridors passing through it, which divide the system into a number of smaller areas. Each area contains a number of facilities, which, in turn, are composed of a series of points and segments. Systems may also be divided into modal subsystems (e.g., the roadway subsystem, the transit subsystem) as well as subsystems composed of specific roadway components (e.g., the freeway subsystem, the urban street subsystem).”

### 2.2 INTERRUPTED-FLOW OPERATIONS ANALYSES

Within the intersection operations analyses scenario, multiple intersection types are considered in this manual. Descriptions of each analysis scenario are described below:

- **Signalized Intersection Operations:** This type of analysis is used to evaluate the functionality of an intersection controlled by a traffic signal in terms of specific MOEs, such as delay and queue.
- **Signalized Intersection Preemption and/or Transit Priority Operations:** This type of analysis is used to evaluate the impacts of a preemption or priority event at a signalized intersection, with or without transit operations with specific MOEs, such as delay and queue.
- **Unsignalized Intersection Operations:** This type of analysis is used to evaluate the functionality of an intersection not controlled by a traffic signal in terms of specific MOEs, such as delay and queue. All-way stop-controlled and two-way stop-controlled intersections are included in this scenario.
- **Roundabout Operations:** This type of analysis is used to evaluate the functionality of a roundabout in terms of specific MOEs including speed, delay, and queue.
- **Arterial Operations:** This type of analysis is used to evaluate the functionality of a roadway featuring interruptions in flow due to signalized and unsignalized intersections and is used to determine the functionality of the facility in terms of speed and queue.
- **Non-Traditional Intersection/Interchange Operations:** This type of analysis is used to evaluate the functionality of non-traditional intersections in terms of specific MOEs including speed, delay, and queue. Examples of this scenario include 5-legged intersections, Diverging Diamond Interchanges (DDI), Single Point Urban Interchanges (SPUI), Superstreet Intersections, Continuous Green-T Intersections (CGT), and Continuous-Flow Intersections (CFI). These analyses only pertain to the intersection operations for interchanges such as DDIs and SPUIs as opposed to the ramp and ramp-freeway junction operations.
- **Parking Area Operations:** This type of analysis is used to evaluate the impacts of on-street parking on arterial operations.
- **Public Transit Facility Operations:** This type of analysis is used to evaluate the functionality of different types of public transit facilities, such as Bus Rapid Transit (BRT) and Light-Rail Transit (LRT).
Chapter 2 – Common Analysis Scenarios

This manual is not intended to provide guidance on large scale design and policy-driven analyses. For such instances, the VDOT project manager shall coordinate with the Department of Rail and Public Transit (DRPT).

- **Adaptive Signal Control Technologies (ASCT) Operations:** This type of analysis is used to evaluate ASCT at single intersections or on an arterial facility. ASCTs contain algorithms that adjust traffic signal timings every few minutes based on real-time traffic information.

- **Pedestrian and Bicycle Operations:** This type of analysis is used to evaluate the functionality of bicycle and/or pedestrian facilities, including sidewalks, multi-use trails or paths, crosswalks at intersections, and bicycle lanes adjacent to mainline lanes of travel. The results provided in these analyses are based on functionality of bicycle and pedestrian facilities themselves and not their impact on traffic signal operations. For intersection analyses, the number and location of pedestrians and bicyclists are parameters to the analysis.

- **Multimodal Facilities:** This type of analysis is used to evaluate the functionality of roadway facilities that service a variety of transportation modes including automobiles, transit, bicycles, and pedestrians. These facilities include areas such as transit centers and airport terminals.

### 2.3 UNINTERRUPTED-FLOW OPERATIONS ANALYSES

A highway, freeway, and/or interchange network consists of several components that may be analyzed. These network components are described in more detail below:

- **Freeway Segment Operations:** For this type of analysis, freeway segments not influenced by merging, diverging, or weaving maneuvers are analyzed in terms of speed and density. Lane changing impacts within a basic freeway segment should only be attributed to passing operations.

- **Freeway Merge/Diverge Segment Operations:** Freeway merging and diverging segments occur primarily at or near interchanges in the presence of an on- and off-ramp. A merging analysis is considered when two or more streams of traffic combine to form a single stream of traffic, while a diverging analysis is considered when a single stream of traffic divides into two or more streams of traffic. This type of analysis is used to evaluate the functionality of a merge or diverge area in terms of speed and density.

- **Freeway Weaving Segment Operations:** Freeway weaving segments are formed when streams of traffic traveling in the same direction are forced to change lanes and cross paths over a significant length of freeway. This type of analysis is used to evaluate the functionality of the weaving segment in terms of speed and density.

- **Managed Lane or Ramp Metering Operations:** Managed lanes and ramp metering control transportation demand by imposing travel restrictions. A managed lane provides operational flexibility by separating one or more lanes from the general purpose lanes on a freeway. The managed lanes control demand through pricing and vehicle eligibility strategies. A ramp metering system restricts access to freeways by regulating traffic entering the network based on operational conditions on the freeway. This type of analysis is used to evaluate the functionality of managed lanes or the impacts of ramp metering on a freeway facility in terms of speed and density.

- **Collector-Distributor Facility Operations:** A collector-distributor facility (or “C-D road”) is parallel to a freeway facility, and is intended to “collect” and “distribute” traffic to one or more interchanges, while also removing weaving, merging, and diverging movements from the mainline freeway. This type of analysis is used to evaluate the functionality of the C-D road in terms of speed and density.

- **Multilane Highway Operations:** This type of analysis is used to evaluate the functionality of a highway with at least two travel lanes in each direction, with traffic signals spaced greater than one mile apart, and with speeds greater than 45 mph. These types are facilities are not arterials nor are they freeways. Unlike
freeways, multilane highway are not limited-access facilities; however, this type of analysis does not account for interruptions in flow due to signalized intersections. This type of analysis is used to evaluate the functionality of the multilane highway in terms of speed and density.

- **Two-Lane Highway Operations**: This type of analysis is used to evaluate the functionality of a highway with one travel lane in each direction, although it may also include a truck climbing lane in one direction. This type of analysis does not account for interruptions in flow due to signalized intersections. This type of analysis is used to evaluate the functionality of the multilane highway in terms of average travel speed (ATS), percent time spent following (PTSF), and percent of free-flow speed (PFFS).

### 2.4 MISCELLANEOUS OPERATIONS ANALYSES

The multimodal and miscellaneous analyses category is intended to capture common analyses that do not include characteristics of the two previously described categories, such as multimodal facilities, toll plazas, parking areas, public transit facilities, work zones, and pedestrian and bicycle facilities. Each of these analysis types is described in more detail below:

- **Toll Plaza Operations**: This type of analysis is used to evaluate the functionality, capacity, and serviceability of a toll collection system.

- **Gated Operations**: This type of analysis is used to evaluate the functionality, capacity, and serviceability of a gated facility. Gated operations may occur at secure locations such as military bases or draw bridges.

- **Work Zone Operations**: This type of analysis is used to evaluate the impacts of a work zone on freeway and arterial operations.

- **Active Traffic Management (ATM)**: This type of ITS solution includes an integrated set of operating strategies and technologies for managing transportation demand, such as advanced lane control signal systems, variable speed limits, dynamic junction control, speed harmonization, and automated signs. This type of analysis is used to examine network functionality for a variety of MOEs including speed, density, travel time, or queue.

- **Dynamic Traffic Assignment (DTA)**: DTA simulates vehicles making alternative route choices based on factors within a network, such as congestion and travel times. It may be appropriate use DTA when evaluating bottleneck removal; ATM and ITS strategies; managed lanes; tolled facilities; transportation demand management strategies; incident management response scenarios; special events; work zone impacts; and/or construction diversion.

Topics such as ATM and DTA are not addressed in detail in this manual. Additional guidance on these topics may be found in the following FHWA Traffic Analysis Toolbox documents:

- Volume XIV: Guidebook on the Utilization of Dynamic Traffic Assignment in Modeling, November 2012
- Guide for Highway Capacity and Operations Analysis of Active Transportation and Demand Management Strategies, June 2013

### 2.5 SAFETY ANALYSES

Common safety analysis scenarios are used to evaluate the predicted safety operations of intersections, segments, and facilities. Each of these safety analysis scenarios is currently available in Parts C and D of the *HSM* is described in more detail below.
- **Rural Two-Lane Roads:** This type of analysis uses crash modification factors and/or crash prediction models, as detailed in the HSM, to determine predicted or expected crashes on rural two-lane roads. A rural two-lane road analysis will consist of the following components:
  - Intersections
  - Segments
  - Facilities

- **Rural Multilane Roads:** This type of analysis uses crash modification factors and/or crash prediction models, as detailed in the HSM, to determine predicted or expected crashes on rural multilane roads (currently limited to four lanes). A rural multilane road analysis will consist of the following components:
  - Intersections
  - Segments
  - Facilities

- **Urban and Suburban Arterials:** This type of analysis uses crash modification factors and/or crash prediction models, as detailed in the HSM, to determine predicted or expected crashes on urban and suburban arterials. An urban and suburban arterials analysis will consist of the following components:
  - Intersections
  - Segments
  - Facilities

- **Freeway Facilities and Interchanges:** This type of analysis uses crash modification factors and/or crash prediction models, as detailed in the HSM, to determine predicted or expected crashes on freeway facilities and interchanges. An urban and suburban arterials analysis will consist of the following components:
  - Freeway Segments
  - Ramp Segments
  - Ramp Terminals (i.e., intersections)
  - Freeway Facilities

- **Non-Traditional Safety Analyses:** This type of analysis uses crash modification factors or traffic modeling results to evaluate the safety benefits of roadway configurations that may fall outside of the methodologies detailed in the HSM. This type of analysis may be required for arterials with higher volumes or more lanes than supported by the HSM. It may also be required for non-traditional intersection configurations such roundabouts and continuous-flow intersections.

### 2.6 UNDERSATURATED AND OVERSATURATED CONDITIONS

It is important to recognize the difference between undersaturated and oversaturated traffic conditions when choosing the most appropriate traffic analysis tool. The HCM 2010 defines undersaturated flow and oversaturated flow as follows:

“Traffic flow during the analysis period is specified as ‘undersaturated’ when all of the following conditions are satisfied: (a) the arrival flow rate is lower than the capacity of a point or segment, (b) no residual queue remains from a prior breakdown of the facility, and (c) traffic flow is unaffected by downstream conditions.”

“Traffic flow during an analysis period is characterized as ‘oversaturated’ when any of the following conditions is satisfied: (a) the arrival flow rate exceeds the capacity of a point or segment, (b) a queue created from a prior breakdown of a facility has not yet dissipated, or (c) traffic flow is affected by downstream conditions.”
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For uninterrupted-flow facilities, speed may be used as an indicator of whether a facility is undersaturated or oversaturated. As uninterrupted-flow facilities approach capacity, travel speeds decline; therefore, a facility may be identified as operating under undersaturated conditions when speeds remain at or near the posted speed limit.

The determination of when a study area should be considered oversaturated should be based on the following sources of information:

- Current traffic count data
- Current traffic analysis results
- Results from previous studies completed in the study area within the last 5 years
- Congestion mapping

One common phenomenon resulting from oversaturated conditions is peak hour spreading (PHS). PHS is most prevalent in urban and suburban transportation networks where the peak hour traffic demand exceeds the available traffic capacity throughout the entire peak hour. This excess traffic then “spreads” to either side of the computed peak hour, which creates a peak period of two or more hours as opposed to just one hour. Refer to Figure 1 for an example of one type of PHS.

There are various degrees of PHS that may occur depending on the extent of peak hour traffic demand and hourly peak period travel distributions; however, the occurrence of PHS should be accounted for in operational analyses. The analysis of PHS requires the use of microsimulation tools, such as CORSIM or VISSIM, and requires traffic data to be entered in 15-minute intervals until all peak hour traffic demand is successfully spread across the adjacent 15-minute periods. The analysis period should be long enough to allow the network to recover from PHS, which occurs when the demand no longer exceeds capacity.

In many instances, a study area may be considered undersaturated under existing conditions but may be classified as oversaturated under future conditions. Special consideration should be given to the saturation conditions in the future years of analyses when selecting the most appropriate traffic analysis tool(s). If a study area is approaching capacity under the base year condition, then depending on the assumed traffic growth rate, oversaturated conditions should be assumed in the future year. Because of this issue, estimated future traffic volumes should be brought to the scoping meeting.

**Figure 1: Example of Peak Hour Spreading (PHS)**

![Image of PHS diagram]
3 Traffic and Safety Analysis Tools

A number of traffic and safety analysis tools may be used to determine results for the common analysis scenarios described in Chapter 2. Based on current traffic operations and safety analysis practices in the VDOT districts, twelve traffic operations and safety analysis tools were included in this manual. The VDOT Software Selection Tool (SST), as shown in Figure 2, was developed to assist users with selecting the appropriate traffic operations and safety analysis tools. The SST is based on the Tool Selection Matrix in Appendix D, which incorporates the functionality and capabilities of each tool. Brief descriptions on the functionality of each tool are provided in the following sections of this chapter.

![Figure 2: SST Input Form](image)

Each traffic and safety analysis tool has limitations that should be considered when selecting a tool. An example of a tool limitation is the maximum number of travel lanes on an approach. Brief descriptions of each tool listed in this chapter do not detail all limitations of each tool; therefore, users should verify that analysis scenarios fall within the functionality of a tool prior to selecting the tool.

It is important to understand that the user is responsible for any results derived from analysis tools. The user shall document that they have reviewed the results from analysis tools by understanding the capabilities and limitations for each tool. The results derived from tools used outside of their limitations may yield inconclusive or misleading results.

3.1 SUMMARY OF ANALYSIS TOOLS

Traffic analysis tools are frequently updated as enhancements are made or when new traffic or safety analysis methodologies are developed, such as when highway capacity equations or thresholds are changed. Prior to selecting traffic and safety analysis tools, verify which version(s) of analysis tools are accepted by VDOT.

Table 1 identifies the version(s) of each analysis tool described in this manual. This also serves as a reference to which version(s) are applicable to the direction and guidance provided in this manual.
Analysis tool versions not listed in **Table 1** will be permitted for use on projects at the discretion of the VDOT project manager and with the approval of the RTE or his/her designee. The same version and build of analysis tool(s) shall be used throughout the life of a project, even if new versions or builds are released, because different versions and builds of the same tool often yield different output results for identical parameters.

**Table 1: Traffic and Safety Analysis Tools in this Manual**

<table>
<thead>
<tr>
<th>Traffic and Safety Analysis Tool</th>
<th>Version(s)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>VDOT Work Zone Spreadsheets**</td>
<td>Varies by VDOT Operations Region. Request the current version from the VDOT Regional Operations that the project is located in.</td>
</tr>
<tr>
<td>Highway Capacity Software (HCS) 2010</td>
<td>HCS 2010, Version 6.5</td>
</tr>
<tr>
<td>SIDRA Intersection</td>
<td>SIDRA Intersection 6</td>
</tr>
<tr>
<td>Vistro</td>
<td>Vistro 3</td>
</tr>
</tbody>
</table>
| Synchro                           | Synchro 8  
Synchro 9 |
| SimTraffic                        | SimTraffic 8  
SimTraffic 9 |
| CORSIM                            | TSIS 6.3 |
| VISSIM                            | VISSIM 6  
VISSIM 7 |
| VDOT Extended HSM Spreadsheets    | HSM Rural 2-Lane Roads  
HSM Rural Multilane Roads  
HSM Urban Suburban Arterials |
| IHSDM                             | IHSDM |
| ISATe                             | ISATe – October 2011 |
| SSAM                              | SSAM – May 2008 |

*A listing of the most recent version(s) of analysis tools is available on the VDOT website under the “Manual and Guides” section. The VDOT website shall be consulted prior to selecting traffic and safety analysis tools.

**VDOT HUB-CAP may also be required to supplement the VDOT Work Zone Spreadsheets for construction projects that require road user fees to be determined.*
3.2 VDOT WORK ZONE SPREADSHEETS

The VDOT Work Zone Spreadsheets are Microsoft® Excel-based tools based on methodologies outlined in the HCM 2010 for the analysis of work zones. The VDOT Work Zone Spreadsheets are deterministic tools distributed, on request by VDOT, to evaluate the impacts of work zone mitigation strategies. These spreadsheets determine measures of effectiveness such as queuing produced by work zones. There are multiple versions of the work zone spreadsheets in use throughout Virginia; therefore, verify that the correct spreadsheet is used based on the project location.

In addition to analyzing work zone operations, the VDOT Highway User Benefit-Cost Analysis Program (HUB-CAP) should be used to determine road user fees for construction projects, including projects that require incentives and/or disincetives to be established. HUB-CAP is an application that is distributed, on request by VDOT and provides a standardized methodology for quantifying road user benefits-costs associated with various alternatives such as detours; temporary roadway and/or shoulder construction; off-peak hour day work; night work; and the most appropriate project delivery-based method. The parameters are roadway geometry and traffic and operating characteristics.

3.3 HIGHWAY CAPACITY SOFTWARE (HCS) 2010

HCS 2010 is a deterministic tool distributed by McTrans. HCS 2010 uses the methodologies outlined in the HCM 2010. HCS 2010 may be used to analyze urban street facilities, urban street segments, signalized intersections, unsignalized intersections (two-way and all-way), freeway facilities, basic freeway segments, merging and diverging segments, weaving segments, collector-distributor facilities, multilane highways, and two-lane highways.

As a deterministic tool, HCS 2010 shall not be used to analyze oversaturated conditions; however, the Freeway Facilities module of HCS 2010 may be used for the preliminary evaluation of alternatives on freeways. HCS 2010 (TRANSYT-7F) may be used to optimize traffic signal timings for an oversaturated network. These traffic signal timings should be further refined in the field and within microsimulation models.

3.4 SIDRA INTERSECTION

SIDRA Intersection is a deterministic tool developed by an Australian transportation operations company, Akcelik & Associates Pty Ltd. Although SIDRA Intersection may be used to analyze signalized, unsignalized, and roundabout intersections, its primary application in the United States has been specifically for roundabout operations. VDOT has only approved SIDRA Intersection for roundabout analyses.

The Virginia Transportation Research Center (VTRC) conducted research on roundabout analysis tools and concluded that SIDRA Intersection is the only deterministic traffic analysis tool suitable for roundabout analyses at this time.

Currently, there are two roundabout capacity models used in SIDRA Intersection: the SIDRA Standard model and the US HCM 2010 model. Unlike Synchro, both models may be used in planning and operations-level analyses and both use the same MOEs: control delay (seconds), speed (miles per hour), and queue (feet). Based on research conducted by the developers of SIDRA Intersection, the US HCM 2010 model does not account for the effects of vehicle arrivals based on adjacent traffic control devices; whereas, the SIDRA Standard model does account for these effects, which is why SIDRA Intersection shall be used for all roundabout analyses, even when microsimulation is warranted. More detailed differences between the two models are described in more detail in Chapter 7. In oversaturated conditions, a VISSIM analysis shall accompany a SIDRA Intersection roundabout analysis.
3.5 VISTRO

Vistro is a deterministic tool developed by PTV Group that is primarily used to analyze traffic operations, evaluate new development impacts, and optimize traffic signal timing. Vistro was developed specifically for traffic analysis and may be used to analyze signalized intersections, unsignalized intersections, and arterial facilities in a network. Vistro cannot be used to analyze freeways, interchange systems, or ramps; therefore, it shall only be used to analyze intersections and arterials.

Vistro is designed to use both HCM 2010 and HCM 2000 methodologies. Among many others, Vistro can output the following MOEs: volume-to-capacity (v/c) ratio, control delay, and queues. Additionally, output results may be produced in both tabular and graphical format using Vistro.

As a deterministic tool, Vistro shall not be used to analyze oversaturated conditions; however, Vistro may be used to optimize traffic signal timings for an oversaturated network. These traffic signal timings should be further refined in the field and within microsimulation models.

3.6 SYNCHRO

Synchro is a deterministic tool developed by Trafficware, and is primarily used for analyzing traffic flow, traffic signal progression, and traffic signal timing optimization. Additionally, Synchro may be used to analyze arterials, signalized intersections, and unsignalized intersections. Synchro shall not be used to analyze freeways, interchange systems, or ramps; therefore, it shall only be used to analyze intersections and arterials.

Synchro uses two different methodologies with different MOEs for analyzing intersections, HCM and Intersection Capacity Utilization (ICU). The HCM methodology is used to analyze intersection operations based on total control delay. The HCM methodology is VDOT's preferred methodology for all types of intersection operational analyses. ICU measures the capacity of an intersection and was primarily designed for planning level studies. The ICU methodology is not accepted by VDOT.

The developer of Synchro, Trafficware, differentiates between the two methodologies as follows: “The ICU has not been designed for operations and signal timing design. Delay-based methods and simulations, such as the Highway Capacity Manual (HCM), Synchro, and SimTraffic should be used for operations and signal timing designt.”

The major difference between the two methodologies is the MOEs used. The ICU methodology is based on volume-to-capacity (v/c) ratios, while the HCM methodology is based on control delay. Because of the explanation provided by Trafficware on the two methodologies, HCM methodology will be used on all intersection traffic analyses using Synchro, with the exception of Synchro analyses for traffic signal optimization. For these types of analyses, the progression optimization features in Synchro will be used.

Since Synchro is a deterministic tool, it shall not be used to analyze oversaturated conditions; however, Synchro may be used to optimize traffic signal timings on an oversaturated network. These traffic signal timings should be further refined in the field.

3.7 SIMTRAFFIC

SimTraffic is the microsimulation companion tool of Synchro and is bundled with the Synchro suite of software tools. SimTraffic may be used to model any network that can be analyzed using Synchro. Prior to conducting analyses using SimTraffic, the network shall first be developed using Synchro. Once the network is developed
in Synchro, SimTraffic can be initiated either from within the Synchro interface or independently. Similar to CORSIM and VISSIM, SimTraffic can output several measures of effectiveness, such as microsimulation delay per vehicle, travel distance, maximum queue length, travel time, and average speed. SimTraffic requires calibration as a microsimulation tool.

One of the strengths of SimTraffic is that it includes the functionality to simulate intersections, arterials, and corridors. Similar to Synchro, SimTraffic does not have the functionality to analyze freeway or interchange systems.

### 3.8 CORSIM

CORSIM (CORridor microscopic SIMulation) is a microsimulation tool that is capable of analyzing arterial and freeway networks separately and in combination. CORSIM uses car-following and driver behavior logic to simulate the traffic operational behavior of various geometric conditions as traffic volumes and speeds fluctuate. The traffic microsimulation output includes several MOEs, and may be used to analyze many different traffic conditions and roadway configurations. CORSIM requires calibration as a microsimulation tool.

CORSIM allows the evaluation of existing and future traffic operations to assist in determining the effectiveness of varying geometric configurations. Additionally, CORSIM can produce cumulative performance results over multiple time periods, so it may be used to conduct a PHS analysis. CORSIM is one of the recommended tools for analyzing oversaturated conditions.

### 3.9 VISSIM

VISSIM (Verkehr In Städten – SIMulationmodell) is a microscopic traffic microsimulation model developed by German-based PTV Group to analyze the full range of roadway and public transportation systems. The primary applications for VISSIM are arterial studies and freeway operational studies; however, VISSIM may also be used for evacuation planning, LRT/BRT studies, transit center designs, railroad grade crossing analyses, toll plaza evaluations, bicycle analyses, pedestrian analyses, ITS assessments, ATM, and DTA impacts. VISSIM requires calibration as a microsimulation tool.

VISSIM allows for flexibility to develop a wide range of roadway networks with respect to vehicle movements and roadway geometry. VISSIM will move unmet demand from one time period to subsequent time periods within the overall analysis timeframe, which is helpful in congested networks experiencing PHS. VISSIM is one of the recommended tools for analyzing oversaturated conditions.

### 3.10 VDOT EXTENDED HSM SPREADSHEETS

The VDOT Extended HSM Spreadsheets are Microsoft® Excel-based tools that were created as a joint effort between VDOT and the Alabama Department of Transportation (ALDOT) to simplify the use of the HSM Part C: Predictive Methods Spreadsheets originally developed by Oregon State University. The VDOT Extended HSM Spreadsheets and the HSM Part C: Predictive Methods Spreadsheets were created to support the AASHTO Highway Safety Manual (HSM) Part C Predictive Method Worksheets for arterials. The VDOT Extended HSM Spreadsheets are based on national data and have not been calibrated to Virginia.

The VDOT Extended HSM Spreadsheets may be used to predict crashes on two-lane rural highways, multilane (presently four-lane) rural highways, and urban and suburban arterials. Five roadway types may be analyzed with the urban and suburban arterial spreadsheet: two-lane undivided sections, three-lane divided sections (with a two-way left-turn lane), four-lane undivided sections, four-lane divided sections, and five-lane divided sections (a two-way left-turn lane).
In addition, five types of crashes are considered: multiple-vehicle non-driveway crashes, single-vehicle crashes, multiple-vehicle driveway-related crashes, vehicle-pedestrian crashes, and vehicle-bicycle crashes. The VDOT Extended HSM Spreadsheets consider the severity level of existing crash data and may be used to perform multi-year analyses. Output is summarized in a tabular format similar to the worksheets provided in Part C of the HSM. To improve functionality, the VDOT Extended HSM Spreadsheets contain macros, which are compatible with Excel 2007 or later.

### 3.11 IHSDM

Interactive Highway Safety Design Model (IHSDM) is a decision-support tool, developed and distributed by FHWA, which may be used to evaluate the safety effects of geometric design on roadways. IHSDM estimates the expected safety results for different roadway designs and checks existing or proposed roadway designs against relevant design standards. The IHSDM currently includes six evaluation models: Crash Prediction module, Design Consistency module, Intersection Review module, Policy Review module, Traffic Analysis module, and Driver Vehicle module.

IHSDM maintains a direct relationship with the HSM. The Crash Prediction module implements Chapter 10, Chapter 11 and Chapter 12 of Part C of the HSM (Predictive Methods) to address rural two-lane roads, rural multilane highways, and urban and suburban arterials. The latest release of IHSDM also implements Chapters 18 and 19 of Part C of the HSM to address freeway segments and freeway ramps.

### 3.12 ISATe

Enhanced Interchange Safety Analysis Tool (ISATe) is a Microsoft® Excel-based tool developed by FHWA used to evaluate the safety effects of geometric design decisions on freeways. ISATe provides information about the safety effects of roadway geometric design features for freeway-to-arterial and freeway-to-freeway interchanges based on the research outlined in Chapters 18 and 19 of Part C of the HSM that quantifies the relationship between various design components, traffic flows, and expected average crash frequencies. ISATe may be used to evaluate the safety of freeways, interchanges, ramps, and collector-distributor (C-D) roads. ISATe is intended to help designers make informed judgments about the safety performance of design alternatives. ISATe implements HSM methods that use safety performance functions (SPFs), crash modification factors (CMFs), and local calibration factors to estimate average crash frequency by crash type or severity. The tool may be used when no existing crash data is available, but may also incorporate existing crash data to obtain more reliable crash predictions.

### 3.13 SSAM

Surrogate Safety Assessment Model (SSAM) is an analysis tool, distributed by FHWA, used to quantify safety conflicts of roadway geometry using microsimulation results. SSAM combines microsimulation and automated conflict analysis to assess the safety effectiveness of different facilities by analyzing the frequency and character of narrowly averted vehicle-to-vehicle collisions in a microsimulation model. The software is most useful in assessing safety of roadway design alternatives yet to be built or flow-control strategies yet to be implemented.

SSAM is compatible with several microsimulation models, but only its use with VISSIM is approved by VDOT.

### 3.14 USE OF OTHER ANALYSIS TOOLS OR METHODS

There may be circumstances where it may be necessary to use one or more analysis tools that are not addressed in this manual. Approval by the RTE or his/her designee, as well as written documentation, is required for the use of other analysis tools. This decision shall be based on the proposed analysis tool(s) providing functionality that is not available with the current suite of approved tools. Two common situations where the use of other analysis tools may be warranted are described below.
Newer Versions of Analysis Tools Addressed in this Manual: New versions of common analysis tools are likely to be released before this manual is updated. VDOT would prefer to evaluate the newer versions prior to their use on projects and inclusion in this manual. However, there may be instances where a VDOT project manager may want to approve the use of a newer version of an analysis tool to take advantage of a new feature(s) that may benefit the project.

Analysis Tools with Functionality Unavailable in the Analysis Tools Addressed in this Manual: The tools addressed in this manual may not fulfill all analysis needs on projects. In these situations, VDOT project managers should consult with technical specialists to determine which tool is most appropriate for their specific project. The decision to use a tool that is not covered in this manual shall be supported by the RTE or his/her designee. If such a tool is used for a federal-aid project, FHWA approval is also required. If the tool has never been used on a project in Virginia, then the VDOT project manager shall contact the RTE and/or the Central Office TED - Systems Analysis Section for review and comment prior to using the analysis tool. Any tool that falls under this category may be evaluated for inclusion in future versions of this manual.

3.15 USE OF MULTIPLE ANALYSIS TOOLS

In many cases, only one analysis tool may be required to analyze the geometric and traffic conditions of a project; however, there may also be cases when multiple analysis tools are needed. It is important that the strengths, functionality, and limitations of each analysis tool are accounted for during the Traffic and Safety Analysis Scoping process to verify when multiple tools are required. When multiple tools are required and the VDOT project manager must decide which MOE(s) to use, it is best to report the MOEs produced by the more appropriate tool and discard the results produced by the less appropriate tool. During the scoping process, the tool associated with each MOE should be determined. More information regarding when each analysis tool is applicable may be found by using the SST or by referencing the Tool Selection Matrix in Appendix D.

While it is desirable to ensure that the results from both tools are similar, it may not be practical for them to be identical. Inconsistencies between the results from traffic and safety analysis tools cannot always be eliminated. Each tool has different methodologies for approximating real-world conditions; therefore, two tools may not present the same results. Results from both tools should be evaluated and presented. Both analysis tools should produce the same general conclusions if a thorough analysis has been conducted with both tools.

Examples of common situations where multiple tools may be selected are described below in more detail.

- Synchro or Vistro and HCS 2010: This combination may occur when a project encompasses an arterial, an interchange, and multiple freeway segments when microsimulation is not required.
  - Intersections and Arterials
    - Synchro or Vistro may be used to analyze the signalized intersections along the arterial as well as the operations on the arterial facility.
  - Freeways
    - HCS 2010 may be used to analyze interchange merging, diverging, and weaving segments, if applicable, for undersaturated freeway conditions.
  - The VDOT project manager should verify that arterial operations do not influence freeway and ramp operations to confirm that microsimulation is not required. Users should verify that queues at ramp terminals do not spill back onto the freeway and that the queues from arterial intersections do not spill back to adjacent interchanges. Additionally, users should have enough information to determine whether or not arterial operations will influence freeway and ramp operations for future conditions.
- **Synchro or Vistro and CORSIM/VISSIM:** This combination may occur when a project encompasses an arterial, an interchange, and multiple freeway segments when microsimulation is required due to factors other than those mentioned in this manual even though the network consists of undersaturated conditions.
  - **Intersections and Arterial Operations**
    - Synchro or Vistro may be used to analyze the signalized intersections along the arterial as well as the operations on the arterial facility. Alternatively, Synchro or Vistro may simply be used to develop optimized traffic signal timings for input into CORSIM/VISSIM.
  - **Intersections, Arterial, Ramps, and Freeways**
    - CORSIM/VISSIM may be used to analyze the intersections, arterials, especially for oversaturated conditions, and/or interchange ramps, and freeway operations in one model.
    - Networks should overlap when splitting them between multiple tools to model the interaction between arterials and freeways. In this case, the CORSIM/VISSIM model should include arterial intersections adjacent to the interchange to account for the interaction between the arterial facility and the freeway facility. The practice of modeling arterial intersections adjacent to interchanges assists in the calibration process of the freeway. In many cases, arterial intersections impact how traffic flows enter the freeway by creating platoons and metering traffic. It is best practice to model the arterial intersections directly adjacent to the interchange ramp terminals.

- **Synchro, Vistro, or HCS 2010 and SIDRA Intersection:** This combination may occur when a project involves the analysis of an arterial that includes a roundabout and one or more signalized or unsignalized intersections when microsimulation is not required.
  - Synchro, Vistro, or HCS may be used to analyze the signalized or unsignalized intersections along an arterial as well as the operations of the arterial facility for undersaturated conditions.
  - SIDRA Intersection shall be used to analyze any roundabouts on the arterial, since SIDRA Intersection is required for all roundabout analyses.

- **SIDRA Intersection and VISSIM:** This combination may occur when a project involves the analysis of an intersection as a roundabout when microsimulation is required due to the study area being oversaturated, when a freeway ramp terminal includes a roundabout, when an arterial contains intersections that may interact with a roundabout, or when a VISSIM model is required for other purposes (e.g., public presentation, verification of operational behavior on the roundabout).
  - SIDRA Intersection shall be used to analyze the roundabout, since SIDRA Intersection is required for all roundabout analyses.
  - VISSIM should be used to analyze the roundabout and the remainder of the study area to produce microsimulation results and animation; however, the VISSIM results shall be accompanied by SIDRA Intersection analysis results.

- **VDOT Extended HSM Spreadsheets and ISATe:** This combination may occur when a project involves performing a safety analysis for a project that includes an arterial, an interchange, and freeway segments.
  - VDOT Extended HSM Spreadsheets should be used to analyze arterial segment and intersection safety conditions.
  - ISATe should be used to analyze interchange ramps, terminals, and freeway safety conditions.

- **CORSIM/VISSIM and IHSDM/ISATe:** This combination may occur when a project involves performing traffic operations and safety analyses for a proposed interchange concept.
  - CORSIM/VISSIM may be used to analyze traffic operational conditions of existing conditions and the proposed interchange concept.
- IHSDM/ISATe may be used to analyze the safety operations of both existing conditions and the proposed interchange concept.

- **VISSIM and SSAM:** This combination may occur when a project involves performing traffic operations and safety analyses for a proposed alternative intersection concept. Alternative intersections consist of configurations that are not compatible with the VDOT Extended HSM Spreadsheets, IHSDM, and ISATe. In these instances, SSAM outputs shall not be compared with the outputs from other safety analysis tools.

- VISSIM should be used to analyze traffic operational conditions of existing conditions and the proposed alternative intersection concept. VISSIM should also be used to create a vehicle trajectory file (*.TRJ) to be imported into SSAM.

- SSAM should be used to import the vehicle trajectory files produced by VISSIM to compare the number of conflicts observed between existing conditions and the proposed alternative intersection concept.
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4 Analysis Measures of Effectiveness (MOEs)

When conducting traffic and safety analyses, there are many MOEs that may be used to document results. This chapter presents the traffic operations and safety MOEs that are accepted for use on projects conducted by or for VDOT. The use of any MOE not listed in this chapter shall be approved by the RTE or his/her designee.

4.1 TRAFFIC OPERATIONS MEASURES OF EFFECTIVENESS (MOES)

For consistency, all definitions presented for traffic operations MOEs are referenced from the HCM 2010 with an understanding that each individual traffic analysis tool may have their own interpretation of the MOE definitions. The HCM 2010 defines a performance measure as a “quantitative or qualitative characterization of some aspect of the service provided to a specific road user group.” Table 2, which denotes which MOEs are acceptable to report for each traffic analysis tool, complements the Software Selection Tool. The traffic operations MOEs approved by VDOT are described below:

- 95th Percentile Queue Length (measured in feet – ft)
  The HCM 2010 defines queue length as “the distance between the upstream and downstream ends of the queue.” The 95th percentile queue length is the queue length that has only a 5% probability of being exceeded during a given analysis period. The computation of queue length is a complex process depending on the degree of congestion. Ninety-fifth percentile queue length is an MOE that is applicable to both interrupted- and uninterrupted-flow conditions (e.g., arterial and freeway networks).

- Maximum Queue Length (measured in feet – ft)
  The HCM 2010 defines queue length as “the distance between the upstream and downstream ends of the queue.” The maximum queue length refers to the longest queue length that is observed or simulated during a given analysis period. The computation of queue length is a complex process depending on the amount of congestion. Maximum queue length is an MOE that is applicable to interrupted- and uninterrupted-flow conditions (e.g., arterial and freeway networks).

- Microsimulation Delay (measured in seconds per vehicle – sec/veh)
  Microsimulation delay is equal to the difference between the simulated travel time and the theoretical travel time if the vehicle was operating at the desired speed calculated by a microsimulation tool. Microsimulation delay is an MOE that is applicable to interrupted- and uninterrupted-flow conditions. However, for the purposes of identifying traffic analysis tools in this manual, microsimulation delay is assumed to be only applicable to interrupted-flow conditions.

- Control Delay (measured in seconds per vehicle – sec/veh)
  The HCM 2010 defines control delay as “delay associated with vehicles slowing in advance of an intersection, the time spent stopped on an intersection approach, the time spent as vehicles move up in the queue, and the time needed for vehicles to accelerate to their desired speed.” Control delay is an MOE that is only applicable to interrupted-flow conditions.

- Volume-to-Capacity (v/c) Ratio
  The HCM 2010 defines volume-to-capacity ratio as “the ratio of the flow rate to capacity for a system element.” The HCM 2010 also states that “the volume-to-capacity (v/c) ratio is a special-case service measure. This ratio cannot be directly measured in the field, nor is it a measure of driver perception. Until capacity is reached (i.e., when flow breaks down on uninterrupted-flow facilities or when queues build on interrupted- or uninterrupted-flow facilities), the v/c ratio is not perceivable by travelers.” V/C ratio is an MOE that is applicable to both interrupted- and uninterrupted-flow conditions, assuming that capacity has been defined for the facility in accordance with HCM 2010 methodology.
## Table 2: Traffic Operations Analyses MOEs

<table>
<thead>
<tr>
<th>Traffic Operations MOE</th>
<th>HCS 2010</th>
<th>SIDRA Intersection</th>
<th>Vistro</th>
<th>Synchro</th>
<th>SimTraffic</th>
<th>CORSIM</th>
<th>VISSIM</th>
</tr>
</thead>
<tbody>
<tr>
<td>95th Percentile Queue Length, ft</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Maximum Queue Length, ft</td>
<td></td>
<td></td>
<td></td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Microsimulation Delay, sec/veh</td>
<td></td>
<td></td>
<td></td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Control Delay, sec/veh</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Volume to Capacity (v/c) Ratio</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Density, pcplpm</td>
<td>✔</td>
<td></td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Density, vplpm</td>
<td>✔</td>
<td></td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Space Mean Speed, mph</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Time Mean Speed, mph</td>
<td></td>
<td></td>
<td></td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Travel Time, sec</td>
<td>✔</td>
<td></td>
<td></td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Percent Time Spent Following</td>
<td>✔</td>
<td></td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Percent of Free-Flow Speed</td>
<td>✔</td>
<td></td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
</tbody>
</table>

- **Density** (measured in passenger cars per lane per mile or vehicles per lane per mile—pcplpm or vplpm)
  The *HCM 2010* defines density as “the number of vehicles occupying a given length of a lane or roadway at a particular instant.” HCS 2010 expresses density results in passenger cars per lane per mile (pcplpm) in all uninterrupted-flow modules and also in vehicles per lane per mile (vplpm) in only the Facilities module. Microsimulation tools express density in vplpm. Density is an MOE compatible with only uninterrupted-flow conditions.

- **Space Mean Speed** (measured in miles per hour – mph)
  The *HCM 2010* defines space mean speed as “an average speed based on the average travel time of vehicles to traverse a length of roadway.” For analyses of Class I two-lane highways in HCS 2010, space mean speed
is referred to as average travel speed (ATS). Space mean speed is an MOE compatible with both interrupted- or uninterrupted-flow conditions.

- **Time Mean Speed (measured in miles per hour – mph)**
  
  The *HCM 2010* defines time mean speed as “the average speed of vehicles observed passing a point on a highway.” Time mean speed is an MOE compatible with both interrupted- or uninterrupted-flow conditions.

- **Travel Time (measured in seconds – sec)**
  
  The *HCM 2010* defines travel time as “the average time spent by vehicles traversing a highway segment, including control delay.” Travel time is an MOE compatible with both interrupted- or uninterrupted-flow conditions.

- **Percent Time Spent Following or PTSF (measured in percentage – %)**
  
  The *HCM 2010* defines percent time spent following as “the average percent of total travel time that vehicles must travel in platoons behind slower vehicles because of the inability to pass on a two-lane highway.” PTSF also represents the approximate percentage of vehicles traveling in platoons. PTSF is an MOE compatible with only uninterrupted-flow, specifically for Class I and Class II two-lane highways. This MOE shall only be used for analyses performed in HCS 2010 for undersaturated conditions.

- **Percent of Free-Flow Speed or PFFS (measured in percentage – %)**
  
  The *HCM 2010* defines percent of free-flow speed as “the average travel speed divided by the free-flow speed.” PFFS represents the ability of vehicles to travel at or near the posted speed limit.” PFFS is an MOE compatible with only uninterrupted-flow conditions, specifically for Class III two-lane highways. This MOE shall only be used for analyses performed in HCS 2010 for undersaturated conditions.

### 4.2 SAFETY MEASURES OF EFFECTIVENESS (MOES)

For consistency, definitions presented for the safety MOEs are referenced from the *Highway Safety Manual (HSM), 1st Edition*, if they are available. Table 3, which illustrates which MOEs are acceptable to report for each safety tool, complements the Software Selection Tool. The safety MOEs approved by VDOT are described below:

- **Predicted Crashes or Predicted Average Crash Frequency (measured in crashes or crashes per year)**
  
  The *HSM* defines predicted average crash frequency as “the estimate of long-term average crash frequency which is forecast to occur at a site using a predictive model found in Part C of the HSM. The predictive models in the HSM involve the use of regression models, known as Safety Performance Functions, in combination with Crash Modification Factors and calibration factors to adjust the model to site-specific and local conditions.” The predicted average crash frequency is based on crash frequencies of similar sites.

- **Expected Crashes or Expected Average Crash Frequency (measured in crashes or crashes per year)**
  
  The *HSM* defines expected average crash frequency as “the estimate of long-term expected average crash frequency of a site, facility, or network under a given set of geometric conditions and traffic volumes (AADT) in a given period of years. In the Empirical Bayes (EB) methodology, this frequency is calculated from observed crash frequency at the site and predicted crash frequency at the site based on crash frequency estimates at similar sites.” This MOE shall only be used if the EB Method is used. Direction and guidance on when to use the EB Method is provided in Chapter 7.

- **Conflicts**
  
  FHWA’s *Surrogate Safety Assessment Model and Validation: Final Report* defines a conflict as “an observable situation in which two or more road users approach each other in time and space to such an extent that there is risk of collision if their movements remain unchanged.” Conflicts may be categorized as rear-end,
lane-change, or crossing based on the angle of hypothetical collision between the two vehicles. This MOE shall only be used for analyses in which the predictive methods outlined in the HSM Part C do not apply.

Table 3: Safety Analyses MOEs

<table>
<thead>
<tr>
<th>Safety MOE</th>
<th>VDOT Extended HSM Spreadsheets</th>
<th>IHSDM¹</th>
<th>ISATe²</th>
<th>SSAM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Predicted Average Crash Frequency</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>Expected Average Crash Frequency</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>Conflicts</td>
<td></td>
<td></td>
<td></td>
<td>✔</td>
</tr>
</tbody>
</table>

4.3 APPLYING LEVEL OF SERVICE

The deterministic analysis procedures outlined in the HCM 2010 result in MOEs that are based on traffic flow theory. Level of Service (LOS) may be used to describe and illustrate the relative differences between traffic operations MOEs. The HCM 2010 provides a LOS scale for several analysis types with a letter grade corresponding to a specified range of values for one or more MOEs. For example, density values for freeway segments may be supported by the corresponding letter grades shown in Table 4.

¹ IHSDM output reports always provide an expected crash frequency. If the EB Method was used, the results should be reported as an expected crash frequency. If the EB Method was not used, the results should be reported as a predicted crash frequency.

² ISATe output reports provide an estimated crash frequency. If the EB Method was used, the results should be reported as an expected crash frequency. If the EB Method was not used, the results should be reported as a predicted crash frequency.
### Table 4: Freeway Facility Level of Service in Terms of Density

<table>
<thead>
<tr>
<th>Level of Service</th>
<th>Density (pc/mi/ln)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>≤ 11</td>
</tr>
<tr>
<td>B</td>
<td>&gt; 11 - 18</td>
</tr>
<tr>
<td>C</td>
<td>&gt; 18 - 26</td>
</tr>
<tr>
<td>D</td>
<td>&gt; 26 - 35</td>
</tr>
<tr>
<td>E</td>
<td>&gt; 35 - 45</td>
</tr>
<tr>
<td>F</td>
<td>&gt; 45</td>
</tr>
</tbody>
</table>

*Source: HCM 2010, Volume 2, Page 10-9*

In contrast to deterministic tools, microsimulation models (stochastic tools) are based on the flow of vehicles along a roadway segment in accordance with principles of physics, vehicle attributes, rules of the road, and driver behavior. Since microsimulation tools contain different definitions for similarly-named MOEs (e.g., microsimulation tools denote density in vehicles per mile whereas, HCM 2010 methods express density results in passenger cars per mile), inaccurate results and conclusions may be reported if the differences are not taken into account. For this reason, LOS shall not be used to support results from microsimulation models.

#### 4.4 SENSITIVITY TESTING

The VDOT project manager may choose to perform sensitivity analyses to evaluate how the operational or safety performance of a design alternative is impacted by uncertainties in the parameters. Sensitivity tests that may be practical for traffic operations and safety analysis projects include, but are not limited to, tests for traffic demand and design components. For example, to account for the inherent uncertainty of traffic demand forecasts, traffic demand may be varied by ± 10%, or some other percentage that indicates the expected forecast error, to determine its impact on operational results. Various design components may be similarly altered (e.g., increasing or decreasing lane or shoulder widths by one foot, increasing or decreasing cycle length by ten seconds) to determine their impacts on safety and operational results.
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5 Microsimulation

When oversaturated conditions are prevalent within a transportation system, deterministic tools shall not be used to analyze traffic operations due to limitations in the fundamental equations used to develop the tools. Microsimulation (stochastic) tools are used for conducting traffic operations analyses in oversaturated conditions, where complex geometric conditions exist, or where there is a need for traffic operational analyses based on car following behavior; however, similar to deterministic tools, microsimulation tools have limitations that need to be considered.

5.1 MICROSIMULATION APPLICABILITY

With each traffic analysis tool, there are tradeoffs that must be made during the analysis process. Deterministic tools are relatively easy to use and are not very time or data intensive. In contrast, microsimulation tools require more time, data, and cost to develop, validate, and calibrate. This difference is depicted illustratively in Figure 3.

Figure 3: Time and Cost Comparison for Deterministic and Microsimulation Tools

The difference in time and cost to use these two types of tools can be explained with the following factors (applicability is based on the type of tool used):

- additional data collection requirements for microsimulation tools for input and/or calibration purposes
  - origin-destination data
  - travel times
  - speeds
  - queue lengths
- additional time to develop and calibrate microsimulation tools
- additional time required to post-process output from microsimulation tools
- significantly more time to learn how to use and properly apply microsimulation tools
- larger computer storage requirements for microsimulation tools than for deterministic tools
The basic functionality of each type of tool is where the time and cost impacts can best be observed. Deterministic tools perform “snapshot” analyses, which, in most undersaturated conditions with non-complex geometry, is adequate. On the other hand, microsimulation tools allow the user to evaluate both undersaturated and oversaturated conditions while other factors fluctuate (speed, lane-changing behavior, driver behavior, etc.) over time. Additionally, microsimulation tools can provide 2-dimensional and/or 3-dimensional visualizations of the results allowing the user to visually observe the analysis results, which is helpful when discerning between varying levels of oversaturated conditions or for public presentations of alternatives.

The guiding principle when using either deterministic or microsimulation tools is that the model is only as accurate as the parameters that are used. This means that the most accurate and appropriate values for parameters should be used at all times and should be supported by field data and documentation, when available.

5.2 BASE MODEL DEVELOPMENT

The goal of developing a base model is to determine whether the model accurately represents the conditions to be modeled. It is good practice to develop a base model that is systematically reviewed for errors prior to starting the model calibration process. The calibration process is often a time-consuming process, but one that cannot be overlooked.

The user should first enter the geometric configuration – depending on the tool used, these will either be links and nodes or connections (e.g., roadway segments, intersections, ramps, etc.). Once the geometry has been reviewed, the user should input the traffic control (traffic signals, stop signs, stop bars, etc.), traffic volumes, and microsimulation run control data.

Thorough quality control reviews should occur during the base model development process. Reviews should verify that the network is properly coded and determine if the model is calibrated to existing traffic and geometric conditions. Fully-calibrated base models should be used to develop future microsimulation models. Calibration thresholds are discussed in Section 5.3.

5.3 CALIBRATION_THRESHOLDS

In addition to the use of accurate parameters, microsimulation tools need to be calibrated. The calibration procedure is the most important step in the network development process whereby the modeler changes approved calibration parameters so the model accurately represents existing traffic conditions. A calibration parameter is a piece of information or variable that is used to fine-tune the base microsimulation model to reflect local, existing traffic operational behavior. These parameters may be collected from the field or be in the form of user-adjustable values within the microsimulation models. A calibrated model typically does not have coding errors and satisfactorily replicates existing conditions. Making changes to global calibration parameters, such as car-following or lane-changing characteristics, prior to establishing that the link level conditions are as accurate as possible will result in a model that does not reflect existing conditions. Therefore, global changes to the model should be made as a last resort following adjustments to link level factors. During the calibration process, first use the calibration parameters documented in Appendix E. If other factors need to be modified to meet the calibration thresholds, then these other factors should be approved by the VDOT project manager prior to the completion of the calibration process.

It is recommended that the users of this manual refer to the step-by-step calibration process described in the Traffic Operations Analysis Toolbox Volume III: Guidelines for Applying Traffic Microsimulation Software (FHWA-HRT-04-040) for more detailed guidance on the calibration process. Minimum microsimulation model calibration thresholds, as shown in Table 5, were created to provide direction on verification that simulated traffic volumes, speeds, travel times, and queue lengths accurately represent existing conditions. Applicable calibration thresholds shall be identified during the project scoping process.
### Table 5: Microsimulation Model Calibration Thresholds

<table>
<thead>
<tr>
<th>Simulated Measure</th>
<th>Calibration Threshold</th>
</tr>
</thead>
</table>
| **Simulated Traffic Volume** (vehicles per hour)  
The top 85% of the network links, based on link traffic volume, or a select number of critical links and/or movements, as determined by the RTE or his/her designee, shall meet the calibration thresholds. The traffic volumes identified in the calibration thresholds are actual traffic volumes as opposed to simulated traffic volumes. | Within ± 20% for <100 vph  
Within ± 15% for ≥100 vph to <300 vph  
Within ± 10% for ≥300 vph to <1,000 vph  
Within ± 5% for ≥1,000 vph |
| **Simulated Average Speed** (miles per hour)  
The top 85% of the network links, based on link traffic volume, or a select number of critical links and/or movements, as determined by the RTE or his/her designee, shall meet the calibration thresholds. | Within ± 5 mph of average observed speeds on arterials  
Within ± 7 mph of average observed speeds on freeways |
| **Simulated Travel Time** (seconds)  
Eight-five percent (85%) of the travel time routes, or a select number of critical routes, as determined by the RTE or his/her designee, shall meet the calibration thresholds. Travel time routes should be determined in cooperation with the VDOT project manager based on project needs and goals. | Within ± 30% for average observed travel times on arterials  
Within ± 20% for average observed travel times on freeways  
The travel time should be calibrated for segments and routes separately or as deemed appropriate by the VDOT project manager. |
| **Simulated Queue Length** (feet)  
The top 85% of the network links, based on link traffic volume, or a select number of critical links and/or movements, as determined by the RTE or his/her designee, shall meet the calibration thresholds. | **Undersaturated conditions** (refer to Section 2.6 for guidance)  
**Average queue length on arterials:**  
Within ± 30% for movements ≤10 vph  
Within ± 20% for movements >10 vph  
**Maximum queue length on arterials:**  
Within ± 25%  
| **Oversaturated conditions** (refer to Section 2.6 for guidance)  
**Average queue length:**  
Within ± 20% on arterials  
Within ± 30% on freeways  
**Maximum queue length:**  
Within ± 20% on arterials  
Within ± 35% on freeways |

**Notes:**

1. The calibration thresholds shall be used as minimum thresholds for calibration. The VDOT project manager may decide to use stricter thresholds based on the project needs. If the minimum thresholds cannot be achieved, written justification shall be provided for review and approval by the RTE or his/her designee.
2. Field measurements should be made when there are no unusual traffic conditions, such as special events, crashes, incidents, etc. and preferably at the same time as the counts are conducted.
3. Critical links, movements, and/or routes in the network, if needed, shall be determined in coordination with the RTE or his/her designee.

**Recommendations for Selecting Simulated Measures Based on Type of Analysis:**

- Intersection Analysis: simulated traffic volume and simulated queue length should be used for calibration.
- Arterial Analysis (no freeways): simulated traffic volume and simulated queue length should be used for calibration.
- Freeway Analysis (no arterials): simulated traffic volume and simulated average speed should be used for calibration. Simulated queue length at bottlenecks should also be checked, if present.
- Network Analysis (both freeways and arterials): simulated traffic volume and simulated travel time should be used for calibration.
Microsimulation models shall meet these thresholds for 85 percent of network links or routes unless critical links, movements, or routes are identified and agreed upon by the RTE or his/her designee. Technical justification shall be provided to and approved by the RTE or his/her designee whenever a specific calibration threshold cannot be met.

A critical link, movement, or route represents a portion of a roadway network that is of decisive importance to the recommendations made as a result of a traffic operations analysis. In order to replicate existing conditions accurately, some networks need to be extended beyond the model spatial limit. In these cases, the decision to calibrate to critical links or routes rather than to 85 percent of network links or routes may be appropriate. The decision to calibrate to critical links, movements, or routes as well as the determination of critical links, movements, or routes shall be based on engineering judgment and agreed upon by the RTE or his/her designee. The following criteria shall be considered when selecting critical links:

- **Traffic Volume**: Areas in the network that carry the highest traffic volumes, such as freeway and arterial mainlines, and will be a primary focus of the traffic operations analyses.

- **Location**: Areas that experience the most congestion within a network or areas within a roadway network that have impacts on the operations of the rest of the network, such as bottlenecks, and will be a primary focus of the traffic operations analyses. These areas may meter traffic throughout the rest of the network and have impacts on upstream and downstream facilities.

- **Impacts on MOEs**: Areas within the network that have the largest impact on MOEs such as speed, density, delay, and queue length and will be a primary focus of the traffic operations analyses. Emphasis should be placed on areas that experience the largest differences in speeds between uncongested and congested periods, highest densities, and highest delays and longest queues.

VDOT project managers may develop calibration thresholds beyond the minimum calibration thresholds outlined in Table 5. However, calibration thresholds that are too stringent may be unachievable, so the project team should be judicious with its selection of thresholds.

### 5.4 MICROSIMULATION SAMPLE SIZE

In addition to conducting proper network model calibration, determining and applying the appropriate number of microsimulation runs is a very important step in developing accurate microsimulation results. Using too few microsimulation runs will not fully account for microsimulation variance, while using too many runs will become overly time-intensive for analysis purposes. FHWA developed a statistical process to ensure that an appropriate number of microsimulation runs are performed at a 95th percentile confidence level.

To assist the users of this manual, the VDOT Sample Size Determination Tool as shown in Figure 4 was developed to determine the appropriate number of microsimulation runs. The number of microsimulation runs shall be calculated using the VDOT Sample Size Determination Tool, which is based on the FHWA sample size determination methodology, as referenced in Appendix A. Computations from the VDOT Sample Size Determination Tool shall be submitted as supporting documentation with the microsimulation analysis results.

MOE results shall be input into the VDOT Sample Size Determination Tool for a minimum of the initial 10 runs. The MOE(s) used to determine the minimum number of microsimulation runs needed, as well as the location(s) from where the MOE(s) are gathered, should be agreed upon with the VDOT project manager. If multiple MOEs are used to determine the minimum number of microsimulation runs, the highest number of microsimulation runs shall be performed. The 95th percentile confidence interval and 10% error tolerance values should not be changed. For step-by-step instructions on how to use the VDOT Sample Size Determination Tool and more detailed explanation of the sample size determination calculations, see the Excel-Based Macro User Guide located in Appendix F.
5.5 UNMET DEMAND

Unmet demand is typically referred to as the number of vehicles that are destined to travel through a network at a specific time period but cannot do so due to capacity constraints. Unmet demand typically occurs during oversaturated conditions and is a cause of PHS. Under these conditions, turning movement counts for a particular time period do not always reflect demand. The number of vehicles in queues at intersections or on roadway segments at the end of the analysis period may be used to determine unmet demand.

Models should replicate existing traffic conditions; therefore, for instances when unmet demand occurs during existing conditions, factors such as traffic volume and maximum queues should be replicated. In most cases, unmet demand in a microsimulation model occurs when modeling future conditions. Unmet demand can have a dramatic impact on results and should be accounted for and quantified.

In many instances, unimproved future (no-build conditions) microsimulation runs will have capacity constraints that prohibit forecasted demand from being modeled. Adding improvements to this model to represent build conditions, such as additional roadway capacity, may reduce the amount of unmet demand. However, simulating different volumes between the build conditions and the no-build conditions may lead to misleading results, such as similar travel speeds. The amount of unmet demand should be quantified for each model to better explain analysis results.

In some instances, it may be appropriate to refine forecasted traffic volumes to account for spreading. Traffic volumes may need to be adjusted to spread traffic volumes from over-capacity time periods to adjacent time periods. Therefore, it is critical to select a traffic analysis tool that can account for multiple time period analyses.
In instances where unmet demand occurs, users should verify that all demand is allowed entry into the network for each microsimulation run to properly measure the impacts of unmet demand. The following steps should be followed to reduce the amount of vehicles being denied entry into a microsimulation model:

- Users should view error logs to determine the locations where vehicles have been denied entry.
- Users should verify that vehicles are not being denied entry due to coding errors such as traffic signal timings or incorrect lane alignments.
- Users should verify that the spatial limits of the network are extended to accommodate the maximum queue lengths simulated within the network.

When extension of spatial limits fails to account for all unmet demand, the model results should be adjusted to account for unreported congestion in the analysis outputs. Documentation should be provided to indicate that boundary limit expansion did not eliminate the unmet demand error.

### 5.6 SAFETY MODELING

Vehicle trajectory files from microsimulation runs are a required input into SSAM. At this time, VISSIM is the only tool listed in this manual that is approved for use with SSAM. Vehicle trajectory files or *.TRJ files may be exported from VISSIM for conflict processing in SSAM. The minimum number of microsimulation runs from which *.TRJ files will be processed should be agreed upon with the VDOT project manager.

Users should note the following limitations in SSAM prior to producing results:

- SSAM is unable to recognize grade separations in the network since the *.TRJ file does not contain a “z” coordinate. Potential approaches to avoid this issue include removing overpasses or underpasses from the network if they are not essential to the analysis, filtering out overpass and underpass links using the Filter tool (note that this would also remove all conflicts associated only with the overpass or underpass links), or exporting the conflict table to a *.CSV file and manually filtering out conflicts between overpass links and underpass links.

- SSAM conflict results do not always match expected outputs based on available safety data such as CMFs and SPFs. SSAM results should be validated.

- SSAM conflict results are generally more accurate when evaluating limited areas such as single intersections as opposed to analyzing an entire corridor.

- SSAM tends to run out of memory when analyzing *.TRJ files in excess of 30 GB.

Although SSAM does not list SimTraffic as a compatible software, SimTraffic contains a ‘SSAM Export’ feature that may be selected to produce a *.TRJ file. Based on an evaluation of SimTraffic *.TRJ files in SSAM, VDOT will not accept the use of SimTraffic with SSAM. The random generation of vehicles in SimTraffic at both network entry points and points within the network create additional conflicts that the user may not be able to identify or filter out of the analysis without considerable effort.
6 Standard Data Requirements for Analyses

The proper collection of data is vital to successful traffic operations and safety analyses. To properly conduct traffic operations and/or safety analyses, transportation professionals should make informed decisions on what data to collect, when to collect it, where to collect it, how long to collect it, and how to manage it once it has been collected. This chapter focuses on answering the aforementioned questions regarding the collection of data and the management of the information, which is dependent on the type of analysis being conducted.

As mentioned in Chapter 0, a traffic and safety analysis scoping meeting shall be held prior to the start of the project between the VDOT project manager, other subject matter experts and individuals involved in the project review process, and the technical specialists responsible for conducting the analysis. The assumptions needed to conduct the analysis shall be discussed and approved at this scoping meeting. Tables with the various types of analysis assumptions provided in this chapter should be taken to the scoping meeting to help with the traffic operations and safety analysis assumptions discussion.

The traffic operations and safety analysis data types will be addressed in this chapter:

- Geometric
- Traffic count
- Signal operations
- Calibration
- Safety

A list of acceptable sources of traffic count and crash data is provided in this chapter.

6.1 GEOMETRIC DATA

Geometric data includes any data required to develop the physical extents and characteristics of a network, such as link lengths, travel lane widths, number of lanes, turn lane lengths, and lane designations. Overall, there are many different geometric input parameters required to develop all of the types of networks covered in this manual; however, not all geometric data are needed for each analysis. Table 6 provides a summary of typical geometric data required for each analysis type. Additional geometric data may be required based on the selected analysis tool.

Current aerial imagery should be used when developing all networks for traffic operations analyses. Aerial imagery should be field verified to validate its accuracy.

6.2 TRAFFIC COUNT DATA

Accurate traffic count data is the cornerstone of traffic operations analyses. This section of the manual focuses on the following topics concerning traffic count data:

- Traffic count data collection best practices
- Traffic count data requirements
- Heavy vehicle classifications
- Appropriate age of traffic count data
- Peak hour/period determination
- Traffic volume balancing
- Data considerations for work zones
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6.2.1 Traffic Count Data Collection Best Practices

The following best practices for data collection should be followed when collecting traffic count data for traffic operations analyses:

- The person(s) responsible for collecting the data should document the source; collection day of the week, date, and time; and condition of the data.

- Automated Traffic Recorder (ATR) counts should be conducted over a period of seven days in order to determine the peak period prior to performing turning movement counts (TMCs).

- Traffic data, including TMCs, ATR counts, and microsimulation calibration data (if needed), should be collected during approximately the same time periods, if possible. Data should be collected in 15-minute or shorter intervals. Large data collection efforts may span over the course of a week or two; however, it is preferable to coordinate efforts between data collection parties to minimize the number of data collection days.

- Traffic data should not be collected on holidays or the days before or after the holiday. If possible, the week of the holiday should also be avoided if the holiday is in the middle of the week.

- Traffic data collection should be kept to a minimum between Thanksgiving Day and New Year’s Day, especially in areas with a high concentration of retail establishments, unless the study is specifically focused on operational impacts during that period.

- Traffic data should not be collected when school is out of session in areas influenced heavily by school traffic from K-12, colleges and/or universities.

- When conducting TMCs, count the unmet demand for intersections operating in oversaturated conditions by observing and documenting the length of the queue for all movements at the end of each traffic count interval. This distance will then be used to estimate the number of queued vehicles.

- Traffic count data should be reviewed and checked for reasonableness. The data should be checked for:
  - Variation in traffic counts collected during the same time periods over several days
  - Variation in traffic counts between adjacent intersections in a network
  - Possible influence of weather, construction, or incidents
  - Collected maximum traffic count should be compared to the estimated theoretical capacity of the roadway
  - Collected travel time data should reflect the operating speeds at the time of data collection
  - If traffic count tubes are used, check to make sure that traffic was not stationary on the tube for extended periods of time due to congestion or an incident
  - TMCs conducted by a person should be verified to make sure the time periods make sense and the counts on each approach makes sense. This may be done by comparing the TMCs to ATR count data collected during the same time period.

- Data collection results should be summarized graphically including lane schematics, intersection geometry, traffic volumes, and traffic control.
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## Table 7: Standard Traffic Data Collection Requirements

<table>
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<tr>
<th>Analysis Categories / Standard Traffic Assumptions</th>
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*Table columns: Peak Hour Turning Movement Counts, Automated Traffic Recorder Counts, Annual Average Daily Traffic (AADT), Parking Maneuvers, Transit Service Data, Vehicle Classification Data, Speed Data, Toll Plaza and Gate Lane Data.*
6.2.2 Traffic Count Data Requirements

Traffic count data includes all data necessary to analyze existing or future conditions, including passenger cars, heavy vehicles, bicycles, and pedestrians. Other data pertinent to signal timing and model calibration, such as speed and queue length, will be addressed later in this chapter. Table 7 documents the traffic data required for each type of traffic analysis. To ensure that the peak hour is captured during the traffic counting period for intersection TMCs, especially in heavily congested areas, traffic counts should be conducted for four consecutive hours in each peak period, collected in 15-minute intervals.

In cases where PHS occurs, with the exception of bicycle and pedestrian analyses, more than four hours of data may be required by the VDOT project manager. If PHS does not exist or the analysis is in a rural location, then two to three hours of TMC data may be acceptable, if approved by the VDOT project manager. Heavy vehicles should be collected by movement for each TMC. When pedestrians and bicycles are present at the intersection, the TMC shall account for them as well. Traffic count data shall be submitted with the analysis.

In addition to the collection of TMC data at intersections, bus blockages and parking maneuvers occurring within 250 feet (in each direction of travel) of the stop bar on each approach, as shown in Figure 5, should be counted during the same time period as the TMCs.

Figure 5: Location of Bus Blockages to Include in Analysis

Traffic count data shall be required for all toll plaza analyses. Four hours of traffic count data are required for each payment choice and lane.

For vehicle classification counts, a minimum of 48 consecutive hours of data should be collected in 15-minute intervals for each lane. The acceptable sample size and methodology used for collecting speed data (e.g., GPS, blue tooth, tube counts, and/or radar gun) should be determined by the VDOT project manager based on the required level of accuracy, project schedule, and project budget. Both vehicle classification and speed data should be collected concurrently with traffic count data.

For all data collection efforts, weekday traffic volumes should only be collected on Tuesdays, Wednesdays, and/or Thursdays, while weekend traffic volumes should only be collected on Saturdays and/or Sundays. In cases where there are special events creating unique peak travel periods, data should be collected on the same day(s) that corresponds to the special event.

If unplanned events occur during the data collection process, such as inclement weather or a vehicle crash, the event should be documented and evaluated by the VDOT project manager to determine if additional traffic counts should be conducted. If the collected data contains anomalies caused by human error or equipment malfunction, the data should be recollected. Any additional traffic counts should be collected as close to the original count dates as possible and during the same time period during the week.
In addition to the data identified in Table 7, O-D counts may be needed for projects requiring microsimulation. The scope and acceptable error tolerances of the O-D counts should be approved by the VDOT project manager.

In areas with seasonal fluctuations in traffic, it may be appropriate to apply seasonal factors. Seasonal factors may be applied to ATR counts and vehicle classification counts. Monthly seasonal factors may be obtained from the VDOT website; however, the VDOT project manager shall approve proposed methodologies for obtaining and applying seasonal factors.

A data collection summary should be developed to document data needs, data collection methods, data storage, and quality control procedures. The summary should be included in the existing conditions analysis in the final traffic analysis report.

### 6.2.3 Appropriate Age of Data

Since traffic count data and aerial imagery are constantly changing, it is important that the network development and analyses be performed using the latest available information. The appropriate age of traffic count data is two years from when the initial traffic data was collected and when the analysis is being conducted, provided that the roadway has not experienced any major geometric and/or traffic control changes since the data was collected.

The appropriate age of aerial imagery used in coordination with traffic operations and safety analyses is also two years; however, field validation is required to ensure that the aerial imagery matches current conditions.

### 6.2.4 Peak Hour Determination

For isolated intersection analyses, four consecutive 15-minute intervals of turning movement traffic count data that represent the highest hour should be considered the peak hour. For segment, facility, corridor, system, and area analyses, a common uniform peak hour should be computed and applied throughout the entire network. The method for determining the common uniform peak hour should be approved by the VDOT project manager. For special cases, such as analyses near schools or industrial sites, an additional peak hour may be selected for the analysis based on a critical movement for a specific intersection approach instead of volumes for the entire intersection. This peak period may not fall during the typical morning and evening peak periods.

As described in Chapter 5 for microsimulation analyses, the modeling period may be increased beyond one hour, with volumes coded in 15-minute intervals, to account for different peak periods at intersections throughout a network.

### 6.2.5 Heavy Vehicle Classification

For traffic operations analyses, the collection of heavy vehicle classifications should comply with existing guidelines established by FHWA. These guidelines, presented in Figure 6, contain thirteen vehicle classifications. By definition, any vehicle with a classification of 4 or higher should be considered a heavy vehicle when traffic counts are collected.

### 6.2.6 Traffic Volume Balancing

When peak period turning movement counts are collected and peak hour traffic volumes are computed, there are several factors that may cause imbalances in traffic volumes departing one intersection and arriving at the next, such as:

- Peak hour selection (e.g., selecting a uniform peak hour between two adjacent intersections that may not be the same as the actual peak hours for both intersections)
- Traffic impact of private driveways, parking lots, or parking garages along the facility that are not counted
Figure 6: FHWA Vehicle Classification

- Variations in traffic volumes between different days of the week, different weeks of the month, or different months of the year
- If a local school was in session when counts were conducted at one intersection in the network and the school was out of session when counts were conducted at another intersection in the network
- Variation caused by different traffic counting methods (e.g., turning movement counts conducted by video at one location in the network compared to turning movement counts conducted by a human at another location in the network)

Discontinuity in traffic volumes between intersections occurs even when traffic counts are conducted on the same day. Deterministic tools with minor fluctuations in volumes (less than 25 vehicles or 10% of the total approach traffic volumes) can still yield accurate results; however, minor fluctuations in volumes can have significant impacts on results from microsimulation tools. Since most microsimulation tools depend on turning percentages, imbalances in traffic volumes will cause the percentages calculated by the software to differ, which impacts the results from these tools. Figure 7 depicts an example of an unbalanced network along with the associated impacts that would be experienced with a microsimulation model. For these reasons, balanced traffic volumes shall be used in microsimulation tools.
If a volume difference greater than 10 percent occurs between intersections or count locations in the network, or if a significant number of driveways exist between intersections, then further investigation may be warranted before the network can be balanced. It is important to determine if the imbalance is created by a large trip generator between intersections. If the differences cannot be attributed to the intermediate driveways, then some of the other previously-mentioned factors (e.g., human error) may be impacting the traffic counts.

There are several methods to balance traffic volumes through a network. The recommended practice is to use the Iterative Procedure – Directional Method, also known as the Fratar technique, outlined in the Transportation Research Board’s (TRB) National Cooperative Highway Research Program (NCHRP) Report 765: Analytical Travel Forecasting Approaches for Project-Level Planning and Design. This method may be used to alternately balance intersection approach and departure volumes based on an initial estimate of turning percentages. The process is repeated until an acceptable level of convergence is reached. Schematic diagrams for both the unbalanced volumes and the balanced volumes, a description of the volume balancing process, and any assumptions made regarding traffic volume balancing shall be included in the traffic and safety analysis report for review.

6.2.7 Other Data Considerations for Work Zones

In addition to the data collection requirements for work zones identified in Table 6 and Table 7 for work zone analyses, other work zone data should be obtained, such as lane closure information, lane closure lengths, time of day of closure, intensity of work zone, detour and alternative route availability, condition of alternative routes (i.e., whether alternative routes are over or under capacity), and percentage of traffic volume expected to detour.

6.3 FUTURE TRAFFIC DATA

The VDOT project manager shall approve proposed methodologies used to develop traffic growth rates and corresponding future year traffic volumes prior to conducting traffic analyses. One useful reference is the VDOT Travel Demand Modeling Policies and Procedures (if the forecast data comes from the regional travel demand model). The district planner can be a resource to provide additional traffic forecasting information.
The methodology used to develop design ADT, design hourly volume, directional distribution factor, and the truck percentages for roadway design projects should be approved by the VDOT project manager.

6.4 TRAFFIC SIGNAL OPERATIONS DATA

For those analyses that involve either traffic signals or pedestrian signals, it is important to obtain signal timing data to accurately analyze existing conditions. All traffic and pedestrian signal timing data, in addition to being observed in the field, shall be obtained from the appropriate VDOT Regional Traffic Operations office or city/town engineering office, and should include, at a minimum, the following timing plan data:

- Green times (minimum green/minimum initial and maximum green)
- All-red time/red clearance and yellow time/yellow clearance
- Cycle lengths
- Offsets
- Type of controller (NEMA, fixed time, etc.)
  - If an existing traffic signal operates with ASCT, the methodology for determining existing signal parameters shall be approved by the RTE or his/her designee.
- Sequencing and phasing diagrams
- Actuation type
- Vehicle extension and gap time
- Recall mode
- Time of day clocks
- Pedestrian crossing times (“WALK” and “DON’T WALK”)
- Transit priorities
- Preemption timings
- Ramp metering data (processing splits, capacity criteria, etc.)

Existing data obtained from the appropriate VDOT Regional Traffic Operations office or city/town engineering office shall be provided in the appendix of traffic and safety analysis reports.

6.5 CALIBRATION DATA

Calibration data is required to properly develop a microsimulation model. Without calibration, the analyst has no assurance that the model will correctly predict traffic performance for the project. Calibration data is collected to help the analyst adjust the model to reflect local driving conditions and characteristics. Refer to Table 5 for calibration thresholds. There is a wide variety of calibration data needs; however, data generally falls into four categories: traffic volume, speed, travel time, and queuing. Table 8 indicates which calibration data are required for each analysis category; however, the VDOT project manager may request additional data based on the traffic analysis needs. For example, the VDOT project manager may identify the need for a travel time run to supplement speed results.
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Table 8: Standard Calibration Data Requirements

<table>
<thead>
<tr>
<th>Analysis Categories / Standard Calibration Assumptions</th>
<th>Peak Hour/Period Traffic Demand</th>
<th>Pedestrian &amp; Bicycle Travel Speeds</th>
<th>Mainline Speed Data</th>
<th>Ramp Speed Data</th>
<th>Toll Lane &amp; Gate Processing Time by Payment Choice</th>
<th>Travel Times</th>
<th>Queuing Data</th>
<th>Existing Crash Data</th>
</tr>
</thead>
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<tr>
<td>Signalized Intersection, Unsignalized Intersection, and Arterial Analyses</td>
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<td>✓</td>
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<tr>
<td>Signalized Intersection Preemption and Transit Priority Analyses</td>
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<td>✓</td>
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<tr>
<td>Roundabout Analyses</td>
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<td>Non-Traditional Intersection/Interchange Analyses (SPUI, CFI, DLT)</td>
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<td>✓</td>
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<tr>
<td>Pedestrian and Bicycle Analyses (On- and Off-Street)</td>
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</tr>
<tr>
<td>Freeway and Interchange Analyses (Merge, Diverge, Weave, and Collector-Distributor)</td>
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<td>✓</td>
<td></td>
<td></td>
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<td>✓</td>
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<tr>
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<tr>
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<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Managed Lane or Ramp Metering Analyses</td>
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<td>Safety Analyses</td>
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<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>
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Calibration data for operational analyses shall be no more than two years old, provided that the roadway has not experienced any major geometric and/or traffic control changes since the data was collected. If older calibration data is used, though still within two years, the VDOT project manager may request that additional sample data be collected and field observations be made for verification.

Although mainline and ramps have posted speed limits and design speeds, the most reliable approach to calibrate a freeway model is to collect speed and travel time data. A minimum of 48 consecutive hours of speed data should be collected for each direction of travel in 15-minute intervals.

The number of travel time runs completed for calibration purposes during peak periods will depend on the length of the network and the level of congestion. However, it is recommended that at least ten travel time runs be collected within the analysis area for each direction of travel during each peak period being analyzed. For example, if AM and PM peak hour microsimulation analyses will be performed, then at least 40 travel time runs should be conducted for the same route over the two peak periods. Travel time runs should be conducted in accordance with the procedures identified in the latest edition of the ITE Manual of Transportation Engineering Studies.

To collect queue data for calibration purposes, queue lengths should be collected once every five minutes during the data collection period. This should be done by observing and documenting the length of queue for all movements. In oversaturated conditions, the entire extent of the queue should be observed and documented, even if the queue extends past an adjacent intersection.

For toll plaza analyses, speed data is not required since travel speeds are dependent on the processing speeds of the individual toll lanes; however, speed data should be collected for uninterrupted-flow tolling facilities, such as express lane toll plazas. At least four hours of vehicle processing data for all available payment options should be performed.

O-D data may be used as another source of calibration data, although it is not a mandatory data requirement. Due to the extensive amount of time to collect and process the data and the associated costs with collecting the data, it should only be collected if the analysis of important traffic movements in the existing conditions would benefit from an understanding of the origins and destinations or if existing travel routes and turning movements will be changed under future conditions. The methodology used for collecting O-D data (e.g., license plate surveys, blue tooth technology, vehicle probe data) should be determined by the VDOT project manager based on the required level of accuracy, the project schedule, and the project budget.

In-field observations should be made during the collection of calibration data to note any unique operating conditions that may aid in the calibration process. These observations may include operating conditions that contribute to higher than expected queue lengths or travel times. Unusual operating conditions, such as slow right-turning speeds or the impacts of a combined through-left lane that operates like a de-facto left-turn lane due to a high volume of left turning vehicles need to be documented.

### 6.6 SAFETY DATA

#### 6.6.1 Historical Crash Data

Historical crash data shall be collected for safety analyses that use the Empirical Bayes (EB) Method (see Chapter 7 for direction and guidance on when to use the EB Method), provided that at least two years of crash data (although five years are preferable) are available and the roadway has not experienced any major geometric and/or traffic control changes since the earliest year of crash data. The crash data should be collected from VDOT, or the appropriate locality, for all roadways in the study area and should include crash location, type, and severity, at a minimum.
6.6.2 Field-Collected Data

The amount of geometric and/or traffic control data required for safety analyses may differ depending on the safety analysis tool selected. The data requirements for the tool(s) that will be used on the project should be verified prior to collecting field data.

6.6.3 Roadway Alignment Data

VDOT has a geospatial database of horizontal and vertical alignment data on the mainline interstate and primary routes. This data should be used to define tangents, curves, and grades for safety analyses on these systems; however, some discrepancies were found between the grades and vertical curve information included in the database and survey or other GPS data, particularly on flatter terrain. For this reason, using the point file elevation (Z axis) to determine grades on 24-foot increments provides a better representation of grades along a segment. The VDOT project manager may request this data from Central Office TED. In addition to the geospatial database data, if available, survey data may be used for existing conditions and proposed alignment data may be used for future conditions.

6.6.4 Crash Modification Factors (CMFs)

Predictive crash methods outlined in the HSM Part C do not apply to every condition (e.g., replacing a signalized intersection with a roundabout); therefore, crash modification factors (CMFs) may be used to estimate safety performance for those conditions. A CMF is a multiplicative factor, based on national data that is applied to an existing crash total or crash prediction to compute the expected number of crashes for a site after implementing a given countermeasure. CMFs often target only specific crash types or crash severities. CMFs are primarily retrievable from two sources: HSM Part D: Introduction and Applications Guidance and FHWA’s CMF Clearinghouse, which is an on-line application.

The HSM Part D applies adjustment factors to a CMF and method correction factors to its published standard error to produce an adjusted standard error that indicates the CMF “confidence” based on the quality of the study or studies from which is was produced. The CMF Clearinghouse similarly rates CMFs, but relies on a star rating (one through five) system instead of an adjusted standard error. The star rating is based on the cumulative performance of the CMF in five categories: study design, sample size, standard error, potential biases, and data source. Generally, star ratings above three should be used if they are available. Often there are multiple CMFs for an improvement. To select the most applicable CMF, care should be taken to review the references provided for the highway and traffic conditions and crash types assessed to develop the published CMF. The VDOT project manager shall approve both the use of CMFs for a given project and the selection of individual CMFs from the HSM Part D or the CMF Clearinghouse based on the adjusted standard error or star rating, respectively.

6.6.5 Safety Calibration Factors

Absolute numbers determined from predictive models are based on national averages and should be adjusted for Virginia conditions whenever possible. At present, VDOT has not produced SPF calibration factors. Until Virginia-specific calibration factors are developed, predictive models shall only be used to compare predicted or expected crashes between analysis alternatives. The calibration factors will be published on the VDOT TED website once they have been developed. VDOT project managers shall confirm that calibration factors have not yet been released before proceeding with the use predictive models to compare project alternatives.

6.6.6 Crash and Severity Distributions

VDOT has not yet produced site sub-type tables of proportions applicable to Virginia. Until Virginia-specific crash and severity proportions are developed, predictive models shall only be used to compare crashes between analysis alternatives. The tables of proportions will be published on the VDOT TED website once they have
been developed. VDOT project managers shall confirm that the tables of proportions have not yet been released before proceeding to use predictive models to compare project alternatives.

### 6.7 ACCEPTABLE SOURCES OF DATA

#### 6.7.1 Traffic Count Data

- **LandTrack**: The VDOT LandTrack system tracks all traffic impact analysis (TIAs) submissions required by Chapter 527 of the 2006 Acts of Assembly. Traffic counts may be taken from any TIA that has been deemed acceptable, provided that the traffic counts meet the data requirements outlined in this chapter.

- **VDOT Traffic Data**: VDOT TED produces daily traffic volume estimates for roadways throughout Virginia from VDOT’s Traffic Monitoring System (TMS). The TMS also includes vehicle classification data. Since TMS stations are spread out and may not be located near the study area, this data should be used as supplemental information for verification purposes.

#### 6.7.2 Crash Data

- **FR300-P Reports**: Police crash reports provided in a database indexed on a unique document number should be retrieved from VDOT.

- **Roadway Network System (RNS)**: VDOT’s geospatial RNS includes a variety of data such as roadway inventory components, speed zone locations, crash data, and railroad crossing locations. The VDOT project manager may request roadway and related crash information from the RNS through District Traffic Engineering staff to Central Office TED.
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Chapter 7 – Standard Input Parameter Assumptions for Tools

7 Standard Input Parameter Assumptions for Tools

Each traffic and safety analysis tool incorporated in this manual has a standard set of input parameters. To promote consistency and uniformity in the use of these tools, it is critical that clear direction and guidance be provided on the correct application of these input parameters. Most, if not all, of the input parameters should be based on existing or future traffic or geometric conditions. Some of these input parameters require assumptions to be made to properly apply the tool, while others do not. This chapter provides direction and guidance to the VDOT project manager for two important reasons:

- To identify input parameters that require direction or guidance on typical values, acceptable ranges, and/or special notes
- To identify input parameters with default values that should be modified to account for available data

All input parameters not mentioned in this chapter should not be modified from the default value unless a modification is supported by data and approved by the VDOT project manager. The direction and guidance provided for each tool should be applied regardless of the type of analysis. Any deviation from the direction and guidance presented in this chapter requires written documentation and justification prior to VDOT project manager review.

The sections in this chapter document standard input parameter assumptions for the following traffic and safety analysis tools:

7.1 VDOT Work Zone Spreadsheets
7.2 HCS 2010
7.3 SIDRA Intersection
7.4 Vistro
7.5 Synchro
7.6 SimTraffic
7.7 CORSIM
7.8 VISSIM
7.9 VDOT Extended HSM Spreadsheets
7.10 IHSDM
7.12 SSAM

7.1 VDOT WORK ZONE SPREADSHEETS

Prior to performing a work zone analysis, a VDOT Work Zone Spreadsheet should be requested from the appropriate VDOT Operations Region based on the project location. Since the VDOT Work Zone Spreadsheets are periodically updated, VDOT project managers shall confirm that the most up-to-date version is used. All input parameters for the VDOT Work Zone Spreadsheets should be discussed and agreed upon with the VDOT project manager. If a work zone spreadsheet is not available and a work zone analysis is required, the tools and methodology of the analysis should be determined by the VDOT project manager.
Chapter 7 – Standard Input Parameter Assumptions for Tools

7.2 HCS 2010

HCS 2010 is a deterministic tool distributed by McTrans that uses the methodologies of the HCM 2010. HCS 2010 includes several modules to evaluate different roadway geometric configurations within a transportation network. This manual covers the following HCS 2010 modules:

- Freeways
- Weaving
- Ramps
- Facilities
- Multilane
- Two-Lane
- TWSC (Two-Way Stop Control)
- AWSC (All-Way Stop Control)
- Streets

Input parameters in HCS 2010 should be based on existing field measurements, observations, and/or design plans. Traffic and pedestrian volume input parameters should be based on existing traffic counts for existing analyses and projected volumes for future analyses. Traffic volume projections shall be approved by the VDOT project manager. In addition, existing traffic signal timing information shall be obtained from the entity that maintains the timings for the traffic signal.

Input parameters in HCS 2010 may be classified into the following three categories:

1. Input parameters that require specific direction or guidance for proper application – these input parameters are described in this manual
2. Input parameters that are dependent on available data that do not require specific direction or guidance on their application – these input parameters are listed but are not described in this manual
3. Input parameters with default values that should not be modified without VDOT project manager approval – these input parameters are not listed in this manual

Input parameters that fall into the first category require specific direction or guidance for proper application. These input parameters are described in Sections 7.2.1 through 7.2.9 and are summarized in Table 9. Many of the HCS 2010 modules contain the same input parameters. To reduce redundancy in application, when the same direction or guidance applies to an input parameter in multiple modules, the input parameter is only described once in the section of the first module where the input parameter is described. For each input parameter, the modules where the same direction or guidance applies are listed in Table 9. In addition, some input parameters require different direction or guidance for existing and future analyses. If different direction or guidance is not provided, then the direction or guidance given should be applied to both existing and future analyses.

Input parameters that fall into the second category do not require specific direction or guidance, but they should be adjusted to reflect field measurements, observations, and/or design plan data, when data is available. These input parameters are listed, but are not described in detail, at the end of the section for each module.

All other input parameters not addressed in this chapter fall into the third category and should not be modified from the default value unless a modification is supported by data and is approved by the VDOT project manager.
<table>
<thead>
<tr>
<th>HCS 2010 INPUT PARAMETER</th>
<th>MODULE</th>
<th>TYPICAL VALUE, ACCEPTABLE RANGES, and/or SPECIAL NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acceleration Length</td>
<td>Facilities</td>
<td>▪ Use effective auxiliary lane length from existing field measurements</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Based on effective auxiliary lane length from existing field measurements for No-Build scenarios OR</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Based on effective auxiliary lane length from design plans</td>
</tr>
<tr>
<td>Bus Stops per Hour</td>
<td>Streets</td>
<td>▪ Only consider if the bus stops actually impede traffic flow</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Only consider movements that occur within 250 feet (upstream or downstream) of the stop bar on an approach</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Use existing count data</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Based on existing count data if future bus service is projected to be similar to existing service OR</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Based on future bus service</td>
</tr>
<tr>
<td>Cycle Length</td>
<td>Streets</td>
<td>▪ Use existing timing plans or field measurements</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Range from 60 to 240 seconds and be approved by the VDOT project manager</td>
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<td>Deceleration Length</td>
<td>Facilities</td>
<td>▪ Based on effective auxiliary lane length from existing field measurements</td>
</tr>
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<td></td>
<td></td>
<td>▪ Based on effective auxiliary lane length from existing field measurements for No-Build scenarios OR</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Based on effective auxiliary lane length from design plans</td>
</tr>
<tr>
<td>Demand</td>
<td>Facilities</td>
<td>▪ 15-minute volume on each segment for undersaturated conditions OR</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Number of vehicles desiring to enter each segment during each 15-minute period for oversaturated conditions</td>
</tr>
<tr>
<td>Existence of Adjacent Ramp</td>
<td>Ramps</td>
<td>▪ Only enter for adjacent ramps located within 8,000 feet of the analysis ramp (upstream or downstream)</td>
</tr>
<tr>
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<td></td>
<td>▪ If there are both upstream and downstream adjacent ramps, run the analysis twice.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Use existing field measurements</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Based on existing field measurements or design plans</td>
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<tr>
<td>Highway Class</td>
<td>Two-Lane</td>
<td>▪ Based on driver expectations, length of trip (long or short), purpose of trip (commuting or sight-seeing), and development of the surrounding area</td>
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<td>HCS 2010 INPUT PARAMETER</td>
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<td>Existing Conditions</td>
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<td>Freeways</td>
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<td>• Select Measured FFS</td>
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<td>• Use existing speed data</td>
</tr>
<tr>
<td></td>
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<td></td>
</tr>
<tr>
<td>Weaving Ramps</td>
<td></td>
<td>• Use existing speed data</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mainline Free-Flow Speed</td>
<td></td>
<td>• Round FFS to the nearest 5 mph</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Use existing speed data</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Facilities</td>
<td></td>
<td>• Select Field Measured FFS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Use existing speed data</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multilane Two-Lane</td>
<td></td>
<td>• Use existing speed data</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HCS 2010 INPUT PARAMETER</td>
<td>MODULE</td>
<td>TYPICAL VALUE, ACCEPTABLE RANGES, and/or SPECIAL NOTES</td>
</tr>
<tr>
<td>--------------------------</td>
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<td>------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Existing Conditions</strong></td>
</tr>
<tr>
<td>Minimum Green</td>
<td>Streets</td>
<td>- Use existing timing plans or field measurements</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Based on existing timing plans or field measurements OR</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Should be approved by the VDOT project manager</td>
</tr>
<tr>
<td>Multimodal</td>
<td>Streets</td>
<td>- Use field measurements or observations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Based on field measurements, observations, or design plans</td>
</tr>
<tr>
<td>Number of Periods</td>
<td>Streets</td>
<td>- Use one period for all analyses</td>
</tr>
<tr>
<td>Offset</td>
<td>Streets</td>
<td>- Use existing timing plans or field measurements</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Use time-space diagrams</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Should be approved by the VDOT project manager</td>
</tr>
<tr>
<td>Optimization</td>
<td>Streets</td>
<td>- Methodology should be approved by the VDOT project manager</td>
</tr>
<tr>
<td>Parking Maneuvers per Hour</td>
<td>Streets</td>
<td>- Only consider maneuvers that occur within 250 feet (upstream) of the stop bar on an approach</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Based on existing parking count data</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Based on future parking conditions are expected to be similar to existing conditions OR</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Based on projected future parking conditions</td>
</tr>
<tr>
<td>Passing Lane Analysis</td>
<td>Two-Lane</td>
<td>- For level or rolling terrain, select “Passing Lane”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- For specific grades, select “Climbing Lane”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Use existing field measurements</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Based on existing field measurements or design plans</td>
</tr>
<tr>
<td>Peak Hour Factor</td>
<td>TWSC AWSC Streets</td>
<td>- Use overall intersection PHF for all individual movements</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Based on future land use, if known OR</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Higher of 0.92 or existing PHF (Urban) OR</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Higher of 0.88 or existing PHF (Rural)</td>
</tr>
<tr>
<td>HCS 2010 INPUT PARAMETER</td>
<td>MODULE</td>
<td>TYPICAL VALUE, ACCEPTABLE RANGES, and/or SPECIAL NOTES</td>
</tr>
<tr>
<td>--------------------------</td>
<td>--------</td>
<td>--------------------------------------------------------</td>
</tr>
<tr>
<td>Pedestrian Clearance Interval</td>
<td>Streets</td>
<td>▪ Use existing timing plans or field measurements</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Based on latest guidance in the MUTCD and VDOT regional pedestrian policy</td>
</tr>
<tr>
<td>Pedestrian Walking Speed</td>
<td>TWSC</td>
<td>▪ Use 3.5 ft/sec based on the current guidance in the MUTCD</td>
</tr>
<tr>
<td>Percent Heavy Vehicles</td>
<td>TWSC, AWSC Streets</td>
<td>▪ Use existing count data</td>
</tr>
<tr>
<td>Percent Trucks and Buses/Percent Recreational Vehicles</td>
<td>Freeways Weaving Ramps Facilities Multilane Two-Lane</td>
<td>▪ Use existing count data</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Based on existing count data if future vehicle mix is projected to be similar to existing vehicle mix OR</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Based on projected future vehicle mix</td>
</tr>
<tr>
<td>Phasing</td>
<td>Streets</td>
<td>▪ Use existing timing plans or field measurements</td>
</tr>
<tr>
<td>Progression Speed</td>
<td>TWSC</td>
<td>▪ Use existing speed data OR</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Posted speed limit</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Based on existing timing plans unless otherwise directed by the VDOT project manager</td>
</tr>
<tr>
<td>Ramp Free-Flow Speed</td>
<td>Ramps</td>
<td>▪ Use existing speed data</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Based on existing speed data if future geometry is similar to the existing geometry OR</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Design speed or 10 mph above the posted warning speed OR</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Maximum allowable FFS in HCS 2010 if 10 mph above the posted warning speed exceeds the allowable FFS in HCS 2010</td>
</tr>
<tr>
<td></td>
<td>Facilities</td>
<td>▪ Use existing speed data</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Based on existing speed data if future geometry is similar to the existing geometry OR</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Design speed or 10 mph above the posted warning speed OR</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Maximum allowable FFS in HCS 2010 if 10 mph above the posted warning speed exceeds the allowable FFS in HCS 2010</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Round FFS to nearest 5 mph</td>
</tr>
<tr>
<td>HCS 2010 INPUT PARAMETER</td>
<td>MODULE</td>
<td>TYPICAL VALUE, ACCEPTABLE RANGES, and/or SPECIAL NOTES</td>
</tr>
<tr>
<td>--------------------------</td>
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<td>--------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Existing Conditions</td>
</tr>
<tr>
<td>Red Clearance</td>
<td>Streets</td>
<td>- Use existing timing plans or field measurements</td>
</tr>
<tr>
<td>Segment Length</td>
<td>Facilities</td>
<td>- Based on the influence area of each feature along the freeway segment, as defined by the HCM 2010</td>
</tr>
<tr>
<td>Segment Type</td>
<td>Facilities</td>
<td>- Select “Basic Segment”, “Weaving”, “On-Ramp”, or “Off-Ramp” based on the definitions presented in the Freeway, Weaving, and Ramps modules</td>
</tr>
<tr>
<td>Short Length</td>
<td>Facilities</td>
<td>- Use existing field measurements</td>
</tr>
<tr>
<td>Storage Length</td>
<td>Streets</td>
<td>- Use effective storage length from existing field measurements</td>
</tr>
<tr>
<td>Terrain</td>
<td>Freeways Weaving Ramps Multilane</td>
<td>- Use existing data OR Select “Level”, “Rolling”, “Mountainous”, “Grade”, or “Composite” based on HCM 2010 guidance</td>
</tr>
<tr>
<td></td>
<td>Facilities</td>
<td>- Use existing data OR Select “Level”, “Rolling”, or “Mountainous” based on HCM 2010 guidance</td>
</tr>
<tr>
<td></td>
<td>Two-Lane</td>
<td>- Use existing data OR Select “Level”, “Rolling”, or “Specific Grade” based on HCM 2010 guidance</td>
</tr>
<tr>
<td>Walk Interval</td>
<td>Streets</td>
<td>- Use existing timing plans or field measurements</td>
</tr>
<tr>
<td>Yellow Change</td>
<td>Streets</td>
<td>- Use existing timing plans or field measurements</td>
</tr>
</tbody>
</table>
7.2.1 Freeways

The HCS 2010 Freeway module applies the analysis methodology presented in Chapter 11 (Basic Freeway Segments) of the HCM 2010. This analysis applies to freeway segments with constant geometric and traffic conditions. The segment should be located outside the influence areas of merging, diverging, and weaving maneuvers. Using this module, freeway analyses should be performed separately for each direction of travel. When creating a new file, select “Operations Analysis Type” and leave “Planning Data” unchecked.

The following Freeway module input parameters require specific direction or guidance:

- **Mainline Free-Flow Speed (FFS):** For all freeway analyses conducted in HCS 2010, select “Measured FFS”. For existing analyses, use the FFS of the freeway segment from existing speed data. For future analyses, use the existing FFS of the freeway segment when the future freeway geometry is the same as the existing geometry; otherwise, use a FFS of 7 mph above the posted speed limit. If a FFS of 7 mph above the posted speed limit exceeds the maximum accepted FFS in HCS 2010, then use the maximum accepted FFS.

- **Peak Hour Factor (PHF):** For existing analyses, calculate the PHF using existing traffic count data. For future analyses, base the PHF on future land use, if possible; otherwise, use the higher of 0.92 and the existing PHF for analyses in urban areas or the higher of 0.88 and the existing PHF for analyses in rural areas.

- **Percent Trucks and Buses/Percent Recreational Vehicles:** For existing analyses, calculate the existing percentage of trucks and buses and percentage of recreational vehicles from existing traffic count data. For future analyses, use the existing percentages when future vehicle mix is expected to be similar to existing vehicle mix; otherwise, use percentages representative of the projected future vehicle mix. When modifying the percentage of trucks and buses or the percentage of recreational vehicles for future analyses, provide supporting documentation. If the ratio of trucks and buses to recreational vehicles is 5:1 or greater, the percentage of all heavy vehicles (trucks, buses, and recreational vehicles) may be entered as the percentage of trucks and buses and the recreational vehicles percentage may be set to 0%.

- **Terrain:** Obtain grade data from existing data or design plans, if available. Select “Level”, “Rolling”, “Mountainous”, “Grade”, or “Composite” based on the steepest grade and the length of the grade, according to guidance provided in Table 10.

<table>
<thead>
<tr>
<th>Steepest Grade</th>
<th>≤2%</th>
<th>&gt;2%</th>
<th>2%-3%</th>
<th>≥3%</th>
<th>&gt;4%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Length of Grade</strong></td>
<td>All Lengths</td>
<td>≤0.25 miles</td>
<td>≤0.50 miles</td>
<td>&gt;0.50 miles</td>
<td>&gt;0.25 miles</td>
</tr>
<tr>
<td><strong>Selection</strong></td>
<td>Level, Rolling, or Mountainous</td>
<td>Grade or Composite</td>
<td>Composite</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Length of entire segment

“Level”, “Rolling”, or “Mountainous” should be selected based on the following guidance from the HCM 2010:

- **Level Terrain:** Terrain that permits heavy vehicles to operate at the same speed as passenger cars. Typically level terrain contains grades of no more than 2%.

- **Rolling Terrain:** Terrain that causes heavy vehicles to reduce their speeds substantially below the speeds of passenger cars, but does not cause heavy vehicles to operate at crawl speed for significant distances or at frequent intervals. The HCM 2010 defines crawl speed as the maximum speed that trucks can maintain on an extended upgrade of a given percent.
Mountainous Terrain: Terrain that causes heavy vehicles to operate at crawl speed for significant distances or at frequent intervals.

Select “Grade” or “Composite” based on the variation in grade over the freeway segment. Select “Grade” should be selected if the grade is constant over the entire length of the freeway segment and “Composite” if the grade varies over the length of the freeway segment. When “Grade” or “Composite” is selected, enter the appropriate grade(s) and the corresponding length(s) of grade.

The following Freeways module input parameter does not require specific direction or guidance but should be adjusted to reflect field measurements, observations, or design plan data, when data is available:

- Number of lanes

### 7.2.2 Weaving

The HCS 2010 Weaving module applies the analysis methodology presented in Chapter 12 (Freeway Weaving Segments) of the HCM 2010. This analysis applies to freeway segments where two or more traffic streams traveling in the same direction cross paths.

The following Weaving module input parameter requires specific direction or guidance:

- **Mainline Free-Flow Speed (FFS):** For existing analyses, use the FFS of the weaving segment from existing speed data. For future analyses, use the existing FFS of the weaving segment when the future freeway geometry is the same as the existing geometry; otherwise, use a FFS of 7 mph above the posted speed limit, if possible. If a FFS of 7 mph above the posted speed limit exceeds the maximum accepted FFS in HCS 2010, use the maximum accepted FFS.

The following Weaving module input parameters do not require specific direction or guidance, but should be adjusted to reflect field measurements, observations, or design plan data when data is available:

- Interchange density
- Minimum lane changes
- Number of lanes
- Number of maneuver lanes
- Segment type
- Weaving configuration
- Weaving segment length

### 7.2.3 Ramps

The HCS 2010 Ramps module applies the analysis methodology presented in Chapter 13 (Freeway Merge and Diverge Segments) of the HCM 2010. This analysis applies to freeway merge and diverge segments at ramp-freeway junctions. For the purposes of analysis, junctions that are designed for high speed merging or diverging with uncontrolled ramp terminals are classified as ramp-freeway junctions.

The following Ramps module input parameters require specific direction or guidance:

- **Existence of Adjacent Ramp:** Identify any adjacent upstream and/or downstream ramp(s) within 8,000 feet of the analysis ramp and enter the associated ramp data. Run the analysis twice if there are both upstream and downstream adjacent ramps. Report the analysis results that produce the larger value for the proportion of freeway vehicles remaining in lanes 1 and 2 (the two outside lanes) immediately upstream of the on-ramp influence area or immediately upstream of the deceleration lane.
Chapter 7 – Standard Input Parameter Assumptions for Tools

Ramp Free-Flow Speed (FFS): For existing analyses, use the FFS on the ramp from existing speed data. For future analyses, use the existing FFS on the ramp when the future ramp geometry is the same as the existing geometry; otherwise, use a FFS equal to the design speed or 10 mph above the posted warning speed, if possible. If a FFS of 10 mph above the posted warning speed exceeds the maximum accepted FFS in HCS 2010, the maximum accepted FFS should be used.

The following Ramps module input parameters do not require specific direction or guidance, but they should be adjusted to reflect field measurements, observations, or design plan data when data is available:

- Number of lanes on freeway
- Number of lanes on ramp
- Side of freeway ramp connects

7.2.4 Facilities

The HCS 2010 Freeway Facilities module applies the analysis methodology presented in Chapter 10 (Freeway Facilities) of the HCM 2010. This analysis applies to extended freeway sections that are continuous and contain basic freeway, weaving, merge, and diverge segments. This module allows multiple 15-minute time periods to be analyzed. Although the Facilities module was created to analyze oversaturated conditions using demand volumes, it was not included as an accepted traffic analysis tool to analyze oversaturated conditions on freeways, since it is a deterministic model. However, this module may be used for the preliminary evaluation of alternatives in oversaturated conditions. Microsimulation is required once the preliminary evaluation has been completed. When using this module, select the segments and time periods included in the analysis such that the first and last segments in the facility do not operate at LOS F and the first and last time periods of the analysis do not include any segments that operate at LOS F.

The following Facilities module input parameters require specific direction or guidance:

- Acceleration Length: Use effective auxiliary lane lengths from existing measurements for existing conditions. Auxiliary lane lengths should be based on effective auxiliary lane length from existing field measurements for No-Build conditions or effective auxiliary lane length should be determined from design plans.

- Deceleration Length: Use effective auxiliary lane lengths from existing measurements for existing conditions. Auxiliary lane lengths should be based on effective auxiliary lane length from existing field measurements for No-Build conditions or effective auxiliary lane length should be determined from design plans.

- Demand: For undersaturated conditions, set the mainline demand and ramp demand equal to 15-minute volume on each segment. For oversaturated conditions, set the demand equal to the number of vehicles desiring to enter each freeway segment during each 15-minute analysis period. Enter the demand for each 15-minute analysis period on each segment, then balance the demand between each adjacent segment for all 15-minute periods.

- Mainline Free-Flow Speed (FFS): For existing analyses, base the FFS of the freeway segment on existing speed data. For future analyses, use the existing FFS of the freeway segment when the future freeway geometry is the same as the existing geometry; otherwise, use a FFS of 7 mph above the posted speed limit. If a FFS of 7 mph above the posted speed limit exceeds the maximum accepted FFS in HCS 2010, use the maximum accepted FFS. Round the mainline FFS entered into the HCS 2010 Facilities module to the nearest 5 mph.

- Ramp Free-Flow Speed (FFS): For existing analyses, base the FFS on the ramp on existing speed data. For future analyses, use the existing FFS on the ramp when the future ramp geometry is the same as the existing geometry; otherwise, use a FFS equal to the design speed or 10 mph above the posted warning speed. If a FFS of 10 mph above the posted warning speed exceeds the maximum accepted FFS in
HCS 2010, use the maximum accepted FFS. Round the ramp FFS entered into the Facilities module to the nearest 5 mph.

- **Segment Length**: Divide the freeway facility should into segments for analysis purposes. Segment lengths should be based on the influence areas of each feature along the freeway segment, as defined by the HCM 2010. Apply the following guidance when determining the segment length:
  - **Weaving Segment**: The length of a weaving segment should be the gore-to-gore distance of the weave plus 500 feet upstream of the entry gore and 500 feet downstream of the entry gore.
  - **On-Ramp Segment**: The length of an on-ramp segment should be 1,500 feet, starting at the gore of the merge point, if there is no adjacent off-ramp located less than 3,000 feet downstream of the on-ramp gore. If there is an off-ramp located less than 3,000 feet downstream of the on-ramp gore, the length of the on-ramp segment should be reduced to the distance between the on- and off-ramp gores minus 1,500 feet.
  - **Off-Ramp Segment**: The length of an off-ramp segment should be 1,500 feet, ending at the gore of the diverge point, if there is no adjacent on-ramp located less than 3,000 feet upstream of the off-ramp gore. If there is an on-ramp located less than 3,000 feet upstream of the off-ramp gore, the length of the off-ramp segment should be reduced to the distance between the on- and off-ramp gores minus 1,500 feet.
  - **Ramp Overlap Segment**: Only use a ramp overlap segment when the distance between successive on- and off- ramps is less than 3,000 feet. The length of the ramp overlap segment should be equal to the distance between the on- and off-ramp gores minus the length of the on-ramp segment and the length of the off-ramp segment.
  - **Basic Segment**: The length of a basic segment should include the distance not within the influence area of any weaving segments or ramps.

- **Segment Type**: Select “Basic Segment”, “Weaving”, “On-Ramp”, or “Off-Ramp” based on the definitions presented in the Freeway, Weaving, and Ramps modules.

- **Short Length**: Obtain the short length from existing measurements or design plans for weaving segments. The short length is defined as the distance where lane changing is not prohibited or discouraged by solid white pavement markings. This length is shorter than the gore-to-gore distance.

- **Terrain**: Obtain grade data from existing data or design plans. Select the terrain types “Level”, “Rolling”, or “Mountainous” based on the following guidance from the HCM 2010:
  - **Level Terrain**: Terrain that permits heavy vehicles to operate at the same speed as passenger cars. Typically level terrain contains grades of no more than 2%.
  - **Rolling Terrain**: Terrain that causes heavy vehicles to reduce their speeds substantially below the speeds of passenger cars but does not cause heavy vehicles to operate at crawl speed for significant distances or at frequent intervals. The HCM 2010 defines crawl speed as the maximum speed that trucks can maintain on an extended upgrade of a given percent.
  - **Mountainous Terrain**: Terrain that causes heavy vehicles to operate at crawl speed for significant distances or at frequent intervals.

The following Facilities module input parameters do not require specific direction or guidance, but they should be adjusted to reflect field measurements, observations, or design plan data when data is available:

- Minimum lane changes
- Number of lanes
- Number of weaving lanes
- Ramp to ramp proportion
- Weaving configuration
7.2.5 Multilane

The HCS 2010 Multilane module applies the analysis methodology presented in Chapter 14 (Multilane Highways) of the HCM 2010. This analysis applies to multilane highways segments operating under uninterrupted-flow conditions. In general, segments are considered to operate with uninterrupted flow when the segment is located two or more miles away from a traffic signal. When creating a new file, select “Operations Analysis” for the analysis type.

The following Multilane module input parameter requires specific guidance:

- **Mainline Free-Flow Speed (FFS):** For all analyses, select “Field Measured FFS”. For existing analyses, base the FFS of the multilane highway segment on existing speed data. For future analyses, use the existing FFS of the multilane highway segment when the future highway geometry is the same as the existing geometry; otherwise, use a FFS of 7 mph above the posted speed limit. If a FFS of 7 mph above the posted speed limit exceeds the maximum accepted FFS in HCS 2010, use the maximum accepted FFS.

The following Multilane module input parameter does not require specific direction or guidance, but it should be adjusted to reflect field measurements, observations, or design plan data when data is available:

- Number of lanes

7.2.6 Two Lane

The HCS 2010 Two Lane module applies the analysis methodology presented in Chapter 15 (Two-Lane Highways) of the HCM 2010. This analysis applies to highways segments with one traffic lane in each direction operating under uninterrupted-flow conditions. Segments are considered to operate with uninterrupted flow when traffic is not influenced by traffic control devices and platoons are not formed at upstream traffic signals. In general, two-lane highway segments that are located two to three miles from traffic signals operate under uninterrupted-flow conditions. Using this module, two-lane highway analysis should be performed separately for each direction.

The following are Two Lane module input parameters that require specific direction or guidance:

- **Highway Class:** Base the selection of Class I Highway, Class II Highway, or Class III Highway class on driver expectations, length of trip (long or short), purpose of trip (commuting or sight-seeing), and surrounding development. The HCM 2010 provides the following guidance on the three classes of two-lane highways:
  - Class I Highway: Two-lane highways in rural areas that largely serve commuter traffic. Drivers on Class I highways typically travel long distances and expect to travel at high speeds.
  - Class II Highway: Two-lane highways in rural areas that largely serve sight-seeing or recreational traffic. Two-lane highways that pass through rugged terrain are also classified as Class II highways. Drivers on Class II highways typically traveling short distances and do not expect to travel at high speeds.
  - Class III Highway: Two-lane highways in moderately developed areas with higher traffic volumes and more frequent access points.

- **Passing Lane Analysis:** Analyze the effect of a passing lane or climbing lane on the operation of a two-lane highway segment. For level or rolling terrain, select “Passing Lane” and for specific grades, select “Climbing Lane”. For passing lane analyses, the analysis segment should include the entire passing lane and the length of the downstream effect of the passing lane. After selecting “Passing Lane”, enter the length of the two-lane highway upstream of the passing lane and the length of the passing lane, including tapers. The climbing lane analysis assumes the climbing lane extends the entire length of the analysis segment and requires no additional input parameters. HCS 2010 reports performance measures with and without considering passing or climbing lanes in the Two Lane module.
• **Terrain:** Obtain grade data from existing data or design plans, if available. Select “Level”, “Rolling”, or “Specific Grade” based on the steepest grade and the length of the grade, according to Table 11.

<table>
<thead>
<tr>
<th>Steepest Grade</th>
<th>≤3%</th>
<th>&gt;3%</th>
<th>&gt;3%</th>
<th>&gt;3%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of Grade</td>
<td>All Lengths</td>
<td>≤0.25 miles</td>
<td>0.25 – 0.60 miles</td>
<td>&gt;0.60 miles</td>
</tr>
<tr>
<td>Selection</td>
<td>Level or Rolling</td>
<td>Level, Rolling, or Specific Grade</td>
<td>Specific Grade</td>
<td></td>
</tr>
</tbody>
</table>

“Level” or “Rolling” should be selected based on the following guidance from the HCM 2010:

• **Level Terrain:** Terrain that permits heavy vehicles to operate at the same speed as passenger cars. Typically level terrain contains grades of no more than 2%.

• **Rolling Terrain:** Terrain that causes heavy vehicles to reduce their speeds substantially below the speeds of passenger cars but does not cause heavy vehicles to operate at crawl speed for significant distances or at frequent intervals. The HCM 2010 defines crawl speed as the maximum speed that trucks can maintain on an extended upgrade of a given percent.

When “Specific Grade” is selected, the grade, length of the grade, percent of truck operating at crawl speeds, and the difference between the FFS and the truck crawl speed should be entered.

The following Two Lane module input parameters do not require specific direction or guidance but should be adjusted to reflect field measurements, observations, or design plan data when data is available:

• access-point density
• lane width
• observed total demand
• percent no-passing zones
• segment length
• shoulder width

### 7.2.7 TWSC (Two-Way Stop Control)

The HCS 2010 TWSC module applies the analysis methodology presented in Chapter 19 (Two-Way Stop-Controlled Intersections) of the HCM 2010. This analysis applies to intersections where the major street approaches are uncontrolled and the minor street approaches are controlled by stop signs.

The following TWSC module input parameters require specific direction or guidance:

• **Peak Hour Factor (PHF):** For existing analyses, calculate the PHF of the overall intersection from existing traffic count data. For future analyses, base the PHF of the overall intersection on future land use, if possible; otherwise, use the higher of 0.92 and the existing PHF for analyses in urban areas or use the higher of 0.88 and the existing PHF for analyses in rural areas. Enter the overall intersection PHF for all individual movements. In the event that individual approaches or movements are peak at different times, multiple 15-minute analysis periods may be analyzed separately.

• **Pedestrian Walking Speed:** Set the pedestrian walking speed to 3.5 ft/sec based on the current guidance in the MUTCD.

• **Percent Heavy Vehicles:** For existing analyses, calculate the percentage of heavy vehicles for each movement from existing traffic count data. For future analyses, use the existing percentages when future
vehicle mix is expected to be similar to existing vehicle mix; otherwise, use percentages representative of
the projected future vehicle mix. When modifying the percent heavy vehicles for future analyses, provide
supporting documentation.

- **Progression Speed:** Progression speed is only a required input parameter for major street approaches
where upstream traffic signals are present. For existing analyses, base the progression speed on the
average speed of platoons progressing from the signalized intersection to the TWSC intersection using
existing speed data, if available; otherwise, use the posted speed limit. For future analyses, use the existing
progression speed if the future conditions are expected to be similar to existing conditions; otherwise,
use the posted speed limit.

The following TWSC module input parameters do not require specific direction or guidance,
but they should be adjusted to reflect field measurements, observations, or design plan data when data is available:

- Arrival type
- Cycle length
- Distance to signal
- Effective green time
- Existing upstream signal
- Flared minor street approach and storage
- Lane width
- Major street direction
- Median type
- Number of lanes and usage
- Percent grade
- Percent using shared lane
- Right turn channelized

### 7.2.8 AWSC (All-Way Stop Control)

The HCS 2010 AWSC module applies the analysis methodology presented in Chapter 20 (All-Way Stop-
Controlled Intersections) of the *HCM 2010*. This analysis applies to intersections where all approaches are
controlled by stop signs.

The AWSC module does not contain any input parameters that require specific direction or guidance other
than those addressed in Section 7.2.7 – TWSC.

The following AWSC module input parameters do not require specific direction or guidance but should be
adjusted to reflect field measurements, observations, or design plan data, when data is available:

- Number of lanes and usage
- Percent through vehicles using left lane

### 7.2.9 Streets

The HCS 2010 Streets module applies the analysis methodology presented in Chapter 17 (Urban Street
Segments) and Chapter 18 (Signalized Intersections) of the *HCM 2010*. This analysis applies to isolated three-
and four-leg signalized intersections as well as urban or suburban street segments that include coordinated
intersections.

The HCS 2010 Street module input parameters that require specific direction or guidance fall into the following
categories of input parameters:

- Geometric/analysis input parameters
- Signal timing input parameters
- Pedestrian, parking, and bus input parameters
Geometric and Analysis Input Parameters

The following geometric and analysis input parameters require specific direction or guidance:

- **Number of Periods**: All analyses should be done in a one period. For multiple period analyses, convert volumes to vehicles per period rather than vehicles per hour and disable the use of PHF, which is not consistent with the methodologies in other HCS 2010 modules. If there are specific reasons for using multiple periods, their use should be approved by the VDOT project manager.

- **Storage Length**: For existing and future no-build analyses, use the effective storage length, which is equal to the existing storage length plus half of the existing taper length. Obtain existing storage and taper lengths from existing field measurements or design plans. For future build analyses, determine the 95th percentile queue length and use that length as the minimum storage length.

Signal Timing Input Parameters

The following signal timing input parameters require specific direction or guidance:

- **Cycle Length**: For existing analyses, obtain cycle lengths from existing signal timing plans or field measurements. For future analyses, cycle lengths shall be approved by the VDOT project manager. Typical cycle length values range from 60 to 240 seconds.

- **Minimum Green**: For existing analyses, obtain minimum green times from existing signal timing plans or field measurements. For future analyses, use the existing minimum green time or other minimum green time approved by the VDOT project manager. Minimum green times should not be less than five seconds.

- **Offset**: For existing analyses, obtain offsets from existing timing plans or field measurements. For future analyses, offsets should be optimized using HCS 2010 Streets time-space diagrams and approved by the VDOT project manager.

- **Optimization**: HCS 2010 Streets module has the functionality to optimize signal timing. The use of the optimization functionality, as well as the input parameters, should be discussed with and approved by the VDOT project manager.

- **Phasing**: For existing analyses, obtain phasing from existing timing plans or field measurements. For future analyses, use the existing phasing unless otherwise directed by the VDOT project manager. Modify the following phasing input parameters to match existing or future signal timing plans:
  - Force Mode
  - Lag Phase
  - Phase Split
  - Phase 2 and Phase 4 Directions
  - Recall Mode
  - Reference Phase and Reference Point
  - Side Street Split Phasing

- **Red Clearance**: For existing analyses, obtain all-red time from existing timing plans or field measurements. For future analyses, compute all-red time based on the guidance in the Yellow Change Intervals and Red Clearance Intervals TED Memorandum (TE-306.1).

- **Yellow Change**: For existing analyses, obtain yellow time from existing timing plans or field measurements. For future analyses, compute yellow time based on the guidance in the Yellow Change Intervals and Red Clearance Intervals TED Memorandum (TE-306.1).
Chapter 7 – Standard Input Parameter Assumptions for Tools

Bus, Parking, and Pedestrian Input Parameters

The following bus, parking, and pedestrian input parameters require specific direction or guidance:

- **Bus Stops Per Hour:** The number of bus stops should only be considered if the bus stops actually impede traffic flow. Bus stops are only counted if the stop occurs within 250 feet (upstream or downstream) of the stop bar on an approach, as shown in Figure 5. For existing analyses, obtain the number of bus stops from existing count data. For future analyses, use the existing number of bus stops when future bus behavior is expected to be similar to existing conditions; otherwise, use a number of bus stops representative of the projected future bus behavior. When modifying the number of bus stops for future analyses, provide supporting documentation.

- **Multimodal:** For analyses including pedestrians, bicycles, or transit, adjust default input parameter values based on field measurements, observations, or design plans.

- **Pedestrian Clearance Interval:** For existing analyses, obtain the pedestrian clearance interval from existing timing plans or field measurements. For future analyses, base the pedestrian clearance interval on the latest guidance in the MUTCD and VDOT regional pedestrian policy.

- **Parking Maneuvers Per Hour:** Parking maneuvers are only counted if the maneuver occurs within 250 feet (upstream) of the stop bar on an approach. For existing analyses, obtain the number of parking maneuvers from existing parking count data. For future analyses, use the existing number of parking maneuvers when future parking conditions are expected to be similar to existing conditions; otherwise, use a number of parking maneuvers representative of the projected future parking conditions.

- **Walk Interval:** For existing analyses, obtain the walk interval from existing timing plans or field measurements. For future analyses, compute the walk interval based on the latest guidance in the MUTCD and VDOT regional pedestrian policy.

In addition to the input parameters listed above, adjust the following Streets module default values to reflect field measurements, observations, design plan data, or signal timing plans, when available:

- Area type
- Arrival type
- Forward direction
- Grade
- Heaviest lane volume
- Interchange type
- Length of restrictive median
- Lanes/shared lanes/receiving lanes
- Lane width
- Percent of right-hand curb
- Percent turn in shared lane
- Right-hand access points
- RTOR
- Segment length
- Speed limit

### 7.3 SIDRA INTERSECTION

SIDRA Intersection is a deterministic tool developed by an Australian transportation operations company, Ackelik & Associates Pty Ltd that may be used to analyze signalized, unsignalized, and roundabout operations. However, VDOT only accepts the use of SIDRA Intersection to analyze roundabouts, and, as a result, this section only includes a discussion of the standard input parameter assumptions that apply to roundabout analyses. As a starting point, the units should be set to English for all analyses. Input parameters to SIDRA Intersection should be based on existing field measurements, observations, and design plans. Vehicle and pedestrian volume input parameters should be from existing counts for existing analyses and projected volumes for future analyses. Volume projections shall be approved by the VDOT project manager. When creating a new file, the “Current Model” in the “Options” tab of the ribbon should be set as US HCM (Customary).
Input parameters in SIDRA Intersection may be classified into the following three categories:

1. Input parameters that require specific direction or guidance for proper application – these input parameters are described in this manual
2. Input parameters that are dependent on available data that do not require specific direction or guidance on their application – these input parameters are listed but not described in this manual
3. Input parameters with default values that should not be modified without VDOT project manager approval – these input parameters are not listed in this manual

Input parameters that fall into the first category require specific direction or guidance for proper application. These input parameters are described in Sections 7.3.1 and 7.3.2 and are summarized in Table 12. Some input parameters require different direction or guidance for existing and future analyses. If different direction or guidance is not provided, then the direction or guidance given should be applied to both existing and future analyses.

The input parameters listed below fall into the second category and do not require specific direction or guidance but should be adjusted to reflect field measurements, observations, or design plan data when data is available:

- Approach distance
- Circulating transition line
- Dominant lane
- Downstream distance
- Lane configuration
- Lane control
- Lane disciplines
- Leg geometry
- Lane length
- Lane type
- Lane utilization ratio
- Lane width
- Movement exists
- Pedestrian
- Pedestrian approach travel distance
- Raindrop design
- Slip/bypass lane control
- Turn designation

All other input parameters not addressed in this chapter fall into the third category and should not be modified from the default value unless a modification is supported by data and approved by the VDOT project manager.

### 7.3.1 Geometric and Analysis Input Parameters

The following geometric and analysis input parameters require specific direction or guidance:

- **Approach Cruise Speed/Exit Cruise Speed:** For existing analyses, the approach and exit cruise speeds should be from existing speed data, if available; otherwise, the posted speed limits should be used. For future analyses, the existing speed data should be used; otherwise, the posted speed limits should be used. Individual approach and exit cruise speeds should be entered for each movement class.

- **Capacity Model:** “SIDRA Standard” should be selected for all analyses in the “Options” tab of the “Roundabouts” input parameter dialog.

- **Circulating Width:** The roundabout circulating width should be obtained from existing field measurements or design plans. For future analyses where full design has not yet been completed, the circulating width should fall within the following ranges, based on guidance from the NCHRP Report 672: Roundabouts: An Informational Guide (Second Edition):
  - Single-lane roundabout: 16 to 20 feet
  - Two-lane roundabout: 28 to 32 feet

For roundabout analyses conducted with SIDRA Intersection, use the SIDRA Standard Model.
## Table 12: SIDRA Intersection Standard Input Parameters

<table>
<thead>
<tr>
<th>SIDRA INTERSECTION INPUT PARAMETER</th>
<th>TYPICAL VALUE, ACCEPTABLE RANGES, and/or SPECIAL NOTES</th>
<th>Existing Conditions</th>
<th>Future Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Geometric and Analysis Input Parameters</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Approach Cruise Speed/Exit Cruise Speed | ▪ Based on existing speed data OR  
▪ Posted speed limit | | |
| Capacity Model | ▪ Select “SIDRA Standard” in the “Options” tab of the “Roundabouts” parameter dialog | | |
| Circulating Width | ▪ Use existing field measurements | ▪ Based on existing field measurements or design plans OR  
▪ Where full design has not yet been completed, use 16 to 20 feet for single-lane roundabouts and 28 to 32 feet for two-lane roundabouts | |
| Current Model | ▪ Select “US HCM (Customary)” in the “Options” tab of the Ribbon | | |
| Entry Angle | ▪ Use existing field measurements | ▪ Based on existing field measurements or design plans OR  
▪ Where full design has not yet been completed, use between 20° and 40°. | |
| Entry Radius | ▪ Use existing field measurements | ▪ Based on existing field measurements or design plans OR  
▪ Where full design has not yet been completed, use 50 to 100 feet for single-lane roundabouts and 65 to 120 feet for two-lane roundabouts | |
| Environmental Factor | ▪ Use 1.1 in the Northern Virginia District OR  
▪ Use 1.2 in all other districts | ▪ Use 1.05 in the Northern Virginia District OR  
▪ Use 1.1 in all other districts | |
| Extra Bunching | ▪ Use the values recommended in the *Quick Guide to SIDRA Intersection 6* | | |
| Inscribed Diameter | ▪ Use existing field measurements | ▪ Based on existing field measurements or design plans OR  
▪ Where full design has not yet been completed, use 90 to 180 feet for single-lane roundabouts and 150 to 300 feet for two-lane roundabouts | |
| Island Diameter | ▪ Calculate diameter using the equation:  
Island Diameter = Inscribed Diameter – 2 x Circulating Width | | |
<p>| Level of Service Method | ▪ Select “Delay &amp; v/c (HCM 2010)” in the “Options” tab of the “Model Settings” parameter dialog for all operational analyses. | | |
| Movement Classes | ▪ Based on the vehicle-type composition. | | |</p>
<table>
<thead>
<tr>
<th>SIDRA INTERSECTION INPUT PARAMETER</th>
<th>TYPICAL VALUE, ACCEPTABLE RANGES, and/or SPECIAL NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Existing Conditions</td>
</tr>
<tr>
<td>Number of Circulating Lanes</td>
<td>Maximum of two circulating lanes</td>
</tr>
<tr>
<td></td>
<td>Use existing field measurements</td>
</tr>
<tr>
<td>Peak Flow Factor</td>
<td>Use overall intersection PHF (reported as a percentage) for all individual movements</td>
</tr>
<tr>
<td></td>
<td>Use existing traffic count data</td>
</tr>
<tr>
<td>Roundabout Level of Service (LOS) Method</td>
<td>Select “Same as Sign Control” in the “Options” tab of the “Roundabouts” parameter dialog when comparing the roundabout to an unsignalized intersection OR Select “Same as Signalized Intersection” in the “Options” tab of the “Roundabouts” parameter dialog for all other analyses</td>
</tr>
<tr>
<td>Sensitivity Analysis</td>
<td>Methodology should be approved by the VDOT project manager</td>
</tr>
<tr>
<td>Vehicle Percentages</td>
<td>Use existing count data</td>
</tr>
</tbody>
</table>

**Pedestrian Parameters**

- **Pedestrian Movement Definition**: Select “Staged Crossing” on all approaches with a pedestrian movement.
- **Pedestrian Walking Speed**: Use 3.5 ft/sec based on the current guidance in the MUTCD.

- **Current Model**: “US HCM (Customary)” should be selected in the “Options” tab of the Ribbon before a roundabout is created.

- **Entry Angle**: The entry angle should be obtained from existing field measurements or design plans. For future analyses where full design has not yet been completed, the entry radius should be between 20° and 40°, based on guidance from the NCHRP Report 672: Roundabouts: An Informational Guide (Second Edition).

- **Entry Radius**: The entry radius should be obtained from existing field measurements or design plans. For future analyses where full design has not yet been completed, the entry radius should be within the following ranges, based on guidance from the NCHRP Report 672: Roundabouts: An Informational Guide (Second Edition):
  - Single-lane roundabout: 50 to 100 feet
  - Two-lane roundabout: 65 to 120 feet
- **Environmental Factor:** For existing analyses, a factor of 1.1 should be used in the Northern Virginia District and a factor of 1.2 should be used in all other districts. For future analyses, a factor of 1.05 should be used in the Northern Virginia District and a factor of 1.1 should be used in all other districts.

- **Extra Bunching:** This input parameter is used to account for traffic platoons and impacts from upstream traffic signals. The Extra Bunching input parameter for an approach should only be modified from the default value of 0.0% when there is an upstream traffic signal on an approach that is less than 2,600 feet from the roundabout. The distance to upstream signal should be measured from the downstream side of the traffic signal to the stop bar of the roundabout approach. When there is an upstream traffic signal on an approach, the Extra Bunching values listed in **Table 13**, recommended in the Quick Guide to SIDRA Intersection 6, should be used:

  **Table 13: SIDRA Intersection Extra Bunching Percentage**

<table>
<thead>
<tr>
<th>Distance to Upstream Signal (ft)</th>
<th>&lt;350</th>
<th>350 - 700</th>
<th>700 - 1,300</th>
<th>1,300 - 2,000</th>
<th>2,000 - 2,600</th>
<th>&gt;2,600</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extra Bunching %</td>
<td>25%</td>
<td>20%</td>
<td>15%</td>
<td>10%</td>
<td>5%</td>
<td>0%</td>
</tr>
</tbody>
</table>

- **Inscribed Diameter:** Obtain the inscribed diameter from existing field measurements or design plans. For future analyses where full design has not yet been completed, the inscribed diameter should be within the following ranges, based on guidance from the *NCHRP Report 672: Roundabouts: An Informational Guide, Second Edition*:
  - Single-lane roundabout: 90 to 180 feet
  - Two-lane roundabout: 150 to 300 feet

- **Island Diameter:** The island diameter is dependent on the inscribed diameter and circulating width of the roundabout. Calculate the inscribed diameter using the following equation:
  
  \[ \text{Island Diameter} = \text{Inscribed Diameter} - 2 \times \text{Circulating Width} \]

- **Level of Service Method:** Select “Delay & v/c (HCM 2010)” in the “Options” tab of the “Model Settings” input parameter dialog for all operational analyses.

- **Movement Classes:** Analyses in SIDRA Intersection always include Light Vehicles and Heavy Vehicle Classes. Only select one of the four additional standard movement classes in SIDRA Intersection (Buses, Bicycles, Large Trucks, and Light Rail/Trams) when there is supporting traffic count data. For existing analyses, base the selection of movement classes on the existing vehicle-type composition. For future analyses, base the selection of movement classes on future land use, if possible; otherwise, use the existing analysis movement classes. In cases where lane use is restricted based on movement classes (i.e. bus lanes or bike lanes), specify movement classes.

- **Number of Circulating Lanes:** Obtain the number of circulating lanes should be obtained from existing field measurements or design plans. SIDRA Intersection allows for entry of up to 6 circulating lanes; however, enter no more than two circulating lanes for roundabouts analyzed in Virginia.

- **Peak Flow Factor:** Use the overall intersection vehicle and pedestrian PHFs, expressed as percentages, as input parameters for vehicular and pedestrian peak flow factors. Use a “Peak Flow Period” of 15 minutes for all analyses. For existing analysis, calculate the PHF of the overall roundabout using existing traffic and pedestrian count data. For future analyses, base the PHF of the overall intersection on future land use, if possible; otherwise, use the higher of 0.92 and the existing PHF for analyses in urban areas or the higher of 0.88 and use the existing PHF for analyses in rural areas. Enter the overall intersection vehicular and pedestrian peak flow factors for all individual movements. In the event that individual
approaches or movements are known to peak at different times, analyze multiple 15-minute analysis periods separately.

- **Roundabout Level of Service (LOS) Method:** Select “Same as Signalized Intersections” as the roundabout LOS method in the “Options” tab of the “Roundabouts” input parameter dialog for all analyses except when comparing a roundabout to an unsignalized intersection. When comparing a roundabout to an unsignalized intersection, select “Same as Sign Control” as the roundabout LOS method.

- **Sensitivity Analysis:** SIDRA Intersection has the functionality to perform sensitivity analysis. The use of this functionality should be discussed with and approved by the VDOT project manager.

- **Vehicle Percentages:** Enter vehicle percentages by movement for all movement classes included in the analysis. For existing analyses, calculate the heavy vehicle (and, when applicable, bus, bicycle, large trucks, and light rail/trams) percentages using existing count data. For future analyses, use the existing percentages when future vehicle mix is expected to be similar to existing vehicle mix; otherwise, use percentages representative of the projected future vehicle mix. When modifying the vehicle percentages for future analyses, provide supporting documentation.

### 7.3.2 Pedestrian Input Parameters

The following pedestrian input parameters require specific direction or guidance:

- **Pedestrian Movement Definition:** Consider pedestrian movements for all analyses. The presence of pedestrian crossings should be based on existing conditions or design plans. On all approaches with a pedestrian movement, select “Staged Crossing” as the “Main Crossing” type. Enter data separately for both stages of the crossing.

- **Pedestrian Walking Speed:** Set the pedestrian walking speed to 3.5 ft/sec based on the current guidance in the MUTCD.

### 7.4 VISTRO

Vistro is a deterministic tool developed by PTV Group that may be used to analyze signalized intersections, unsignalized intersections, and arterial facilities in a network. Base input parameters to Vistro on existing field measurements, observations, and design plans. Obtain base traffic, conflicting pedestrian, and conflicting bicycle volume input parameters from existing counts for existing analyses and projected volumes for future analyses. Volume projections shall be approved by the VDOT project manager. In addition, obtain existing traffic signal timing information from the entity that maintains the timings for the traffic signal.

Input parameters in Vistro may be classified into the following three categories:

1. Input parameters that require specific direction or guidance for proper application – these input parameters are described in this manual
2. Input parameters that are dependent on available data that do not require specific direction or guidance on their application – these input parameters are listed but not described in this manual
3. Input parameters with default values that should not be modified without VDOT project manager approval – these input parameters are not listed in this manual

Input parameters that fall into the first category require specific direction or guidance for proper application. These input parameters are provided in Sections 7.4.1 through 7.4.4 and are summarized in Table 14. Some input parameters require different direction or guidance for existing and future analyses. If different direction or guidance is not provided, then the direction or guidance given should be applied to both existing and future analyses.
### Table 14: Vistro Standard Input Parameters

<table>
<thead>
<tr>
<th>VISTRO PARAMETER</th>
<th>TYPICAL VALUE, ACCEPTABLE RANGES, and/or SPECIAL NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Existing Conditions</td>
</tr>
<tr>
<td><strong>Geometric and Analysis Input Parameters</strong></td>
<td></td>
</tr>
<tr>
<td>Analysis Method</td>
<td>▪ Select “HCM 2010”</td>
</tr>
<tr>
<td>Channelized Control/Radius</td>
<td>▪ Use existing field measurements</td>
</tr>
<tr>
<td>Crosswalk Width</td>
<td>▪ One half of the crosswalk width from existing field data or design plans</td>
</tr>
<tr>
<td>Heavy Vehicle Percentages</td>
<td>▪ Use existing count data</td>
</tr>
<tr>
<td>Link Speed</td>
<td>▪ Use existing speed data OR ▪ Posted speed limit</td>
</tr>
<tr>
<td>Peak Hour Factor</td>
<td>▪ Use overall intersection PHF for all individual movements</td>
</tr>
<tr>
<td>Pocket Length (Turn Lanes)</td>
<td>▪ Use effective storage length from existing field measurements</td>
</tr>
<tr>
<td><strong>Signal Timing Input Parameters</strong></td>
<td></td>
</tr>
<tr>
<td>Actuation Type</td>
<td>▪ Use existing timing plans</td>
</tr>
<tr>
<td>All Red [Time]</td>
<td>▪ Use existing timing plans or field measurements</td>
</tr>
<tr>
<td>Amber [Time]</td>
<td>▪ Use existing timing plans or field measurements</td>
</tr>
<tr>
<td>Control Type</td>
<td>▪ Use existing timing plans or field observations</td>
</tr>
<tr>
<td>Coordination Type</td>
<td>▪ Use existing timing plans</td>
</tr>
<tr>
<td>Cycle Length</td>
<td>▪ Use existing timing plans or field measurements</td>
</tr>
<tr>
<td>VISTRO PARAMETER</td>
<td>TYPICAL VALUE, ACCEPTABLE RANGES, and/or SPECIAL NOTES</td>
</tr>
<tr>
<td>---------------------------</td>
<td>--------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td><strong>Existing Conditions</strong></td>
</tr>
<tr>
<td>Minimum Green [Time]</td>
<td>• Use existing timing plans or field measurements</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Offset</td>
<td>• Use existing timing plans or field measurements</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Optimize</td>
<td>• Methodology should be approved by the VDOT project manager</td>
</tr>
<tr>
<td>Pedestrian, Parking, and Bus Input Parameters</td>
<td></td>
</tr>
<tr>
<td>Local Bus Stopping Rate</td>
<td>• Only consider if the bus stoppages actually impede traffic flow</td>
</tr>
<tr>
<td></td>
<td>• Only consider bus stops occurring within 250 feet (upstream or downstream) of the stop bar on an approach</td>
</tr>
<tr>
<td></td>
<td>• Use existing count data</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>On-Street Parking Maneuver Rate</td>
<td>• Only consider maneuvers that occur within 250 feet (upstream) of the stop bar on an approach</td>
</tr>
<tr>
<td></td>
<td>• Use existing parking count data</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Pedestrian Clearance</td>
<td>• Use existing timing plans or field measurements</td>
</tr>
<tr>
<td>Presence of On-Street Parking</td>
<td>• Only consider if the on-street parking actually impedes traffic flow</td>
</tr>
<tr>
<td>Walk [Time]</td>
<td>• Use existing timing plans or field measurements</td>
</tr>
<tr>
<td>Traffic Impact Analysis Input Parameters</td>
<td></td>
</tr>
<tr>
<td>Data Entry</td>
<td>• Consult the VDOT TIA Regulations Administrative Guidelines (Chapter 527 of the 2006 Acts of Assembly) to determine if the fitted curve equation (“Trips”) or the average rate (“Rate”) applies</td>
</tr>
<tr>
<td>Trips In/Out</td>
<td>• If the fitted curve equation is used, solve by hand and enter the number of trips generated</td>
</tr>
</tbody>
</table>
The input parameters listed below fall into the second category and do not require specific direction or guidance but should be adjusted to reflect field measurements, observations, or design plan data when data is available:

- Detector length (actuated control only)
- Detector location (actuated control only)
- Grade
- Lane configuration
- Lane width
- Lead/lag
- Located in CBD
- Maximum recall (actuated control only)
- Median length
- Median width
- Minimum recall (actuated control only)
- Number of storage spaces in median
- Offset reference
- Pedestrian recall (actuated control only)
- Priority scheme
- Right turn on red
- Two-stage gap acceptance
- Vehicle extension (actuated control only)

All other input parameters not addressed in this chapter fall into the third category and should not be modified from the default value unless a modification is supported by data and approved by the VDOT project manager.

### 7.4.1 Geometric and Analysis Input Parameters

The following geometric and analysis input parameters require specific direction or guidance:

- **Analysis Method:** Select “HCM 2010” for all operational analyses.

- **Channelized Control/Radius:** For all channelized right-turn movements, select the type of control on the channelized movement (Signalized, Stop, Yield Right of Way, or Target Lane) and enter the curb radius. Obtain curb radii from existing field measurements or design plans.

- **Crosswalk Width:** Use one half of the crosswalk width obtained from existing field data for existing analyses or from design plans for future analyses. When exporting to VISSIM, crosswalks are modeled using two opposing links where each link contains the Vistro crosswalk width. A crosswalk width of 5 feet in Vistro will generate a crosswalk width of 10 feet in VISSIM.

- **Heavy Vehicle Percentages:** For existing analyses, calculate the heavy vehicle percentage for each movement from existing traffic count data. For future analyses, use the existing percentages when future vehicle mix is expected to be similar to existing vehicle mix; otherwise, use percentages representative of the projected future vehicle mix. When modifying the heavy vehicle percentage for future analyses, provide supporting documentation.

- **Link Speed:** For existing analyses, base the link speeds on existing speed data if available; otherwise, use the posted speed limits (for arterials only). For future analyses, use the existing speed data; otherwise, use the posted speed limits (for arterials only).

- **Peak Hour Factor:** For existing analyses, calculate the PHF of the overall intersection from existing traffic count data. For future year analyses, calculate the PHF based on future land use, if possible; otherwise, use the higher of 0.92 and the existing PHF for analyses in urban areas or the higher of 0.88 and use the existing PHF for analyses in rural areas. Enter the overall intersection PHF for all individual movements. In the event that individual approaches or movements are known to peak at different times, separately analyze multiple 15-minute analysis periods.

- **Pocket Length:** For existing and future no-build analyses, use the “effective storage length”, which is equal to the existing storage length plus half of the existing taper length. Obtain existing storage and taper lengths from existing field measurements. For future build analyses, use the pocket length, which should be greater than or equal to the back-of-queue length.
7.4.2 Signal Timing Input Parameters

The following signal timing input parameters require specific direction or guidance:

- **Actuation Type:** For existing analyses, base the actuation type (Fixed Timed, Semi-Actuated, or Actuated) on the existing type of controller. For future analyses, use the existing actuation type unless otherwise directed by the VDOT project manager.

- **All Red [Time]:** For existing analyses, obtain all-red time from existing timing plans or field measurements. For future analyses, compute all-red time based on the guidance in the *Yellow Change Intervals and Red Clearance Intervals* TED Memorandum (TE-306.1).

- **Amber [Time]:** For existing analyses, obtain yellow time from existing timing plans or field measurements. For future analyses, compute yellow time based on the guidance in the *Yellow Change Intervals and Red Clearance Intervals* TED Memorandum (TE-306.1).

- **Coordination Type:** For existing analyses, base the coordination type (Free Running, Time of Day Pattern Coordinated, or Time of Day Pattern Isolated) on the existing type of controller. For future analyses, use the existing coordination type unless otherwise directed by the VDOT project manager.

- **Control Type:** For existing analyses, obtain left-turn control type and right-turn control type from existing timing plans or field observations. For future analyses, base left-turn control type on TED’s *Guidance for Determination and Documentation of Left-Turn Phasing Mode* and should be approved by the VDOT project manager.

- **Cycle Length:** For existing analyses, obtain cycle lengths from existing timing plans or field measurements. For future analyses, cycle lengths shall be approved by the VDOT project manager. Typical cycle length values range from 60 to 240 seconds.

- **Minimum Green [Time]:** For existing analyses, obtain minimum initial green times from existing timing plans or field measurements. For future analyses, use the existing minimum initial green time or other minimum initial green time approved by the VDOT project manager. Minimum initial green times should not be less than five seconds.

- **Offset:** For existing analyses, obtain offsets from existing timing plans or field measurements. For future analyses, optimize offsets using Vistro time-space diagrams, which would be approved by the VDOT project manager.

- **Optimize:** Vistro has the functionality to optimize cycle length, splits, and lead/lag operations. The use of the optimization functionality for existing and future analyses should be discussed with and approved by the VDOT project manager.

7.4.3 Pedestrian, Parking, and Bus Input Parameters

The following pedestrian, parking, and bus input parameters require specific direction or guidance:

- **Local Bus Stopping Rate:** The number of bus stops should only be considered if the bus stoppages actually impede traffic flow. Bus stops are only counted if the stop occurs within 250 feet (upstream or downstream) of the stop bar on an approach, as shown in Figure 5. For existing analyses, obtain the number of bus stops from existing count data. For future analyses, use the existing number of bus stops when future bus behavior is expected to be similar to existing conditions; otherwise, use a number of bus stops representative of the projected future bus behavior. When modifying the number of bus stops for future analyses, provide supporting documentation.

- **On-Street Parking Maneuver Rate:** Parking maneuvers are only counted if the maneuver occurs within 250 feet (upstream) of the stop bar on an approach. For existing analyses, obtain the number of parking maneuvers from existing parking count data. For future analyses, use the existing number of parking
maneuvers when future parking conditions are expected to be similar to existing conditions; otherwise, use a number of parking maneuvers representative of the projected future parking conditions.

- **Pedestrian Clearance**: For existing analyses, obtain the flashing don’t walk time from existing timing plans or field measurements. For future analyses, base the flashing don’t walk time on the latest guidance in the MUTCD and VDOT regional pedestrian policy.

- **Presence of On-Street Parking**: This input parameter adjusts the saturated flow rate and should only be considered if the on-street parking actually impedes traffic flow.

- **Walk [Time]**: For existing analyses, obtain the walk time from existing timing plans or field measurements. For future analyses, compute the walk time based on the latest guidance in the MUTCD and VDOT regional pedestrian policy.

### 7.4.4 Traffic Impact Analysis Input Parameters

The following Traffic Impact Analysis input parameters require specific direction or guidance:

- **Data Entry**: Consult the VDOT TIA Regulations Administrative Guidelines (Chapter 527 of the 2006 Acts of Assembly) to determine if the fitted curve equation or the average rate published in the latest ITE Trip Generation Manual applies. If the fitted curve equation applies, set this input parameter as “Trips”. If the average rate applies, set this input parameter as “Rate”.

- **Trips In/Out**: If the fitted curve equation from the latest ITE Trip Generation Manual applies, solve the equation by hand and input parameter the total number of trips entering and exiting the site.

### 7.5 SYNCHRO

Synchro is a deterministic tool developed by Trafficware that may be used to analyze arterials, signalized intersections, and unsignalized intersections. Input parameters to Synchro should be from existing field measurements, observations, and design plans. Obtain base traffic, conflicting pedestrian, and conflicting bicycle volume input parameters from existing counts for existing analyses and projected volumes for future analyses. In addition, obtain signal timing information from the entity that maintains the timings for the traffic signal.

Input parameters in Synchro may be classified into the following three categories:

1. Input parameters that require specific direction or guidance for proper application – these input parameters are described in this manual
2. Input parameters that are dependent on available data that do not require specific direction or guidance on their application – these input parameters are listed but not described in this manual
3. Input parameters with default values that should not be modified without VDOT project manager approval – these input parameters are not listed in this manual

Input parameters that fall into the first category require specific direction or guidance for proper application. These input parameters are provided in Sections 7.5.1 through 7.5.3 and are summarized in Table 15. Some input parameters require different direction or guidance for existing and future analyses. If different direction or guidance is not provided, then the direction or guidance given should be applied to both existing and future analyses.
# Table 15: Synchro Standard Input Parameters

<table>
<thead>
<tr>
<th>SYNCHRO INPUT PARAMETER</th>
<th>TYPICAL VALUE, ACCEPTABLE RANGES, and/or SPECIAL NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Existing Conditions</td>
</tr>
<tr>
<td></td>
<td>Geometric/Analysis Input Parameters</td>
</tr>
<tr>
<td>Analysis Method</td>
<td>▪ Use <em>HCM 2010</em> methodology OR</td>
</tr>
<tr>
<td></td>
<td>▪ Use <em>HCM 2000</em> methodology for analyses where <em>HCM 2010</em> methodology does not apply</td>
</tr>
<tr>
<td>Heavy Vehicles</td>
<td>▪ Use existing count data</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Link Distance</td>
<td>▪ Use existing field measurements</td>
</tr>
<tr>
<td></td>
<td>▪ If microsimulation is required, links at network entry points should be longer than the maximum queue reported by SimTraffic</td>
</tr>
<tr>
<td>Link Speed</td>
<td>▪ Based on existing speed data OR</td>
</tr>
<tr>
<td></td>
<td>▪ Posted speed limit</td>
</tr>
<tr>
<td>Peak Hour Factor</td>
<td>▪ Use overall intersection PHF for all individual movements</td>
</tr>
<tr>
<td></td>
<td>▪ Use existing traffic count data</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Right-Turn Channelized</td>
<td>▪ Select the type of control on the channelized movement (Free, Yield, Stop, or Signal) and enter the curb radius</td>
</tr>
<tr>
<td></td>
<td>▪ Use existing field measurements</td>
</tr>
<tr>
<td>Storage Length</td>
<td>▪ Use effective storage length from existing field measurements</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Taper Length</td>
<td>▪ Use a taper length of zero feet</td>
</tr>
<tr>
<td>Signal Timing Input Parameters</td>
<td></td>
</tr>
<tr>
<td>All-Red Time</td>
<td>▪ Use existing timing plans or field measurements</td>
</tr>
<tr>
<td>Control Type</td>
<td>▪ Use existing timing plans or field measurements</td>
</tr>
</tbody>
</table>
### Chapter 7 – Standard Input Parameter Assumptions for Tools

#### SYNCHRO INPUT PARAMETER

<table>
<thead>
<tr>
<th>TYPICAL VALUE, ACCEPTABLE RANGES, and/or SPECIAL NOTES</th>
<th>Existing Conditions</th>
<th>Future Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cycle Length</strong></td>
<td>▪ Use existing timing plans or field measurements</td>
<td>▪ Should range from 60 to 240 seconds and be approved by the VDOT project manager</td>
</tr>
<tr>
<td><strong>Minimum Initial</strong></td>
<td>▪ Use existing timing plans or field measurements</td>
<td>▪ Based on existing timing plans or field measurements OR ▪ Should be approved by the VDOT project manager</td>
</tr>
<tr>
<td><strong>Minimum Split</strong></td>
<td>▪ Use existing timing plans or field measurements</td>
<td>▪ Based on existing timing plans or field measurements OR ▪ Should be approved by the VDOT project manager</td>
</tr>
<tr>
<td><strong>Offset</strong></td>
<td>▪ Use existing timing plans or field measurements</td>
<td>▪ Use time-space diagrams ▪ Should be approved by the VDOT project manager</td>
</tr>
<tr>
<td><strong>Optimize</strong></td>
<td>▪ Methodology should be approved by the VDOT project manager</td>
<td></td>
</tr>
<tr>
<td><strong>Total Split</strong></td>
<td>▪ Use existing timing plans or field measurements</td>
<td>▪ Based on existing timing plans or field measurements OR ▪ Should be approved by the VDOT project manager</td>
</tr>
<tr>
<td><strong>Turn Type</strong></td>
<td>▪ Use existing timing plans or field measurements</td>
<td>▪ Based on TED’s Guidance for Determination and Documentation of Left-Turn Phasing Mode</td>
</tr>
<tr>
<td><strong>Yellow Time</strong></td>
<td>▪ Use existing timing plans or field measurements</td>
<td>▪ Based on guidance in the Yellow Change Intervals and Red Clearance Intervals TED Memorandum (TE-306.1)</td>
</tr>
</tbody>
</table>

**Pedestrian, Parking, and Bus Input Parameters**

| **Adjacent Parking Lane**                             | ▪ Only consider maneuvers that occur within 250 feet (upstream) of the stop bar on an approach | ▪ Based on existing parking count data if future parking conditions are expected to be similar to existing conditions OR ▪ Based on projected future parking conditions |
|                                                       | ▪ Use existing parking count data | |
| **Bus Blockages**                                     | ▪ Only consider if the bus stoppages actually impede traffic flow ▪ Only consider movements that occur within 250 feet (upstream or downstream) of the stop bar on an approach | ▪ Based on existing count data if future bus service is projected to be similar to existing service OR ▪ Based on future bus service |
|                                                       | ▪ Use existing count data | |
The input parameters listed below fall into the second category and do not require specific direction or guidance but should be adjusted to reflect field measurements, observations, or design plan data when data is available:

- Area type CBD
- Crosswalk width
- Enter blocked intersection
- Grade
- Lane alignment
- Lanes and sharing
- Lane utilization/right-turn/left-turn factors
- Lane width
- Median width
- Right turn on red
- Storage lanes
- Turning speed
- TWLTL median

All other input parameters not addressed in this chapter fall into the third category and should not be modified from the default value unless a modification is supported by data and approved by the VDOT project manager.

### 7.5.1 Geometric and Analysis Input Parameters

The following geometric and analysis input parameters require specific direction or guidance:

- **Analysis Method**: The analysis method is selected in the “Create Report” dialog box after the model has been built. Use **HCM 2010** methodology for all operational analyses for which it is applicable. For analyses where **HCM 2010** methodology does not apply (e.g., intersections with non-NEMA phasing, intersections with five or more legs, clustered intersections), use **HCM 2000** methodology.

- **Heavy Vehicles**: For existing analyses, calculate the heavy vehicle percentage for each movement from existing traffic count data. For future analyses, use the existing percentages when future vehicle mix is expected to be similar to existing vehicle mix; otherwise, use percentages representative of the projected future vehicle mix. When modifying the heavy vehicle percentage for future analyses, provide supporting documentation.

- **Link Distance**: Base link lengths on field measurements or design plans. If microsimulation is required, links at network entry points should be longer than the maximum queue observed in the field for existing analyses and the maximum queue reported by SimTraffic for future analyses.

- **Link Speed**: For existing analyses, base the link speeds on existing speed data if available; otherwise, use the posted speed limits (for arterials only). For future analyses, use the existing speed data; otherwise, use the posted speed limits (for arterials only).

- **Peak Hour Factor (PHF)**: For existing analyses, calculate the PHF of the overall intersection using existing traffic count data. For future analyses, base the PHF of the overall intersection on future land use, if possible; otherwise, use the higher of 0.92 and the existing PHF for analyses in urban areas or the...
higher of 0.88 and use the existing PHF for analyses in rural areas. Enter the overall intersection PHF for all individual movements. In the event that individual approaches or movements are known to peak at different times, analyze multiple 15-minute periods separately.

- **Right-Turn Channelized:** For all channelized right-turn movements, select the type of control on the channelized movement (Free, Yield, Stop, or Signal) and enter the curb radius. Obtain the curb radii from existing field measurements or design plans.

- **Storage Length:** For existing and future no-build analyses, use the “effective storage length”, which is equal to the existing storage length plus half of the existing taper length. Obtain existing storage and taper lengths from existing field measurements. For future build analyses, the storage length should be greater than or equal to the back-of-queue length.

- **Taper Length:** For all analyses, set the taper length equal to zero. For existing and future no-build analyses, the length of the taper is considered in the “effective storage length” to remain consistent with other traffic analysis tools. For future build analyses, the storage length will accommodate the maximum queue on the link, so it is not necessary to enter a taper length.

### 7.5.2 Signal Timing Input Parameters

The following signal timing input parameters require specific direction or guidance:

- **All-Red Time:** For existing analyses, obtain all-red time from existing timing plans or field measurements. For future analyses, compute all-red time based on the guidance in the *Yellow Change Intervals and Red Clearance Intervals* TED Memorandum (TE-306.1).

- **Control Type:** For existing analyses, base the control type (Pretimed, Semi-Actuated-Uncoordinated, Actuated-Uncoordinated, Actuated-Coordinated, and/or Unsignalized) on the existing type of controller. For future analyses, use the existing control type unless otherwise directed by the VDOT project manager. After selecting the control type, modify the following input parameters to match existing or future signal timing plans:
  - Referenced to and Reference Phase (coordinated control only)
  - Lagging Phase
  - Vehicle Extension (actuated control only)
  - Minimum Gap (actuated control only)
  - Time Before Reduce (actuated control only)
  - Time To Reduce (actuated control only)
  - Recall Mode (actuated control only)
  - Detector sizes, positions, and settings (actuated control only)

- **Cycle Length:** For existing analyses, obtain cycle lengths from existing timing plans or field measurements. For future analyses, cycle lengths shall be approved by the VDOT project manager. Typical cycle length values range from 60 to 240 seconds.

- **Minimum Initial:** For existing analyses, minimum initial green times shall be obtained from existing timing plans or field measurements. For future analyses, the existing minimum initial green time or other minimum initial green time approved by the VDOT project manager should be used. Minimum initial green times should not be less than five seconds.

- **Minimum Split:** For existing analyses, minimum split times shall be obtained from existing timing plans or field measurements. For future analyses, the existing minimum split time or other minimum split time approved by the VDOT project manager should be used.
Offset: For existing analyses, obtain offsets from existing timing plans or field measurements. For future analyses, optimize offsets using time-space diagrams from Synchro.

Optimize: Synchro has the functionality to optimize cycle length, splits, and lead/lag operations. The use of the optimization functionality for existing and future analyses should be discussed with and approved by the VDOT project manager.

Total Split: For existing analyses, total split times shall be obtained from existing timing plans or field measurements. For future analyses, the existing total split time or other total split time approved by the VDOT project manager should be used.

Turn Type: For existing analyses, left-turn type and right-turn type shall be obtained from existing timing plans or field observations. For future analyses, left-turn type should be based on the following guidance from the latest VDOT Guidance for Determination and Documentation of Left-Turn Mode and should be approved by the VDOT project manager:
- If there are two or more left-turn lanes on the approach, protect the left-turn phase.
- If there are four or more through lanes on the opposing approach, protect the left-turn phase.
- If the posted speed limit on the opposing approach is greater than 45 mph, protect the left-turn phase.
- If there are two or three through lanes on the opposing approach and the product of the left-turn volume and the opposing right-turn/through volume is greater than 100,000 during the peak hour, the left-turn phase should be protected + permissive or protected only. Otherwise, the left-turn phase may be permissive.
- If there is one through lane on the opposing approach and the product of the left-turn volume and the opposing right-turn/through volume is greater than 50,000 during the peak hour, the left-turn phase should be protected + permissive or protected only. Otherwise, the left-turn phase may be permissive.

Yellow Time: For existing analyses, obtain yellow time from existing timing plans or field measurements. For future analyses, compute yellow time based on the guidance in the Yellow Change Intervals and Red Clearance Intervals TED Memorandum (TE-306.1).

7.5.3 Pedestrian, Parking, and Bus Input Parameters

The following pedestrian, parking, and bus input parameters require specific direction or guidance:

Adjacent Parking Lane: Parking maneuvers are only counted if the maneuver occurs within 250 feet (upstream) of the stop bar on an approach. For existing analyses, obtain the number of parking maneuvers from existing parking count data. For future analyses, use the existing number of parking maneuvers when future parking conditions are expected to be similar to existing conditions; otherwise, use a number of parking maneuvers representative of the projected future parking conditions.

Bus Blockages: The number of bus blockages should only be considered if the bus blockages actually impede traffic flow. Bus blockages are only counted if the stop occurs within 250 feet (upstream or downstream) from the stop bar of an approach, as shown in Figure 5. For existing analyses, obtain the number of bus blockages from existing count data. For future analyses, use the existing number of bus blockages when future bus behavior is expected to be similar to existing conditions; otherwise, use a number of bus blockages representative of the projected future bus behavior. When modifying the number of bus blockages for future analyses, provide supporting documentation.

Flash Don't Walk: For existing analyses, obtain the flash don’t walk time from existing timing plans or field measurements. For future analyses, compute the flash don’t walk time on the latest guidance in the MUTCD and VDOT regional pedestrian policy.
• **Walk Time:** For existing analyses, obtain the walk time from existing timing plans or field measurements. For future analyses, compute the walk time on the latest guidance in the MUTCD and VDOT regional pedestrian policy.

### 7.6 SIMTRAFFIC

SimTraffic is the microsimulation companion tool of Synchro and is pre-loaded with the Synchro suite of software tools. A complete Synchro model is required before any SimTraffic analysis can be conducted and the direction and guidance provided in Section 7.5 should be followed in the development of the Synchro model.

Input parameters in SimTraffic may be classified into the following two categories:

1. Input parameters that require specific direction or guidance for proper application – these input parameters are described in this manual
2. Input parameters with default values that should not be modified without VDOT project manager approval – these input parameters are not described in this manual

Input parameters that fall into the first category require specific direction or guidance for proper application. These input parameters are provided in Section 7.6.1 - Analysis Input parameters and summarized in **Table 16.** Apply the direction or guidance provided to both existing and future analyses.

All other input parameters not addressed in this chapter fall into the second category and should not be modified from the default value unless a modification is supported by data and approved by the VDOT project manager.

<table>
<thead>
<tr>
<th>SIMTRAFFIC INPUT PARAMETER</th>
<th>TYPICAL VALUE, ACCEPTABLE RANGES, and/or SPECIAL NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Analysis Input Parameters</strong></td>
<td></td>
</tr>
<tr>
<td>Number of Intervals</td>
<td>• One seeding interval and four, 15-minute recording intervals</td>
</tr>
<tr>
<td>Seeding Interval Duration</td>
<td>• Use a duration long enough to distribute traffic throughout the entire network</td>
</tr>
</tbody>
</table>
| PHF Adjust                 | • Select “Yes” for one of the four, 15-minute recording intervals  
                             | • Select “No” for all other intervals |
| Anti-PHF Adjust            | • Select “Yes” for the three, 15-minute recording intervals where PHF Adjust is set to “No”  
                             | • Select “No” for the seeding interval and the recording interval where PHF Adjust is set to “Yes” |
| Number of Runs             | • Based on the microsimulation sample size direction and guidance provided in Section 5.4 and the Sample Size Determination Tool. |

**Note:** The Synchro network should be developed using the direction and guidance in Section 7.5, prior to performing SimTraffic analysis.
7.6.1 Analysis Input Parameters

The following analysis input parameters require specific direction or guidance:

- **Anti-PHF Adjust:** For all analyses, set the Anti-PHF Adjust to “Yes” for the three, 15-minute recording intervals where PHF Adjust is set to “No”. Set the Anti-PHF Adjust to “No” for the seeding interval and the recording interval where PHF Adjust is set to “Yes”.

- **Number of Intervals:** For all analyses, use one seeding interval and four, 15-minute recording intervals.

- **Number of Runs:** Determine the minimum number of microsimulation runs based on the microsimulation sample size direction and guidance provided in Section 5.4 of this manual and the Sample Size Determination Tool.

- **PHF Adjust:** For all analyses, set the PHF Adjust to “Yes” for one of the four, 15-minute recording intervals and to “No” for all other intervals.

- **Seeding Interval Duration:** The duration of the seeding interval should be long enough to distribute traffic throughout the entire network. In general, the minimum seeding interval duration is equal to the peak hour travel time through the network or twice as long as the off peak travel time.

7.7 CORSIM

CORSIM is a microsimulation tool that can model a wide array of transportation networks. CORSIM provides a variety of model input parameters that could be modified or coded to model existing and future conditions. These input parameters include analysis, geometric, and driver/vehicular characteristics. Although the majority of these input parameters have default values that should not be changed (unless technical justification is provided), there are some input parameters that should be modified. The following information, which is summarized in Table 17, either details these specific input parameters, or further emphasizes the necessity for technical justification for modifying particular critical input parameters.

Input parameters in CORSIM may be classified into the following three categories:

1. Input parameters that require specific direction or guidance for proper application – these input parameters are described in this manual

2. Input parameters that are dependent on available data that do not require specific direction or guidance on their application – these input parameters are listed but not described in this manual

3. Input parameters with default values that should not be modified without VDOT project manager approval – these input parameters are not listed in this manual

Input parameters that fall into the first category require specific direction or guidance for proper application. These input parameters are provided in Sections 7.7.1 through 7.7.3 and are summarized in Table 17. Some input parameters require different direction or guidance for existing and future analyses. If different direction or guidance is not provided, then apply the direction or guidance given to both existing and future analyses.
### Table 17: CORSIM Standard Input Parameters

<table>
<thead>
<tr>
<th>CORSIM INPUT PARAMETER</th>
<th>TYPICAL VALUE, ACCEPTABLE RANGES, and/or SPECIAL NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Existing Conditions</strong></td>
<td><strong>Future Conditions</strong></td>
</tr>
<tr>
<td><strong>Geometric and Analysis Input Parameters</strong></td>
<td></td>
</tr>
</tbody>
</table>
| Arterial Free-Flow Speed                | - Based on existing speed data OR  
- Posted speed limit                                                                                                                                                                                                                                                                                                          |
| Auxiliary Lanes (Freeways Only)        | - Based on effective auxiliary lane length from existing field measurements  
- Based on effective auxiliary lane length from existing field measurements for No-Build scenarios OR  
- Based on effective auxiliary lane length from design plans                                                                                                                                                                                                                     |
| Car Following Sensitivity Multipliers (Freeways Only) | - Use if individual freeway links have varying capacities (rather than adjusting the Minimum Separation for Generation of Vehicles)                                                                                                                                                                                              |
| Conditional Turn Movements             | - Use to accurately model turning movement restrictions or to calibrate arterial movements                                                                                                                                                                                                                                    |
| Curvature                              | - Only consider when “short links” (lengths less than 100 feet) are the only option to represent actual roadway curvature                                                                                                                                                                                                                                       |
| Entry Traffic Volumes (Flows)          | - Enter as 15-minute volumes for a period long enough to account for PHS and for a minimum of four 15-minute intervals  
- Use existing traffic count data  
- Based on projected traffic volumes                                                                                                                                                                                                                                                                                             |
| Freeway Free-Flow Speed                | - Use existing speed data  
- Based on existing speed data if the future geometry is similar to the existing geometry OR  
- 7 mph above the posted speed limit OR  
- Maximum allowable FFS in CORSIM if 7 mph above the posted speed limit exceeds the allowable FFS in CORSIM                                                                                                                                                                      |
| Heavy Vehicle Percentages             | - Use existing count data  
- Based on existing count data if future vehicle mix is projected to be similar to existing vehicle mix OR  
- Based on projected future vehicle mix (minimum of 2%)                                                                                                                                                                                                                               |
<p>| Initialization Period                  | - Select the option of “Stop if initialization does not reach equilibrium”                                                                                                                                                                                                                                               |
| Lane-Change Parameters (Arterials Only)| - “Duration of a lane-change maneuver” and “percentage of drivers who cooperate with a lane changer” may be modified                                                                                                                                                                                                 |
| Lane-Change Parameters (Freeways Only) | - “Time to complete a lane-change maneuver” “percent of drivers desiring to yield right-of-way to lane-changing vehicles attempting to merge,” and “mandatory lane-change gap acceptance parameter” may be modified                                                                                                           |</p>
<table>
<thead>
<tr>
<th>CORSIM INPUT PARAMETER</th>
<th>TYPICAL VALUE, ACCEPTABLE RANGES, and/or SPECIAL NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Existing Conditions</td>
</tr>
<tr>
<td>Link Length</td>
<td>Do not code “short links” (lengths less than 100 feet) since these links do not function properly.</td>
</tr>
<tr>
<td>Minimum Separation for Generation of Vehicles</td>
<td>Use default value unless technical justification is provided to justify a network-wide adjustment.</td>
</tr>
<tr>
<td>Multilane Highway Free-Flow Speed</td>
<td>Use existing speed data</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Node Placement</td>
<td>Place nodes at intersections, ramp gores, points of curvature, locations where roadway geometry changes and at driver decision points</td>
</tr>
<tr>
<td>Number of Microsimulation Runs</td>
<td>Based on the microsimulation sample size direction and guidance provided in Section 5.4 and the Sample Size Determination Tool.</td>
</tr>
<tr>
<td>Origin-Destination (O-D)</td>
<td>Based on existing O-D data OR</td>
</tr>
<tr>
<td></td>
<td>Use &quot;dummy&quot; O-D factors to calibrate weaving movements</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Ramp Free-Flow Speed</td>
<td>Use existing speed data</td>
</tr>
<tr>
<td>Relative Turn Volumes</td>
<td>Enter for each 15-minute analysis period</td>
</tr>
<tr>
<td></td>
<td>Use existing traffic count data</td>
</tr>
<tr>
<td>Time Periods</td>
<td>Use 900 seconds (15 minute) time periods</td>
</tr>
<tr>
<td></td>
<td>Total analysis time should be a minimum of one hour and should show traffic demand within capacity at the beginning and end of the analysis period.</td>
</tr>
<tr>
<td>Turn Pocket (Arterials Only)</td>
<td>Use effective storage length from existing field measurements</td>
</tr>
<tr>
<td></td>
<td>Use effective storage length from existing field measurements for No-Build scenarios</td>
</tr>
<tr>
<td></td>
<td>Use maximum queue length as a minimum for Build scenarios</td>
</tr>
<tr>
<td>Vehicle Entry Headway (Distribution Type)</td>
<td>Use an Erlang distribution with &quot;a&quot; = 1 for freeway dominated networks</td>
</tr>
</tbody>
</table>
# Chapter 7 – Standard Input Parameter Assumptions for Tools

<table>
<thead>
<tr>
<th>CORSIM INPUT PARAMETER</th>
<th>TYPICAL VALUE, ACCEPTABLE RANGES, and/or SPECIAL NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Existing Conditions</strong></td>
<td><strong>Future Conditions</strong></td>
</tr>
<tr>
<td>Vehicle Reaction Points (Distance)</td>
<td>Use field observations to address microsimulation anomalies</td>
</tr>
<tr>
<td>Vehicle Types</td>
<td>Use the existing vehicle type composition</td>
</tr>
<tr>
<td>Warning Sign Location (Freeways Only)</td>
<td>Use existing warning sign locations or vehicle reaction points (where vehicles position themselves in advance of a ramp)</td>
</tr>
</tbody>
</table>

## Signal Timing Input Parameters

<table>
<thead>
<tr>
<th>Control Type</th>
<th>Use existing timing plans or field observations</th>
<th>Based on existing timing plans unless otherwise directed by the VDOT project manager</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cycle Length</td>
<td>Use existing timing plans or field measurements</td>
<td>Should range from 60 to 240 seconds and be approved by the VDOT project manager</td>
</tr>
<tr>
<td>Left-Turn Phasing</td>
<td>Use existing timing plans or field observations</td>
<td>Based on TED’s Guidance for Determination and Documentation of Left-Turn Phasing Mode</td>
</tr>
<tr>
<td>Min Green</td>
<td>Use existing timing plans or field measurements</td>
<td>Based on existing timing plans or field measurements OR Should be approved by the VDOT project manager</td>
</tr>
<tr>
<td>Offset</td>
<td>Use existing timing plans or field measurements</td>
<td>Use HCS 2010 (TRANSYT-7F), Synchro, or Vistro time-space diagrams Should be approved by the VDOT project manager</td>
</tr>
<tr>
<td>Red Clear</td>
<td>Use existing timing plans or field measurements</td>
<td>Based on guidance in the Yellow Change Intervals and Red Clearance Intervals TED Memorandum (TE-306.1)</td>
</tr>
<tr>
<td>Timing Optimization</td>
<td>Methodology should be approved by the VDOT project manager</td>
<td></td>
</tr>
<tr>
<td>Yellow</td>
<td>Use existing timing plans or field measurements</td>
<td>Based on guidance in the Yellow Change Intervals and Red Clearance Intervals TED Memorandum (TE-306.1)</td>
</tr>
</tbody>
</table>
### CORSIM INPUT PARAMETER

<table>
<thead>
<tr>
<th></th>
<th>Existing Conditions</th>
<th>Future Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pedestrian Input Parameters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ped Clear</td>
<td>Use existing timing plans or field measurements</td>
<td>Based on the latest guidance in the MUTCD and VDOT regional pedestrian policy</td>
</tr>
<tr>
<td>Walk</td>
<td>Use existing timing plans or field measurements</td>
<td>Based on the latest guidance in the MUTCD and VDOT regional pedestrian policy</td>
</tr>
</tbody>
</table>

The input parameters listed below fall into the second category and do not require specific direction or guidance, but should be adjusted to reflect field measurements, observations, or design plan data when data is available:

- Bus stations
- Grade
- HOV lanes
- Pavement
- Radius
- Number of lanes
- Lane add/drop
- Lane alignment
- Lane channelization
- Lane distribution of entering vehicles
- Lane width
- Parking location
- Parking maneuvers
- Pedestrian traffic
- Superelevation
- Truck lane restrictions
- Turn movements
- Type(s) of auxiliary lanes

All other input parameters not addressed in this chapter fall into the third category and should not be modified from the default value unless a modification is supported by data and approved by the VDOT project manager.

#### 7.7.1 Geometric and Analysis Input Parameters

- **Auxiliary Lanes (Freeways Only):** Obtain effective auxiliary lane lengths from existing measurements or design plans. Auxiliary lane lengths should be based on effective auxiliary lane length from existing field measurements for No-Build conditions or effective auxiliary lane length should be determined from design plans.

- **Car Following Sensitivity Multipliers (Freeways Only):** This input parameter adjusts the space between vehicles on a link. A lower value indicates less space between vehicles, which may be used to increase the capacity of a link. Car Following Sensitivity Multipliers (CFSM) should be used if individual freeway links have varying capacities rather than adjusting the “Minimum Separation for Generation of Vehicles.”

- **Conditional Turn Movements:** Use this input parameter to accurately model existing or proposed turning movement restrictions (i.e., time-of-day left-turn prohibition). If turning movement restrictions are not present, this input parameter should still be one of the input parameters used to calibrate arterial movements on the arterial network.
Chapter 7 – Standard Input Parameter Assumptions for Tools

- **Curvature**: This input parameter may be used when “short links” (lengths less than 100 feet) are the only option to represent actual roadway curvature.

- **Entry Traffic Volumes (Flows)**: Traffic volume intervals will vary by project; however, code entry traffic volumes for a minimum of four 15-minute intervals. If an hourly volume is over capacity, additional 15-minute intervals may be necessary, either before and/or after the peak hour of interest, to account for PHS. For existing analyses, use existing 15-minute traffic volumes. For future analyses, use projected 15-minute traffic volumes.

- **Heavy Vehicle Percentages**: For existing analyses, calculate existing heavy vehicle percentages from existing traffic count data. For future analyses, use existing heavy vehicle percentages when future vehicle mix is expected to be similar to the existing vehicle mix; otherwise, use percentages representative of the projected future vehicle mix. When modifying the heavy vehicle percentages for future analyses, provide supporting documentation.

- **Initialization Period**: An initialization period or seeding time is required prior to recording CORSIM network statistics. The maximum initialization period should be long enough to distribute traffic throughout the entire network. Equilibrium should be achieved prior to recording CORSIM network statistics; therefore, select the option to “Stop if initialization does not reach equilibrium” to verify that all models have been fully seeded. Typically, initialization time should be approximately equal to either the actual peak hour travel time or twice the off-peak travel time, when traversing from one end of the network to the other.

- **Lane-Change Input parameters (Arterials Only)**: On heavily congested arterials, there are multiple lane-change input parameters that may require adjustment to assist in the calibration process. These input parameters include:
  - Duration of a lane-change maneuver (may be adjusted from the default value of 3 seconds in a range of 1 to 8 seconds)
  - Percentage of drivers who cooperate with a lane changer (may be adjusted from the default value of 50 percent).

- **Lane-Change Input parameters (Freeways Only)**: On heavily congested freeways, there are multiple lane-change input parameters that may be adjusted to assist in the calibration process. These input parameters include:
  - Time to complete a lane-change maneuver (may be adjusted from the default value of 20 seconds)
  - Percent of drivers desiring to yield right-of-way to lane-changing vehicles attempting to merge (may be adjusted from the default value of 20 percent)
  - Mandatory lane-change gap acceptance input parameter (may be adjusted from the default value of 3 in a range of 1 to 6 with 1 being the most aggressive and 6 being the least aggressive)

- **Link Free-Flow Speed (FFS)**: For existing analyses, base the link FFS on existing speed data. For future analyses, guidance on this input parameter varies based on the roadway characteristics as follows:
  - Freeway Free-Flow Speed (FFS): For future analyses, use the existing FFS of the freeway segment when the future freeway geometry is the same as the existing geometry; otherwise, use a FFS of up to 7 mph above the posted speed limit. If a FFS of 7 mph above the posted speed limit exceeds the maximum accepted FFS in CORSIM, use the maximum accepted FFS.
  - Ramp Free-Flow Speed (FFS): For future analyses, use the existing FFS on the ramp when the future ramp geometry is the same as the existing geometry; otherwise, use a FFS of up to 10 mph above the posted warning speed. If a FFS of 10 mph above the posted warning speed exceeds the maximum accepted FFS in CORSIM, use the maximum accepted FFS.
  - Multilane Highway Free-Flow Speed (FFS): For future analyses, use the existing FFS of the multilane highway segment when the future highway geometry is the same as the existing geometry; otherwise,
use a FFS of up to 7 mph above the posted speed limit. If a FFS of 7 mph above the posted speed limit exceeds the maximum accepted FFS in CORSIM, use the maximum accepted FFS.

- **Arterial Free-Flow Speed (FFS):** For future analyses, use existing speed data; otherwise, use the posted speed limit.

- **Link Length:** There is no limitation on the maximum link length; however, CORSIM models should not include “short links” (lengths less than 100 feet), since these links do not function properly. “Short links” do not allow enough distance to accurately report link statistics.

- **Minimum Separation for Generation of Vehicles:** This input parameter adjusts capacity on all freeway links in the entire network. The CORSIM default value of 1.6 seconds limits the amount of vehicles generated on a facility to 2250 vehicles per lane. The default value should not be modified unless technical data is provided to justify a network-wide adjustment. Car Following Sensitivity Multipliers (CFSM) should be used if individual freeway links have varying capacities.

- **Node Placement:** Nodes should be placed at intersections, ramp gores, points of curvature, locations where roadway geometry changes (including number of lanes, type of lanes, grade changes, etc.) and at driver decision points. Nodes should also be located at influence area points that define merge, diverge, and weaving areas, which is depicted in Figure 8. Separate nodes should be placed for each direction of a freeway rather than using a two-way links. Additionally, entry links do not record statistics; therefore, they should not be located in areas where output results are required.

**Figure 8: Exhibit 10-1 HCM 2010**

- **Number of Microsimulation Runs:** The minimum number of microsimulation runs shall be based on the VDOT Sample Size Determination Tool up to a maximum of 30 runs. An initial assumption of ten microsimulation runs, with different random number seeds, will be performed prior to applying the methodology outlined in the VDOT Sample Size Determination Tool.

- **Origin-Destination:** Only use this input parameter if O-D data is available. If actual O-D data is not available, then use the O-D input parameter to calibrate weaving movements on the freeway network to prevent inaccurate ramp-ramp movements.

- **Relative Turn Volumes:** For existing analyses, calculate existing relative turn volumes for each 15-minute period using existing traffic count data. For future analyses, use projected 15-minute relative turn volumes.
volumes. Relative turn volumes may be coded in as either traffic volumes, which is the preferred method, or as percentages.

- **Time Periods:** The number of time periods will be determined by the peak period duration, which may extend beyond an hour. Each time period should be 900 seconds (15 minutes). Analyze a minimum of a one hour peak period in CORSIM; therefore, analyze a minimum of four 15-minute time periods unless the peak period warrants additional time periods. Future analyses should include the same time periods as existing analyses.

- **Turn Pocket (Arterials Only):** For existing and future no-build analyses, use the effective storage length, which is equal to the existing storage length plus half of the existing taper length. Obtain existing storage and taper lengths from existing field measurements or design plans. For future build analyses, determine the maximum queue length and use that length as the minimum storage length.

- **Vehicle Entry Headway (Distribution Type):** Set this distribution to an Erlang Distribution with “a” equal to 1, which represents a negative exponential distribution. A negative exponential distribution best resembles Poisson distribution, which best represents the random arrival of vehicles on a roadway network.

- **Vehicle Reaction Points (Distance):** Iteratively modify this input parameter based on the review of microsimulation results to reflect existing travel conditions. In cases where this input parameter is modified based on existing travel conditions, technical justification is not required; however, justify changes when they are used as a solution to an anomaly in the microsimulation. For future analyses, use existing distances unless modifications are required to reflect a proposed condition (i.e. improved signing).

- **Vehicle Types:** Revise the vehicle properties to match existing vehicle classification count data. For future analyses, use existing vehicle types when future vehicle types are expected to be similar to the existing vehicle types; otherwise, use percentages representative of the projected future vehicle types. When modifying the heavy vehicle types for future analyses, provide supporting documentation.

- **Warning Sign Location (Freeways Only):** Adjust the default value of 2,500 feet for “Distance From Downstream End of Link to Exit Warning Sign” input parameter based on existing warning sign locations or vehicle reaction points where vehicles position themselves in advance of a ramp. This factor aids in the calibration of freeway operations, especially under congested conditions. For future analyses, base this factor on what was coded for the existing warning sign locations when signing will remain in the same location; otherwise, use the proposed warning sign locations based on roadway plans.

### 7.7.2 Signal Timing Input Parameters

- **Control Type:** For existing analyses, control type (pre-timed or actuated), shall be based on the existing type of controller. For future analyses, use the existing control type unless otherwise directed by the VDOT project manager. After selecting the control type, modify the following input parameters to match existing or future signal timing plans:
  - Detector sizes, positions, and settings (actuated control only)
  - Operation (free or coordinated, cycle length and offset)
  - Time Settings
  - Volume/Density (actuated control only)
  - Phase control (including Recall Mode for actuated control)
  - Phase Sequence (including lag phases and overlaps)
  - Ped Generator (from existing or projected pedestrian data)
Chapter 7 – Standard Input Parameter Assumptions for Tools

**Cycle Length:** For existing analyses, obtain cycle lengths from existing timing plans or field measurements. For future analyses, cycle lengths shall be approved by the VDOT project manager. Typical cycle length values range from 60 to 240 seconds.

**Left-Turn Phasing:** For existing analyses, obtain left-turn type and right turn type from existing timing plans or field observations. For future analyses, base left-turn type on the following guidance from the latest VDOT Guidance for Determination and Documentation of Left-Turn Mode and should be approved by the VDOT project manager:
- If there are two or more left-turn lanes on the approach, protect the left-turn phase.
- If there are four or more through lanes on the opposing approach, protect the left-turn phase.
- If the posted speed limit on the opposing approach is greater than 45 mph, protect the left-turn phase.
- If there are two or three through lanes on the opposing approach and the product of the left-turn volume and the opposing right-turn/through volume is greater than 100,000 during the peak hour, the left-turn phase should be protected + permissive or protected only. Otherwise, the left-turn phase may be permissive.
- If there is one through lane on the opposing approach and the product of the left-turn volume and the opposing right-turn/through volume is greater than 50,000 during the peak hour, the left-turn phase should be protected + permissive or protected only. Otherwise, the left-turn phase may be permissive.

**Min Green:** For existing analyses, obtain minimum green times from existing timing plans or field measurements. For future analyses, use the existing minimum green time or another minimum green time approved by the VDOT project manager. Minimum green times should not be less than five seconds.

**Offset:** For existing analyses, obtain offsets from existing timing plans or field measurements. For future analyses, optimize offsets using Synchro, HCS 2010 or Vistro time-space diagrams.

**Red Clear:** For existing analyses, obtain all-red time from existing timing plans or field measurements. For future analyses, compute all-red time based on the guidance in the Yellow Change Intervals and Red Clearance Intervals TED Memorandum (TE-306.1).

**Timing Optimization:** CORSIM does not have the functionality to optimize cycle length, splits, and lead/lag operations. Other tools such as HCS 2010 (TRANSYT-7F), Synchro or Vistro should be used to optimize traffic signal timings. The use of the optimization functionality for existing and future analyses should be discussed with and approved by the VDOT project manager.

**Yellow:** For existing analyses, obtain yellow time from existing timing plans or field measurements. For future analyses, compute yellow time based on the guidance in the Yellow Change Intervals and Red Clearance Intervals TED Memorandum (TE-306.1).

### 7.7.3 Pedestrian Input Parameters

**Ped Clear:** For existing analyses, obtain the pedestrian clearance time (flash don’t walk time) from existing timing plans or field measurements. For future analyses, compute flash don’t walk time on the latest guidance in the MUTCD and VDOT regional pedestrian policy.

**Walk:** For existing analyses, obtain the walk time from existing timing plans or field measurements. For future analyses, compute walk time based on the latest guidance in the MUTCD and VDOT regional pedestrian policy.
7.8 VISSIM

VISSIM is a complex microsimulation tool that allows for the flexibility to model a wide range of traffic environments. Base input parameters to VISSIM on existing field measurements, observations, and design plans. Traffic, conflicting pedestrian, and conflicting bicycle volume input parameters should be from existing counts for existing analyses and project volumes for future analyses. Volume projections shall be approved by the VDOT project manager. In addition, obtain traffic signal timing information from the entity that maintains the timings for the traffic signal. Prior to running a VISSIM model, the user should change the units to English units.

Input parameters in VISSIM may be classified into the following three categories:

1. Input parameters that require specific direction or guidance for proper application – these input parameters are described in this manual
2. Input parameters that are dependent on available data that do not require specific direction or guidance on their application – these input parameters are listed but not described in this manual
3. Input parameters with default values that should not be modified without VDOT project manager approval – these input parameters are not listed in this manual

Input parameters that fall into the first category require specific direction or guidance for proper application. These input parameters are provided in Sections 7.8.1 through 7.8.3 and are summarized in Table 18. Some input parameters require different direction or guidance for existing and future analyses. If different direction or guidance is not provided, then apply the direction or guidance given to both existing and future analyses.

In addition to the direction and guidance provided in this manual, VDOT has developed the VDOT VISSIM User Guide to assist VISSIM users with model development, calibration, and post-processing using VISSIM Versions 6 and 7. The practices outlined in the VDOT VISSIM User Guide are intended to supplement the direction and guidance provided in this document. The VDOT VISSIM User Guide is available on the VDOT website.

The input parameters listed below fall into the second category and do not require specific direction or guidance but should be adjusted to reflect field measurements, observations, or design plan data when data is available:

- Grade
- Number of lanes
- Lane configurations
- Lane restrictions
- Parking maneuvers
- Pavement
- Pedestrian traffic
- Transit information
- Turn movements
- Type(s) of auxiliary lanes

All other parameters not addressed in this chapter fall into the third category and should not be modified from the default value unless a modification is supported by data and approved by the VDOT project manager.
### Table 18: VISSIM Standard Input Parameters

<table>
<thead>
<tr>
<th>VISSIM INPUT PARAMETER</th>
<th>TYPICAL VALUE, ACCEPTABLE RANGES, and/or SPECIAL NOTES</th>
<th>EXISTING CONDITIONS</th>
<th>FUTURE CONDITIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Geometric and Analysis Parameters</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arrival Distribution</td>
<td>▪ Select to &quot;Exact Volume&quot; instead of the default &quot;Stochastic Volume&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auxiliary Lane Length</td>
<td>▪ Use existing field measurements</td>
<td>▪ Based on existing field measurements or design plans</td>
<td></td>
</tr>
<tr>
<td>Car Following Model</td>
<td>▪ Use the Wiedemann 74 car following model (arterial links) OR ▪ Use the Wiedemann 99 car following model (freeway links)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Entry Traffic Volumes</td>
<td>▪ Enter as 15-minute volumes for a period long enough to account for PHS and for a minimum of four 15-minute intervals) ▪ Use existing traffic count data</td>
<td>▪ Based on projected traffic count data</td>
<td></td>
</tr>
<tr>
<td>Evaluations</td>
<td>▪ Refer to the VDOT VISSIM User Guide for more detail on the different evaluation methods and guidance on coding each evaluation method (Node Evaluation, Data Collection Points, Queue Counter, Travel Time, Link Evaluation, and Network Performance)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heavy Vehicle Percentages (Vehicle Compositions)</td>
<td>▪ Use existing count data</td>
<td>▪ Based on existing count data if future vehicle mix is projected to be similar to existing vehicle mix OR ▪ Based on projected future vehicle mix (minimum of 2%)</td>
<td></td>
</tr>
<tr>
<td>Link Length</td>
<td>▪ No limitation on link length ▪ Links should be continuous through areas with consistent lane configuration.</td>
<td>▪ For turn lanes, use effective storage length from existing field measurements ▪ For turn lanes, use maximum queue length as a minimum for Build scenarios</td>
<td></td>
</tr>
<tr>
<td>Link Speed (Desired Speed Distributions)</td>
<td>▪ Use existing speed data</td>
<td>▪ Based on existing speed data if the future geometry is similar to the existing geometry OR ▪ Use a linear distribution ranging +/- 5 mph from the posted speed limit (arterials) OR ▪ Use a linear distribution ranging from 3 mph below the posted speed limit to 10 mph above the posted speed limit (freeways)</td>
<td></td>
</tr>
<tr>
<td>Number of Microsimulation Runs</td>
<td>▪ Based on the microsimulation sample size direction and guidance provided in Section 5.4 and the Sample Size Determination Tool</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### VISSIM INPUT PARAMETER

<table>
<thead>
<tr>
<th>VISSIM INPUT PARAMETER</th>
<th>TYPICAL VALUE, ACCEPTABLE RANGES, and/or SPECIAL NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Existing Conditions</strong></td>
<td><strong>Future Conditions</strong></td>
</tr>
<tr>
<td><strong>Origin-Destination (O-D)</strong></td>
<td>Based on existing O-D data OR Routing decisions may be combined or set up as O-D</td>
</tr>
<tr>
<td><strong>Performance Intervals</strong></td>
<td>Report in one-hour intervals unless otherwise specified in project requirements</td>
</tr>
<tr>
<td><strong>Simulation Resolution</strong></td>
<td>Use a value between 5 and 10 This value shall not change between existing and future analyses</td>
</tr>
<tr>
<td><strong>Simulation Run Time</strong></td>
<td>Determined by the peak period duration, which may extend beyond an hour Each time period should be 900 seconds (15 minutes) A minimum of a one hour peak period should be analyzed Future analyses should include the same simulation run time as existing analyses</td>
</tr>
<tr>
<td><strong>Turning Speed (Reduced Speed Areas)</strong></td>
<td>For right turns, use 7.5 mph to 15.5 mph For left turns, use 12.4 mph and 18.6 mph</td>
</tr>
<tr>
<td><strong>Vehicle Fleet</strong></td>
<td>Use vehicle fleet in example file &quot;NorthAmericaDefault.inpx&quot; provided on the VDOT website</td>
</tr>
</tbody>
</table>

### Signal Timing Input Parameters

<table>
<thead>
<tr>
<th>Signal Timing Input Parameters</th>
<th>TYPICAL VALUE, ACCEPTABLE RANGES, and/or SPECIAL NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>All-Red Time</strong></td>
<td>Based existing timing plans or field measurements Based on guidance in the <em>Yellow Change Intervals and Red Clearance Intervals</em> TED Memorandum (TE-306.1)</td>
</tr>
<tr>
<td><strong>Controller</strong></td>
<td>Ring-Barrier Controller (RBC) is the preferred traffic signal emulator Use existing timing plans or field observations Based on existing timing plans unless otherwise directed by the VDOT project manager</td>
</tr>
<tr>
<td><strong>Cycle Length</strong></td>
<td>Use existing timing plans or field measurements Should range from 60 to 240 seconds and be approved by the VDOT project manager</td>
</tr>
<tr>
<td><strong>Left-Turn Phasing</strong></td>
<td>Use existing timing plans or field observations Based on TED’s <em>Guidance for Determination and Documentation of Left-Turn Phasing Mode</em></td>
</tr>
<tr>
<td><strong>Max Green Mode</strong></td>
<td>Use existing timing plans or field measurements Based on existing timing plans or field measurements OR Should be approved by the VDOT project manager</td>
</tr>
<tr>
<td><strong>Max Recall</strong></td>
<td>Use existing timing plans Based on existing timing plans OR Should be approved by the VDOT project manager</td>
</tr>
</tbody>
</table>
# Chapter 7 – Standard Input Parameter Assumptions for Tools

## Traffic Operations and Safety Analysis Manual

### Version 1.0

## VISSIM Input Parameters

<table>
<thead>
<tr>
<th>VISSIM Input Parameter</th>
<th>Typical Value, Acceptable Ranges, and/or Special Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Existing Conditions</strong></td>
<td><strong>Future Conditions</strong></td>
</tr>
<tr>
<td><strong>Minimum Green Time</strong></td>
<td>- Use existing timing plans or field measurements</td>
</tr>
<tr>
<td></td>
<td>- Should be approved by the VDOT project manager</td>
</tr>
<tr>
<td><strong>Min Recall</strong></td>
<td>- Use existing timing plans</td>
</tr>
<tr>
<td></td>
<td>- Should be approved by the VDOT project manager</td>
</tr>
<tr>
<td><strong>Offset Reference</strong></td>
<td>- Use existing timing plans or field measurements</td>
</tr>
<tr>
<td></td>
<td>- Should be approved by the VDOT project manager</td>
</tr>
<tr>
<td><strong>Yellow Time</strong></td>
<td>- Use existing timing plans or field measurements</td>
</tr>
</tbody>
</table>

### Pedestrian Input Parameters

| **Flash Don't Walk Time**  | - Use existing timing plans or field measurements |
|                           | - Based on the latest guidance in the MUTCD and VDOT regional pedestrian policy |
| **Walk Time**             | - Use existing timing plans or field measurements |
|                           | - Based on the latest guidance in the MUTCD and VDOT regional pedestrian policy |

## 7.8.1 Geometric and Analysis Input Parameters

The following geometric and analysis input parameters require specific guidance:

- **Arrival Distribution:** Arrival distribution cannot be changed in VISSIM. Set all input parameters to “Exact Volume” instead of the default of “Stochastic Volume” to reduce the number of microsimulation runs required.

- **Auxiliary Lanes:** Obtain effective auxiliary lane lengths from existing measurements or design plans.

- **Car Following Model:** For arterial links, use the Wiedemann 74 car following model. For freeway links, use the Wiedemann 99 car following model. If individual input parameters need to be changed, create a new driving behavior profile so the values may be modified as necessary. Provide justification for the modification of any factors.

- **Entry Traffic Volumes:** Traffic volume intervals will vary by project; however, code entry traffic volumes for a minimum of four, 15-minute intervals. Traffic volumes are entered in vehicles per hour even if the time period is not one hour. If an hourly volume is over capacity, additional 15-minute intervals may be necessary, either before and/or after the peak hour of interest, to account for PHS. For existing analyses, use existing 15-minute traffic volumes. For future analyses, use projected 15-minute traffic volumes.

- **Evaluations:** VISSIM has numerous evaluation output file options available. The most common options are node evaluation, data collection points, queue counters, travel times, link evaluation, delay evaluation
and network evaluation. Customize the content of each of these output files for the individual needs of each project and submit it for approval by the VDOT project manager at the start of the project. Refer to the VDOT VISSIM User Guide for more detail on the different evaluation methods and guidance on coding each evaluation method.

- **Node Evaluation:** Should be used to evaluate intersections. Intersection microsimulation delay and maximum queues may be derived from node evaluation results.
- **Data Collection Points:** May be used to collect MOEs at specific locations on a network, such as volumes and speeds. Data collection points collect time mean speed.
- **Queue Counter:** Queue lengths should be obtained from the node evaluation; however, place queue counters at the stop line on each approach if additional queuing locations are necessary.
- **Travel Time:** Travel time segments may be used report travel times through specific parts of a network. Travel time segments should be placed at the same start and end points as the field data collection runs.
- **Link Evaluation:** Should be used to report freeway link results, such as average space mean speed, volume, and density. Link Evaluation may be activated on a link-by-link basis. To ensure one set of results are reported for the entire link, the segment length should be set to a value larger than the link length. Link evaluation should be collected on a “by lane.”
- **Network Performance:** Should only be used when system-wide MOEs, such as total microsimulation delay are reported.

- **Heavy Vehicle Percentages (Vehicle Compositions):** For existing analyses, calculate existing heavy vehicle percentages from existing traffic count data. For future analyses, use existing heavy vehicle percentages when future vehicle mix is expected to be similar to the existing vehicle mix; otherwise, use percentages representative of the projected future vehicle mix. When modifying the heavy vehicle percentages for future analyses, provide supporting documentation.

- **Link Length:** There is no limitation on link length in VISSIM. Links should be continuous through areas of constant lane configuration. As a general practice, break links at each intersection.
  - **Turn Lanes:** For existing and future no-build analyses, use the effective storage length, which is equal to the existing storage length plus half of the existing taper length. Obtain existing storage and taper lengths from existing field measurements or design plans. For future build analyses, determine the maximum queue length and use that length as the minimum storage length.

- **Link Speed (Desired Speed Distributions):** Use existing speed data for existing analyses. For future analyses, use existing speed data if the future geometry is similar to the existing geometry. Otherwise, for future analyses on arterial networks, use a linear distribution ranging +/− 5 mph of the posted speed limit and for future analyses on freeway networks, use a linear distribution ranging from 3 mph below the posted speed limit to 10 mph above the posted speed limit.

- **Number of Microsimulation Runs:** The minimum number of microsimulation runs shall be based on the VDOT Sample Size Determination Tool up to a maximum of 30 runs. An initial assumption of 10 microsimulation runs, with different random number seeds, will be performed prior to applying the methodology outlined in the VDOT Sample Size Determination Tool by setting the random number seed increment in the multi-run tool to one.

- **Origin-Destination:** O-D data, if available, should be coded as static routes. Only use Dynamic Assignment features of VISSIM with prior approval from the VDOT project manager. Static routes may also be combined between closely spaced intersections as needed to control localized O-D behavior and to better replicate lane utilization.

- **Performance Measure Intervals:** Report performance measures in one-hour intervals unless otherwise specified in project requirements.
• **Simulation Resolution:** The number of times the position of a vehicle will be calculated within one simulated second (ranging from 1 to 10). The input parameter of one will result in the vehicles moving once per simulation second while an input parameter of 10 will result in the position of the vehicle being calculated 10 times per simulation second, thus making vehicles move more smoothly throughout the network. The change of simulation speed is inversely proportional to the number of time steps. A value between 5 and 10 should be used on all models and this value shall not change between existing and future analyses.

• **Simulation Run Time:** The simulation run time is the time it takes for the model to process the entire peak period, including the seeding time.
  - The seeding period refers to a period of simulation time prior to the analysis period(s) used to populate the model with a sufficient amount of vehicles to better represent field conditions. MOEs used for calibration and reporting should not be reported for seeding period. Typically, initialization time should be approximately equal to either the actual peak hour travel time or twice the off-peak travel time, when traversing from one end of the network to the other.
  - The simulation run time should be determined by the peak period duration, which may extend beyond an hour. Each time period should be 900 seconds (15 minutes). Analyze a minimum of a one hour peak period in VISSIM; therefore, analyze a minimum of four 15-minute time periods unless the peak period warrants additional time periods. Future analyses should include the same simulation run time as existing analyses.

• **Turning Speed (Reduced Speed Areas):** Reduced speed areas for turning vehicles should typically be set to “Speed Distributions” ranging from 7.5 to 15.5 mph for right turns and 12.4 to 18.6 mph for left-turns as a starting point. These values may be adjusted (with technical justification documentation) as needed during the calibration process to match real-world conditions.

• **Vehicle Fleet:** Use the vehicle fleet in the “NorthAmericaDefault.inpx” that is provided on the VDOT webpage. Vehicle models in this fleet are available on PTV website.

### 7.8.2 Signal Timing Input Parameters

• **All-Red Time:** For existing analyses, obtain all-red time from existing timing plans or field measurements. For future analyses, compute all-red time based on the guidance in the *Yellow Change Intervals and Red Clearance Intervals* TED Memorandum (TE-306.1).

• **Controller:** The Ring-Barrier Controller (RBC) is the preferred traffic signal emulator. Obtain existing traffic signal timing information from the entity that controls the traffic signal. If not available, measure existing traffic signal timing information in the field during peak hour operations. Use existing traffic signal timings for existing analyses and use optimized traffic signal timings for future analyses.
  - Timing Optimization: VISSIM does not have the functionality to optimize cycle length, splits, and lead/lag operations. Other tools such as HCS 2010 (TRANSYT-7F), Synchro, or Vistro should be used to optimize traffic signal timings. The use of the optimization functionality for existing and future analyses should be discussed with and approved by the VDOT project manager.

• **Cycle Length:** For existing analyses, obtain cycle lengths from existing timing plans or field measurements. For future analyses, cycle lengths shall be approved by the VDOT project manager. Typical cycle length values range from 60 to 240 seconds.

• **Left-Turn Phasing:** For existing analyses, obtain left-turn type and right turn type from existing timing plans or field observations. For future analyses, base left-turn type on the following guidance from the latest VDOT *Guidance for Determination and Documentation of Left-Turn Mode* and should be approved by the VDOT project manager.
Chapter 7 – Standard Input Parameter Assumptions for Tools

### Chapter 7

**Standard Input Parameter Assumptions for Tools**

- If there are two or more left-turn lanes on the approach, protect the left-turn phase.
- If there are four or more through lanes on the opposing approach, protect the left-turn phase.
- If the posted speed limit on the opposing approach is greater than 45 mph, protect the left-turn phase.
- If there are two or three through lanes on the opposing approach and the product of the left-turn volume and the opposing right-turn/through volume is greater than 100,000 during the peak hour, the left-turn phase should be protected + permissive or protected only. Otherwise, the left-turn phase may be permissive.
- If there is one through lane on the opposing approach and the product of the left-turn volume and the opposing right-turn/through volume is greater than 50,000 during the peak hour, the left-turn phase should be protected + permissive or protected only. Otherwise, the left-turn phase may be permissive.

**Max Green Mode:** For existing analyses, obtain the max green mode to replicate existing timing plans or field measurements. For future analyses, use the existing max green mode or another max green mode approved by the VDOT project manager.

**Max Recall:** For existing analyses, obtain max recall selected/not selected from existing timing plans. For future analyses, use the existing max recall or another max recall approved by the VDOT project manager.

**Minimum Green Time:** For existing analyses, obtain minimum green times from existing timing plans or field measurements. For future analyses, use the existing minimum green time or another minimum green time approved by the VDOT project manager. Minimum green times should not be less than five seconds.

**Min Recall:** For existing analyses, obtain min recall selected/not selected from existing timing plans. For future analyses, use the existing min recall or another min recall approved by the VDOT project manager.

**Offset Reference:** For existing analyses, obtain offset references from existing timing plans or field measurements. For future analyses, optimize offsets using Synchro, HCS 2010 or Vistro time-space diagrams.

**Yellow Time:** For existing analyses, obtain yellow time from existing timing plans or field measurements. For future analyses, compute yellow time based on the guidance in the *Yellow Change Intervals and Red Clearance Intervals* TED Memorandum (TE-306.1).

### 7.8.3 Pedestrian Input Parameters

- **Flash Don't Walk Time:** For existing analyses, obtain the flash don’t walk time from existing timing plans or field measurements. For future analyses, compute the flash don’t walk time based on the latest guidance in the MUTCD and VDOT regional pedestrian policy.

- **Walk Time:** For existing analyses, obtain the walk time from existing timing plans or field measurements. For future analyses, compute the walk time based on the latest guidance in the MUTCD and VDOT regional pedestrian policy.

### 7.9 VDOT EXTENDED HSM SPREADSHEETS

The VDOT Extended HSM Spreadsheets were jointly created by VDOT and ALDOT to simplify the use of the HSM Part C: Predictive Methods Spreadsheets. Three separate spreadsheets have been created that may be used to predict crashes on rural two-lane roads, rural multilane highways, and urban and suburban arterials. The spreadsheet for urban and suburban arterials may be used to analyze five roadway types: two-lane undivided sections, three-lane divided sections (with a two-way left-turn lane), four-lane undivided sections, four-lane divided sections, and five-lane divided sections (with a two-way left-turn lane).
Input parameters in the VDOT Extended HSM Spreadsheets may be classified into the following two categories:

1. Input parameters that require specific direction or guidance for proper application – these input parameters are described in this manual

2. Input parameters that are dependent on available data that do not require specific direction or guidance on their application – these input parameters are not described in this manual

Input parameters that fall into the first category require specific direction or guidance for proper application. These input parameters are provided in Sections 7.9.1 and 7.9.2 and are summarized in Table 19. Some input parameters require different direction or guidance for existing and future analyses. If different direction or guidance is not provided, then apply the direction or guidance given to both existing and future analyses.

All other input parameters not addressed in this chapter fall into the second category and do not require specific direction or guidance, but should be adjusted to reflect field measurements, observations, and/or design plan data when data is available.

### 7.9.1 Geometric and Analysis Input Parameters

The following geometric and analysis input parameters require specific guidance:

- **AADT$_{major}$/AADT$_{minor}$**: If the AADTs on the two major-road legs or on the two minor-road legs of an intersection differ, use the larger of the two values for AADT$_{major}$ or AADT$_{minor}$. For a three-leg intersection, use the AADT of the minor road for AADT$_{minor}$.

- **Driveway Density**: Use the driveway density over the length of the entire facility, rather than the segment-specific driveway density. The segment-specific driveway density may result in an inflated number of predicted crashes for segments shorter than 0.5 miles.

- **Major/Minor Driveways**: A major driveway is generally considered one that serves sites with 50 or more parking spaces while a minor driveway is generally considered one that serves sites with less than 50 parking spaces. The VDOT project manager may also classify driveways as major or minor based on the character of the establishment served by the driveway (e.g., the entrance to a high-turnover, fast-food restaurant with less than 50 parking spaces may be considered a major driveway). Sites with no restrictions on access along the entire property frontage should be considered to have two driveways.

- **Number of Bus Stops/Schools/Alcohol Sales Establishments**: This input parameter should only be considered if a bus stop, school, or alcohol sales establishment is located within 1,000 feet of the center of the intersection in any direction.

- **Roadside Hazard Rating**: Roadside hazard rating is based on the scale ranging from 1 to 7. An average roadside hazard rating for a segment should be used, provided that the difference between the maximum and minimum ratings throughout the segment is not greater than two.

- **Segment Length**: A roadway segment is a section of continuous road that is not interrupted by an intersection and consists of homogenous geometric features. A new segment should be created if any input parameter changes along a roadway. The HSM may be consulted for more specific guidance on how to properly segment a roadway for use with the VDOT Extended HSM spreadsheets. The length of a segment should be measured to or from the center of an intersection or the break point between two homogenous segments. For the rural two-lane road and rural multilane highway modules, the segment length should not be shorter than 0.10 miles.
### 7.9.2 Crash Data Input Parameters

The Empirical Bayes (EB) Method may be used to improve the reliability of the number of crashes produced from a predictive model by combining the model prediction with observed crash data. In cases where the EB Method will not be used to compare alternatives for future analyses, the user shall run the existing scenario using the EB Method only to gain an understanding of the reasonableness of the predictive model and not for comparison purposes. The VDOT Extended HSM Spreadsheets can implement the EB Method by analyzing the model for both predicted and expected crashes. Guidance on when to use the EB Method is provided below and detailed in the *HSM Part C*.

#### Table 19: VDOT Extended HSM Spreadsheets Standard Input Parameters

<table>
<thead>
<tr>
<th>VDOT EXTENDED HSM SPREADSHEETS INPUT PARAMETER</th>
<th>MODULE</th>
<th>TYPICAL VALUE, ACCEPTABLE RANGES, and/or SPECIAL NOTES</th>
</tr>
</thead>
</table>
| **AADT_{major}/AADT_{minor}**                 | Rural Two-Lane Roads  
Rural Multilane Highways  
Urban and Suburban Arterials | Use the larger value of two road legs for AADT_{major} and AADT_{minor}. |
| Average Annual Crash History                  | Rural Two-Lane Roads  
Rural Multilane Highways  
Urban and Suburban Arterials | Use at least two years of crash data (five years preferred)  
Classify each crash:  
   - Fatal/ injury or property damage only  
   - Intersection-related or segment-related  
   - Single-vehicle or multiple-vehicle (urban and suburban arteries)  
   - Driveway-related or non-driveway-related (urban and suburban arteries) |
| Driveway Density                              | Rural Two-Lane Roads | Use the driveway density over the length of the entire study area facility |
| Major/Minor Driveways                         | Urban and Suburban Arterials | Based on:  
   - Site characteristics OR  
   - Number of parking spaces (major = 50+)  
Assume two driveways for sites with continuous access along the property frontage |
| Number of Bus Stops/Schools/Alcohol Sales Establishments | Urban and Suburban Arterials | Only if located within 1,000 feet of the center of the intersection. |
| Predicted/Expected Crashes                    | Rural Two-Lane Roads  
Rural Multilane Highways  
Urban and Suburban Arterials | “Predicted & Expected” if an alternative contains only minor changes from the existing conditions OR  
“Predicted” if an alternative contains a major change |
### VDOT EXTENDED HSM SPREADSHEETS INPUT PARAMETER

<table>
<thead>
<tr>
<th>MODULE</th>
<th>TYPICAL VALUE, ACCEPTABLE RANGES, and/or SPECIAL NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural Two-Lane Roads</td>
<td>Use average roadside hazard rating for a segment, The difference between the maximum and minimum ratings throughout the segment should be less than two</td>
</tr>
<tr>
<td>Rural Two-Lane Roads</td>
<td>Distance between the center of two intersections OR The break point between two homogenous segments</td>
</tr>
<tr>
<td>Rural Multilane Highways</td>
<td>Minimum segment length is 0.10 miles</td>
</tr>
<tr>
<td>Urban and Suburban Arterials</td>
<td>Distance between the center of two intersections OR The break point between two homogenous segments</td>
</tr>
</tbody>
</table>

### Average Annual Crash History: This factor should only be considered when using predicted and expected crashes. At least two years, and preferably five years of crash data should be used if no major geometric or traffic control change has occurred during the period. Each crash shall be classified as a fatal and injury crash or a property damage only crash and as an intersection-related or segment-related crash based on the guidance provided in the *HSM Part C Appendix A.2*. For analyses of urban and suburban arterials, each crash shall be further classified as a single-vehicle or multiple-vehicle crash and as a driveway-related or non-driveway-related crash.

### Predicted/Expected Crashes: For future analyses, this input parameter should be set as “Predicted & Expected” if alternatives that are being compared only contain minor changes from the existing conditions. A minor change should be considered any change that does not affect the safety performance functions (SPFs) used in the analysis of the existing conditions (e.g., change in site type, area type, number of through lanes, traffic control type, alignment for a substantial portion of the project length). For future analyses where any alternative contains a major change from the existing conditions, set this input parameter to “Predicted”.

#### 7.10 IHSDM

IHSDM is a tool developed and distributed by FHWA. IHSDM implements Chapters 10, 11, and 12 and Chapters 18 and 19 of Part C of the HSM (Predictive Methods) to predict crashes on rural two-lane roads, rural multilane highways, urban and suburban arterials, freeways, and ramps.

Input parameters in IHSDM may be classified into the following two categories:

1. Input parameters that require specific direction or guidance for proper application – these input parameters are described in this manual
2. Input parameters that are dependent on available data that do not require specific direction or guidance on their application – these input parameters are not described in this manual

Input parameters that fall into the first category require specific direction or guidance for proper application. These input parameters are provided in Sections 7.10.1 and 7.10.2 and are summarized in Table 20. Some input parameters require different direction or guidance for existing and future analyses. If different direction or guidance is not provided, then apply the direction or guidance given to both existing and future analyses.
Table 20: IHSDM Standard Input Parameters

<table>
<thead>
<tr>
<th>IHSDM INPUT PARAMETER</th>
<th>MODULE</th>
<th>TYPICAL VALUE, ACCEPTABLE RANGES, and/or SPECIAL NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major/Minor Driveways</td>
<td>• Rural Two-Lane Roads</td>
<td>• Based on:</td>
</tr>
<tr>
<td></td>
<td>• Rural Multilane Highways</td>
<td>• Site characteristics OR</td>
</tr>
<tr>
<td></td>
<td>• Urban and Suburban Arterials</td>
<td>• Number of parking spaces (major = 50+)</td>
</tr>
<tr>
<td></td>
<td>• Freeways</td>
<td>• Assume two driveways for sites with continuous access along the property frontage</td>
</tr>
<tr>
<td>Number of Bus Stops/Schools/Alcohol Sales Establishments</td>
<td>• Urban and Suburban Arterials</td>
<td>• Only if located within 1000 feet of the center of the intersection</td>
</tr>
<tr>
<td>Site Specific Crash Data</td>
<td>• Rural Two-Lane Roads</td>
<td>• Include if each alternative contains only minor changes from the existing conditions</td>
</tr>
<tr>
<td></td>
<td>• Rural Multilane Highway</td>
<td>• Use at least two years of crash data (five years preferred)</td>
</tr>
<tr>
<td></td>
<td>• Urban and Suburban Arterials</td>
<td>• Classify each crash:</td>
</tr>
<tr>
<td></td>
<td>• Freeways</td>
<td>• Fatal/injury or property damage only</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Intersection-related or non-intersection-related</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Single-vehicle or multiple vehicle</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Driveway-related</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Vehicle-pedestrian or vehicle-bicycle</td>
</tr>
</tbody>
</table>

All other input parameters not addressed in this chapter fall into the second category and do not require specific direction or guidance, but should be adjusted to reflect field measurements, observations, and/or design plan data when data is available.

### 7.10.1 Geometric and Analysis Input Parameters

The following geometric and analysis input parameters require specific guidance:

- **Major/Minor Driveways:** A major driveway is generally considered one that serves sites with 50 or more parking spaces. A minor driveway is generally considered one that serves sites with less than 50 parking spaces. The VDOT project manager may classify driveways as major or minor based on the character of the establishment served by the driveway (e.g., the entrance to a high turnover fast food restaurant with less than 50 parking spaces may be considered a major driveway). Consider sites with no restrictions on access along the entire property frontage to have two driveways.

- **Number of Bus Stops/Schools/Alcohol Sales Establishments:** This input parameter should only be considered if a bus stop, school, or alcohol sales establishment is located within 1,000 feet of the center of the intersection in any direction.

### 7.10.2 Crash Data Input Parameters

The Empirical Bayes (EB) Method may be used to improve the reliability of the number of crashes produced from a predictive model by combining the model prediction with observed crash data. In cases where the EB Method will not be used to compare alternatives for future analyses, the user shall run the ‘no-build’ scenario using the EB Method only to gain an understanding of the reasonableness of the predictive model and not for
comparison purposes. IHSDM can implement the EB Method by considering observed crash data on a site-specific or project-specific level. The project-specific EB Method is not recommended for use with this manual. Guidance on when to use the site-specific EB Method is provided below.

- **Site-Specific Crash Data:** For future analyses, enter site-specific crash data if alternatives that are being compared only contain minor changes from the existing conditions. A minor change should be considered any change that does not affect the SPFs used in the analysis of the existing conditions (e.g., change in site type, area type, number of through lanes, traffic control type, alignment for a substantial portion of the project length). At least two years, and preferably five years, of crash data should be used. Each crash shall be classified as a fatal and injury crash or as a property damage only crash and as an intersection-related crash or a non-intersection-related crash based on the guidance provided in the *HSM Part C Appendix A.2*. Crashes shall also be classified as a single-vehicle, multiple-vehicle, driveway-related, vehicle-pedestrian, or vehicle-bicycle crash. For future analyses where any alternative contains a major traffic control, alignment, or cross-section change from the existing conditions, do not include site-specific crash data.

### 7.11 ISATe

ISATe is a Microsoft® Excel-based tool that has been developed by FHWA. ISATe may be used to evaluate the safety performance of freeways, interchanges, ramps, and C-D roads by utilizing SPFs, CMFs, and a local calibration factor, if available from VDOT, to estimate average crash frequency by crash type or by severity.

Input parameters in ISATe may be classified into the following two categories:

1. Input parameters that require specific direction or guidance for proper application – these input parameters are described in this manual
2. Input parameters that are dependent on available data that do not require specific direction or guidance on their application – these input parameters are not described in this manual

Input parameters that fall into the first category require specific direction or guidance for proper application. These input parameters are provided in Sections 7.11.1 and 7.11.2 and are summarized in Table 21. Some input parameters require different direction or guidance for existing and future analyses. If different direction or guidance is not provided, then the direction or guidance given should be applied to both existing and future analyses.

All other input parameters not addressed in this chapter fall into the second category and do not require specific direction or guidance, but should be adjusted to reflect field measurements, observations, and/or design plan data when data is available.

#### 7.11.1 Geometric and Analysis Input Parameters

The following are geometric and analysis input parameters that require specific guidance:

- **Curve Radius:** ISATe is not designed to analyze curve radii less than 1,000 feet on freeway segments or less than 100 feet on ramp segments. For curves less than 1,000 or 100 feet on the respective facilities, the VDOT project manager should determine if the curve radius can be increased to 1,000 or 100 feet for the purpose of the analysis. If radius cannot be increased, then exclude the segment containing the horizontal curve from the analysis.

- **Entrance/Exit Ramp:** This input parameter should only be considered when a ramp speed-change lane, lane add, or lane drop is present in the segment. A speed-change lane or lane add/drop begins or ends at the gore point, which is considered to be the point at which the pair of solid white pavement edge markings that separate the ramp from the freeway main lanes are two feet apart.
Segment Length: A roadway segment is a section of continuous road that consists of homogenous geometric features. A new segment should begin when there is a significant change in at least one of the following input parameters. The ISATe User Manual may be consulted for more specific guidance on the segmentation of the network for analysis purposes.

- Number of through lanes
- Lane width
- Shoulder width
- Median width
- Ramp presence
- Clear zone width
- Merging ramp or C-D road presence
- Diverging ramp or C-D road presence

### Table 21: ISATe Standard Input Parameters

<table>
<thead>
<tr>
<th>ISATe INPUT PARAMETER</th>
<th>TYPICAL VALUE, ACCEPTABLE RANGES, and/or SPECIAL NOTES</th>
</tr>
</thead>
</table>
| **Crash Data**         | • Use at least two years of crash data (five years preferred)  
                          • Classify each crash:  
                            ▪ fatal/injury or property damage only  
                            ▪ ramp related or non-ramp related  
                            ▪ single-vehicle or multiple vehicle |
| **Crash Data Description** | • Set as “Data for each individual segment” if each alternative contains only minor changes from the existing conditions  
                              • Set as “No crash data” if any alternative contains a major change |
| **Crash/Study Period**  | • Use existing geometry if an alternative contains only minor changes from the existing conditions  
                              • Input parameter data for the study period only if an alternative contains a major change |
| **Curve Radius**        | • Exclude segments containing horizontal curves with radii less than 1,000 feet on freeway segments or less than 100 feet on ramp segments |
| **Entrance/Exit Ramp**  | • Only consider when a segment contains:  
                            ▪ ramp speed-change lane  
                            ▪ lane add  
                            ▪ lane drop |
| **Segment Length**      | • Begin a new segment when there is a significant change in at least one of the following input parameters:  
                            ▪ number of through lanes  
                            ▪ lane width  
                            ▪ shoulder width  
                            ▪ median width  
                            ▪ ramp presence  
                            ▪ clear zone width  
                            ▪ merging/diverging ramp  
                            ▪ C-D road presence |
7.11.2 Crash Data Input Parameters

The Empirical Bayes (EB) Method may be used to improve the reliability of the number of crashes produced from a predictive model by combining the model prediction with observed crash data. In cases where the EB Method is not to be used to compare alternatives for future analyses, the user shall run the no-build scenario using only the EB Method to gain an understanding of the reasonableness of the predictive model and not for comparison purposes. ISATe can implement the EB Method by considering observed crash data on a site-specific or project-specific level. The project-specific EB Method is not recommended for use with this manual. Guidance on when to use the site-specific EB Method is provided below.

- **Crash Data:** At least two years, and preferably five years, of crash data should be used, provided that no major geometric or traffic control change has occurred during the crash period. Each crash shall be classified as a fatal and injury crash or as a property damage only crash and as a ramp-related crash or a non-ramp-related crash. For a segment with a ramp speed-change lane, consider a crash as ramp-related if it is located between the gore point and the taper point of the ramp speed-change lane. No crashes should be designated as ramp-related for a ramp entrance that adds a lane to the freeway cross-section or a ramp exit that removes a lane from the freeway cross-section. For a segment with a Type B weaving section (as defined in the ISATe user guide), a crash should be considered as ramp-related if it is located between the two gore points and the distance between the two gore points is less than 4,500 feet. If the distance between the two gore points exceeds 4,500 feet, the segment is no longer considered a Type B weave and no crashes should be designated as ramp-related. Any crash classified as a non-ramp-related crash shall also be classified as a multiple-vehicle crash or a single-vehicle crash.

- **Crash Data Description:** For future analyses, set this input parameter as “Data for each individual segment” if alternatives that are being compared only contain minor changes from the existing conditions. A minor change should be considered any change that does not affect the SPF's used in the analysis of the existing conditions (e.g., change in site type, area type, number of through lanes, traffic control type, alignment for a substantial portion of the project length). For future analyses where any alternative contains a major change from the existing conditions, this input parameter should be set as ‘No crash data’.

- **Crash/Study Period:** For future analyses where each alternative contains only minor changes from the existing conditions, the crash period input parameters should reflect the existing geometry and the study period input parameters should represent the minor changes. A minor change should be considered any change that does not affect the SPF's used in the analysis of the existing conditions (e.g., change in site type, area type, number of through lanes, traffic control type, alignment for a substantial portion of the project length). For future analyses where any alternative contains a major change from the existing conditions, provide input parameters for the study period only.

7.12 SSAM

SSAM is an analysis tool distributed by FHWA used to quantify safety conflicts of roadway geometry using microsimulation results. SSAM analysis requires the input of a trajectory file from VISSIM. SSAM is sensitive to lane-changing characteristics; therefore, calibration of the microsimulation model shall be completed prior to exporting the trajectory file. When analyzing the trajectory file in SSAM, use all of the default configuration input parameters unless a modification is supported by data and is approved by the VDOT project manager.

SSAM is unable to recognize grade separations in a network since the model trajectory file does not contain “z” coordinates. As a result, SSAM reports false conflicts at grade-separated crossings. For this reason, review the conflicts reported by SSAM and remove false conflicts. SSAM has a filtering feature that allows the user to isolate subsets of conflicts, and in some cases, false conflicts can be removed. However, the functionality of the filtering feature is limited and often conflicts must be exported to a *.CSV file and manually filtered. Assumptions used to filter SSAM conflict results, both manually and through the filtering feature built into SSAM, should be discussed with and approved by the VDOT project manager.
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8 Output

To provide a clear, accurate and effective depiction of traffic operations and safety performance, the results should be conveyed in formats that are easy to digest and understand. It is important to understand how the results will be viewed by both technical and non-technical audiences. This chapter describes and provides approved, standardized formats to present results from the approved traffic and safety analysis tools addressed in this manual; however, the VDOT project manager may require additional output requirements not discussed in the manual, such as congestion mapping or MOE statistics such as standard deviation. The purpose of developing standardized output formats is twofold:

1. To provide consistent output formats to VDOT reviewers:
   - Reduces the potential for requiring multiple submittals
   - Reduces review time required by VDOT staff
2. To relay key MOE information from traffic and safety analysis tool outputs

8.1 OUTPUT FORMATS

Both depictive and tabular output formats are required for all analyses. A depictive output format represents data and results with colors, shapes, and/or symbols along with numerical results. A tabular output format represents data and results in rows and columns. A minimum of two MOEs shall be summarized for each link or intersection in the network when more than one MOE is available. In addition to the depictive and tabular output formats, raw software outputs shall be included with all submittals.

The following sections of this chapter provide recommended output templates for each software tool. These templates may be modified based on project needs.

8.2 HCS 2010 OUTPUT FORMATS

HCS 2010 shall only be used to report results for analyses operating in undersaturated conditions. The recommended output templates to summarize HCS 2010 results are shown in Table 22, Table 23, Table 24, Figure 9, Figure 10, and Figure 11. The three tables are tabular templates created in Microsoft® Excel to display delay, queue length, and density, respectively. Table 22 and Table 24 also show LOS. Notes are provided at the bottom of each table that list modifications that should be made to the tables based on the software being reported. Similar templates may also be created to display v/c ratio, travel time, PTSF, or PFFS.

Figure 9 and Figure 10 are depictive format templates created in Microsoft® PowerPoint that display one MOE (delay or queue length) at four intersections. An aerial image is included to depict the general study area while a number is used as a label for each study intersection. The aerial image is not a required component on the output summary, but is recommended to aid in the review process.

Figure 11 illustrates a depictive output format created in Microsoft® Excel to display freeway operations, including ramps and weaving areas. This template presents density and speed, with the density results supplemented by LOS. Sections are color-coded according to the corresponding LOS and density. Other items illustrated on the figure include free-flow speed, traffic volume, distances between ramps, ramp lengths, and acceleration/deceleration lane lengths. Brief descriptions of the ramps are also included on the figure. An aerial that depicts the overall study area is also included on the figure for reference. The aerial imagery is not a required component on the output summary, but is recommended to aid in the review process.
Table 22: HCS 2010/Vistro/Synchro/SimTraffic/CORSIM/VISSIM Delay Tabular Format

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Overall Delay (LOS)</th>
<th>Delay per Lane Group by Approach (sec/veh) (Level of Service)</th>
<th>Eastbound</th>
<th>Westbound</th>
<th>Northbound</th>
<th>Southbound</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LT</td>
<td>TH</td>
<td>RT</td>
<td>LT</td>
<td>TH</td>
<td>RT</td>
</tr>
<tr>
<td>2012 Existing</td>
<td>40.9 (D)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AM Peak Hour</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2020 No Build</td>
<td>35.8 (D)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>47.7 (D)</td>
<td>59.8 (E)</td>
<td>39.5 (D)</td>
<td>36.2 (D)</td>
<td>11.4 (B)</td>
<td>14.5 (B)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>54.0 (D)</td>
<td>32.2 (C)</td>
<td>27.4 (C)</td>
<td>41.6 (C)</td>
<td></td>
</tr>
<tr>
<td>2020 Build-Out</td>
<td>40.1 (D)</td>
<td>60.5 (E)</td>
<td>54.8 (D)</td>
<td>32.4 (C)</td>
<td>6.3 (A)</td>
<td>14.4 (B)</td>
</tr>
<tr>
<td></td>
<td>55.0 (D)</td>
<td>37.8 (D)</td>
<td>36.0 (D)</td>
<td>41.4 (D)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PM Peak Hour</td>
<td>27.3 (C)</td>
<td>59.8 (E)</td>
<td>53.6 (D)</td>
<td>28.5 (C)</td>
<td>21.0 (C)</td>
<td>1.3 (A)</td>
</tr>
<tr>
<td>2020 No Build</td>
<td>24.4 (C)</td>
<td>54.5 (D)</td>
<td>59.4 (E)</td>
<td>33.7 (C)</td>
<td>32.5 (C)</td>
<td>7.4 (A)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>57.0 (E)</td>
<td>26.0 (C)</td>
<td>27.0 (C)</td>
<td>13.5 (B)</td>
<td></td>
</tr>
<tr>
<td>2020 Build-Out</td>
<td>28.8 (C)</td>
<td>52.8 (D)</td>
<td>60.8 (E)</td>
<td>33.1 (C)</td>
<td>30.0 (C)</td>
<td>4.9 (A)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>57.4 (E)</td>
<td>25.9 (C)</td>
<td>34.1 (C)</td>
<td>16.7 (B)</td>
<td></td>
</tr>
</tbody>
</table>

* When displaying results from SimTraffic, CORSIM, or VISSIM, this template shall not display LOS and should contain a note indicating that the results displayed are the average results across “X” microsimulation runs.

**When reporting delay results from HCS 2010, Vistro, or Synchro, control delay shall be reported. When reporting delay results from SimTraffic, CORSIM, or VISSIM, microsimulation delay shall be reported.

Table 23: HCS 2010/Vistro/Synchro/SimTraffic/CORSIM/VISSIM Queue Length Tabular Format

<table>
<thead>
<tr>
<th>Intersection</th>
<th>Movement</th>
<th>Queue Length (ft)</th>
<th>Storage Length Available (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Street/First Street</td>
<td>Westbound RT/LT</td>
<td>225</td>
<td>300</td>
</tr>
<tr>
<td>Main Street/First Street</td>
<td>Southbound TH</td>
<td>450</td>
<td>850</td>
</tr>
</tbody>
</table>

* When displaying results from SimTraffic, CORSIM, or VISSIM, this template should contain a note indicating that the results displayed are the average results across “X” microsimulation runs.

**When reporting queue results from HCS 2010, Vistro, or Synchro, 95th percentile queue length shall be reported. When reporting queue results from SimTraffic, CORSIM, or VISSIM, maximum queue length shall be reported.
Table 24: HCS 2010/CORSIM/VISSIM Density Tabular Format

<table>
<thead>
<tr>
<th>Direction</th>
<th>Movement</th>
<th>2012 Baseline Density - pcplpm (LOS)</th>
<th>2020 Baseline Density - pcplpm (LOS)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>AM</td>
<td>PM</td>
</tr>
<tr>
<td>Northbound I-95</td>
<td>Diverge: Off-ramp to Eastbound Main Street</td>
<td>22.7 (C)</td>
<td>11.4 (B)</td>
</tr>
<tr>
<td></td>
<td>Weave</td>
<td>20.5 (C)</td>
<td>9.0 (A)</td>
</tr>
<tr>
<td></td>
<td>Merge: I-95 Northbound On-ramp from Westbound Main Street</td>
<td>19.3 (B)</td>
<td>9.9 (A)</td>
</tr>
<tr>
<td>Southbound I-95</td>
<td>Diverge: Off-ramp to Main Street</td>
<td>6.7 (A)</td>
<td>15.6 (B)</td>
</tr>
<tr>
<td></td>
<td>Merge: On-ramp from Main Street</td>
<td>3.8 (A)</td>
<td>11.6 (B)</td>
</tr>
</tbody>
</table>

* When displaying results from CORSIM, or VISSIM, this template shall not display LOS and should contain a note indicating that the results displayed are the average results across “X” microsimulation runs. Density results from CORSIM or VISSIM should be reported in vplpm.

8.3 SIDRA OUTPUT FORMATS

SIDRA Intersection produces several acceptable output templates. The first template, shown in Table 25, illustrates a tabular format that displays v/c ratio, average control delay, LOS, 95th percentile queue length, and average speed for each movement. The second template, shown in Figure 12, is a depictive output format that displays average control delay by movement. Arrows representing each movement are color-coded based on the LOS of the movement. SIDRA also produces similar depictive output formats that display v/c ratio, 95th percentile queue length, and average speed.

8.4 VISTRO OUTPUT FORMATS

Vistro shall only be used to report results for analyses operating in undersaturated conditions. The recommended output templates to summarize Vistro intersection results are the same as those for HCS 2010 as shown in Table 22, Table 23, Figure 9, and Figure 10. The built-in reporting features in Vistro provide additional figures that may be useful for traffic impact analyses (TIAs). Figure 13 displays one of the built-in figures from Vistro, which illustrates the net new site trips created by a proposed development zone that are attributed to two nearby intersections. Vistro also provides depictive output formats for base volumes, in-process volumes, other volumes, and future total volumes.

8.5 SYNCHRO OUTPUT FORMATS

HCM 2010 methodology should be used for reporting Synchro analyses; however, certain restrictions for analyzing signalized and unsignalized intersections exist in the HCM 2010 methodology (e.g., intersections with non-NEMA phasing, intersections with five or more legs, clustered intersections). HCM 2000 methodology should be used for reporting all Synchro analyses that fall under these limitations. If one or more intersections in a network require the use of HCM 2000 methodology, the VDOT project manager may decide to use the HCM 2000 methodology for the reporting of the entire network. Synchro shall only be used to report results in undersaturated conditions. The recommended templates to summarize Synchro intersection results are the same as those for HCS 2010 as shown in as shown in Table 22, Table 23, Figure 9, and Figure 10.
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* When displaying results from CORSIM or VISSIM, this template shall not display LOS and should contain a note indicating that the results displayed are the average results across “X” number of microsimulation runs.

**When reporting delay results from HCS 2010, Vistro, or Synchro, control delay shall be reported. When reporting delay results from SimTraffic, CORSIM, or VISSIM, microsimulation delay shall be reported.
Figure 10: HCS 2010/Vistro/Synchro/SimTraffic/CORSIM/VISSIM Queue Lengths Depictive Format

* This template should contain a note indicating that the results displayed are the average results across “X” microsimulation runs when displaying results from SimTraffic, CORSIM, or VISSIM.

**When reporting queue results from HCS 2010, Vistro, or Synchro, 95th percentile queue length shall be reported. When reporting queue results from SimTraffic, CORSIM, or VISSIM, maximum queue length shall be reported.
Figure 11: HCS 2010 Freeways Depictive Format

**Project Title**
Somewhere, Virginia

**Ramp / Merge Level of Service**

**FIGURE X**
### Table 25: SIDRA Intersection Movement Summary Tabular Format

<table>
<thead>
<tr>
<th>Movement Performance - Vehicles</th>
<th>Mov ID</th>
<th>OD Mov</th>
<th>Demand Flow Total vch/h</th>
<th>Dog. Sat v/c</th>
<th>Average Delay sec</th>
<th>Level of Service</th>
<th>95% Back of Queue Vehicles vch</th>
<th>Prop. Queued</th>
<th>Effective Stop Rate per vch</th>
<th>Average Speed mph</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>South: Side Street</strong></td>
<td>3</td>
<td>L2</td>
<td>22</td>
<td>2.0</td>
<td>0.040</td>
<td>10.3</td>
<td>LOS B</td>
<td>0.2</td>
<td>4.1</td>
<td>0.60</td>
</tr>
<tr>
<td>8</td>
<td>T1</td>
<td>5</td>
<td>2.0</td>
<td>0.040</td>
<td>4.8</td>
<td>LOS A</td>
<td>0.2</td>
<td>4.1</td>
<td>0.60</td>
<td>0.73</td>
</tr>
<tr>
<td>10</td>
<td>R2</td>
<td>22</td>
<td>2.0</td>
<td>0.036</td>
<td>5.8</td>
<td>LOS A</td>
<td>0.1</td>
<td>3.5</td>
<td>0.61</td>
<td>0.65</td>
</tr>
<tr>
<td><strong>Approach</strong></td>
<td>49</td>
<td>2.0</td>
<td>0.040</td>
<td>7.0</td>
<td>LOS A</td>
<td>0.2</td>
<td>4.1</td>
<td>0.60</td>
<td>0.70</td>
<td>30.0</td>
</tr>
<tr>
<td><strong>East: Main Street</strong></td>
<td>1</td>
<td>L2</td>
<td>5</td>
<td>1.0</td>
<td>0.455</td>
<td>10.5</td>
<td>LOS B</td>
<td>2.9</td>
<td>72.6</td>
<td>0.34</td>
</tr>
<tr>
<td>6</td>
<td>T1</td>
<td>858</td>
<td>1.0</td>
<td>0.455</td>
<td>4.7</td>
<td>LOS A</td>
<td>2.9</td>
<td>72.6</td>
<td>0.34</td>
<td>0.45</td>
</tr>
<tr>
<td>16</td>
<td>R2</td>
<td>147</td>
<td>1.0</td>
<td>0.455</td>
<td>4.7</td>
<td>LOS A</td>
<td>2.9</td>
<td>72.6</td>
<td>0.34</td>
<td>0.45</td>
</tr>
<tr>
<td><strong>Approach</strong></td>
<td>1038</td>
<td>1.0</td>
<td>0.455</td>
<td>4.8</td>
<td>LOS A</td>
<td>2.9</td>
<td>72.6</td>
<td>0.34</td>
<td>0.45</td>
<td>36.5</td>
</tr>
<tr>
<td><strong>North: Side Street</strong></td>
<td>7</td>
<td>L2</td>
<td>239</td>
<td>2.0</td>
<td>0.341</td>
<td>12.4</td>
<td>LOS B</td>
<td>1.6</td>
<td>39.5</td>
<td>0.66</td>
</tr>
<tr>
<td>4</td>
<td>T1</td>
<td>1</td>
<td>2.0</td>
<td>0.341</td>
<td>6.5</td>
<td>LOS A</td>
<td>1.6</td>
<td>35.6</td>
<td>0.66</td>
<td>0.59</td>
</tr>
<tr>
<td>14</td>
<td>R2</td>
<td>223</td>
<td>2.0</td>
<td>0.332</td>
<td>7.2</td>
<td>LOS A</td>
<td>1.5</td>
<td>37.8</td>
<td>0.66</td>
<td>0.31</td>
</tr>
<tr>
<td><strong>Approach</strong></td>
<td>463</td>
<td>2.0</td>
<td>0.341</td>
<td>9.3</td>
<td>LOS A</td>
<td>1.5</td>
<td>39.5</td>
<td>0.66</td>
<td>0.85</td>
<td>32.3</td>
</tr>
<tr>
<td><strong>West: Main Street</strong></td>
<td>5</td>
<td>L2</td>
<td>71</td>
<td>1.0</td>
<td>0.360</td>
<td>11.3</td>
<td>LOS B</td>
<td>2.1</td>
<td>52.6</td>
<td>0.48</td>
</tr>
<tr>
<td>2</td>
<td>T1</td>
<td>641</td>
<td>1.0</td>
<td>0.360</td>
<td>5.5</td>
<td>LOS A</td>
<td>2.1</td>
<td>52.6</td>
<td>0.49</td>
<td>0.53</td>
</tr>
<tr>
<td>12</td>
<td>R2</td>
<td>5</td>
<td>1.0</td>
<td>0.360</td>
<td>5.5</td>
<td>LOS A</td>
<td>2.1</td>
<td>52.6</td>
<td>0.49</td>
<td>0.51</td>
</tr>
<tr>
<td><strong>Approach</strong></td>
<td>717</td>
<td>1.0</td>
<td>0.360</td>
<td>6.0</td>
<td>LOS A</td>
<td>2.1</td>
<td>52.6</td>
<td>0.48</td>
<td>0.54</td>
<td>35.9</td>
</tr>
<tr>
<td><strong>All Vehicles</strong></td>
<td>2257</td>
<td>1.2</td>
<td>0.455</td>
<td>6.3</td>
<td>LOS A</td>
<td>2.9</td>
<td>72.6</td>
<td>0.46</td>
<td>0.55</td>
<td>35.2</td>
</tr>
</tbody>
</table>

Level of Service (LOS) Method: Delay & v/c (HCM 2010).
Roundabout LOS Method: Same as Signalised Intersections.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement.
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 2010).
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Figure 12: SIDRA Intersection Control Delay Depictive Format
Figure 13: Vistro TIA Depictive Format
8.6 SIMTRAFFIC OUTPUT FORMATS

The recommended output templates to summarize SimTraffic intersection results are the same as the ones that were recommended for HCS 2010 results and are shown in Table 22, Table 23, Figure 9, and Figure 10; however, all four templates may be adjusted to include a note that indicates that the results shown are the average results across a specified number of microsimulation runs. In addition, adjust Table 22 and Figure 9 so that LOS is not displayed and that microsimulation delay is displayed instead of control delay. Additionally, adjust Table 23 and Figure 10 to display maximum queue length instead of 95th percentile queue length. Similar templates may be created to display results for space mean speed and travel time.

8.7 CORSIM OUTPUT FORMATS

The recommended output templates to summarize CORSIM results include some of the templates recommended for HCS 2010 results, as well as an additional CORSIM-specific template. The templates for reporting intersection results are the same as the ones developed for HCS 2010 and are shown in Table 22, Table 23, Figure 9, and Figure 10; however, all four templates should be adjusted to include a note that indicates that the results shown are the average results across a specified number of microsimulation runs. In addition, adjust Table 22 and Figure 9 so that LOS is not displayed and so microsimulation delay is displayed instead of control delay. Additionally, adjust Table 23 and Figure 10 to display maximum queue length instead of 95th percentile queue length. Similar templates may be created to display results for space mean speed, time mean speed, and travel time. The tabular template for reporting freeway density results is the same as the one developed for HCS 2010, which is shown in Table 24. This template shall be adjusted so that LOS is not displayed and to include a note that indicates that the results shown are the average results across a specified number of microsimulation runs.

The final CORSIM template is a depictive freeway schematic that was created using a Microsoft® Excel-based macro and is shown in Figure 14. This template includes actual volumes, simulated volumes, link distances, speeds, and densities. Results are reported both by segment and by individual lane. With this template, select MOEs can be color coded to help the reviewer interpret the results. Instructions for the Microsoft® Excel-based macro used to create this template are provided in Appendix F. Additionally, electronically submit output files for each individual microsimulation run.

8.8 VISSIM OUTPUT FORMATS

The recommended output templates to summarize VISSIM results include some of the templates recommended for HCS 2010 results, as well as an additional VISSIM-specific template. The templates for reporting intersection results are the same as the ones developed for HCS 2010 and are shown in Table 22, Table 23, Figure 9, and Figure 10; however, all four templates should be adjusted to include a note that indicates that the results shown are the average results across a specified number of microsimulation runs. In addition, adjust Table 22 and Figure 9 so that LOS is not displayed and so microsimulation delay is displayed instead of control delay. Additionally, adjust Table 23 and Figure 10 to display maximum queue length instead of 95th percentile queue length. Similar templates may be created to display results for space mean speed, time mean speed, and travel time. The tabular template for reporting freeway density results is the same as the one developed for HCS 2010, which is shown in Table 24. This template shall be adjusted so that LOS is not displayed and to include a note that indicates that the results shown are the average results across a specified number of microsimulation runs. The final VISSIM template is a depictive freeway schematic that was created using a Microsoft® Excel-based macro and is shown in Figure 15. This template includes actual volumes, simulated volumes, link distances, speeds, and densities. Results are reported both by segment and by lane. With this template, select MOEs can be color coded to help the reviewer interpret the results. Instructions for the Microsoft® Excel-based macro used to create this template are provided in Appendix F. Additionally, electronically submit output files for each individual microsimulation run.
Figure 14: CORSIM Freeway Lane Schematic Depictive Format

NOTE: Numbers in chart are provided for illustrative purposes only

LEGEND

- Node Number
- Auxiliary Lane Length

Freeway Density

- 45 and above
- 43 and above
- 35 to 45
- 35 to 43
- 26 to 35
- 28 to 35
- 18 to 26
- 20 to 28
- 11 to 18
- 10 to 20
- 0 to 11
- 0 to 10

* The results shown are the average results across "X" number of microsimulation runs.

US-58 SB
Am_Peak_1
US-58 SB
2013 Existing Scenario
### Table: Simulated and Actual Volumes

<table>
<thead>
<tr>
<th>Link Number</th>
<th>Phase</th>
<th>Segment</th>
<th>Simulated Volumes</th>
<th>Actual Volumes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>vph</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3,390</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>486</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>7,552</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2,224</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2,833</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>vph</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>vph</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>vph</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note: Numbers in chart are provided for illustrative purposes only.*

### Figure 15: VISSIM Freeway Lane Schematic Depictive Format

[Image of the schematic depictive format]

*The results shown are the average results across "X" number of microsimulation runs.*

### Legend
- **Existing am_macro test**
- **Existing Scenario**
- **2013 Existing Scenario**

**Note:** Colours in chart are provided for illustrative purposes only.
8.9 VDOT EXTENDED HSM SPREADSHEETS OUTPUT FORMATS

Sites in the VDOT Extended HSM Spreadsheets can be analyzed with or without the Empirical Bayes (EB) Method, which combines historical crash data with the predicted crash frequency based solely on geometric and analysis parameters to produce an expected crash frequency. The recommended output templates to summarize the Extended HSM Spreadsheet results are shown in Table 26, Table 27, Table 28, and Figure 16. The template shown in Table 26 presents results for an existing conditions analysis that incorporated the EB Method in tabular format. The template shown in Table 27 presents results for a future year analysis in tabular format. This template may be modified to display predicted crash frequency if the EB method was not used or expected crash frequency if the EB method was used. The template shown in Table 28 provides the breakdown of crash types for a given site in tabular format. This template may be modified to display results for multiple alternatives. The template shown in Table 29 may be used to present all applicable CMFs applied to a given alternative. This template may also be used to present applicable countermeasures if the CMF Clearinghouse is used for any analysis type not covered by the safety tools described in this manual. The standard error from the HSM Part D or the star rating from the CMF Clearinghouse should be reported for any CMF if it is available.

The template shown in Figure 16 presents predicted crash frequency and severity by roadway segment in a depictive output format. This template may be modified to compare crashes across several alternatives, provided that each alternative has the same segmentation. An aerial image that depicts the overall study area is also included on the figure for reference. The aerial image is not a required component on the output summary, but is recommended to aid in the review process.

8.10 IHSDM OUTPUT FORMATS

Sites in IHSDM can be analyzed with or without the EB Method. The recommended output templates to summarize IHSDM results are the same as the templates that were recommended for the VDOT Extended HSM Spreadsheets results and are shown in Table 26, Table 27, Table 28, and Figure 16.

8.11 ISATe OUTPUT FORMATS

Since ISATe has similar outputs as the VDOT Extended HSM Spreadsheets and IHSDM, the recommended output templates to summarize ISATe results are also those shown in Table 26, Table 27, Table 28, and Figure 16.

Table 26: VDOT Extended HSM Spreadsheets/IHSDM/ISATe Existing Analysis Tabular Format

<table>
<thead>
<tr>
<th>Segment/Intersection</th>
<th>Description</th>
<th>Historical Crash Data</th>
<th>Predicted Crash Frequency (crashes/year)</th>
<th>Expected Crash Frequency (crashes/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>KABC</td>
<td>PDO</td>
<td>Total</td>
</tr>
<tr>
<td>Segment 1</td>
<td>MM 45.0-45.6</td>
<td>0.3</td>
<td>3.0</td>
<td>3.3</td>
</tr>
<tr>
<td>Segment 2</td>
<td>MM 45.6-46.2</td>
<td>1.8</td>
<td>4.2</td>
<td>6.0</td>
</tr>
<tr>
<td>Segment 3</td>
<td>MM 46.2-48.9</td>
<td>3.6</td>
<td>7.5</td>
<td>11.1</td>
</tr>
<tr>
<td>Intersection 1</td>
<td>Main St./1st St.</td>
<td>0.5</td>
<td>4.4</td>
<td>4.9</td>
</tr>
<tr>
<td>Intersection 2</td>
<td>Main St./2nd St.</td>
<td>0.7</td>
<td>2.4</td>
<td>3.1</td>
</tr>
<tr>
<td>Total</td>
<td>--</td>
<td>6.9</td>
<td>21.5</td>
<td>28.4</td>
</tr>
</tbody>
</table>
### Table 27: VDOT Extended HSM Spreadsheets/IHSDM/ISATe Future Analysis Tabular Format

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Segments</th>
<th>Description</th>
<th>Predicted Crash Frequency (crashes/year)</th>
<th>Percent Reduction in Crashes vs No Build (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>KABC</td>
<td>PDO</td>
</tr>
<tr>
<td>No Build</td>
<td>1-20</td>
<td>MM 18.5-20.4</td>
<td>40.0</td>
<td>102.1</td>
</tr>
<tr>
<td></td>
<td>21-27</td>
<td>MM 20.4-21.1</td>
<td>16.1</td>
<td>39.7</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>--</td>
<td>56.1</td>
<td>141.8</td>
</tr>
<tr>
<td>Alternative 1</td>
<td>1-20</td>
<td>MM 18.5-20.4</td>
<td>34.9</td>
<td>88.8</td>
</tr>
<tr>
<td></td>
<td>21-27</td>
<td>MM 20.4-21.1</td>
<td>14.3</td>
<td>33.5</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>--</td>
<td>49.2</td>
<td>122.3</td>
</tr>
<tr>
<td>Alternative 2</td>
<td>1-20</td>
<td>MM 18.5-20.4</td>
<td>34.4</td>
<td>90.2</td>
</tr>
<tr>
<td></td>
<td>21-27</td>
<td>MM 20.4-21.1</td>
<td>14.4</td>
<td>34.1</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>--</td>
<td>48.8</td>
<td>124.3</td>
</tr>
</tbody>
</table>

### Table 28: VDOT Extended HSM Spreadsheets/IHSDM/ISATe Crash Type Tabular Format

<table>
<thead>
<tr>
<th>Crash Type</th>
<th>FI</th>
<th>PDO</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Crashes</td>
<td>Crashes (%)</td>
<td>Crashes</td>
</tr>
<tr>
<td>Crashes with Animal</td>
<td>0.12</td>
<td>0.0</td>
<td>0.87</td>
</tr>
<tr>
<td>Crashes with Fixed Object</td>
<td>21.34</td>
<td>5.6</td>
<td>28.20</td>
</tr>
<tr>
<td>Crashes with Other Object</td>
<td>1.51</td>
<td>0.4</td>
<td>5.48</td>
</tr>
<tr>
<td>Crashes with Parked Vehicle</td>
<td>0.44</td>
<td>0.1</td>
<td>0.63</td>
</tr>
<tr>
<td>Other Single Vehicle Crashes</td>
<td>6.15</td>
<td>1.6</td>
<td>4.22</td>
</tr>
<tr>
<td>Total Single Vehicle Crashes</td>
<td>29.56</td>
<td>7.7</td>
<td>39.39</td>
</tr>
<tr>
<td>Right-Angle Crashes</td>
<td>2.11</td>
<td>0.6</td>
<td>4.42</td>
</tr>
<tr>
<td>Head-On Crashes</td>
<td>0.55</td>
<td>0.1</td>
<td>0.49</td>
</tr>
<tr>
<td>Rear-End Crashes</td>
<td>51.14</td>
<td>13.4</td>
<td>169.25</td>
</tr>
<tr>
<td>Sideswipe Crashes</td>
<td>12.27</td>
<td>3.2</td>
<td>65.25</td>
</tr>
<tr>
<td>Other Multiple Vehicle Crashes</td>
<td>2.11</td>
<td>0.6</td>
<td>5.89</td>
</tr>
<tr>
<td>Total Multiple Vehicle Crashes</td>
<td>68.19</td>
<td>17.8</td>
<td>245.29</td>
</tr>
<tr>
<td>Total Crashes</td>
<td>97.75</td>
<td>25.6</td>
<td>284.68</td>
</tr>
</tbody>
</table>
Table 29: VDOT Extended HSM Spreadsheets/IHSDM/ISATe CMF Tabular Template

<table>
<thead>
<tr>
<th>Description/Countermeasure</th>
<th>CMF</th>
<th>Source</th>
<th>Standard Error/Star Rating*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lane Width</td>
<td>1.00</td>
<td>HSM Part D</td>
<td>--</td>
</tr>
<tr>
<td>Shoulder Width and Type</td>
<td>1.29</td>
<td>HSM Part D</td>
<td>--</td>
</tr>
<tr>
<td>Horizontal Curves</td>
<td>1.00</td>
<td>HSM Part D</td>
<td>--</td>
</tr>
<tr>
<td>Super-elevation</td>
<td>1.00</td>
<td>HSM Part D</td>
<td>--</td>
</tr>
<tr>
<td>Grades</td>
<td>1.10</td>
<td>HSM Part D</td>
<td>--</td>
</tr>
<tr>
<td>Driveway Density</td>
<td>1.00</td>
<td>HSM Part D</td>
<td>--</td>
</tr>
<tr>
<td>Centerline Rumble Strips</td>
<td>0.94</td>
<td>HSM Part D</td>
<td>--</td>
</tr>
<tr>
<td>Passing Lanes</td>
<td>1.00</td>
<td>HSM Part D</td>
<td>--</td>
</tr>
<tr>
<td>Two-Way Left-Turn Lane</td>
<td>1.00</td>
<td>HSM Part D</td>
<td>--</td>
</tr>
<tr>
<td>Roadside Design</td>
<td>1.14</td>
<td>HSM Part D</td>
<td>--</td>
</tr>
<tr>
<td>Lighting</td>
<td>0.92</td>
<td>HSM Part D</td>
<td>--</td>
</tr>
<tr>
<td>Automated Speed Enforcement</td>
<td>1.00</td>
<td>HSM Part D</td>
<td>--</td>
</tr>
<tr>
<td>Total CMF</td>
<td>1.517</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

The standard error from the HSM Part D or the star rating from the CMF Clearinghouse for a given CMF should be provided if it is known.

8.12 SSAM OUTPUT FORMATS

The recommended output templates to summarize SSAM results are shown in Table 30 and Figure 17. The template shown in Table 30 compares the number of conflicts, broken down by type, for two scenarios in tabular output format. The template shown in Figure 17 illustrates a depictive output created in Microsoft® PowerPoint using output from the map feature within SSAM that displays conflicts, broken down by type. The map feature within SSAM may only be used if no filtering is applied outside of the tool. Otherwise, a depictive output may be created using other graphic analysis tools, such as GIS. For mapping consistency, crossing conflicts should be represented by a red X, lane-change conflicts should be represented by a blue circle, and rear-end conflicts should be represented by a yellow triangle.

Table 30: SSAM Conflict Summary Tabular Format

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Conflict Type</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rear-End</td>
<td>Lane-Change</td>
</tr>
<tr>
<td>2040 No Build</td>
<td>49</td>
<td>17</td>
</tr>
<tr>
<td>2040 Build Alternative 1</td>
<td>30</td>
<td>13</td>
</tr>
<tr>
<td>Δ Conflicts</td>
<td>(19)</td>
<td>(4)</td>
</tr>
<tr>
<td>% Change</td>
<td>-38.8%</td>
<td>-23.5%</td>
</tr>
</tbody>
</table>
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Figure 16: VDOT Extended HSM Spreadsheets/IHSDM/ISATe Crash Frequency Depictive Format
Figure 17: SSAM Conflict Summary Depictive Format

Legend

- Crossing Conflicts
- Lane-Change Conflicts
- Rear-End Conflicts
APPENDIX A

Additional Resources Reviewed
External References
Appendix A - Additional Resources Reviewed


<http://www.cmfclearinghouse.org/index.cfm>


Instructional and Informational Memorandum – Development of Justification for Additional or Revised Access Points; Creation of Interchange Justification/Modification Reports (IIM-LD-200.7). Virginia Department of Transportation Location and Design Division, 2013. Web. 

<http://landtrx.vdot.virginia.gov/?District=4>


<http://www.oregon.gov/ODOT/TD/TP/APM/AddC.pdf>


FHWA Sample Size Information
Determination of Sample Size

• Beside the urban myths of 10 / 20 / 30 runs?
• Here is a quick process
  – Choose your performance measures(s) (MOE)
  – Run the simulation a number of times initially (e.g., 10) to determine the mean and the standard deviation
  – Choose a confidence level (this should be done in the assumption document)
  – Choose a tolerance error (this should be done in the assumption document)
  – Compute the required sample size
Sample Size Example

1. Assume MOE is Speed in mph
2. Run simulation (initially 10 times) with the following results:
   - Sample Mean (Xs) = 32.5 mph
   - Sample Standard Dev (Ss) = 8.5 mph
3. Assume 95% Confidence Level
4. Tolerance Error
   - Observed data: n = 30, Xs = 34.5 mph, Ss = 9.64 mph
   - Tolerable error is 10%
Sample Size Calculations

- **95% Confidence Interval** = \( X_s \pm Z(Ss/\sqrt{N}) \)

  Where:
  
  - \( Z(Ss/\sqrt{N}) \) = sampling error or tolerable error
  - \( X_s \) = sample mean
  - \( Z \) = Number of standard deviations away from the mean corresponding to the required confidence level in a normal distribution
  - \( Ss \) = sample standard deviation
  - \( N \) = sample size

  \[ 32.5 \pm 1.96(8.5/\sqrt{10}) \rightarrow 32.5 \pm 5.27 \rightarrow \text{5.27 is 16.21\% of the mean: too high} \]

  To bring it to 10\% tolerable error or 3.25 mph away from the mean:

- **Sample Size Needed**

  \[ N = (Z^2)(Ss)^2/(E)^2 \rightarrow N = (1.96)^2(8.5)^2/(3.25)^2 = 27 \]

  Therefore, 27 runs will be needed to be 95\% confident that the sampling error or the tolerable error will not be greater than 10\% of the mean speed.
Sample Size Calculations: Additional Iterations

When we run the simulation 17 more times to get to 27 runs, the mean and/or standard deviation may change. Once we have all 27 runs, repeat the computation of the confidence interval to make sure that the sampling error is 10% of the mean or lower.

- Example:
  - After 27 runs, mean is 31.5 mph and standard deviation is 10.5 mph
  - New 95% confidence interval: 31.5 ± 1.96(10.5/√27) ≈ 31.5 ± 3.96
  - The new sampling error is 12.57% of the mean which is still not good enough.
  - Repeating the computation of the sample size: \( N = (Z)^2(Ss)^2/(E)^2 = (1.96)^2(10.5)^2/(3.15)^2 = 43 \)
  - Therefore, 43 runs will be needed to be 95% confident that the sampling error or the tolerable error will not be greater than 10% of the mean speed.
  - Repeating the process of running the simulation 43 times, the new mean now is 30.5 with a standard deviation of 9.5 mph.
  - The new 95% confidence interval is: 30.5 ± 1.96(9.5/√43) ≈ 30.5 ± 2.84
  - The new sampling error now is 9.31% of the mean which is lower than the maximum tolerable error of 10% so now we are 95% confident that the sampling error or the tolerable error is not greater than 10% of the mean speed.
APPENDIX B

Traffic Operations Analysis Reviewers Prompt List
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## Traffic Operations Analysis Reviewers Prompt List

### Project Information
- **Project Name:**
- **Project Description:**
- **UPC Number:**
- **State Project Number:**
- **Project Location:**
- **City/County:**
- **VDOT District:**

### VDOT Project Manager
- [Name]

### Consultant Project Manager
- [Name]

### Project Type/Analysis Category
- [Type/Category]

### Software Tool(s) Version and Build
- [Version/Build]

### Study Limits
- [Limits]

### Traffic Operations Analysis Review

The following items should be considered during the traffic operations analysis review. Every item will not apply to all projects.

#### Inputs and Assumptions
- Geometric inputs based on existing field measurements and/or design plans
- Existing traffic volume inputs based on existing traffic count data
- Future traffic volume inputs based on projected traffic volumes approved by the PM
- Traffic signal timing inputs obtained from the entity that maintains the traffic signal timings
- All TOSAM standard input assumptions identified in Chapter 7 for each traffic and safety analysis tool
- Written documentation of justification and PM approval of any deviation from TOSAM standard input assumptions

#### Model Calibration (for microsimulation tools)
- Calibration process, including assumptions and calibration parameters, clearly documented
- Model runs, without errors, with balanced traffic volumes
- Model animation accurately represents the observed field conditions
- Model meets minimum calibration targets identified in Table 5 of the TOSAM
- Model meets any additional calibration targets required by the PM
- Technical justification for any calibration targets not met
- Appropriate number of microsimulation runs completed (as determined by the VDOT Sample Size Determination Tool)

#### Results
- Minimum of two MOEs, or as otherwise agreed upon during project scoping, summarized for each link or intersection in the network
- MOEs summarized in tabular output format(s)
- MOEs summarized in descriptive output format(s)
- Analysis report submitted in the format determined by the PM
- Documentation of any deviation from standards in the TOSAM submitted with analysis report
- Analysis files submitted in electronic format

### Comments
- [Comments]

---

**Version 1.0, Rev 11/15**
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APPENDIX C

Data Collection Checklist
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## Traffic Operations and Safety Analysis Manual, Version 1.0

### Data Collection Prompt List

#### Project Information

<table>
<thead>
<tr>
<th>Field</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Name</td>
<td></td>
</tr>
<tr>
<td>Project Description</td>
<td></td>
</tr>
<tr>
<td>UPC Number</td>
<td>State Project Number</td>
</tr>
<tr>
<td>Project Location</td>
<td></td>
</tr>
<tr>
<td>City/County</td>
<td>VDOT District</td>
</tr>
</tbody>
</table>

#### VDOT Project Manager

#### Consultant Project Manager

#### Project Type/Analysis Category

#### Software Tool(s)

#### Study Limits

#### Data Collection

The following items should be considered during data collection. Every item will not apply to all projects.

#### Geometric Data

- Geometric input parameters identified in Table 6 of the TOSAM for the project analysis category

#### Traffic Count Data

- Traffic data collection parameters identified in Table 7 of the TOSAM for the project analysis category
- Traffic count data collected during the same time periods
- TMCs conducted for at least 4 consecutive hours in each peak period
- Vehicle classification counts conducted for a minimum of 48 consecutive hours
- All traffic count data collected at 15-minute or shorter intervals
- Heavy vehicles counted by movement for TMCs
- Heavy vehicle classification counts that comply with FHWA guidelines
- Pedestrian and/or bicycle counts (when present at an intersection)
- Weekday traffic counts collected only on Tuesdays, Wednesdays, and/or Thursdays
- Weekend traffic counts collected on Saturdays and/or Sundays
- Traffic count data not collected on holidays or days influenced by holiday traffic
- Traffic count data collected when school is in session in areas influenced by school traffic
- Traffic count data reviewed and checked for reasonableness
- Traffic count data that is no more than two years old and the roadway has not experienced any major geometric and/or traffic control changes since the data was collected
- Common uniform peak hour computed and applied to the entire network (method of determining common uniform peak hour to be approved by PM)
- Balanced traffic count data (required if using microsimulation tools)
- Work zone data including lane closure information, lane closure lengths, time of day closure, intensity of work zone, detour and alternative route availability, condition of alternative routes, and percentage of traffic volume expected to detour (for work zone analyses)
### Signal Operations Data

- Traffic and pedestrian signal timing data obtained from the appropriate VDOT Regional Traffic Operations office or city/town engineering office
- Green times
- Clearance intervals
- Cycle lengths
- Offsets
- Type of controller (NEMA, fixed time, etc.)
- Sequencing and traffic signal phasing diagrams
- Actuation type
- Vehicle extension and gap time
- Recall mode
- Time of day plans
- Pedestrian crossing times ("WALK" and "DON'T WALK")
- Transit priorities
- Preemption timings
- Ramp metering data (processing splits, capacity criteria, etc.)

### Calibration Data

Refer to Table 8 in the TOSAM for a listing of the calibration parameters for each project analysis category.

- When using speed data for model calibration, collect a minimum of 48 consecutive hours of speed data in each direction of travel in 15-minute intervals.
- When using travel time data for model calibration, collect a minimum of 10 runs collected in each direction of travel during each peak hour. Conduct travel time runs have in accordance with the procedures in the latest edition of the ITE Manual of Transportation Engineering Studies.
- When using queues for model calibration, collect queue lengths once every five minutes over the data collection period.
- For toll plaza analyses, collect a minimum of four hours of vehicle processing data for all available payment options.
- When collecting O-D data, PM approval on the collection methodology
- Identify other additional calibration data requirements of the PM.
- Use calibration data that is no more than two years old and on a roadway that has not experienced any major geometric and/or traffic control changes since the data was collected.

### Safety Data

- Historical crash data for at least 5 years that includes crash location, type, and severity (at a minimum)
- All geometric and/or traffic control data required for the specific safety analysis tool
- All roadway alignment data required for the specific safety analysis tool
- PM approval of the use of CMFs on a project and the selection of individual CMFs
- SPF site sub-type calibration factors to adjust national averages to Virginia conditions (if available)
- Table of proportions to adjust national averages of crash and severity distributions to Virginia conditions (if available)
APPENDIX D

Tool Selection Matrix
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APPENDIX D

TRAFFIC OPERATIONS ANALYSIS TOOL SELECTION MATRIX
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### Traffic Operations Analysis Tool Selection Matrix

<table>
<thead>
<tr>
<th>Saturation Level (General Description)</th>
<th>UNDERSATURATED CONDITIONS</th>
<th>OVERSATURATED CONDITIONS</th>
<th>Special Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Location Description</strong></td>
<td>Point</td>
<td>Segment and Facility</td>
<td>Corridor, Area, and System</td>
</tr>
<tr>
<td><strong>Signalized Intersection Operations</strong></td>
<td>CORSIM</td>
<td>CORSIM</td>
<td>CORSIM</td>
</tr>
<tr>
<td></td>
<td>HCS</td>
<td>SimTraffic</td>
<td>Vistro</td>
</tr>
<tr>
<td><strong>Special Notes</strong></td>
<td>• Synchro is the preferred tool for this type of analysis for undersaturated conditions.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Signalized Intersection Preemption/Transit Priority</strong></td>
<td>VISSIM</td>
<td>VISSIM</td>
<td>VISSIM</td>
</tr>
<tr>
<td><strong>Special Notes</strong></td>
<td>• VISSIM is the preferred tool for this type of analysis.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Unsignalized Intersection Operations (AWS and TWS)</strong></td>
<td>CORSIM</td>
<td>CORSIM</td>
<td>CORSIM</td>
</tr>
<tr>
<td></td>
<td>HCS</td>
<td>SimTraffic</td>
<td>Synchro</td>
</tr>
<tr>
<td><strong>Special Notes</strong></td>
<td>• HCS is the preferred tool for undersaturated point analyses, but should not be used to analyze oversaturated conditions.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Roundabout Operations</strong></td>
<td>SIDRA Intersection</td>
<td>SIDRA Intersection</td>
<td>SIDRA Intersection</td>
</tr>
<tr>
<td></td>
<td>VISSIM</td>
<td>VISSIM</td>
<td>VISSIM</td>
</tr>
<tr>
<td><strong>Special Notes</strong></td>
<td>• SIDRA Intersection is a required tool for this type of analysis. A SIDRA Intersection analysis is required to accompany any roundabout analysis completed using VISSIM.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• VISSIM is the preferred tool in networks including roundabouts.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• If roundabouts are included in a study area analyzed by Synchro or Vistro, then the roundabouts should be analyzed using SIDRA Intersection.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Arterial Operations</strong></td>
<td>Not Applicable</td>
<td>CORSIM</td>
<td>CORSIM</td>
</tr>
<tr>
<td></td>
<td>HCS</td>
<td>SimTraffic</td>
<td>Synchro</td>
</tr>
<tr>
<td><strong>Special Notes</strong></td>
<td>• Synchro and HCS can only generate HCS 2000 arterial reports.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Non-Traditional Intersection Operations (5-Legs, SPUI)</strong></td>
<td>CORSIM</td>
<td>CORSIM</td>
<td>CORSIM</td>
</tr>
<tr>
<td></td>
<td>Synchro</td>
<td>Synchro</td>
<td>Synchro</td>
</tr>
<tr>
<td></td>
<td>VISSIM</td>
<td>VISSIM</td>
<td>VISSIM</td>
</tr>
<tr>
<td><strong>Special Notes</strong></td>
<td>• VISSIM is the preferred tool for these types of analyses.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Synchro (HCM 2000 module only) has the capability to model DDI, CFI, CGT, and 5-legged intersections for undersaturated conditions.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Synchro has the capability to model SPUI intersections for undersaturated conditions.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• SimTraffic has the capability to model DDI, SPUI, CFI, CGT, and 5-legged intersections for undersaturated conditions.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• CORSIM is not capable of modeling multiple traffic signals under one signal controller or intersections with 5 or more legs.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### ***GENERAL NOTES***

The tools included in each box, listed in alphabetical order, are identified as acceptable tools for the subject analysis. If a tool is not listed, then VDOT will not accept it for that type of operational analysis. Refer to "Special Notes" for tool preferences.
### Traffic Operations Analysis Tool Selection Matrix

<table>
<thead>
<tr>
<th>Saturation Level (General Description)</th>
<th>UNDERSATURATED CONDITIONS</th>
<th>OVERSATURATED CONDITIONS</th>
<th>Special Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location Description</td>
<td></td>
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<tr>
<td>Point</td>
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<td>VISSIM</td>
<td>VISSIM</td>
</tr>
<tr>
<td>Segment and Facility</td>
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<td>VISSIM</td>
<td>VISSIM</td>
</tr>
<tr>
<td>Corridor, Area, and System</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Special Notes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interrupted-Flow Operations Analyses</td>
<td></td>
<td></td>
<td>VISSIM is the preferred tool for this type of analysis.</td>
</tr>
<tr>
<td>Parking Operations</td>
<td>VISSIM</td>
<td>VISSIM</td>
<td>VISSIM</td>
</tr>
<tr>
<td>Public Transit Operations (BRT, LRT, etc.)</td>
<td>VISSIM</td>
<td>VISSIM</td>
<td>VISSIM</td>
</tr>
<tr>
<td>Adaptive Signal Control Technologies (ASCT) Operations</td>
<td>VISSIM</td>
<td>VISSIM</td>
<td>VISSIM</td>
</tr>
<tr>
<td>Pedestrian and Bicycle Simulation and Analysis</td>
<td>VISSIM</td>
<td>VISSIM</td>
<td>VISSIM</td>
</tr>
<tr>
<td>Multimodal Facilities</td>
<td>VISSIM</td>
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<td>VISSIM</td>
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</table>

**GENERAL NOTES**

The tools included in each box, listed in alphabetical order, are identified as acceptable tools for the subject analysis. If a tool is not listed, then VDOT will not accept it for that type of operational analysis. Refer to "Special Notes" for tool preferences.
## Traffic Operations Analysis Tool Selection Matrix

### Special Notes
- HCS is the preferred tool for undersaturated segments and facilities analyses.
- VISSIM is the preferred tool for these analyses.
- The HCS Facilities module may be used for oversaturated conditions for screening purposes only.

### General Notes
The tools in each box, listed in alphabetical order, are identified as acceptable tools for the subject analysis. If a tool is not listed, then VDOT will not accept it for that type of operational analysis. Refer to "Special Notes" for tool preferences.

<table>
<thead>
<tr>
<th>Saturation Level (General Description)</th>
<th>Location Description</th>
<th>Location Description</th>
<th>Segment and Facility</th>
<th>Segment and Facility</th>
<th>CORRIDOR, AREA, AND SYSTEM</th>
<th>Segment and Facility</th>
<th>Segment and Facility</th>
<th>CORRIDOR, AREA, AND SYSTEM</th>
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</thead>
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<td>UNINTERRUPTED-FLOW OPERATIONS ANALYSES</td>
<td>Freeway Segment Operations (limited access)</td>
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<td>CORSIM HCS VISSIM</td>
<td>CORSIM HCS VISSIM</td>
<td>Not Applicable</td>
<td>CORSIM HCS VISSIM</td>
<td>CORSIM VISSIM</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Merge / Diverge Operations</td>
<td>Not Applicable</td>
<td>CORSIM HCS VISSIM</td>
<td>CORSIM HCS VISSIM</td>
<td>Not Applicable</td>
<td>CORSIM VISSIM</td>
<td>Not Applicable</td>
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</tr>
<tr>
<td></td>
<td>Weaving Segment Operations</td>
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<td>CORSIM HCS VISSIM</td>
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<td>CORSIM VISSIM</td>
<td>Not Applicable</td>
<td></td>
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<tr>
<td></td>
<td>Freeway HOV / Ramp Metering Operations / Managed Lanes</td>
<td>Not Applicable</td>
<td>CORSIM VISSIM</td>
<td>CORSIM VISSIM</td>
<td>Not Applicable</td>
<td>CORSIM VISSIM</td>
<td>CORSIM VISSIM</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Collector-Distributor Facilities</td>
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<td>CORSIM HCS VISSIM</td>
<td>CORSIM HCS VISSIM</td>
<td>Not Applicable</td>
<td>CORSIM VISSIM</td>
<td>CORSIM VISSIM</td>
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<tr>
<td></td>
<td>Two-Lane Highway Operations</td>
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<td>HCS VISSIM</td>
<td>VISSIM</td>
<td>Not Applicable</td>
<td>VISSIM</td>
<td>VISSIM</td>
<td></td>
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<tr>
<td></td>
<td>Multilane Highway Operations</td>
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<td>CORSIM HCS VISSIM</td>
<td>CORSIM HCS VISSIM</td>
<td>Not Applicable</td>
<td>CORSIM VISSIM</td>
<td>CORSIM VISSIM</td>
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</table>
### Traffic Operations Analysis Tool Selection Matrix

<table>
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<tr>
<th>Saturation Level (General Description)</th>
<th>UNDERSATURATED CONDITIONS</th>
<th>OVERSATURATED CONDITIONS</th>
<th>Special Notes</th>
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</thead>
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<td><strong>Location Description</strong></td>
<td>Point</td>
<td>Segment and Facility</td>
<td>Corridor, Area, and System</td>
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<td><strong>Toll Plaza Operations</strong></td>
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<td>VISSIM</td>
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<td></td>
<td>VISSIM</td>
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<td>VISSIM</td>
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<tr>
<td><strong>Gated Operations</strong></td>
<td>CORSIM</td>
<td>VISSIM</td>
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<td></td>
<td>VISSIM</td>
<td></td>
<td>VISSIM</td>
</tr>
<tr>
<td><strong>Work Zone Traffic Operations</strong></td>
<td>CORSIM</td>
<td>HCS</td>
<td>SimTraffic</td>
</tr>
<tr>
<td>(Arterials)</td>
<td>VISSIM</td>
<td>SimTraffic</td>
<td>Synchro</td>
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<td></td>
<td>VISSIM</td>
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<td>VISSIM</td>
</tr>
<tr>
<td><strong>Work Zone Traffic Operations</strong></td>
<td>CORSIM</td>
<td>HCS</td>
<td>SimTraffic</td>
</tr>
<tr>
<td>(Freeways)</td>
<td>VISSIM</td>
<td>HCS</td>
<td>Synchro</td>
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<tr>
<td></td>
<td></td>
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<td>VISSIM</td>
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<tr>
<td><strong>Active Traffic Management</strong></td>
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<td>VISSIM</td>
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<tr>
<td>(ATM)</td>
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<td>VISSIM</td>
</tr>
<tr>
<td><strong>Dynamic Traffic Assignment (DTA)</strong></td>
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<td></td>
<td>VISSIM</td>
</tr>
</tbody>
</table>

### General Notes

The tools in each box, listed in alphabetical order, are identified as acceptable tools for the subject analysis. If a tool is not listed, then VDOT will not accept it for that type of operational analysis. Refer to "Special Notes" for tool preferences.
<table>
<thead>
<tr>
<th>Location Description</th>
<th>Point</th>
<th>Segment and Facility</th>
<th>Corridor, Area, and System</th>
<th>Special Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural Two-Lane Roads</td>
<td>Extended HSM Spreadsheets IHDSM</td>
<td>Extended HSM Spreadsheets IHDSM</td>
<td>Extended HSM Spreadsheets IHDSM</td>
<td>IHSDM is the preferred tool to analyze rural two-lane roads, especially when geometric data can be imported from CAD files.</td>
</tr>
<tr>
<td>Rural Multilane Roads</td>
<td>Extended HSM Spreadsheets IHDSM</td>
<td>Extended HSM Spreadsheets IHDSM</td>
<td>Extended HSM Spreadsheets IHDSM</td>
<td>IHSDM is the preferred tool to analyze rural multilane roads, especially when geometric data can be imported from CAD files.</td>
</tr>
<tr>
<td>Urban and Suburban Arterials</td>
<td>Extended HSM Spreadsheets IHDSM</td>
<td>Extended HSM Spreadsheets IHDSM</td>
<td>Extended HSM Spreadsheets IHDSM</td>
<td>IHSDM is the preferred tool to analyze urban and suburban arterials, especially when geometric data can be imported from CAD files.</td>
</tr>
<tr>
<td>Freeway Facilities and Interchanges</td>
<td>IHSDM ISATe</td>
<td>IHSDM ISATe</td>
<td>IHSDM ISATe</td>
<td>IHSDM is the preferred tool to analyze freeway facilities and interchanges, especially when geometric data can be imported from CAD files.</td>
</tr>
<tr>
<td>Non-Traditional Safety Analyses</td>
<td>SSAM</td>
<td>SSAM</td>
<td>SSAM</td>
<td>Users should verify that other safety analysis tools are not applicable prior to selecting SSAM.</td>
</tr>
</tbody>
</table>

***GENERAL NOTES***

The tools in each box, listed in alphabetical order, are identified as acceptable tools for the subject analysis. If a tool is not listed, then VDOT will not accept the tool for that type of safety analysis. Refer to “Special Notes” for tool preferences.
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APPENDIX E

Microsimulation Calibration Parameters
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APPENDIX E

MICROSIMULATION CALIBRATION PARAMETERS

This appendix is intended to provide a list of calibration parameters that can be modified to meet the thresholds outlined in Table 5, the calibration thresholds shall be used as minimum thresholds for calibration. The VDOT project manager may decide to use stricter thresholds based on the project needs. If the minimum thresholds cannot be achieved, written justification shall be provided for review and approval by the RTE or his/her designee. Out of the calibration parameters identified in this appendix some have values that are directly measured in the field while some cannot be directly measured; and there may be instances where these field-measured values may be modified to achieve calibration thresholds. It must be noted that before beginning the model calibration process, users should verify that all field-measured values, for both input and calibration parameters, have been correctly coded including balanced volumes.

The following microsimulation tools are covered in this appendix:

1. SimTraffic
2. CORSIM
3. VISSIM

A memorandum detailing which parameters were adjusted to calibrate a network shall be provided with traffic operations analysis results.
SIMTRAFFIC CALIBRATION PARAMETERS

**Intersections** – simulated traffic volume and simulated queue length should be used for calibration.

**Arterials** – simulated traffic volume and simulated queue length should be used for calibration.

**Simulation Settings (Synchro)**
- Headway Factor
- Turning Speed (mph)
- Mandatory Distance (ft)
- Positioning Distance (ft)
- Mandatory Distance 2 (ft)
- Positioning Distance 2 (ft)

**SimTraffic Parameters (SimTraffic)**
- Vehicles
  - Vehicle Occurrence (%)
- Drivers
  - Speed Factor (%)
  - Headway @ 0 mph (s)
  - Headway @ 20 mph (s)
  - Headway @ 50 mph (s)
  - Gap Acceptance Factor
  - Positioning Advantage (veh)
  - Optional Advantage (veh)
  - Mandatory Dist Adj (%)
  - Positioning Dist Adj (%)
  - Average Lane Change Time (s)
CORSIM CALIBRATION PARAMETERS

**Freeways** – simulated traffic volume and simulated average speed should be used for calibration. Simulated queue length at bottlenecks should also be checked, if present.

- Headway factor
- Anticipatory lane change parameter – ramp merge speed (default – 43 mph)
  - Maximum non-emergency deceleration
  - Maximum emergency deceleration
- Fresim model parameters
  - Minimum separation for generation of vehicles – controls freeway capacity (default – 1.6 sec = 2250 vplph)
- Fresim vehicle parameters information

**Intersections** – simulated traffic volume and simulated queue length should be used for calibration.

**Arterials** – simulated traffic volume and simulated queue length should be used for calibration.

- Headway spacing
- Netsim vehicle parameters information
  - Maximum non-emergency deceleration
  - Maximum emergency deceleration
VISSIM CALIBRATION PARAMETERS

**Freeways**—simulated traffic volume and simulated average speed should be used for calibration. If bottlenecks are present, then simulated queue length at bottlenecks should also be checked.

- Connector lane change and emergency stop distances
- Location of static route decision points
- Car following parameters
  - Wiedemann 99 model – freeway traffic
    - Standstill distance
    - Headway time
    - Necessary lane change parameters
    - Waiting time before diffusion
    - Safety distance reduction factor
    - Advanced merging
    - Cooperative lane change

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Default Value</th>
<th>Unit</th>
<th>Suggested Range</th>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Basic Segment</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Weave/Merge/</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Diverge Segment</td>
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<tr>
<td>CC0</td>
<td>4.92</td>
<td>feet (ft)</td>
<td>4.5 to 5.5</td>
</tr>
<tr>
<td>CC1</td>
<td>0.9</td>
<td>seconds (s)</td>
<td>0.85 to 1.05</td>
</tr>
<tr>
<td>CC2</td>
<td>13.12</td>
<td>ft</td>
<td>6.56 to 22.97</td>
</tr>
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<td>CC3</td>
<td>-8</td>
<td>--</td>
<td>Use default</td>
</tr>
<tr>
<td>CC4</td>
<td>-0.35</td>
<td>--</td>
<td>Use default</td>
</tr>
<tr>
<td>CC5</td>
<td>0.35</td>
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<td>Use default</td>
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<tr>
<td>CC6</td>
<td>11.44</td>
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<td>Use default</td>
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<tr>
<td>CC7</td>
<td>0.82</td>
<td>ft/s²</td>
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</tr>
<tr>
<td>CC8</td>
<td>11.48</td>
<td>ft/s²</td>
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</tr>
<tr>
<td>CC9</td>
<td>4.92</td>
<td>ft/s²</td>
<td>Use default</td>
</tr>
</tbody>
</table>

**Intersections**—simulated traffic volume and simulated queue length should be used for calibration.

**Arterials**—simulated traffic volume and simulated queue length should be used for calibration.

- Connector lane change and emergency stop distances
- Location of static route decision points
- Dwell time distribution at STOP signs (if needed)
- Minimum headway – priority rules (if applicable)
Conflict area parameters
- Front gap
- Rear gap
- Safety Distance Factor

Car following parameters
- Wiedemann 74 model – arterial / urban traffic
  - Average standstill distance
  - Necessary lane change parameters
  - Waiting time before diffusion
  - Safety distance reduction factor
  - Advanced merging
  - Cooperative lane change

<table>
<thead>
<tr>
<th>Arterial Car Following Model (Wiedemann 74) – Calibration Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameter</td>
</tr>
<tr>
<td>--------------------------------</td>
</tr>
<tr>
<td>Average standstill distance</td>
</tr>
<tr>
<td>Additive part of safety distance</td>
</tr>
<tr>
<td>Multiplicative part of safety distance</td>
</tr>
</tbody>
</table>
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APPENDIX F

Excel-Based Macro User Guide
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EXCEL-BASED MACRO USER GUIDE

Version 1.0

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VDOT Traffic Engineering Division

November 2015
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<td>3</td>
<td>Output from Software Selection Tool Input Form</td>
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<td>4</td>
<td>Calculated Software</td>
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<td>5</td>
<td>VDOT Sample Size Determination Tool (Version 2.0)</td>
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<td>6</td>
<td>“Good” Percentage of Mean</td>
<td>7</td>
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<tr>
<td>7</td>
<td>“Too High” Percentage of Mean</td>
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<td>CORSIM Intersection Data Processing Tool (Version 2.0)</td>
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<td>CORSIM File Processing Utility Menu</td>
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<td>11</td>
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<td>CORSIM File Processing Utility</td>
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<td>CORSIM Freeway Schematic</td>
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<td>32</td>
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<td>Base Delay Results Table</td>
<td>26</td>
</tr>
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<td>34</td>
<td>Select Intersection Type</td>
<td>26</td>
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<td>35</td>
<td>Specify Approach Movements</td>
<td>27</td>
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<td>36</td>
<td>Link Data Window</td>
<td>29</td>
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<td>37</td>
<td>Open Link Segment Results Table</td>
<td>29</td>
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<tr>
<td>38</td>
<td>Link Segment Results Table</td>
<td>30</td>
</tr>
<tr>
<td>39</td>
<td>Select Attributes</td>
<td>30</td>
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<tr>
<td>40</td>
<td>Preformatted VISSIM Freeway Template Worksheet</td>
<td>31</td>
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<td>41</td>
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</tr>
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<td>42</td>
<td>VISSIM File Processing Utility</td>
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<td>43</td>
<td>VISSIM Freeway Calibration Sheet</td>
<td>33</td>
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<tr>
<td>44</td>
<td>VISSIM Freeway Schematic</td>
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<tr>
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<td>VISSIM Freeway Lane Schematic Tabs</td>
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<td>VISSIM Freeway Schematic Values</td>
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<td>VISSIM Freeway Schematic Values (2)</td>
<td>36</td>
</tr>
<tr>
<td>48</td>
<td>VISSIM Freeway Legend</td>
<td>36</td>
</tr>
<tr>
<td>49</td>
<td>VISSIM Freeway Schematic Labels</td>
<td>37</td>
</tr>
</tbody>
</table>
Glossary of Terms


Control Delay: Delay associated with vehicles passing through an intersection, including slowing in advance of an intersection, the time spent on an intersection approach, the time spent as vehicles advance in a queue, and the time needed for vehicles to accelerate to their desired speed (expressed in seconds per vehicle).

CORSIM Calibration and Freeway Output Template Processing Tool (Version 2.0): This tool helps the project manager during the CORSIM calibration and output processing, specifically for freeway operations (CORSIM_Calibration_and_Freeway_Output_v2.0.xlsm).

CORSIM Intersection Data Processing Tool (Version 2.0): This tool helps the project manager to summarize intersection-related output from CORSIM (CORSIM_Intersection_v2.0.xlsm).

Data Collection File: Text file that contains VISSIM data collection points.

Delay: Travel time experienced by a driver, passenger, bicyclist, or pedestrian beyond that required to travel at the desired speed (expressed in seconds per vehicle). See control delay or microsimulation delay for more information.

Density: The number of vehicles occupying a given length of lane at a particular instant (expressed in either passenger cars per mile per lane (pcpmpl) for deterministic traffic tools or vehicles per mile per lane (vpmpl) for stochastic traffic tools).

Deterministic traffic tools: Traffic analysis tools in which there is no variability in driver-vehicle characteristics (e.g., HCS 2010).

FRESIM: Freeway and highway network analysis module in CORSIM.


*.KNA: VISSIM output file containing arterial results.

Level of service (LOS): Stratification of a performance measure(s) that represent quality of service, measured in an A-F scale with LOS A representing the best.

Measure of Effectiveness (MOE): Factor that quantifies operational and safety objectives and provides a basis for evaluating the performance of the transportation network.

*.MES: VISSIM output file containing freeway results.

Microscopic analysis tools: Tools used to simulate the characteristics and interactions of individual vehicles. These tools include algorithms and rules describing how vehicles move and interact within the transportation network, including acceleration, deceleration, and lane changing (e.g., CORSIM, SimTraffic, and VISSIM).

Microsimulation: Modeling of individual vehicle movements on a second or sub-second basis to assess the traffic performance of a transportation node, segment, or network.

Microsimulation delay: The difference (expressed in seconds per vehicle) between the simulated travel time and the theoretical travel time if the vehicle was operating at the desired speed calculated by a microsimulation tool.

Model calibration: Modeling process where the modeler modifies calibration parameters that cause the model to best replicate field-measured and observed traffic volumes, speeds, travel times, and queues.
Model validation: Modeling process where the modeler checks the overall model-predicted traffic performance for a network against field measurements of traffic performance not using data from the calibration process.

NETSIM: Arterial and urban streets network analysis module in CORSIM.

*.OUT: CORSIM output file containing arterial and freeway results.

*.STR: VISSIM, Version 5.40 output file containing microsimulation results.

*.TNO: TSIS, Version 6.3 file extension compatible with TRAFED.


TRAF Editor (TRAFED): A graphical input editor used to define traffic networks and other input for microsimulation.

Traffic Software Integrated System (TSIS): A traffic microsimulation software package that includes CORSIM.

TRAFVU: TRAF Visualization Utility: A graphics processor used to display traffic networks and animate vehicles and traffic signals on that network.

*.TRF: TSIS, Version 6.3 file extension compatible with CORSIM.

Tshell: The graphical user interface (GUI) for TSIS.

VDOT project manager: Individual responsible for overseeing and directing the project from scoping through project delivery. The VDOT project manager is responsible for ensuring the direction and guidance presented in this manual are followed and should consult with technical specialists, as needed, throughout the project process.

VDOT Sample Size Determination Tool (Version 2.0): This tool helps the project manager determine the number of traffic microsimulation runs to be conducted for each project (VDOT_Sample_Size_Determination_Tool_v2.0.xlsx).

VDOT Software Selection Tool (Version 2.0): This tool provides direction to the project manager to determine the most appropriate traffic operations and/or safety analysis tool(s) to be used for each project (VDOT_Software_Selection_Tool_v2.0.xlsm).

VISSIM Calibration and Freeway Output Template Processing Tool (Version 2.0): This tool helps the project manager during the VISSIM calibration and output processing, specifically for freeway operations (VISSIM_Calibration_and_Freeway_Output_v2.0.xlsm).

VISSIM Intersection Data Processing Tool (Version 2.0): This tool helps the project manager to summarize intersection-related output from VISSIM (VISSIM_Intersection_v2.0.xlsm).
1 Introduction

1.1 BACKGROUND

This user guide is intended to assist users of the Traffic Operations and Safety Analysis Manual, Version 1.0 (TOSAM) in using the Microsoft® Excel-based macros that were developed in support of the manual. VDOT identified the need to develop the TOSAM to provide direction to project managers to select the most appropriate traffic and analysis tool(s) during the project scoping phase, understand the data requirements and standard assumptions related to each analysis tool, and produce consistent output results from those tools for transportation analyses. As part of the process to produce consistent output results from traffic analysis tools, multiple Excel-based macros were developed in conjunction with the TOSAM to assist users in reporting output results in a graphical format. This user guide and the associated Excel-based macros are intended to be used by VDOT and consultant project managers that use CORSIM or VISSIM for analysis.

The current version of the TOSAM requires users to report output results in a graphical format. The following macros were developed to assist users in applying the methodologies outlined in the TOSAM:

- VDOT Software Selection Tool (Version 2.0)
- VDOT Sample Size Determination Tool (Version 2.0)
- CORSIM Intersection Data Processing Tool (Version 2.0)
- CORSIM Calibration and Freeway Output Template Processing Tool (Version 2.0)
- VISSIM Intersection Data Processing Tool (Version 2.0)
- VISSIM Calibration and Freeway Output Template Processing Tool (Version 2.0)

The calibration and output processing macros are intended to:

1. Combine output results from multiple microsimulation runs into a single set of results; and
2. Extract output data from microsimulation runs into tabular and graphical formats compatible with the TOSAM.

The Excel-based macros WILL NOT:

1. Report MOEs other than density, microsimulation delay and space mean speed;
2. Report Level of Service (LOS);
3. Produce arterial outputs in a graphical format;
4. Identify user errors in the coding of microsimulation models;
5. Work with versions of Microsoft® Excel earlier than 2007; and
6. Ensure that the minimum requirement of reporting two MOEs is met (Note: the freeway results that are reported on the output schematic will meet this requirement).

Limitations specific to each Excel-based tool are explained in its respective section.
This user guide is not intended to serve as a specific software user guide; however, it does provide guidance on how to properly code CORSIM (Version 6.3), VISSIM Version 6 and VISSIM Version 7 models to produce outputs compatible with the Excel-based macros. For a brief description of the history and capabilities of CORSIM and VISSIM, refer to Chapter 3 of the TOSAM.

1.2 EXCEL-BASED MACRO MAINTENANCE AND UPDATES

VDOT will have the primary responsibility for maintaining the functionality of the Excel-based macros. Future refinements and improved functionality are expected as analytical tools change and the TOSAM evolves.
2 VDOT Software Selection Tool (Version 2.0)

This chapter describes how to use the VDOT Software Selection Tool (Version 2.0). Instructions for using the tool may also be found in the “User Guide” tab of the Excel spreadsheet.

Microsoft® Excel may produce a security warning message that some of the active content in the tool has been disabled. Select “Enable Content” to enable macros within the spreadsheet. If the macro does not work after it has been enabled, verify that security settings have enabled all macros and that the version of Microsoft® Excel is compatible with the macro.

This tool consists of the following four buttons as shown in Figure 1:

1. Open Form
2. Calculate Software
3. Set Print Area
4. Clear Table

2.1 OPEN FORM

Once the “Open Form” button is clicked, the “Software Selection Tool Input Form” will open in a popup window (Figure 2). The input form allows the user to specify the following six criteria:

- Analysis Category
- Analysis Type
- Oversaturated or Undersaturated Conditions
- Location Type
- Microsimulation Preference
- Measure of Effectiveness (MOE)
Direction on determining analysis category, analysis type, saturation conditions, and location type can be found in Chapter 2 of the TOSAM. Direction and guidance on MOEs can be found in Chapter 4 of the TOSAM. Direction and guidance on determining whether or not microsimulation is required can be found in Chapter 5 of the TOSAM.

Once the inputs have been specified, click “Export to Spreadsheet” to transfer the selected inputs to the Excel spreadsheet as shown in Figure 3. The user may continue to export scenarios to represent all the project needs. For example, if the user would like to report both delay and queue length for an intersection analysis, the user should fill out the form twice, once with delay selected and once with queue length selected. The user may export as many scenarios as they choose before closing the form and running the “Calculate Software” macro (Section 2.2).
2.2 CALCULATE SOFTWARE, SET PRINT AREA, CLEAR TABLE

Once the inputs from the “Software Selection Tool Input Form” have been exported to the Excel spreadsheet, click “Calculate Software”. A “✓” will indicate which traffic operations or safety analysis tool(s) is applicable for each input scenario (Figure 4). If an MOE with multiple definitions is specified (delay, queue, or speed), then the definition that applies to a certain tool will be listed underneath the “✓”. Additionally, the tool provides notes that may be helpful in determining which of the indicated tools (if multiple tools are identified) should be selected. A column is also included for the user to document any additional comments on the project such as budget or time constraints.

The user may format the print area of the results table using the “Set Print Area” button. This button will automatically set the printing extents to encompass the entire results table. Once the print area has been set, the user may use the “print” command in Excel.

Once the user has printed the results table or if the user wishes to start over, the “Clear Table” button may be used to clear the results table.
3 VDOT Sample Size Determination Tool

This chapter describes how to use the VDOT Sample Size Determination Tool (Version 2.0). Prior to running the traffic microsimulation model, identify an MOE and a location in the network to obtain the chosen MOE. The location(s) where MOEs are gathered from should be agreed upon with the project manager. Once the location(s) has been identified, an initial ten microsimulation runs should be conducted. After running the initial ten traffic microsimulation runs for a scenario, the following steps should be followed to determine the required number of traffic microsimulation runs for that scenario (Figure 5).

Figure 5: VDOT Sample Size Determination Tool (Version 2.0)
1. **Select a Measure of Effectiveness (MOE):** Select “Speed” or “Density” as an input MOE.

2. **Input the Number of Model Runs:** Enter the number of runs performed thus far. The cells identifying that number of runs will change to a gray background to indicate that an input is needed (i.e., if the number of runs is 15, then Run Numbers 1 through 15 will have a gray background).

3. **Input MOE Values:** Enter the MOE result for each run. Once a value has been entered into a cell, the cell will change to a pink background.

4. **View Sample Size Outputs:** The Excel sheet will determine if additional traffic microsimulation runs are needed (up to a maximum of 30 runs) to meet the required tolerance error and confidence interval. If the current number of runs is sufficient, the “Percentage of Mean” will be shown as “Good” (Figure 6). If additional runs are needed, the “Percentage of Mean” will be shown as “Too High” and the “Sample Size Needed” will indicate the number of runs needed (Figure 7) based on the current data set. If the value is shown as “Good”, no additional traffic simulations are needed. If the value is shown as “Too High”, proceed to step 5.

   **Figure 6: “Good” Percentage of Mean**
   
   | Sampling Error | = 0.80 |
   | 95% Confidence Interval | = 8.1 to 9.7 |
   | Percentage of Mean | = 8.96% Good |
   | Sample Size Needed | = 10 |

   **Figure 7: “Too High” Percentage of Mean**
   
   | Sampling Error | = 1.44 |
   | 95% Confidence Interval | = 8.0 to 10.8 |
   | Percentage of Mean | = 15.29% Too High |
   | Sample Size Needed | = 23 |

5. **Repeat Steps 2, 3, and 4 (if necessary):** If the “Sample Size Needed” value exceeds the number of runs that have already been performed, additional traffic microsimulation runs are needed. The results from the previous runs should not be replaced. Instead, the user should only simulate the additional runs needed and repeat steps 2, 3, and 4 to account for the additional runs.

Users should verify that each traffic microsimulation run has been reviewed for errors both visually and through error logging. It is important to ensure that erroneous traffic microsimulation runs are not included within the reported output results or the data sample. For example, traffic microsimulation runs with gridlocked conditions due to a nonfunctioning vehicle(s) should not be included in the reported output results or the data sample.
4 CORSIM Macros

This chapter describes how to use two Excel-based macros when conducting traffic operational analyses using CORSIM, the CORSIM Intersection Data Processing Tool (Version 2.0) and the CORSIM Calibration and Freeway Output Template Processing Tool (Version 2.0). The current macros were developed to be compatible with CORSIM, Version 6.3 and Excel 2007 or higher.

4.1 CORSIM INTERSECTION DATA PROCESSING TOOL (VERSION 2.0)

This section describes the following steps and limitations associated with using the CORSIM Intersection Data Processing Tool (Version 2.0):

1. Process CORSIM Intersections
2. CORSIM Intersection Results (Microsimulation Delay Results Tab)
3. CORSIM Intersection Data Processing Tool Limitations

4.1.1 Process CORSIM Intersections

Open the CORSIM Intersection Data Processing Tool (Version 2.0) after building a CORSIM arterial network (NETSIM) and producing CORSIM *OUT files. Microsoft® Excel may produce a security warning message that some of the active content in the tool has been disabled. Select “Enable Content” to activate the macro. If the macro does not work once the macro has been enabled, verify that the security settings are set to allow macros and that Microsoft® Excel is compatible with the macro.

The following steps describe how to import data into the CORSIM Intersection Data Processing Tool (Version 2.0) shown in Figure 8.

![Figure 8: CORSIM Intersection Data Processing Tool (Version 2.0)](image)

1. Main Sheet

   a. Process CORSIM Intersections: Select “PROCESS CORSIM INTERSECTIONS” and the “CORSIM File Processing Utility” menu will appear in a popup box (Figure 9).
2. CORSIM File Processing Utility Menu
   a. **Select .OUT Folder:** Select the folder that contains the CORSIM *.OUT files that are to be processed. This macro will select **EVERY** *.OUT file in a folder. To prevent incorrect *.OUT files from being processed, files from different time periods and scenarios (e.g., AM, PM, Build, No-Build), as well as all calibration files, should be stored in separate folders.
   b. **Select Output Folder:** Specify a folder location where the results file will automatically be saved. The .OUT folder will be selected as the default folder.
   c. **Select Interval Length:** Specify whether volumes in CORSIM were entered in 15-minute or 1-hour intervals.
   d. **Process Selected Files:** Once folders have been selected, click “Process Selected Files” and the “Choose Time Periods” menu will appear in a popup window (Figure 10).

![Figure 9: CORSIM File Processing Utility Menu](image)

![Figure 10: Choose Time Periods Popup Window](image)

3. Choose Time Periods Menu
   a. **Select Starting Time Period:** Select the beginning time period from the drop down menu. (e.g., if the first hour of the analysis is required and traffic volumes were entered in 15-minute intervals, select TP 1; however, if results are needed for the second hour, select TP 5).
   b. **Select Continue:** The macro will automatically create and save a file in the previously specified output folder.

4. CORSIM Intersection Results File: The following information will be included in the newly created Excel spreadsheet.
a. **File Name:** The file will be titled CORSIMIntersectionResults YYMMDDHHMMSS.xlsm. This unique file name with a time stamp will prevent files from being overwritten.

b. **Time Period Tabs:** Separate tabs will be provided for each of the time periods in the microsimulation. Each tab will contain the following results for each network link.

- Vehicle-Miles
- Vehicle-Trips
- Speed
- Stops
- Moving Time
- Delay Time
- Total Time
- Moving Time to Total Time Ratio

c. **Microsimulation Delay Results Tab:** The microsimulation delay results tab summarizes the following results for each intersection (Figure 11). Section 4.1.2 outlines the additional steps needed to finalize the reporting process.

- Turning Movement Volumes
- Microsimulation Delay by Movement
- Microsimulation Delay by Approach
- Microsimulation Delay by Intersection

**Figure 11: Base Microsimulation Delay Results Table**

<table>
<thead>
<tr>
<th>Name / ID</th>
<th>Approach Control Type</th>
<th>Link</th>
<th>Turning Movement Volumes</th>
<th>Microsimulation Delay by Movement (sec)</th>
<th>Microsimulation Delay by Approach (sec)</th>
<th>Microsimulation Delay by Intersection (sec)</th>
<th>Intersection Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name / ID</td>
<td>Approach Control Type</td>
<td>Link</td>
<td>Turning Movement Volumes</td>
<td>Microsimulation Delay by Movement (sec)</td>
<td>Microsimulation Delay by Approach (sec)</td>
<td>Microsimulation Delay by Intersection (sec)</td>
<td>Intersection Type</td>
</tr>
<tr>
<td>Name / ID</td>
<td>Approach Control Type</td>
<td>Link</td>
<td>Turning Movement Volumes</td>
<td>Microsimulation Delay by Movement (sec)</td>
<td>Microsimulation Delay by Approach (sec)</td>
<td>Microsimulation Delay by Intersection (sec)</td>
<td>Intersection Type</td>
</tr>
<tr>
<td>Name / ID</td>
<td>Approach Control Type</td>
<td>Link</td>
<td>Turning Movement Volumes</td>
<td>Microsimulation Delay by Movement (sec)</td>
<td>Microsimulation Delay by Approach (sec)</td>
<td>Microsimulation Delay by Intersection (sec)</td>
<td>Intersection Type</td>
</tr>
<tr>
<td>Name / ID</td>
<td>Approach Control Type</td>
<td>Link</td>
<td>Turning Movement Volumes</td>
<td>Microsimulation Delay by Movement (sec)</td>
<td>Microsimulation Delay by Approach (sec)</td>
<td>Microsimulation Delay by Intersection (sec)</td>
<td>Intersection Type</td>
</tr>
</tbody>
</table>

4.1.2 **CORSIM Intersection Results File (Microsimulation Delay Results Tab)**

The following steps will describe how to finalize the reporting process.

1. **Select Intersection Type:** In the “Intersection Type” column, specify whether an intersection is a signalized intersection (default), an unsignalized all-way stop intersection, or an unsignalized two-way stop intersection (Figure 12).

**Figure 12: Select Intersection Type**
2. **Select Approach Control Type**: In the “Approach Control Type” column, specify whether an approach is signal-controlled (default), stop-controlled, or a free movement (Figure 13). Free movements could include left-turn movements that yield to opposing through movements.

**Figure 13: Specify Approach Control Type**

<table>
<thead>
<tr>
<th>Approach</th>
<th>Control Type</th>
<th>Free</th>
<th>Stop</th>
<th>Signal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Free</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Stop</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Signal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Signal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Signal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Signal</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. **Specify Intersection Name/ID and Approach Directions**: Specify the intersection name and/or ID number (e.g., Broad Street at 14th Street) and the approach cardinal direction (e.g., north, south, northwest) at each intersection (Figure 14).

**Figure 14: Input Intersection Name and Approach Cardinal Direction**

<table>
<thead>
<tr>
<th>Name / ID</th>
<th>Approach</th>
</tr>
</thead>
</table>
| Broad Street at 14th Street | NB  
|                     | SB  
|                     | EB  
|                     | WB  |
| Broad Street at 15th Street  | NB  
|                       | SB  
|                       | EB  
|                       | WB  |

### 4.1.3 CORSIM Intersection Data Processing Tool (Version 2.0) Limitations

The CORSIM Intersection Data Processing Tool (Version 2.0) has the following known limitations:

- Intersections are limited to nodes with 3 to 5 inbound links.
- Users must manually specify intersection and approach type.
- Nodes with midblock pedestrian crossings are not compatible with this macro.
- Macro will not determine an HCM equivalent pedestrian LOS.
- There is a minimum requirement of one 60-minute time period or four 15-minute time periods for the tool to properly display results.
- The tool is bound by any limitations to CORSIM, Version 6.3.
4.2 CORSIM CALIBRATION AND FREEWAY OUTPUT TEMPLATE PROCESSING TOOL (VERSION 2.0)

This section describes the steps and limitations associated with using the CORSIM Calibration and Freeway Output Template Processing Tool (Version 2.0).

1. Format Freeway Template
2. Process CORSIM Freeways
3. CORSIM Freeway Schematics
4. Limitations

4.2.1 Format Freeway Template

Open the CORSIM Calibration and Freeway Output Template Processing Tool (Version 2.0) after building a CORSIM freeway network (FRESIM) and producing CORSIM *.OUT files. Microsoft® Excel may produce a security warning message that some of the active content in the tool has been disabled. Select “Enable Content” to activate the macro. If the macro does not work once the macro has been enabled, verify that the security settings are set to allow macros and that Microsoft® Excel is compatible with the macro.

Before processing the CORSIM output data, view the Freeway Template tab. This template may be preformatted if desired. Any changes to the format on the template, such as adding a company logo (Figure 15), will automatically carry over to each output worksheet. The ranges and color schemes for density (veh/ln/mi) may be edited; however, these edits will require the user to manually modify the conditional formatting on each freeway schematic to reflect any changes.

**Figure 15: Preformatted Freeway Template Worksheet**

![Preformatted Freeway Template Worksheet](image)

4.2.2 Process CORSIM Freeways

The following steps describe how to import data into the CORSIM Calibration and Freeway Output Template Processing Tool (Version 2.0) as shown in **Figure 16**.
Figure 16: CORSIM Calibration and Freeway Output Template Processing Tool (Version 2.0)

1. Main Sheet
   a. **Process CORSIM Freeways**: Select “PROCESS CORSIM FREEWAYS” and the “CORSIM File Processing Utility” menu will appear in a popup box (Figure 17).

Figure 17: CORSIM File Processing Utility

2. CORSIM File Processing Utility Menu
   a. **Select .OUT Folder**: Select the folder that contains the CORSIM *.OUT files that are to be processed. This macro will select EVERY *.OUT file in a folder. To prevent incorrect *.OUT files from being processed, files from different time periods and scenarios (e.g., AM, PM, Build, No-Build), as well as all calibration files, should be stored in separate folders.
   b. **Select Output Folder**: Specify a folder location where the lane schematic will automatically be saved. The .OUT Folder will be selected as the default folder.
   c. **Select Process .OUT**: Click “Process .OUT” to process all *.OUT files.
   d. **Process Info**: A summary of output files, processing statistics, and warnings are provided in this space. Common error and warning messages are listed below with potential solutions.
Appendix F - Excel-Based Macro User Guide

- **“WARNING! Please select at least one route. WARNING!”**
  Solution: The user will need to check the box next to at least one freeway route (Step 6) in the “Select Freeway to Output” window to generate output.

- **“WARNING! 4 or more time periods are required to process hourly results. WARNING!”**
  Solution: This warning will only show when 3 or fewer 15-minute time periods are present in an *.OUT file. Verify that there are enough time periods to produce hourly results.

- **“WARNING! Auxiliary lane required to accurately determine left or right ramp placement at link ID (FromNode-ToNode). WARNING!”**
  Solution: This warning will only show when there are no auxiliary lanes present on a freeway network in an *.OUT file. Verify that ramps are provided with auxiliary lanes for proper identification.

- **“WARNING! Link ID (FromNode-ToNode) cannot have more than (number) thru lanes. WARNING!”**
  Solution: The CORSIM Calibration and Freeway Output Template Processing Tool (Version 2.0) is limited to a maximum of 5 thru lanes on a freeway. A freeway with more than five through lanes coded with auxiliary lanes may not display properly.

- **“ERROR! No FRESIM link found in (FILENAME).OUT file ERROR!”**
  Solution: Confirm that the freeway network is coded using FRESIM and not NETSIM links.

- **“ERROR! No Time Period found in (FILENAME).OUT file ERROR!”**
  Solution: Verify that the CORSIM microsimulation run was completed without any fatal error messages.

- **“ERROR! No .OUT file found ERROR!”**
  Solution: Confirm that *.OUT files are in the correct folder identified in the CORSIM File Processing Utility Window.

- **“ERROR! Mismatch number of links in (FILENAME).OUT file ERROR!”**
  Solution: Verify that all of the *.OUT files in the specified folder are from the same analysis scenario.

- **“ERROR! (NUMBER).OUT file is missing time period information. Verify that all runs have been completed. ERROR!”**
  Solution: Verify that the CORSIM microsimulation run was completed without any fatal error messages.

- **“ERROR! (NUMBER).OUT files are missing time period information. Verify that all runs have been completed. ERROR!”**
  Solution: Verify that all of the CORSIM microsimulation runs in the folder were completed without any fatal error messages.

- **“ERROR! Cannot find link (FromNode-ToNode) ERROR!”**
  Solution: Verify that all of the *.OUT files in the specified folder are from the same analysis scenario with matching geometry.

e. **Select Freeway to Output:** Select all freeways to display in a lane schematic. By default, the macro will identify the freeways as coded in CORSIM. It is important to properly code each freeway name on the links in the model so that the results are correctly reported. Before creating a calibration sheet (Step F), all freeways should be selected to account for every link in the network.

f. **Make Calibration Sheet:** Prior to creating a calibration sheet, select all freeways in the “Select Freeway to Output” option (Step E). The macro will automatically create and save a calibration Excel spreadsheet with the name “CORSIMFreewayCalibration_YYMDDHHMMSS.xlsx”. Insert “actual volumes” and “actual speeds” for all FRESIM and NETSIM links to accompany the simulated speeds and volumes from the CORSIM microsimulation. The calibration sheet will highlight green all values that fall within the top 85th percentile of network links based on volume and will highlight red any simulated volumes or speeds that do not meet the calibration thresholds outlined in the TO.x:AM (Figure 18). Be sure to save the spreadsheet once the “actual volumes” and “actual speeds” have been entered.
g. **Select Calibration Excel:** Select the calibration sheet prepared in Step F. The “actual volumes” and “actual speeds” manually entered into the calibration sheet will populate in the lane schematic.

h. **Combine Links / 1 Sheet:** Select “Combine Links” to merge consecutive links with the same geometry and volume inputs in the lane schematic. If links are merged, the average of the simulated values across the individual links will be displayed.

Select “1 Sheet” to create a continuous lane schematic on one tab instead of limiting each tab to 15 links (Section 4.2.3). If this option is selected, the schematic will not be preformatted for printing.

i. **Select a Time Period:** Choose the correct time period for analysis. The macro will process four 15-minute intervals or one one-hour interval. The time period selected is the end of the interval (i.e. 715 represents 7:00-7:15 interval) as displayed by CORSIM. If the first interval is not 900 seconds (15 minutes), the macro will assume that the entire first interval represents data for an hourly time frame. The macro will only provide link statistics by lane if TP1 is selected as the starting time period for the analysis.

j. **Process Schematics:** Click “Process Schematics” to create lane schematics for CORSIM results. All lane schematics will be automatically be created and saved in an Excel spreadsheet titled CORSIMFreewaySchematic_YYYYMMDDHHMMSS.xlsm. An example schematic is shown in Figure 19.

k. **Select Close:** Exit macro.
4.2.3 CORSIM Freeway Schematics

The Freeway Schematic Excel file includes a tab for each freeway in the CORSIM model. A maximum of 15 links will be shown on each tab. An additional freeway tab will be created for every set of 15 links as shown in Figure 20.

![Figure 20: CORSIM Freeway Lane Schematic Tabs](image)

Each CORSIM model is unique and the user will need to format the lane schematic template to customize for each specific project/scenario. The following steps explain how to customize the template for a project:

1. If a calibration sheet was identified in the CORSIM File Processing Utility window, actual freeway link volumes will populate based on the user-specified inputs in the calibration sheet. If a calibration sheet was not identified, the user must manually input freeway link and ramp volumes.

2. Confirm the freeway name and node numbers are correct on the schematic as shown in Figure 21.

3. Confirm that freeway, ramp and weave segments are correctly identified in row 3 as shown in Figure 22. Confirm that ramp and weave distances are correctly reported on the lane schematic.

4. The user may need to manually adjust shading and lines if freeway and ramp segments are not correctly represented in lane schematics. Elements to consider include number of lanes, acceleration lanes, deceleration lanes, auxiliary lanes, on ramps, and off ramps. The “RampTemplate” tab of the macro file depicts various configurations that can be used to properly display link geometry.

5. The legend in the bottom left corner of each tab (as shown in Figure 23) displays a summary for the density thresholds that will be highlighted by-lane and by-link using built-in conditional formatting. These thresholds can be modified in Excel using conditional formatting.

![Figure 21: CORSIM Freeway Schematic Values](image)
6. The labels in the bottom right-hand corner of the lane schematic display the following information from the model (as shown in Figure 24).

   a. **Figure Number**: The user must manually change this value based on the report format.

   b. **Model Description**: This description is specified in TRAFED. If no description is provided, this defaults to the model file name.

   c. **Freeway Route**: The freeway route name is automatically generated. This value is determined for each the first named link on each facility. If all of the links are unnamed, the macro will assign the first freeway node number as the route name. The user may manually change this value.
d. **Model File Name:** The macro will truncate an underscore (e.g., “_1”) that typically depicts the microsimulation run number when multiple runs are generated.

![Figure 24: CORSIM Freeway Schematic Labels](image)

Figure 24: CORSIM Freeway Schematic Labels

4.2.4 **CORSIM Calibration and Freeway Output Template Processing Tool (Version 2.0) Limitations**

The CORSIM Calibration and Freeway Output Template Processing Tool (Version 2.0) has the following known limitations:

- This macro does not report arterial analysis results.
- This macro does not report level of service results.
- Users must verify lane geometry and ramp configurations.
- Users must manually adjust lane geometry and ramp configurations to accurately represent each model.
- This macro will not report "actual volumes," users must manually input these values into the calibration sheet depicted in **Figure 18**.
- This macro will not create an output template for every possible lane configuration.

**Note:** The macro does not have the ability to accurately reflect a lane add / lane drop from CORSIM. The macro will assume the link geometry displayed at the beginning of each link. Users must manually report added lane operational results. Additionally, users must verify that the correct upstream and downstream lanes are aligned with one another per the CORSIM lane numbering system.

- This macro will assume freeway route names from the first named link on a continuous freeway (including "dummy" links).
- This macro will not provide link statistics by lane for analyses with starting time periods other than TP1.
- This macro is designed for Excel 2007 or higher.
- This macro allows for only one off ramp or one on ramp on each link.
- This macro is not compatible with links that feature auxiliary lanes on both sides of the roadway.
- This macro limits the number of CORSIM freeway lanes to 5.
- This macro requires an auxiliary lane on the previous upstream link for an off ramp on the left. An auxiliary lane is also required on the next downstream link for an off ramp on the left.
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- This macro will not show dummy links with zero distance in the lane schematics. However, a dummy link with zero volume and speed will be shown.
- The freeway route name is determined from the first named link on a facility. If all of the links are unnamed, the macro will assign the first freeway node number as the route name.
- The freeway must be coded with at least one off ramp to be added to the selection list in Step 6 of File Processing Utility Window.
- There is a minimum requirement of one 60-minute time period or four 15-minute time periods for the tool to properly display results.
- The tool is bound by any limitations to CORSIM, Version 6.3.
5 VISSIM Macros

This chapter describes how to use two Excel-based macros when conducting traffic operational analyses using VISSIM, the VISSIM Intersection Data Processing Tool (Version 2.0) and the VISSIM Calibration and Freeway Output Template Processing Tool (Version 2.0). The macros are compatible with VISSIM, Versions 5.40, 6 and 7 and Excel 2007 or higher. Users should use the Network Performance Results attribute table to produce output reports when using VISSIM, Version 6.

5.1 VISSIM INTERSECTION DATA PROCESSING TOOL (VERSION 2.0)

This section describes the following steps and limitations associated with using the VISSIM Intersection Data Processing Tool (Version 2.0):

1. VISSIM Intersection Coding Setup
2. Process VISSIM Intersections
3. VISSIM Intersection Results (Microsimulation Delay Results Tab)
4. Processing Tool Limitations

5.1.1 VISSIM Intersection Coding Setup

After building a VISSIM network, a node evaluation must be developed for all intersections that require analysis. The following sections outline how to configure models in VISSIM 5.40, VISSIM 6, and VISSIM 7 to output the necessary files for processing.

5.1.1.1 Exporting a *.KNA file from VISSIM 5.40

1. **Review Nodes**: Ensure that each intersection for which analysis is required has a node. Nodes should be numbered and named (results will process in the order of the numbering).

2. **Initiate Node Evaluation**
   a. Select “Evaluation” > “Files…”
   b. Check the box for “Nodes” and Click “Configure”

3. **Configure Data to be Collected**: Define the data to be collected for the desired vehicle type(s) in the following order (Figure 25):
   a. Node
   b. Movement
   c. Number Veh (All veh. Types)
   d. Delay Time (All veh. Types)

4. **Identify Output File**: Check “Compiled Data” (Figure 25). This will generate a *.KNA file when the model is run.
5. **Filter Nodes for Evaluation:** (Figure 26)
   a. Click OK in the Configuration Window and then click “Filter” next to Node Evaluation
   b. Select time boundaries and interval according to analysis
   c. Move all nodes to be used for analysis into the “Active Nodes” section

6. **Verify Output:** Verify that the node evaluation box is checked for outputs in the Evaluation Files window (Figure 26). This will create *.KNA files upon running the model.

7. **Run Model:** Run the model using a single run or multiple runs.
   a. Files from different time periods or scenarios (i.e., AM, PM, build, no-build) should be stored in separate folders to prevent incorrect *.KNA files from being processed by the macro.
5.1.1.2 Exporting an *.ATT file from VISSIM 6 or VISSIM 7

1. **Review Nodes**: Ensure that each intersection for which analysis is required has a node. Nodes should be numbered and named (results will process in the order of the numbering).

2. **Initiate Node Evaluation**
   a. Select “Evaluation” > “Configuration”
   b. Check the box for “Nodes” and input the analysis time interval
   c. Click “More” to change the definition of delay and queue measurement

3. **Configure Data to be Collected**: Define the data to be collected for the desired vehicle type(s) in the following order (Figure 27):
   a. Simulation Run Number
   b. Time Interval
   c. Movement\Node\Number
   d. Movement\Node\Name
   e. Movement\Direction
   f. Vehicles (All veh. Types)
   g. Vehicle Delay (average) (All veh. Types)

4. **Save Output File**: After the model runs are completed, click “Save to File” (Figure 28). This will generate an *.ATT file with the average results across all microsimulation runs.

   ![Figure 27: Node Evaluation - Configuration](image-url)
5. **Filter Nodes for Evaluation (Figure 29)**
   a. Select “Evaluation” > “Configuration”
   b. Select time boundaries and interval according to analysis

6. **Verify Output**: Verify that the nodes box is checked for outputs in the Evaluation configuration window (Figure 29). This will create results in VISSIM list tables after running the model.
7. **Run Model**: Run the model using a single run or multiple runs.
   
a. Files from different time periods or scenarios (i.e., AM, PM, build, no-build) should be stored in separate folders to prevent incorrect *.ATT files from being processed by the macro.

### 5.1.2 Process VISSIM Intersections

Open the VISSIM Intersection Data Processing Tool (Version 2.0) after producing VISSIM *.KNA files. Microsoft® Excel may produce a security warning message that some of the active content in the tool has been disabled. Select “Enable Content” to activate the macro. If the macro does not work after it has been enabled, verify that security settings have enabled all macros and that the version of Microsoft® Excel is compatible with the macro.

The following steps describe how to import data into the VISSIM Intersection Data Processing Tool (Version 2.0) as shown in Figure 30:

**Figure 30: VISSIM Intersection Data Processing Tool (Version 2.0)**

![VISSIM Intersection Data Processing Tool (Version 2.0)](image)

1. **Main Sheet**

   a. **Process VISSIM Intersections**: Select “PROCESS VISSIM INTERSECTIONS” and the “VISSIM File Processing Utility” menu will appear in a popup box (Figure 31).

**Figure 31: VISSIM Intersection File Processing Utility Menu**

![VISSIM File Processing Utility Menu](image)
2. VISSIM File Processing Utility Menu
   a. Select VISSIM Version: Select the VISSIM Version used to run the microsimulation.
   b. Select .KNA Folder or Select .ATT File:
      - If VISSIM 5.40 was used, select the folder that contains the *.KNA files that are to be processed. This macro will select EVERY *.KNA file in a folder. To prevent incorrect *.OUT files from being processed, files from different time periods and scenarios (e.g., AM, PM, Build, No-Build), as well as all calibration files, should be stored in separate folders.
      - If VISSIM 6 or VISSIM 7 was used, select the *.ATT file to be processed.
   c. Select Output Folder: Specify a folder location where the results file will automatically be saved. The .KNA Folder will be selected as the default folder.
   d. Select Interval Length: Specify whether volumes in VISSIM were entered in 15-minute or 1-hour intervals.
   e. Process Selected Files: Once folders have been selected, click “Process Selected Files” and the “Choose Time Periods” menu will appear in a popup window (Figure 32).

   ![Figure 32: VISSIM Intersection Choose Time Periods](image)

3. Choose Time Periods
   a. Select Starting Time Period: Select the beginning time period from the drop down menu (e.g., if the first hour of the analysis is required and volumes were entered in 15-minute intervals, select TP 1; however, if results are needed for the second hour, select TP 5).
   b. Select Continue: The macro will automatically create and save a file in the previously specified output folder.

4. VISSIM Intersection Results File: The following information will be included in the newly created Excel spreadsheet:
   a. File Name: The file will be titled VISSIMIntersectionResults_YYMMDDHHMMSS.xlsm. This unique file name with a time stamp will prevent files from being overwritten.
   b. Time Period Tabs: Separate tabs will be provided for each of the time periods in the microsimilation. Each tab will contain the following results for each intersection movement:
      - Modeled Volume
      - Microsimulation Delay
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c. Microsimulation Delay Results Tab: The microsimulation delay results tab summarizes the following results for each intersection (Figure 33). Section 5.1.3 outlines the additional steps needed to finalize the reporting process.

- Modeled Volumes
- Microsimulation Delay by Movement
- Approach Microsimulation Delay
- Intersection Microsimulation Delay

Figure 33: Base Microsimulation Delay Results Table

<table>
<thead>
<tr>
<th>Intersection</th>
<th>Name</th>
<th>Intersection Type</th>
<th>Movement</th>
<th>Modeled Volume</th>
<th>Microsimulation Delay (sec/veh)</th>
<th>Approach Control Type</th>
<th>Approach Microsimulation Delay (sec/veh)</th>
<th>Intersection Microsimulation Delay (sec/veh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Candlers Mountain Rd / Liberty Mountain Dr / US 460 EB Off-Ramp</td>
<td>Signalized</td>
<td>S-N</td>
<td>49</td>
<td>2.6</td>
<td>Signal</td>
<td>From South</td>
<td>2.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>S-SW</td>
<td>12</td>
<td>1.2</td>
<td>Signal</td>
<td>From North</td>
<td>1.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>N-SW</td>
<td>12</td>
<td>1.2</td>
<td>Signal</td>
<td>From SouthWest</td>
<td>1.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>S-SW</td>
<td>12</td>
<td>1.2</td>
<td>Signal</td>
<td>From North</td>
<td>1.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>N-SW</td>
<td>12</td>
<td>1.2</td>
<td>Signal</td>
<td>From North</td>
<td>1.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>S-W</td>
<td>15</td>
<td>8.4</td>
<td>Signal</td>
<td>From North</td>
<td>8.4</td>
</tr>
<tr>
<td>2</td>
<td>Liberty Mountain Dr / US 460 EB On-Ramp</td>
<td>Signalized</td>
<td>N-S</td>
<td>25</td>
<td>98</td>
<td>Signal</td>
<td>From South</td>
<td>97.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>N-SW</td>
<td>25</td>
<td>98</td>
<td>Signal</td>
<td>From South</td>
<td>97.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>S-SW</td>
<td>6</td>
<td>0.9</td>
<td>Signal</td>
<td>From SouthWest</td>
<td>0.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>SW-NW</td>
<td>18</td>
<td>1.1</td>
<td>Signal</td>
<td>From North</td>
<td>0.7</td>
</tr>
</tbody>
</table>

5.1.3VISSIM Intersection Results (LOS Results Tab)
The following steps will describe how to finalize the LOS reporting process:

1. Select Traffic Control Type: Select the appropriate intersection type for each intersection from the drop down menu (Figure 34). The following intersection types are available for selection:
   - Signalized (default)
   - Unsignalized All-Way Stop
   - Unsignalized Two-Way Stop

   Figure 34: Select Intersection Type

2. Select Stop-Controlled Approaches: For unsignalized two-way stop intersections, specify in the “Right-Of-Way” column which approaches are free movements and which approaches are stop-controlled (Figure 35). Free movements could include left-turn movements that yield to opposing through movements.
5.1.4 **VISSIM Intersection Data Processing Tool (Version 2.0) Limitations**

The VISSIM Intersection Data Processing Tool (Version 2.0) has the following known limitations:

- Intersections are limited to nodes with 3 or more inbound links.
- Users must manually specify intersection type.
- Nodes with midblock pedestrian crossings are not compatible with this macro.
- Macro will not determine an HCM equivalent pedestrian LOS.
- There is a minimum requirement of one 60-minute time period or four 15-minute time periods for the tool to properly display results.
- The tool is bound by any limitations to VISSIM, Versions 5.40, 6, and 7.
5.2 VISSIM CALIBRATION AND FREEWAY OUTPUT TEMPLATE PROCESSING TOOL (VERSION 2.0)

This section describes the following steps and limitations associated with using the VISSIM Calibration and Freeway Output Template Processing Tool (Version 2.0).

1. VISSIM Output Reporting Requirements
2. Format Freeway Template
3. Process VISSIM Freeways
4. VISSIM Freeway Schematics
5. Limitations

5.2.1 VISSIM Output Reporting Requirements

The VISSIM Calibration and Freeway Output Template Processing Tool (Version 2.0) requires VISSIM, Version 5.40 results to be reported in *.STR format and VISSIM, Version 6.0 results to be reported in *.ATT format in order to be processed by the VISSIM Calibration and Freeway Output Template Processing Tool (Version 2.0). The following procedures must be followed to properly export *.STR and *.ATT files into a format compatible with the VISSIM Calibration and Freeway Output Template Processing Tool (Version 2.0).

5.2.1.1 Exporting an *.STR file from VISSIM, Version 5.40

An *.STR file is required to report VISSIM, Version 5.40, link results. VISSIM, Version 5.40, automatically produces an *.STR file that contains output results compatible with the VISSIM Calibration and Freeway Output Template Processing Tool. Users should verify that “Link Evaluation” is turned on each link that output results are required using the following steps:

1. Double Click on a link to open the “Link Data” window
2. Select the “Other” tab
3. Click on the “Evaluation” button to pull up the “Link Evaluation” window.
4. Select “Link Evaluation”
5. Verify the “Segment Length” exceeds the link of the link so that the entire length is evaluated.

5.2.1.2 Exporting *.ATT Files from VISSIM, Version 6.0

To be compatible with VISSIM, Version 6.0, the VISSIM Calibration and Freeway Output Template Processing Tool requires an *.ATT file to be output from VISSIM, Version 6.0.

In order to output an *.ATT file, the following steps must be completed prior to running a microsimulation:

1. Select “Link Evaluation” on all links of interest. On all links that the user wishes to collect data, “Link Evaluation” must be selected. To select “Link Evaluation”, first double click on an individual link to open the Link Data window (Figure 36). Then select the “Other” tab and check “Link Evaluation”.

---

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2. **Select Attributes to evaluate:** Attributes are selected via the Link Segment Results table. If the Link Segment Results table is not already open, select “Evaluation” > “Result Lists” > “Link Segments” (Figure 37) and the Link Segment Results table will appear (Figure 38). From the Link Segment Results table menu, click the Select Attributes button (Figure 38 - #1) to open the Select Attributes window (Figure 39). The user should select the following attributes: microsimulation run, time interval, link evaluation segment\link\name, link evaluation segment\link\numb, link evaluation segment, density (all), loss time (relative) (all), speed (all), volume (all).

3. **Save *.ATT file.** The user may also save down an *.ATT file after completing each microsimulation run (Figure 38 - #2). However, the user should toggle on the “Autosave After Simulation” button (Figure 38 - #3) prior to the microsimulation so that an *.ATT file is automatically saved when the microsimulation is complete.
5.2.2 Editing the Output Schematic Template

Open the VISSIM Calibration and Freeway Output Template Processing Tool (Version 2.0) after building a VISSIM freeway network and producing *.INP or *.INPX files. Microsoft® Excel may produce a security warning message that some of the active content in the tool has been disabled. Select “Enable Content” to activate the macro. If the macro does not work after it has been enabled, verify that security settings have enabled all macros and that the version of Microsoft® Excel is compatible with the macro.

Before processing the VISSIM output data, view the Freeway Template tab. This template may be preformatted if desired. Any changes to the format on the template, such as adding a company logo (Figure 40), will automatically carry over to each output worksheet. The ranges and color schemes for density (veh/ln/mi) may be edited; however, these edits will require the user to manually modify the conditional formatting on each freeway schematic to reflect any changes.
5.2.3 Process VISSIM Freeways

The following steps document how to use the VISSIM Calibration and Freeway Output Template Processing Tool (Version 2.0) as shown in Figure 41.

Figure 41: VISSIM Calibration and Freeway Output Template Processing Tool (Version 2.0)

1. Main Sheet
   a. **Process VISSIM Freeways**: Select “PROCESS VISSIM FREEWAYS” and the “VISSIM File Processing Utility” menu will appear in a popup box (Figure 42).

2. VISSIM File Processing Utility Menu
   a. **Select VISSIM File**: Select the *.INP or *.INPX file for the desired microsimulation run. Verify that VISSIM *.INP and *.INPX files are not located in the same folder directory and that the respective *.STR files (if *.INP is selected) or *.ATT files (if *.INPX is selected) are located in the same folder directory. Confirm that only the desired *.STR or *.ATT files are located in the same folder directory. The macro will average the results from every *.STR or *.ATT file in the folder.
   b. **Select Output Folder**: Specify a folder location where the lane schematic will automatically be saved. The folder containing the selected *.INP or *.INPX file will be selected as the default folder.
Figure 42: VISSIM File Processing Utility

- **Process Info:** A summary of output files, processing statistics, and warnings are provided in this space. Common error and warning messages are listed below with potential solutions.
  
  - **“WARNING! Please select at least one route. WARNING!”**
    
    **Solution:** The user will need to check the box next to at least one freeway route (Step 5) in the “Select Freeway to Output” window to generate output.
  
  - **“WARNING! 4 or more time periods are required to process hourly results. WARNING!”**
    
    **Solution:** This warning will only show when 3 or fewer 15-minute time periods are present in an *.ATT or *.STR file. Verify that there are enough time periods to produce hourly results.
  
  - **“WARNING! Auxiliary lane required to accurately determine left or right ramp placement at link ID (linkID). WARNING!”**
    
    **Solution:** This warning will only show when there are no auxiliary lanes present on a freeway network in an *.INP or *.INPX file. Verify that ramps are provided with auxiliary lanes for proper identification.
  
  - **“WARNING! Link ID (linkID) cannot have more than (number) thru lanes. WARNING!”**
    
    **Solution:** The VISSIM Calibration and Freeway Output Template Processing Tool (Version 2.0) is limited to a maximum of 5 thru lanes on a freeway. A freeway with more than five through lanes may not display properly.
  
  - **“WARNING! Title information is missing. WARNING!”**
    
    **Solution:** Verify that a title has been provided in the VISSIM file for display in the output schematic.
  
  - **“ERROR! No link found in (FILENAME) file ERROR!”**
    
    **Solution:** Confirm that a freeway network is coded using VISSIM. The tool is not compatible with arterial links.
  
  - **“ERROR! No Time Period found in (FILENAME) ERROR!”**
    
    **Solution:** Verify that the VISSIM microsimulation run was completed without any errors.
  
  - **“ERROR! Lane (NUMBER) not in link (linkID) with (TOTAL NUMBER OF LANES) lanes. ERROR!”**
    
    **Solution:** Verify that all of the *.ATT or *.STR files in the specified folder are from the same analysis scenario with matching geometry.
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- “ERROR! Cannot find link (linkID) ERROR!”
  Solution: Verify that all of the *.ATT or *.STR files in the specified folder are from the same analysis scenario with matching geometry.

d. **Select Freeway to Output:** Select all freeways to display in a lane schematic. By default, the macro will identify the freeways as coded in VISSIM. It is important to properly code each freeway name on the links in the model so that the results are correctly reported. Before creating a calibration sheet (Step E), all freeways must be selected.

e. **Make Calibration Sheet:** Prior to creating a calibration sheet, select all freeways in the “Select Freeway to Output” option (Step E). The macro will automatically create and save a calibration Excel spreadsheet with the name “VISSIMFreewayCalibration_YYMMDDHHMMSS.xlsx”. Insert “actual volumes” and “actual speeds” for all links to accompany the simulated speeds and volumes from the VISSIM microsimulation. The calibration sheet will highlight green all values that fall within the top 85th percentile of network links based on volume and will highlight red (Figure 43) any simulated volumes or space mean speeds that do not meet the calibration thresholds outlined in the TOx-AM. Be sure to save the spreadsheet once the “actual volumes” and “actual speeds” have been entered.

![Figure 43: VISSIM Freeway Calibration Sheet](image)

<table>
<thead>
<tr>
<th>Route</th>
<th>Link ID</th>
<th>Type</th>
<th>Link Distance</th>
<th>Volume Percentile</th>
<th>Actual Volumes</th>
<th>Simulated Volumes</th>
<th>Percent Difference</th>
<th>Actual Speeds</th>
<th>Simulated Space Mean Speeds</th>
<th>Speed Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>383</td>
<td>Freeway</td>
<td>5394</td>
<td>5180</td>
<td>75%</td>
<td>5214</td>
<td>5224</td>
<td>0.3%</td>
<td>58.4</td>
<td>58.1</td>
<td>0.3%</td>
</tr>
<tr>
<td>385</td>
<td>Freeway</td>
<td>1262</td>
<td>5180</td>
<td>75%</td>
<td>5183</td>
<td>5183</td>
<td>0.1%</td>
<td>58.1</td>
<td>56.9</td>
<td>-1.2</td>
</tr>
<tr>
<td>382</td>
<td>Freeway</td>
<td>308</td>
<td>5180</td>
<td>75%</td>
<td>5188</td>
<td>5188</td>
<td>0.2%</td>
<td>56.5</td>
<td>54.7</td>
<td>-1.8</td>
</tr>
<tr>
<td>473</td>
<td>Ramp</td>
<td>687</td>
<td>420</td>
<td>13%</td>
<td>408</td>
<td>404</td>
<td>-3.8%</td>
<td>35.7</td>
<td>34.8</td>
<td>-1.1</td>
</tr>
<tr>
<td>475</td>
<td>Ramp</td>
<td>687</td>
<td>420</td>
<td>13%</td>
<td>4770</td>
<td>4770</td>
<td>0.2%</td>
<td>54</td>
<td>51.2</td>
<td>-2.8</td>
</tr>
<tr>
<td>587</td>
<td>Freeway</td>
<td>476</td>
<td>2050</td>
<td>25%</td>
<td>2098</td>
<td>2098</td>
<td>2.3%</td>
<td>45</td>
<td>41.9</td>
<td>-3.1</td>
</tr>
<tr>
<td>421</td>
<td>Ramp</td>
<td>1429</td>
<td>2750</td>
<td>38%</td>
<td>2661</td>
<td>2661</td>
<td>-1.8%</td>
<td>45</td>
<td>43.7</td>
<td>-1.3</td>
</tr>
<tr>
<td>577</td>
<td>Freeway</td>
<td>366</td>
<td>264</td>
<td>50%</td>
<td>2651</td>
<td>2651</td>
<td>-0.8%</td>
<td>45</td>
<td>44.9</td>
<td>-1.2</td>
</tr>
<tr>
<td>577</td>
<td>Freeway</td>
<td>1066</td>
<td>0%</td>
<td>0%</td>
<td>100</td>
<td>2651</td>
<td>2553.0%</td>
<td>95</td>
<td>53.2</td>
<td>-1.2</td>
</tr>
</tbody>
</table>

f. **Select Calibration Excel:** Select the calibration sheet prepared in Step E. The “actual volumes” and “actual speeds” manually entered into the calibration sheet will populated in the lane schematic.

g. **Use Freeway Display Types:** If this option is selected, the schematic will identify links in the schematic based on the display type coded into the VISSIM model. Table 1 lists the display types that are compatible with the tool. Using this feature assists the tool in identifying freeway, ramp, weave, and CD weave links for networks that also contain arterial links. Arterial features such as artery links, crosswalks, and bridges will not be generated in the output schematic. The “Segment Type” column on Table 1 identifies how each lane will be identified on the output schematic tool. Additionally, the tool also has the ability to identify HOV and shoulder lane closures. Closed lanes will be displayed on the schematic with a red fill.

h. **Combine Links / 1 Sheet:** Select “Combine Links” to merge consecutive links with the same geometry and volume inputs in the lane schematic. If links are merged, the average of the simulated values across the individual links will be displayed.

Select “1 Sheet” to create a continuous lane schematic on one tab instead of limiting each tab to 15 links (Section 5.2.4). If this option is selected, the schematic will not be preformatted for printing.
### Table 1: Use Freeway Display Types Table

<table>
<thead>
<tr>
<th>DISPLAYTYPE</th>
<th>Name</th>
<th>Color</th>
<th>Segment Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Freeway GP Lanes</td>
<td>169 169 169</td>
<td>FREEWAY</td>
</tr>
<tr>
<td>2</td>
<td>Freeway HOV/HOT</td>
<td>255 128 128</td>
<td>FREEWAY</td>
</tr>
<tr>
<td>3</td>
<td>Arterial Links</td>
<td>211 211 211</td>
<td>N/A</td>
</tr>
<tr>
<td>4</td>
<td>Crosswalks</td>
<td>255 215 0</td>
<td>N/A</td>
</tr>
<tr>
<td>5</td>
<td>Ramps</td>
<td>0 192 192</td>
<td>N/A</td>
</tr>
<tr>
<td>6</td>
<td>Bridge</td>
<td>255 192 128</td>
<td>N/A</td>
</tr>
<tr>
<td>10</td>
<td>Freeway Merge1</td>
<td>RED</td>
<td>RAMP</td>
</tr>
<tr>
<td>11</td>
<td>Freeway Merge2</td>
<td>255 128 128</td>
<td>RAMP</td>
</tr>
<tr>
<td>12</td>
<td>Freeway-Freeway Ramp Merge</td>
<td>255 192 192</td>
<td>RAMP</td>
</tr>
<tr>
<td>13</td>
<td>Mainline Before Merge</td>
<td>255 224 192</td>
<td>RAMP</td>
</tr>
<tr>
<td>14</td>
<td>Freeway Weave1</td>
<td>255 192 128</td>
<td>WEAVE</td>
</tr>
<tr>
<td>15</td>
<td>Freeway Weave2</td>
<td>255 128 0</td>
<td>WEAVE</td>
</tr>
<tr>
<td>16</td>
<td>Mainline Downstream of Freeway - Freeway Ramp</td>
<td>192 64 0</td>
<td>RAMP</td>
</tr>
<tr>
<td>20</td>
<td>Urban (Aggressive Lane Change)</td>
<td>128 128 255</td>
<td>N/A</td>
</tr>
<tr>
<td>21</td>
<td>C-D Road Weave</td>
<td>0 192 192</td>
<td>CD WEAVE</td>
</tr>
<tr>
<td>22</td>
<td>Mainline Weave Merge</td>
<td>255 192 128</td>
<td>RAMP</td>
</tr>
<tr>
<td>28</td>
<td>Urban High Capacity - Default Driver Behavior</td>
<td>192 192 255</td>
<td>N/A</td>
</tr>
<tr>
<td>31</td>
<td>HOV Lane Closure (Left Most or Ramp)</td>
<td>255 192 255</td>
<td>FREEWAY (RED)</td>
</tr>
<tr>
<td>32</td>
<td>HOV Lane Closure (All Lanes)</td>
<td>PURPLE</td>
<td>FREEWAY (RED)</td>
</tr>
<tr>
<td>33</td>
<td>Shoulder Lane Closure</td>
<td>128 255 128</td>
<td>FREEWAY (RED)</td>
</tr>
</tbody>
</table>

i. **Select a Time Period:** Select the correct time period for analysis. The macro will process four 15-minute intervals or one-hour intervals. The time period selected is the beginning of the interval (i.e. TP1 2700-3600 represents the first 15-minute interval) as displayed by VISSIM. If the first interval is not 900 seconds (15 minutes), the macro will assume that the entire first interval represents data for an hourly time frame.

j. **Process Schematics:** Click “Process Schematics” to create lane schematics for VISSIM results. All lane schematics will be created and saved in an Excel spreadsheet titled `VISSIMFreewaySchematic_YYMMDDHHMSS.xlsx`. An example schematic is shown in Figure 44.

k. **Close:** Exit macro.
5.2.4 VISSIM Freeway Schematics

The Freeway Schematic Excel file will include a tab for each freeway in the VISSIM model. A maximum of 15 links will be shown on each tab. An additional freeway tab will be created for every set of 15 links as shown in Figure 45.

Each VISSIM model is unique and the user will need to format the lane schematic template to customize for each specific project/scenario. The following steps explain how to customize the template for a project:

1. If a calibration sheet was identified in the VISSIM File Processing Utility window, actual freeway link volumes will populate based on the user-specified inputs in the calibration sheet. If a calibration sheet was not identified, the user must manually input freeway link and ramp volumes (Figure 46).

2. Confirm the freeway name and node numbers are correct.

3. Confirm that freeway, ramp and weave segments are correctly identified in row 3 as shown in Figure 47. Confirm that ramp and weave distances are correctly reported on the lane schematic.

4. The user may need to manually adjust shading and lines if freeway and ramp segments are not correctly represented in lane schematics. Elements to consider include number of lanes, acceleration lanes, deceleration lanes, auxiliary lanes, on ramps, and off ramps. The “RampTemplate” tab of the macro file depicts various configurations that can be used to properly display link geometry.

5. The legend in the bottom left corner of each tab (as shown in Figure 48) displays a summary for the density thresholds that will be highlighted by-lane and by-link using built-in conditional formatting. These thresholds can be modified in Excel using conditional formatting.
Figure 46: VISSIM Freeway Schematic Values

Figure 47: VISSIM Freeway Schematic Values (2)

Figure 48: VISSIM Freeway Legend
6. The labels in the bottom right-hand corner of the lane schematic display the following information from the model (as shown in Figure 49):
   a. **Figure Number:** The user must manually change this value based on the report format.
   b. **Model Description:** This description is specified as the “Title” in VISSIM. If no description is provided in VISSIM, this defaults to the name of the *.INP or *.INPX file.
   c. **Freeway Route:** The freeway route name is automatically generated. This value is determined for each the first named link on each facility. If all of the links are unnamed, the macro will assign the first freeway node number as the route name. The user may manually change this value.
   d. **Model File Name:** The macro will truncate an underscore (e.g., “_1”) that typically depicts the microsimulation run number when multiple runs are generated.

   ![Figure 49: VISSIM Freeway Schematic Labels](image)

5.2.5 **VISSIM Calibration and Freeway Output Template Processing Tool (Version 2.0) Limitations**

The VISSIM Calibration and Freeway Output Template Processing Tool (Version 2.0) has the following known limitations:

- This macro does not report arterial analysis results.
- This macro does not report level of service results.
- Users must verify lane geometry and ramp configurations.
- Users must manually adjust lane geometry and ramp configurations to accurately represent each model.
- This macro will not report "actual volumes," users must manually input these values into the calibration sheet depicted on Figure 43.
- This macro will not create an output template for every possible lane configuration.
- The freeway route name is determined from the first named link on a facility. If all of the links are unnamed, the macro will assign the first freeway node number as the route name.
- This macro is designed for Excel 2007 or higher.
- This macro allows for only one off ramp or one on ramp on each link.
- This macro is not compatible with links that feature auxiliary lanes on both sides of the roadway.
- This macro limits the number of VISSIM freeway lanes to five.
• This macro requires an auxiliary lane on the previous upstream link for an off ramp on the left. An auxiliary lane is also required on the next downstream link for an off ramp on the left.

• The freeway must be coded with at least one off ramp to be added to the selection list in Step 5 of File Processing Utility Window.

• There is a minimum requirement of one 60-minute time period or four 15-minute time periods for the tool to properly display results.

• The tool is bound by any limitations to VISSIM 5.40, VISSIM 6 and VISSIM 7.