Fill-in all of the information highlighted in yellow. Once the scope is finalized select all text and remove highlighting.

Items in pink are comments that can be removed once scope has been finalized

*Is a base year build or opening year build model required?*

For locations that potentially include adding new signals to the network it is often beneficial to know how the intersection will operate with and without the signal in the base year or the opening year for the project. If the project proposes to add new signals it is recommended that an analysis be completed that analyzes each location as both unsignalized and signalized.

Base Year Build analysis may also be required to provide information for air quality modeling, so coordination with the Project Development and Environmental Analysis Branch should be undertaken to determine if this scenario is needed. Utilize highlighted text in scope if a base year build is required, if not, remove the highlighted text from the scope.

It is likely that all of the details required to complete the scope won’t be available at the time the scope is being developed, especially if all of the alternatives have not been developed yet. However, if the scope is uncertain please make a good faith estimate of the number of analysis segments or intersections and note that it is an assumption. If the number is substantially different then it can be rectified in a future task order.

**Guidance on Level of Complexity**

Simple: This category includes basic traffic operations that are common in most analyses, including stop-controlled intersections, basic signals with standard phasing and basic single lane roundabout intersections. This category should be used for projects with under saturated operations that do not have intersections whose operations are substantially affected by adjacent intersections.

Low: This category includes the same basic types included in the Simple category as well as basic unconventional intersections such as superstreets, Michigan u-turns and quadrant roadways. This category should be used for projects with the operations being near or above the capacity of the roadway with some intersections having operations that are substantially affected by adjacent intersections.

Moderate: This category includes the same types included in the Simple and Low categories as well as more advanced unconventional intersections and interchanges such as CFI’s and DDI’s. This category should be used for projects with the operations being near or above the capacity of the roadway with more than a few intersections having operations that are substantially affected by adjacent intersections. This category should also be used for more complex multi-hour simulations and for systems that have multiple paths requiring routine DTA or more complex volume development requiring ODME.

High: This category includes the same types included in the previous categories as well as more advanced modeling techniques such as complex DTA, tolled facilities or express lane modeling, etc. This category should be used for projects with the operations being at or above the capacity of the roadway with numerous intersections having operations that are substantially affected by adjacent intersections. This category should also be used for complex multi-hour simulations and for systems that have multiple paths requiring routine DTA or more complex volume development requiring ODME. **Use of this category requires approval from NCDOT.**

Very Complex: This category includes the same types included in the previous categories as well as a combination of multiple advanced modeling requirements. It should only be utilized for very complex and large systems/network level analyses. **Use of this category requires approval from NCDOT.**

**Note on Volume Balancing**

The use of balancing between intersections on STIP projects is not typically needed. TransModeler does not require balanced volumes and is able to add or remove volume mid-link to adequately accommodate volume differences. For locations where there is If there a substantial imbalance (typically greater than a 10% difference) consideration should be given to adding a dummy node/links to accommodate the change in volume. If the PEF believes volume balancing is needed, it must be approved by NCDOT.

**Note on Elevations**

The need for adding elevation data to models should be evaluated and determined during the scoping phase of the project. For projects location in Divisions 1-4 grades are not typically required unless there is a unique circumstance where grades may affect operations. The results are not typically affected for projects that do not have grades that exceed three percent (3%); therefore, grades are not typically needed for these projects. For projects that have grades that exceed 3% the use of grades is typically included. Grades can either be added through the use of GIS data that adds the z-elevations to the links or by another means that only adds the grades to the segment layer without modifying the z-elevations.

**SCOPE TEMPLATE LAST UPDATED: 03/04/2019**

**S****cope of Work**

**Task Order 1**

**Insert Project Description**

Insert County Name **County**

**STIP Project No.:** Insert STIP No.

**WBS No.: Insert WBS No.**

**Contract No.:** Insert Contract No.

**Prepared for:**

**North Carolina Department of Transportation**

**Prepared by:**

**Insert Private Engineering Firm Name**

**Task Order Period:** Month 2016-Month 2016

Date: Insert Initial Development Date.

Finalized: Insert Finalized Date

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# General Information

*{Insert a BRIEF statement about the contract mechanism, such as TM&S On-Call, Division On-Call, stand-alone contract, etc.}*

*{The timeframe listed should be for the completion of the actual assignment being scoped, not the overall project. Timeframes should also be exclusive of any previously scoped timeframes and if overlap occurs it should be included as: The study period for this assignment is expected to extend over a X month period with Y months included in Task Order Z.}*

Under insert Contract Type/Mechanism. with the North Carolina Department of Transportation (NCDOT), insert PEF Name (CONSULTANT) has been requested to assist NCDOT in the development of traffic operations analysis utilizing TransModeler microscopic simulation models for the subject project. Assignments under this contract will be assigned and defined on a Task Order basis.

The following Scope of Work (Scope) for Task Order insert Task Order # has been prepared to define the services that the CONSULTANT will provide NCDOT for developing and running the simulation models in TransModeler. The analysis will conform with the NCDOT Congestion Management Simulation Guidelines - TransModeler (https://connect.ncdot.gov/resources/safety/Congestion%20Mngmt%20and%20Signing/Congestion%20Management/NCDOT%20CONGESTION%20MANAGEMENT%20SIMULATION%20GUIDELINES%20-%20Effective%2010-01-2016.pdf).

The study period for this assignment is expected to extend over a insert # month period. Unless specified otherwise under a particular task, it is assumed that NCDOT or its representatives will provide all data, technical analyses, and other pertinent information in a form sufficient for the CONSULTANT to complete this scope of work. The CONSULTANT will assume information including, but not limited to, technical reports, technical data, technical references and citations, and project correspondence received from NCDOT or a third party is accurate and up to date. If errant data or technical analyses are discovered by the CONSULTANT during the performance of the scope, the CONSULTANT will immediately notify NCDOT. Current documents and standards are those in effect at the signing of this task order.

# Project Information

*{Please fill this section in with as much information as is known. This is the basis for many of the items and should be provided in enough detail that the values included in the scope can be verified/justified.}*

The study includes the Insert Project/Study Overview and includes the following Insert # intersections:

* List of intersections

The analysis includes the following Build Alternatives:

* List and description of alternatives

# Project Management, Coordination and Administration

## Project Management and Administration

{Insert any other units or entities that you will need to coordinate with for the traffic analysis only. The units should be for general project coordination, the technical aspects are included in Section 1.2. This is to cover the administration of the contract, the invoicing and progress reporting. If this scope is part of a larger contract (or task order) that also includes this administrative time, then it should be noted and the time will be reduced or removed for the traffic portion.}

The CONSULTANT will manage and administer this contract with NCDOT throughout the duration of this assignment, including coordination with the Congestion Management Section, Insert other units/agencies, as needed.

The study is anticipated to have a insert # month duration. The CONSULTANT will prepare a monthly progress report and submit an invoice to the NCDOT Project Manager each month throughout the duration of the study. For projects where the contract is not through the Transportation Mobility and Safety Division or the Congestion Management Section, the CONSULTANT will provide a duplicate copy of the monthly progress report to the Congestion Management Section.

## Project Coordination

*{This covers any coordination required between the CONSULTANT and NCDOT for technical aspects of the study. Insert the duration of the analysis and the number of meetings and staff members. If the meeting requires travel beyond the consultants’ local area it should be noted here and will be included in the estimate.}*

The CONSULTANT will coordinate with NCDOT relating to the technical aspects of the assignment throughout the duration of this study, including coordination with the Congestion Management Section.

The study is anticipated to have a insert # month duration. The CONSULTANT will attend up to insert # coordination meetings with NCDOT, including up to insert # staff members for each meeting.

## Consultant Coordination

*{If a subconsultant is being utilized to develop portions of the analysis and coordination is required between the firms, then add the information included below. Also designate the individual tasks to be completed by subconsultant in each scope item.}*

The CONSULTANT and SUBCONSULTANT (Insert Name of Subconsultant) will coordinate with one another during the completion of this scope of work. The coordination will include both technical aspects of the evaluation and coordination relating to schedule and tracking of progress.

*{If the Consultant is preparing the traffic analysis for a prime consultant from a different firm or separately through an on-call contract, and coordination is required between the firms then add the information below.*

The CONSULTANT and PRIME CONSULTANT (Insert Name of Prime Consultant)will coordinate with one another during the completion of this scope of work. The coordination will include both technical aspects of the evaluation and coordination relating to schedule and tracking of progress.

*{If no subconsultants are being utilized or if the work is being completed by a single firm then ~~strike through~~ the above tasks.}*

# Data Collection and Field Visit

## Data Collection

The CONSULTANT will acquire the following items for developing the simulation models:

* Latest aerial photography
* Existing contour data from NC OneMap
* Existing Signal Design Plans
* Review Database of TransModeler files from SPOT Analysis and Other Studies and download applicable TransModeler databases
* Traffic Forecast
* [List any other data needed including design plans, etc.]

*{If existing models are already developed they need to be noted as this reduces the level of effort required to develop them. Any details about the level of detail in the models, including what may need to be modified should also be included so that it can be determined what the additional effort will be to develop them for this scope of work.}*

*{If no existing models are available, it should be stated here.}*

## Field Visit

*{Please coordinate with NCDOT Congestion Management to determine if a field visit is needed. If one is needed, then the Consultant will visit the site during the more critical of the peak periods to observe traffic and spend some time reviewing the area and verifying the geometry and operations. If a field visit it not required, then ~~strike through~~ this text instead of deleting it.}*

The CONSULTANT will visit the project site during the critical peak period to observe traffic patterns, note any congestion, and develop a basis for visually validating the base year model. The CONSULTANT will also verify that any data collected or provided is consistent with the actual operations. Two (2) staff members will participate in the field visit with the approximate travel time to the project being insert # hours.

# Traffic Volume Development

The CONSULTANT will utilize the traffic forecast for the project to develop peak hour volumes for each of the scenarios being evaluated. The traffic volumes will be developed for the following scenarios:

* 201X Base Year No-Build
* 201X Base Year Build
* 204X No-Build
* 204X Build

*For the 201X Base Year Build, if there are multiple Build Alternatives only the preferred alternative should be included, as this will be used to make decisions during the final design stage.* *If there are multiple 204XX Build Alternatives they should be listed here individually.}*

*{if the forecast volumes are the same for any of the scenarios (ie. BY No-Build and Build are the same) then it should be noted and the totals below should only be for each unique set of volumes.* *The Consultant will be paid for each unique scenario that needs to be developed. If there is substantial overlap between alternatives that have the same volumes it should be noted as well.}*

## Convert Forecast to Peak Hour Volumes

The CONSULTANT will convert the Average Annual Daily Traffic (AADT) data included in the traffic forecast to peak hour volumes for insert # intersections for insert # scenarios utilizing the Intersection Analysis Utility (IAU). The volume development process also includes the breakout of insert # interchanges and/or non-standard intersection configurations for insert # scenarios.

*{Note that the # of scenarios is based on this listing above in Item 3 with 20XX Base Year Build being one scenario and includes both AM and PM peak hour. If there are a different number of intersections for certain scenarios, then each scenario can be described separately. If any of the scenarios have identical traffic volumes, then they should only be listed one time.}*

## Balance Peak Hour Volumes

The CONSULTANT will balance the peak hour volumes for the entire network by starting at the center of the network and working outward, or by another means approved by NCDOT. The balancing will occur for both the AM and PM peak periods for insert # intersections for insert # scenarios. The balancing method will be documented in the report and calculations provided in the appendix.

*{If there is a need to develop a balanced network the above section should be added. Balancing of the peak hour volumes is typically only utilized when simulating from turning movement volumes and is not typically done when developing OD matrices.* If the Consultant feels that balanced volumes for the network are needed they should discuss it with the Congestion Management Engineer before adding the item to the scope.*}*

## OD Matrix Development

*{If OD matrices are being utilized for the project, select one of the methods below and ~~strike through~~ the remaining methods}*

### Method 1 – Corridor Turn Proportions

The CONSULTANT will utilize the NCDOT Corridor OD Development Tool to develop AM and PM peak hour matrices for use in TransModeler in accordance with the NCDOT Volume Development Guidelines. OD matrices will be developed for insert # intersections for insert # scenarios.

### Method 2 – Engineering Judgment/Manual Balancing

The CONSULTANT will develop OD matrices for the AM and PM peak hours based on manually balancing the network utilizing engineering judgment in accordance with the NCDOT Volume Development Guidelines. The target volumes for each origin and destination will either be the approach volume for each entry node from the IAU or by calculating the link volume directly from the forecast (AADT \* K \* D). OD matrices will be developed for insert # intersections for insert # scenarios.

### Method 3 – Travel Demand Models

The CONSULTANT will develop OD matrices for the AM and PM peak hours based on utilizing subarea output from a travel demand model in accordance with the NCDOT Volume Development Guidelines. The CONSULTANT will review the travel demand model and export a subarea matrix utilizing TransCAD for the extents of the study area included in the simulation. The CONSULTANT will then utilize the resultant OD matrix as an input matrix to develop the final OD matrices utilizing the NCDOT Matrix Iteration Tool. The target volumes for each origin and destination will either be the approach volume for each entry node from the IAU or by calculating the link volume directly from the forecast (AADT \* K \* D). For any external links that are included in the simulation model and not in the travel demand model, the CONSULTANT will utilize engineering judgment to select representative volumes for the link based on similar facilities in the model or by another means approved by NCDOT. OD matrices will be developed for insert # intersections for insert # scenarios.

### Method 4 – O-D Data Collection

The CONSULTANT will develop OD matrices for the AM and PM peak hours based on OD data collected for the study area (typically StreetLight Data or another similar service).

For projects utilizing data from StreetLight Data, Inc., the CONSULTANT will extract O-D data for the study area based on the NCDOT Volume Development Guidelines. The CONSULTANT will extract recent data to develop the Base Year No-Build OD matrices. The cost of acquiring the data from StreetLight Data, Inc. is included as a direct expense and the quote is included as an attachment to this scope of work. The StreetLight Data OD initial input matrix will be a insert # by insert # matrix that will be developed for both the AM and PM peak periods.

The CONSULTANT will then utilize the resultant input OD matrix as an input matrix to develop the final Base Year No-Build OD matrices utilizing the NCDOT Matrix Iteration Tool. The target volumes for each origin and destination will either be the approach volume for each entry node from the IAU or by calculating the link volume directly from the forecast (AADT \* K \* D). The CONSULTANT will then utilize the final Base Year No-Build OD matrix as the input matrix to develop OD matrices for each of the other scenarios by utilizing the NCDOT Matrix Iteration Tool. In addition to the Base Year No-Build matrix, OD matrices for insert # scenarios will be developed and include a insert # by insert # matrix for each scenario.

### Method 5 – Turning Movement Based Simulation Output

The CONSULTANT will develop OD matrices for the AM and PM peak hours based on the coding of turning movement counts in the TransModeler model and then extracting output OD matrices in accordance with the NCDOT Volume Development Guidelines. OD matrices will be developed for insert # intersections for insert # scenarios. Note that the coding of the turning movement volumes is included in Section 4.1.3, 5.1.2, 6.1.2 and 7.1.1.

## Origin Destination Matrix Estimation (ODME) Development

*{OD matrices developed in Section 3.3 should be adequate for many low to medium complexity projects; however, some projects are more complex and require additional refinement of the volumes. The use of ODME should only be utilized after consultation with NCDOT and when the additional effort is warranted.}*

The CONSULTANT will utilize the OD matrices developed in Section 3.3 as the seed matrices for the ODME process and develop refined OD matrices in accordance with the NCDOT Volume Development Guidelines. The CONSULTANT will utilize the seed matrices and the NCDOT Matrix Iteration Tool to develop upper and lower bound constraint matrices to further constrain the ODME process. The CONSULTANT will utilize the turning movement volumes coded into the TransModeler network (scoped in Section 4.1.3, 5.1.2, 6.1.2 and 7.1.1.) and will add a weight field to the link layer in TransModeler to prioritize the links and further constrain the ODME process. The CONSULTANT will either code the target link volumes into the network or utilize the Aggregate Turning Movement tool in TransModeler to add the average volume to each link from the turning movement data.

The CONSULTANT will utilize the ODME procedure in TransModeler with the seed matrices and constraint matrices as an input, and the target link volumes, link weights and turning movement counts as targets and constraints. The ODME process will be run such that the estimated volumes for each link will be compared to the target volumes with a statistical analysis of the closeness of fit as included in the NCDOT Link Volume Comparison Tool. The ODME process is an iterative process where the inputs may be adjusted to allow for output matrices that replicate the target volumes to the greatest extent possible. The result of the ODME process will be two (2) one-hour matrices (one for the AM peak hour and one for the PM peak hour) that include the total number of vehicles between each OD pair.

The development of the seed matrices, upper/lower bound matrices, link volumes, link weights and the setting used for the ODME procedure will be thoroughly documented in the Traffic Operations Analysis Technical Memorandum for the project. In total, the ODME process will be utilized to develop OD matrices for insert # scenarios and will include a insert # by insert # matrix for each scenario.

## Class-Based OD Matrix Development

*{OD matrices developed in Section 3.3 or 3.4 should be adequate for many projects that do not have substantial variation in the truck percentages within the network. The use of class-based OD matrices should only be utilized after consultation with NCDOT and when the additional effort is warranted.}*

The CONSULTANT will utilize the ODME output matrices for the AM and PM peak hours being simulated and the traffic forecast/count data to create separate OD matrices for each vehicle class, passenger car, dual truck, TTST in accordance with the NCDOT Volume Development Guidelines. The result of this step will be six (6) individual matrices that include each of the three (3) vehicle classes for each of the two (2) hours being simulated. In total, the class-based OD matrix process will be utilized to develop OD matrices for insert # scenarios and will include a insert # by insert # matrix for each scenario.

## Multi-hour Simulation OD Matrix Development

*{If the project includes analysis of a peak period that extends beyond the normal one-hour AM and PM peak then the* task included below should be included in the scope. The use of multi-hour simulation and determination of the appropriate method to develop the volumes should only be utilized after consultation with NCDOT and when the additional effort is warranted Therefore, one of the below items should be utilized and the information for the approach that was not selected should be edited by ~~striking through~~ the text.}

The development of multi-hour simulation models requires additional effort beyond what is required for a standard single peak hour model. The development of volumes for multi-hour simulation models can be accomplished by either developing a scaling factor and project specific loading curves (while utilizing a single OD matrix) or by developing individual matrices for each of the peak hours being simulated.

For projects that will utilize a scaling factor and specific loading curves that are derived from traffic count data, the CONSULTANT will develop (and provide full documentation of the procedure and results) a scaling factor for each hour being simulated and demand curves (in fifteen-minute increments) for each of the peak hours. The CONSULTANT will develop the factor and curves for insert # hours (including the two standard peak hours) for the base year no-build scenario. The development of additional scenarios should use the same data as the base year no-build scenario unless approved by NCDOT.

---- OR ----

For projects that will create individual OD matrices for each hour being simulated, the CONSULTANT will utilize the steps included in Sections 3.3, 3.4 and/or 3.5 to develop OD matrices for each hour being simulated. The CONSULTANT will develop OD matrices for insert # hours for insert # scenarios

## Add Origin Destination Matrices in TransModeler

The CONSULTANT will then add the matrices (and any warm-up matrices) developed in the previous sections to the TransModeler models for use in the simulation.

# 201X Base Year Model

The CONSULTANT will develop a 20XX base year model for the subject project that will not be calibrated to existing conditions. If a field visit is conducted or the CONSULTANT has observed traffic operations in the field, the model should be visually validated to match the field observed operations.

## Model Development

The model network coding will include the following sub items:

*{If there are any details in the existing models that need to be added or updated it should be noted here and included in Section 4.1.2.}*

### Initial Model Setup

The CONSULTANT will utilize the latest available NCDOT TransModeler default file to develop the base year model database. The CONSULTANT will import Insert # previously developed models from the NCDOT TransModeler database and merge them together if multiple models exist. The CONSULTANT will review the model provided by NCDOT and add any additional elements to the network to the level required for microscopic simulation. The CONSULTANT will also import the aerial photography into the database as an image library or utilize the NCOneMap web layers. Before performing any coding, the CONSULTANT will coordinate with NCDOT regarding the appropriate version of TransModeler they should use to complete this effort.

### Develop Base Year Model in TransModeler

The CONSULTANT will complete the model network coding, including:

* Coding of lanes and geometry based on link type, including speed and facility type
* Adding in traffic control devices such as traffic signals and yield and stop signs, including sensor locations and settings
* Adding the base signal timings and phasing based on the signal plans or engineering judgment if no signal plans are available
* Adding any known lane restrictions or turning movement prohibitions
* Adding z-elevations and grades for all roadway links based on GIS data

*{if the model does not require the input of grades then the text included in green above should be removed by ~~striking through~~ the text.}*

The base year model network includes the following attributes:

*{The length should be the total length modeled for the project and should be based on a two-way roadway length unless there is a substantial difference in the alignment of each direction (ie: coding a freeway for two miles in the northbound and southbound directions is counted as two miles). Each element is coded in a cumulative manner: (First the freeway or arterial/collector/local lengths are determined, then the coding of the basic interchange forms are added in, then the coding of the intersections is added in.}*

* ## miles of freeway roadways (including C-D roadways)
* ## miles of arterial/collector/local roadways
* ## system (freeway-to-freeway) interchanges
	+ ## simple interchanges (cloverleaf, trumpet, etc.)
	+ ## complex interchanges (fully directional, C-D roadways, etc.)
* ## service (freeway-to-non-controlled access roadway) interchanges
	+ ## simple interchanges (diamonds, partial cloverleaf, etc.)
	+ ## complex interchanges (diverging diamonds, single point interchanges, etc.)
* ## unsignalized intersections
* ## unsignalized superstreet intersections (includes main intersection and two adjacent u-turn locations)
* ## roundabouts

* + ## single lane roundabouts
	+ ## multi-lane or roundabouts with slip lanes
* ## signalized intersections
	+ ## simple intersections (2-4 phases)
	+ ## complex intersections (5-8 phases)
	+ ## superstreet intersections (includes main intersection and two adjacent u-turn locations)
	+ ## unconventional intersections (quadrant left, continuous flow, etc.)

*{Note that the above list should not include attributes for models already created and imported from previous TransModeler models. Any missing items within the previously developed models should be noted below if additional effort is required.}*

### Add Volume Data to Model

*{The number of intersections assumes that each intersection will have an AM and PM peak hour volume entered into the model and will be counted as one intersection. Volume data, in the form of turning movement counts, should only be added to the model under the following conditions:*

* *Projects that do not utilize OD matrices are simulated based on turning movement volumes*
* *Projects that are utilizing OD matrices developed based on ODME (Section 3.4), or*
* *Intersections that will be optimized as isolated intersections are discussed in Section 4.1.4}*

The CONSULTANT will add the volume data to the model for insert # intersections as turning movement volumes at each node. The model volumes will be entered for the peak hour as well as for a minimum fifteen (15) minute warm-up period.

The CONSULTANT will add the vehicle composition data for heavy vehicle modeling to the model database at each external node unless class-based matrices (Section 3.5) are being utilized.

### Optimize Signalized Intersections

The CONSULTANT will utilize the TransModeler signal optimization function to optimize the signal phasing, cycle length and splits for each intersection. Each signal that is part of a coordinated system or within one-half mile of an adjacent signal will be coordinated and the offsets optimized by the CONSULTANT in TransModeler utilizing the corridor optimization feature. The CONSULTANT will optimize insert # corridor(s) for a total of insert # intersection(s) in TransModeler. Isolated intersections will be optimized utilizing Webster’s formula in the TransModeler intersection control editor. The CONSULTANT will optimize insert # isolated intersection(s) in TransModeler. Each optimization (corridor or isolated) includes the optimization of both the AM and PM peak periods. Optimization for superstreets will include two corridors being optimized, with one in each direction along the roadway.

### Dynamic Traffic Assignment (DTA)

*{Note that DTA should only be utilized when there are multiple paths between important origins and important destinations that need to be evaluated. The process of running DTA can be an iterative process that should always end with a review and fine-tuning of the signals. Multiple rounds of DTA may be required for very complex projects and should be discussed with NCDOT during scoping before being added to the scope}*

Due to multiple competitive routes in the study area, the CONSULTANT will utilize Dynamic Traffic Assignment (DTA) to route traffic within the network in accordance with the procedure included in the NCDOT Simulation Guidelines. The Base Year No‑Build scenario will be iterated for at least the minimum number of iterations included in the NCDOT Simulation Guidelines. Following the completion of DTA, each of the signals will be reviewed visually, and adjusted manually, based on the results of the DTA run.

The CONSULTANT will run one (1) round(s) of DTA for insert # number of iterations. The CONSULTANT will also manually review and fine tune the signal operations for insert # of intersections.

If the traffic routing within the study area is not reasonable and stable following the completion of the above listed number of rounds of DTA, the CONSULTANT will coordinate with NCDOT to determine if additional rounds of DTA should be run. Any additional rounds of DTA required will be included in a new task order or supplemental agreement. This should also be documented in the Traffic Technical Memorandum.

### Code Measures of Effectiveness and Develop Output Spreadsheet

*{Note that Network MOEs are required for all simulations. The remaining MOEs should be determined in coordination with NCDOT with any items listed below that are not applicable to the project, or not deemed to be necessary, being edited by striking through the text.}*

The CONSULTANT will code the following measures of effectiveness (MOE) into the model such that they can be extracted and reported for each peak period:

* Network Measures of Effectiveness
	+ Vehicle Miles Traveled (VMT)
	+ Vehicle Hours Traveled (VHT)
	+ Average Speed
	+ Delay
* Unsignalized and Signalized Intersections
	+ Delay and Level of Service for the overall intersection
	+ Delay and Level of Service for each Lane Group of the Intersection
		- Delay will be the 95th percentile of the 10 runs aggregated over the one-hour peak period.
		- Level of Service will be determined based on the overall 95th percentile delay determined above
	+ Average and Maximum Queue Length by Lane Group (for under-saturated conditions)
		- Utilize Lane Queue output for each lane group with results having spillback of 0%
	+ Average and Maximum Queue Length by Approach (for over-saturated conditions)
		- Utilize Spillback Queue output for each approach to an intersection for queue lengths that exceed the link length used for Lane Queue output
* Freeway Segments
	+ Density and Level of Service for each Freeway Segment
		- Density will be the 95th percentile of the 10 runs aggregated over the one-hour peak period.
		- Level of Service will be determined based on the overall 95th percentile density determined above
* Multi-lane Highways (for corridors with no signals within 2 miles)
	+ Density
	+ Level of Service
* Two-lane Highways (for corridors with no signals within 2 miles)
	+ Percent Time Spent Following
	+ Level of Service
* Corridor/Route Measures of Effectiveness (matrix format)
	+ Travel Time
	+ Average Speed
* Corridor Heat Maps
	+ Speed
	+ Density

The CONSULTANT will also develop a spreadsheet that will process the simulation output and present the results of the analysis in a concise manner. The MOE’s to be collected for this task include:

* insert # intersections
* insert # freeway analysis points
* insert # multi-lane highway analysis points
* insert # two-lane highway analysis points
* insert # corridor heat maps
* Corridor/Route Measures of Effectiveness

### Error Checking/Visual Audit/Quality Control

The CONSULTANT will then continue to the error checking phase which will include a thorough review of the animation output to see the resulting vehicle behavior and assess the reasonableness of the microscopic simulation model itself. The model will be reviewed in close detail at key congestion points to determine if the animated vehicle behavior is realistic. Neither output nor MOE data will not be collected at this time.

The coding of the base year model will be reviewed in detail by a member of the CONSULTANT team that was not responsible for developing the model. The quality control process will be documented by the CONSULTANT and may be requested by NCDOT.

### Default Values/Visual Validation/Calibration

*{The CONSULTANT shall determine the proper level of model development for the project during scoping based on Coordination with NCDOT. Simple projects that are under capacity can utilize default values only, while most projects will include visual validation of the model to match the observed operations from the field visit (required for visual validation.) A small number of projects will include calibration and will require extensive coordination with NCDOT to determine the proper level of detail for developing the calibrated model.*

*Once the decision is made on which type of model will be developed the remaining section may be edited using the ~~strike through~~ feature.}*

The CONSULTANT will, in coordination NCDOT, determine the level of detail for the model, with one of the following being selected:

#### Default Values

The CONSULTANT will utilize the default parameters included in the NCDOT default TransModeler file without modification. This item requires no additional effort.

#### Visual Validation

Visual validation includes modifying parameters within the model to better replicate the real-world operations observed in the field. The use of visual validation requires that traffic be observed in the field during at least the critical peak period. The model should be reviewed and parameters adjusted to allow the model to better represent the real world conditions. For projects involving an NCDOT forecast, the model should be visually validated to match the worse of the AM or PM peak hours. The CONSULTANT will review the model and adjust parameters within the model to replicate the real-world conditions as closely as possible. The modification of any model parameters shall be documented in the Traffic Operations Analysis Technical Memorandum. In the event that the operations cannot be reasonably modified to replicate the observed conditions then the CONSULTANT will coordinate with NCDOT on how to proceed.

#### Calibration

The process for developing calibrated models is typically reserved for projects that require additional precision in the evaluation of alternatives. The goal of calibration is to develop a model that is able to reproduce, within a reasonable margin, actual field-collected data. For projects requiring calibration, extensive coordination with NCDOT is required to established calibration thresholds for the model. Project specific scopes are required for models requiring calibration and should be detailed in Section 10: Additional Scope Items; therefore, no additional effort is included for this scope item.

### Run Model/Extract Outputs

The CONSULTANT will code the run controls and project settings in the TransModeler database. The CONSULTANT will then run the model for both the AM and PM peak periods for ten (10) repetitions each and extract the output data. The output data will be added to the output spreadsheet and the results will be calculated and reported for each of the MOE’s defined in Section 4.1.6.

### Multi-hour Simulation Adjustment,

*{If the project includes analysis of a peak period that extends beyond the normal one-hour AM and PM peak then the task included below should be included in the scope. The use of multi-hour simulation should only be utilized after consultation with NCDOT and when the additional effort is warranted.}*

The development of multi-hour simulation models requires additional effort beyond what is required for a standard single peak hour model including the development of models and the associated outputs for multi-hour simulation models. Instead of detailing all of the items that require additional effort and attempting to capture the difference for multi-hour models it is assumed that the development and analysis increases the level of effort included in Section 4.1.1 through Section 4.1.9 by ten percent (10%) to thirty percent (30%) depending on the number of additional hours being simulated. The additional effort will be captured in this task on the estimate form.

The CONSULTANT will develop the model and outputs for a total of insert # simulation hours.

# 204X No-Build Analysis

{*The analysis for the future year no-build should include any fiscally constrained project with the exception of the proposed project. Only include projects that are located within the limits of the traffic analysis. If there are no additional project, please note it. Based on the location of the project, please remove either the MPO or non‑MPO portions that are not applicable.}*

The CONSULTANT will develop an analysis of the No-Build scenario that will include all fiscally constrained projects within the model study area being constructed with the exception of the proposed project.

For MPO areas, the current [Insert MPO Name and title of Long Range Transportation Plan or Metropolitan Transportation Plan] will be utilized to determine if any fiscally constrained project besides the subject project are present. For scoping purposes, the following projects are located within the model limits and are considered to be constructed by the design year:

* Add list of project(s)

For non-MPO areas, any project located within the model study area that has construction funding in the current State Transportation Improvement Program (STIP) or Municipal Transportation Improvement Program (MTIP) will be included in the analysis. For scoping purposes, the following projects are located within the model limits and are to be included in the future year networks:

* Add list of project(s)

## Model Development

### Develop Future Year No-Build Model in TransModeler

The CONSULTANT will complete the model network coding for any listed projects within the study area with the exception of the proposed project, including:

* Coding of lanes and geometry based on link type, including speed and facility type
* Adding in traffic control devices such as traffic signals and yield and stop signs, including sensor locations and settings
* Adding the base signal timings and phasing based on engineering judgment and signal plans, if available
* Adding any known lane restrictions or turning movement prohibitions
* Adding z-elevations and grades for all roadway links based on GIS data

*{if the model does not require the input of grades then the text included in green above should be removed by ~~striking through~~ the text.}*

While the exact improvements for a future project may not be provided, the CONSULTANT will make a good faith effort to model reasonable improvements based on available information on the project.

The future year model network includes the following attributes that were not coded in the base year model:

*{The length should be the total length modeled for the project and should be based on a two-way roadway length unless there is a substantial difference in the alignment of each direction (ie: coding a freeway for two miles in the northbound and southbound directions is counted as two miles). Each element is coded in a cumulative manner: first the freeway or arterial/collector/local lengths are determined, then the coding of the basic interchange forms are added in, then the coding of the intersections is added in.}*

* ## miles of freeway roadways (including C-D roadways)
* ## miles of arterial/collector/local roadways
* ## system (freeway-to-freeway) interchanges
	+ ## simple interchanges (cloverleaf, trumpet, etc.)
	+ ## complex interchanges (fully directional, C-D roadways, etc.)
* ## service (freeway-to-non-controlled access roadway) interchanges
	+ ## simple interchanges (diamonds, partial cloverleaf, etc.)
	+ ## complex interchanges (diverging diamonds, single point interchanges, etc.)
* ## unsignalized intersections
* ## unsignalized superstreet intersections (includes main intersection and two adjacent u-turn locations)
* ## roundabouts
	+ ## single lane roundabouts
	+ ## multi-lane or roundabouts with slip lanes
* ## signalized intersections
	+ ## simple intersections (2-4 phases)
	+ ## complex intersections (5-8 phases)
	+ ## superstreet intersections (includes main intersection and two adjacent u-turn locations)
	+ ## unconventional intersections (quadrant left, continuous flow, etc.)

*{Only model attributes that are not included in the base year model should be included in the above list}*

### Add Volume Data to Model

The CONSULTANT will add the volume data to the model for insert # intersections and vehicle composition data to each external node. The model volumes will be entered for the peak hour as well as for a minimum fifteen (15) minute warm-up period. The appropriate volumes to be input in the warm-up period will be proposed to and accepted by NCDOT.

### Optimize Signalized Intersections

The CONSULTANT will utilize the TransModeler signal optimization function to optimize the signal phasing, cycle length and splits for each intersection. Each signal that is part of a coordinated system or within one-half mile of an adjacent signal will be coordinated and the offsets optimized by the CONSULTANT in TransModeler utilizing the corridor optimization feature. The CONSULTANT will optimize insert # corridor(s) for a total of insert # intersection(s) in TransModeler. Isolated intersections will be optimized utilizing Webster’s formula in the TransModeler intersection control editor. The CONSULTANT will optimize insert # isolated intersection(s) in TransModeler. Each optimization (corridor or isolated) includes the optimization of both the AM and PM peak periods. Optimization for superstreets will include two corridors being optimized, with one in each direction along the roadway.

### Dynamic Traffic Assignment (DTA)

*{Note that DTA should only be utilized when there are multiple paths between important origins and important destinations that need to be evaluated. The process of running DTA can be an iterative process that should always end with a review and fine-tuning of the signals. Multiple rounds of DTA may be required for very complex projects and should be discussed with NCDOT during scoping before being added to the scope}*

Due to multiple competitive routes in the study area, the CONSULTANT will utilize Dynamic Traffic Assignment (DTA) to route traffic within the network in accordance with the procedure included in the NCDOT Simulation Guidelines. The Future Year No‑Build scenario will be iterated for at least the minimum number of iterations included in the NCDOT Simulation Guidelines. Following the completion of DTA, each of the signals will be reviewed visually, and adjusted manually, based on the results of the DTA run.

The CONSULTANT will run one (1) round(s) of DTA for insert # number of iterations. The CONSULTANT will also manually review and fine tune the signal operations for insert # of intersections.

If the traffic routing within the study area is not reasonable and stable following the completion of the above listed number of rounds of DTA, the CONSULTANT will coordinate with NCDOT to determine if additional rounds of DTA should be run. Any additional rounds of DTA required will be included in a new task order or supplemental agreement. This should also be documented in the Traffic Technical Memorandum.

### Code Measures of Effectiveness and Develop Output Spreadsheet

*{Note that Network MOEs are required for all simulations. The remaining MOEs should be determined in coordination with NCDOT with any items listed below that are not applicable to the project or not deemed to be necessary being edited by striking through the text.}*

The CONSULTANT will code the following measures of effectiveness (MOE) into the model (beyond those included in any previous analysis) such that they can be extracted and reported for each peak period:

* Network Measures of Effectiveness
	+ Vehicle Miles Traveled (VMT)
	+ Vehicle Hours Traveled (VHT)
	+ Average Speed
	+ Delay
* Unsignalized and Signalized Intersections
	+ Delay and Level of Service for the overall intersection
	+ Delay and Level of Service for each Lane Group of the Intersection
		- Delay will be the 95th percentile of the 10 runs aggregated over the one-hour peak period.
		- Level of Service will be determined based on the overall 95th percentile delay determined above
	+ Average and Maximum Queue Length by Lane Group (for under-saturated conditions)
		- Utilize Lane Queue output for each lane group with results having spillback of 0%
	+ Average and Maximum Queue Length by Approach (for over-saturated conditions)
		- Utilize Spillback Queue output for each approach to an intersection for queue lengths that exceed the link length used for Lane Queue output
* Freeway Segments
	+ Density and Level of Service for each Freeway Segment
		- Density will be the 95th percentile of the 10 runs aggregated over the one-hour peak period.
		- Level of Service will be determined based on the overall 95th percentile density determined above
* Multi-lane Highways (for corridors with no signals within 2 miles)
	+ Density
	+ Level of Service
* Two-lane Highways (for corridors with no signals within 2 miles)
	+ Percent Time Spent Following
	+ Level of Service
* Corridor/Route Measures of Effectiveness (matrix format)
	+ Travel Time
	+ Average Speed
* Corridor Heat Maps
	+ Speed
	+ Density

The CONSULTANT will also develop a spreadsheet that will process the simulation output and present the results of the analysis in a concise manner. The MOE’s to be collected for this task include:

* insert # intersections
* insert # freeway analysis points
* insert # multi-lane highway analysis points
* insert # two-lane highway analysis points
* Corridor/Route Measures of Effectiveness
* insert # corridor heat maps

*{The MOE’s included in this section should only include those that are new to the future year no-build model. If there are no changes in the network the following should be added: There is no difference in the study area or model for this scenario; therefore, no effort is required for this task item.}*

### Error Checking/Visual Audit/Quality Control

The CONSULTANT will then continue to the error checking phase which will include a thorough review of the animation output to see the vehicle behavior that is being modeled and assess the reasonableness of the microscopic simulation model itself. The model will be reviewed in close detail at key congestion points to determine if the animated vehicle behavior is realistic. Neither output data nor MOE data will not be collected at this time.

The coding of the future year no-build model will be reviewed in detail by a member of the CONSULTANT team that was not responsible for developing the model. The quality control process will be documented by the CONSULTANT and may be requested by NCDOT, if necessary.

### Run Model/Extract Outputs

The CONSULTANT will code the run controls and project settings in the TransModeler database. The CONSULTANT will then run the model for both the AM and PM peak periods for ten (10) repetitions each and extract the output data. The output data will be added to the output spreadsheet and the results will be calculated and reported for each of the MOE’s defined in Section 5.1.4.

### Multi-hour Simulation Adjustment

*{If the project includes analysis of a peak period that extends beyond the normal one-hour AM and PM peak then the task included below should be included in the scope. The use of multi-hour simulation should only be utilized after consultation with NCDOT and when the additional effort is warranted.}*

The development of multi-hour simulation models requires additional effort beyond what is required for a standard single peak hour model. The development of models and the associated outputs for multi-hour simulation models. Instead of detailing all of the items that require additional effort and attempting to capture the difference for multi-hour models it is assumed that the development and analysis increases the level of effort included in Section 5.1.1 through Section 5.1.7 by ten percent (10%) to thirty percent (30%) depending on the number of additional hours being simulated. The additional effort will be captured in this task on the estimate form.

The CONSULTANT will develop the model and outputs for a total of insert # simulation hours.

# 204X Build Analysis

*{Enough details on the Build Alternatives should be provided such that the model coding attributes can be determined. If it is not well known what the build design will be then it should be noted and any assumptions should be provided to justify the details included in the following sections.}*

The CONSULTANT will develop an analysis of the Build scenario that will include all listed projects within the model study area (as were added in Section 5) including the proposed project.

The analysis includes the following Build Alternatives:

* List and description of alternatives

## Model Development

### Develop Future Year Build Model in TransModeler

The CONSULTANT will complete the model network coding for any listed projects within the study area including the proposed project, including:

* Coding of lanes and geometry based on link type, including speed and facility type
* Adding in traffic control devices such as traffic signals and yield and stop signs, including sensor locations and settings
* Adding the base signal timings and phasing, modified based on engineering judgment if appropriate
* Adding any known lane restrictions or movement restrictions and lane alignments (mini skips through an intersection for example)
* Adding z-elevations and grades for all roadway links based on design data

*{if the model does not require the input of grades then the text included in green aboveshould be removed by ~~striking through~~ the text.}*

*{Note: A separate listing of attributes should be included for each alternative that includes the differences from the other alternatives, with any overlapping aspects removed. The following list should include a summary of the overall attributes for all build models.}*

The future year model network includes the following attributes that were not coded in the base year or future year no-build model:

*{The length should be the total length modeled for the project and should be based on a two-way roadway length unless there is a substantial difference in the alignment of each direction (ie: coding a freeway for two miles in the northbound and southbound directions is counted as two miles). Each element is coded in a cumulative manner: first the freeway or arterial/collector/local lengths are determined, then the coding of the basic interchange forms are added in, then the coding of the intersections is added in.}*

* ## miles of freeway roadways (including C-D roadways)
* ## miles of arterial/collector/local roadways
* ## system (freeway-to-freeway) interchanges
	+ ## simple interchanges (cloverleaf, trumpet, etc.)
	+ ## complex interchanges (fully directional, C-D roadways, etc.)
* ## service (freeway-to-non-controlled access roadway) interchanges
	+ ## simple interchanges (diamonds, partial cloverleaf, etc.)
	+ ## complex interchanges (diverging diamonds, single point interchanges, etc.)
* ## unsignalized intersections
* ## unsignalized superstreet intersections (includes main intersection and two adjacent u-turn locations)
* ## roundabouts
	+ ## single lane roundabouts
	+ ## multi-lane or roundabouts with slip lanes
* ## signalized intersections
	+ ## simple intersections (2-4 phases)
	+ ## complex intersections (5-8 phases)
	+ ## superstreet intersections (includes main intersection and two adjacent u-turn locations)
	+ ## unconventional intersections (quadrant left, continuous flow, etc.)

### Add Volume Data to Model

*{This should allow for the calculation of the number of unique intersections that need to have volumes updated.}*

The CONSULTANT will add the volume data to the model for insert # intersections for insert # Build Scenario(s) and the vehicle composition data to each external node. The model volumes will be entered for the peak hour as well as for a minimum fifteen (15) minute warm-up period. The CONSULTANT will have the appropriate method to model warm-up volumes presented to and approved by NCDOT.

### Optimize Signalized Intersections

The CONSULTANT will utilize the TransModeler signal optimization function to optimize the signal phasing, cycle length and splits for each intersection. Each signal that is part of a coordinated system or within one-half mile of an adjacent signal will be coordinated and the offsets optimized by the CONSULTANT in TransModeler utilizing the corridor optimization feature. The CONSULTANT will optimize insert # corridor(s) for a total of insert # intersection(s) in TransModeler. Isolated intersections will be optimized utilizing Webster’s formula in the TransModeler intersection control editor. The CONSULTANT will optimize insert # isolated intersection(s) in TransModeler. Each optimization (corridor or isolated) includes the optimization of both the AM and PM peak periods. Optimization for superstreets will include two corridors being optimized, with one in each direction along the roadway.

### Dynamic Traffic Assignment (DTA)

*{Note that DTA should only be utilized when there are multiple paths between important origins and important destinations that need to be evaluated. The process of running DTA can be an iterative process that should always end with a review and fine-tuning of the signals. Multiple rounds of DTA may be required for very complex projects and should be discussed with NCDOT during scoping before being added to the scope}*

Due to multiple competitive routes in the study area, the CONSULTANT will utilize Dynamic Traffic Assignment (DTA) to route traffic within the network in accordance with the procedure included in the NCDOT Simulation Guidelines. The Future Year Build scenario(s) will be iterated for at least the minimum number of iterations included in the NCDOT Simulation Guidelines. Following the completion of DTA each of the signals will be reviewed visually and adjusted manually based on the results of the DTA run.

The CONSULTANT will run one (1) round(s) of DTA for insert # number of iterations for insert # of scenarios. The CONSULTANT will also manually review and fine tune the signal operations for insert # of intersections for insert # of scenarios.

If the traffic routing within the study area is not reasonable and stable following the completion of the above listed number of rounds of DTA, the CONSULTANT will coordinate with NCDOT to determine if additional rounds of DTA should be run. Any additional rounds of DTA required will be included in a new task order or supplemental agreement. This should also be documented in the Traffic Technical Memorandum.

### Code Measures of Effectiveness and Develop Output Spreadsheet

*{Note that Network MOEs are required for all simulations. The remaining MOEs should be determined in coordination with NCDOT with any items listed below that are not applicable to the project or not deemed to be necessary being edited by striking through the text.}*

The CONSULTANT will code the following measures of effectiveness (MOE) into the model (beyond those included in any previous analysis) such that they can be extracted and reported for each peak period:

* Network Measures of Effectiveness
	+ Vehicle Miles Traveled (VMT)
	+ Vehicle Hours Traveled (VHT)
	+ Average Speed
	+ Delay
* Unsignalized and Signalized Intersections
	+ Delay and Level of Service for the overall intersection
	+ Delay and Level of Service for each Lane Group of the Intersection
		- Delay will be the 95th percentile of the 10 runs aggregated over the one-hour peak period.
		- Level of Service will be determined based on the overall 95th percentile delay determined above
	+ Average and Maximum Queue Length by Lane Group (for under-saturated conditions)
		- Utilize Lane Queue output for each lane group with results having spillback of 0%
	+ Average and Maximum Queue Length by Approach (for over-saturated conditions)
		- Utilize Spillback Queue output for each approach to an intersection for queue lengths that exceed the link length used for Lane Queue output
* Freeway Segments
	+ Density and Level of Service for each Freeway Segment
		- Density will be the 95th percentile of the 10 runs aggregated over the one-hour peak period.
		- Level of Service will be determined based on the overall 95th percentile density determined above
* Multi-lane Highways (for corridors with no signals within 2 miles)
	+ Density
	+ Level of Service
* Two-lane Highways (for corridors with no signals within 2 miles)
	+ Percent Time Spent Following
	+ Level of Service
* Corridor/Route Measures of Effectiveness
	+ Travel Time
	+ Average Speed
* Corridor Heat Maps (Matrix format)
	+ Speed
	+ Density

The CONSULTANT will also develop a spreadsheet that will process the simulation output and present the results of the analysis in a concise manner. The MOE’s to be collected for this task include:

* insert # intersections
* insert # freeway analysis points
* insert # multi-lane highway analysis points
* insert # two-lane highway analysis points
* Corridor/Route Measures of Effectiveness
* insert # corridor heat maps

{*The MOE’s included in this section should only include those that are new to the future year build models. The total above should be for all of the Build scenarios combined.}*

### Error Checking/Visual Audit/Quality Control

The CONSULTANT will then continue to the error checking phase which will include a thorough review of the animation output to see the vehicle behavior that is being modeled and assess the reasonableness of the microscopic simulation model itself. The model will be reviewed in close detail at key congestion points to determine if the animated vehicle behavior is realistic. Neither output nor MOE data will not be collected at this time.

The coding of the future year build model will be reviewed in detail by a member of the CONSULTANT team that was not responsible for developing the model. The quality control process will be documented by the CONSULTANT and may be requested by NCDOT.

### Run Model/Extract Outputs

The CONSULTANT will code the run controls and project settings in the TransModeler database for insert # Build Scenario(s). The CONSULTANT will then run the model for both the AM and PM peak periods for the minimum number of repetitions required for statistical validity and extract the output data which is detailed in the NCDOT Simulation Guidelines. The output data will be added to the output spreadsheet and the results will be calculated and reported for each of the MOEs defined in Section 6.1.4.

### Multi-hour Simulation Adjustment

*{If the project includes analysis of a peak period that extends beyond the normal one-hour AM and PM peak then the task included below should be included in the scope. The use of multi-hour simulation should only be utilized after consultation with NCDOT and when the additional effort is warranted.}*

The development of multi-hour simulation models requires additional effort beyond what is required for a standard single peak hour model. The development of models and the associated outputs for multi-hour simulation models. Instead of detailing all of the items that require additional effort and attempting to capture the difference for multi-hour models it is assumed that the development and analysis increases the level of effort included in Section 6.1.1 through 6.1.7 by ten percent (10%) to thirty percent (30%) depending on the number of additional hours being simulated. The additional effort will be captured in this task on the estimate form.

The CONSULTANT will develop the model and outputs for a total of insert # simulation hours.

### Design Iterations

*{This section is to capture the effort of the back and forth in the analysis between the design team and the traffic team. The level of complexity and potential for highly iterative designs will be the primary measure used to determine the level of effort here. Details that justify why additional time will be needed for the project should be provided such that the individual developing the in-house estimate can provide an adequate estimate.}*

The CONSULTANT will review the MOEs for the AM and PM peak periods and determine if design modifications are required to achieve desirable operations. The CONSULTANT will then make changes to the model to improve operations or attain a prescribed MOE for the project and will re-run the steps described in Sections 6.1.1 through 6.1.6. The CONSULTANT will notify NCDOT if modifications are being made to determine if coordination with the NCDOT design team is required before modifications are developed.

*{Insert a description of the number of designs and level of design expected. (conceptual/functional/preliminary/final) and what the expected level of design iterations is expected to be. If the design is not well defined, it may take more iterations compared with the analysis of a project that is in the final design phases. The description should be adequate to develop an estimate of the level of effort that will be required.}*

# 201X Base Year Build

*{This analysis will only include detailed analysis of the preferred alternative and will focus on the signalized intersections only.}*

The CONSULTANT will develop an analysis of the preferred alternative for the Build scenario using 20XX base year build volumes.

## Model Development

### Add Volume Data to Model

The CONSULTANT will add the volume data to the model for insert # of intersections and the vehicle composition data to each external node. The model volumes will be entered for the peak hour as well as for a minimum fifteen (15) minute warm-up period. The CONSULTANT will propose and have NCDOT approve the methodology to input the warm-up volumes.

### Optimize Signalized Intersections

The CONSULTANT will utilize the TransModeler signal optimization function to optimize the signal phasing, cycle length and splits for each intersection. Each signal that is part of a coordinated system or within one-half mile of an adjacent signal will be coordinated and the offsets optimized by the CONSULTANT in TransModeler utilizing the corridor optimization feature. The CONSULTANT will optimize insert # corridor(s) for a total of insert # intersection(s) in TransModeler. Isolated intersections will be optimized utilizing Webster’s formula in the TransModeler intersection control editor. The CONSULTANT will optimize insert # isolated intersection(s) in TransModeler. Each optimization (corridor or isolated) includes the optimization of both the AM and PM peak periods. Optimization for superstreets will include two corridors being optimized, with one in each direction along the roadway.

### Dynamic Traffic Assignment (DTA)

*{Note that DTA should only be utilized when there are multiple paths between important origins and important destinations that need to be evaluated. The process of running DTA can be an iterative process that should always end with a review and fine-tuning of the signals. Multiple rounds of DTA may be required for very complex projects and should be discussed with NCDOT during scoping before being added to the scope}*

Due to multiple competitive routes in the study area, the CONSULTANT will utilize Dynamic Traffic Assignment (DTA) to route traffic within the network in accordance with the procedure included in the NCDOT Simulation Guidelines. The Base Year Build scenario will be iterated for at least the minimum number of iterations included in the NCDOT Simulation Guidelines. Following the completion of DTA ,each of the signals will be reviewed visually, and adjusted manually, based on the results of the DTA run.

The CONSULTANT will run one (1) round(s) of DTA for insert # number of iterations. The CONSULTANT will also manually review and fine tune the signal operations for insert # of intersections.

If the traffic routing within the study area is not reasonable and stable following the completion of the above listed number of rounds of DTA, the CONSULTANT will coordinate with NCDOT to determine if additional rounds of DTA should be run. Any additional rounds of DTA required will be included in a new task order or supplemental agreement. This should also be documented in the Traffic Technical Memorandum.

### Run Model/Extract Outputs

The CONSULTANT will code the run controls and project settings in the TransModeler database. The CONSULTANT will then run the model for both the AM and PM peak periods for the minimum number of repetitions required for statistical validity and extract the output data. The output data will be added to the output spreadsheet developed in the previous steps and the results will be calculated and reported for each of the MOEs.

# Documentation

## Traffic Operations Analysis Technical Memorandum

*{It should be determined how many hard copies are actually needed. Many units are fine with just receiving pdf’s of the report.}*

The CONSULTANT will prepare a traffic operations analysis technical memorandum including the results of microscopic simulation analyses. The memorandum will include all pertinent information relating to the model, the model development process and the results of the modeling effort and figures depicting existing conditions, all proposed concepts, and volumes analyzed for all. A digital copy of the Draft Technical Memorandum will be prepared for NCDOT review and revised based on comments received. The comments provided by NCDOT on the Draft Technical Memorandum will be addressed and the Final Technical Memorandum will be prepared with ## hard copies being provided to NCDOT. A digital copy of the Final Technical Memorandum in Adobe Acrobat format will also be developed.

At the conclusion of the study, the CONSULTANT will also provide NCDOT with all digital files utilized in the development of the analysis.

## Interchange Access Report

*{If the proposed project will be modifying access to an Interstate facility that requires the approval of an Interchange Access Report (IAR) then the following language should be included in the scope. If the project does not require an IAR then the scope language can be edited by ~~striking through~~ the text.}*

The CONSULTANT will develop an Interchange Access Report for submittal and approval by FHWA that addresses the two Policy Points required for modifications to access to the Interstate System. This scope assumes that no additional analysis will be required to satisfy the policy points and that the crash analysis and signing plan required for Policy Point 1 will be provided by NCDOT or developed separately from this task item. If additional analysis is required, it will be included in a future task order.

# Schedule and Deliverables

At the conclusion of the study, the CONSULTANT will provide the following deliverables to NCDOT:

* TransModeler Project Archive for 20XX Base Year Model
* TransModeler Project Archive for 204X No-Build Model
* TransModeler Project Archive for 204X Build Model for each design alternative
* TransModeler Project Archive for 20XX Build Model
* Traffic Operations Analysis Technical Memorandum
* Interchange Access Report
* Digital Files utilized in developing models
* Pertinent information used in developing the model (included in the memorandum) including but not limited to, signal plans, design concepts, etc.

The anticipated schedule is shown below. It assumes that Notice to Proceed is received by insert date. Total duration for traffic operations analysis is insert # weeks from receipt of NTP.

|  |  |  |
| --- | --- | --- |
| **Task** | **Duration** | **Date of Completion** |
| Notice to Proceed | n/a | 00/00/0000 (assumed) |
| Submit Interim Review Information | # weeks | 00/00/0000 |
| NCDOT Review | # weeks | 00/00/0000 |
| Submit Draft Traffic Operations Analysis | # weeks | 00/00/0000 |
| NCDOT Review | # weeks | 00/00/0000 |
| Submit Final Traffic Operations Analysis | # weeks | 00/00/0000 |

*{Note that the schedule should be established such that it provides an estimate of when submittals and deliverables will be completed.}*

The CONSULTANT may submit models for an interim review by NCDOT if deemed appropriate. Any interim submittals must include FULL DOCUMENTATION of the volume and model development process. Models submitted without proper documentation will be returned to the CONSULTANT without review.

The duration of NCDOT reviews will be 3 weeks for projects with an “Estimation Index” of 6 or less (see estimate spreadsheet for Estimation Index). For projects with an index of 7 or more please allow 4 weeks for review by NCDOT.

The CONSULTANT should also coordinate with NCDOT at least one week prior to making any submittal to alert them that it will be submitted and to allow them to coordinate the review. Any submittals made without prior coordination with NCDOT will have the review time increased by two weeks.

# Crash Analysis

*{The inclusion of the crash analysis should only be included if requested by NCDOT. This scope should only be used for individual projects when it is ancillary to the traffic operations analysis.}*

## Develop/Request TEAAS Data

*{The development of the crash data in TEAAS requires prequalification for Code 458 – Crash Analysis and approval from the Traffic Safety System Section. If the firm completing the analysis is approved to develop TEAAS Data the following should be included, if not, then ~~strike through~~ the below tasks.}*

The CONSULTANT will prepare a section/strip crash analysis of the project corridor within the analysis study limits. The time frame will be the most current five (5) year study range.

The CONSULTANT will provide the following in the development of the crash analysis:

* Coordination with NCDOT Traffic Safety Unit.
* Preparation and QC of the strip crash analysis using TEAAS.
* Review of crashes/crash history
* Perform safety review and prepare summary tables

*{If the firm completing the analysis is not prequalified or approved to develop the TEAAS Data the following should be included, if not, then ~~strike through~~ the below tasks.}*

The CONSULTANT will prepare a request for crash data to the NCDOT Traffic Safety Unit for the TEAAS strip crash analysis.

## Prepare Traffic Safety Analysis

The CONSULTANT will prepare a Traffic Safety Analysis that includes the following information:

* Identify critical crash rates and develop a comparison of the rates.
* Identify crash patterns.
* Identify potential safety issues (based on crash analysis).
* Provide write up in the Draft and Final Traffic Operations Analysis Technical Memorandum Reports.

# Additional Scope Items

*{Insert any additional scope items beyond those included in Sections 1-10. This section is for any additional items or considerations that are beyond what is included in the basic scope items in Sections 1-10. The individual tasks should be numbered with the same formatting as the above items and listed in the Cost Estimate. They will be estimated and negotiated individually. If there are no additional scope items insert the following statement: There are no additional scope items identified for this Task Order.}*

**Model Scope Language**

The following items are not typically utilized for most projects; however, have been utilized under special circumstances. The following sections include model scope language if any of these items are required due to the unique requirements for a project.

**Advanced Signal Operations**

**Pedestrian Implementation at Signals**

The CONSULTANT will include the existing (or proposed) pedestrian crosswalks in the coding of the signalized intersection in TransModeler. The CONSULTANT will also provide the Walk + Flashing Don’t Walk time for each crosswalk in accordance with the NCDOT Simulation Guidelines. The CONSULTANT will develop a pedestrian volume file and add it to the project setting for each location where crosswalks are being modeled. The parameters, timings and volume development will all be summarized in detail in the Traffic Operations Analysis Technical Memorandum. The CONSULTANT will code pedestrian crosswalks at insert # intersections.

**Coding Actual Signals and Detectors**

The CONSULTANT will code the signal plan settings as they are included in the signal plan instead of using the default values. This step includes coding the actual timings and settings for the controller, the actual loop configurations and settings and the variable phasing plans that exist in the field. The signal coding will be completed for the insert # existing signals in the base year network.

**Coding Existing Coordination Plans**

The CONSULTANT will acquire the actual coordinated timing plans for each of the insert # signals and input the timings into TransModeler. Coordinated signals will also be setup with the coordinated phases linked and offsets coded per the coordinated timing plan.

**Bicycle Modeling**

**Modeling Separated Bicycle Facilities**

Scope to be developed in the future

**Modeling Shared Bicycle Facilities**

Scope to be developed in the future

**Preferential, Tolled and Managed Lane Modeling**

**High Occupancy Vehicle Operations**

The CONSULTANT will utilize Dynamic Traffic Assignment (DTA) to model the operations of High Occupancy Vehicle (HOV) lanes by reviewing and defining the occupancy data, driver and vehicle attributes, and driver groups. The CONSULTANT will code the HOV lanes into the model by changing the lane use for the designated lanes by prohibiting users not include in the HOV driver group from entering the lanes.

**Toll Road Operations**

*{This scope assumes the Toll Road parameters are available from NCDOT, if they are to be developed by the consultant then specific scope language should be developed to include this task.}*

The CONSULTANT will utilize Dynamic Traffic Assignment (DTA) and the Toll Plaza Toolbox to model the operations of Toll Roads. The CONSULTANT will utilize the Toll Plaza Toolbox to code the Toll Road operations for each tolling zone in the network. The Toll Road parameters will be provided by NCDOT. The level of effort for completing this task is based on the number of tolling zones along the Toll Road. The CONSULTANT will implement toll road operations for insert # tolling zones for insert # scenarios.

**Express Lane Operations**

The modeling of Express Lane projects can be accomplished using multiple techniques. Express Lanes can either be modeled statically or dynamically. Statically routed Express Lane operations include modifying the input volume data and the model network to divert a specified volume onto the Express Lanes. Dynamic routing utilizes the HOT toolbox in TransModeler to model the actual driver and route choice behaviors for the individual vehicles in the network. It is possible that both techniques may be utilized on a single project as connections to other existing or proposed Express Lane facilities that extend beyond the limits of the network may require static routing while the facilities within the model can utilize dynamic routing.

**Dynamic Routing with DTA**

*{This scope assumes the Express Lane parameters are available from NCDOT, if they are to be developed by the consultant then specific scope language should be developed to include this task.}*

The CONSULTANT will implement the Express Lanes operations through dynamic routing utilizing Dynamic Traffic Assignment (DTA). The CONSULTANT will utilize the HOT Toolbox to code the Express Lanes operations for each access point in the network. The Express Lane parameters will be provided by NCDOT. The level of effort for completing this task is based on the number of access points to the Express Lanes. The CONSULTANT will implement dynamic routing for insert # access points for insert # scenarios.

**Static Routing**

The CONSULTANT will implement the Express Lanes operations through static routing, including the modification of the input volumes and the coding of lane use restrictions to direct traffic to and from the Express Lanes. The level of effort for completing this task is based on the number of access points to the Express Lanes. The CONSULTANT will implement static routing for insert # access points for insert # scenarios.