CHAPTER 2 – METHODOLOGY AND COORDINATION

This chapter provides the framework for the technical methodology used to analyze the Existing, future No Build and future Build (ten short-listed alternatives) transportation conditions for the Circ-Williston Transportation Project Environmental Impact Statement (Circ-Williston EIS). It also defines the methods used to calculate the various performance measures for evaluating each Build Alternative. In order to accomplish this, a rigorous level of coordination with stakeholder agencies, in terms of data and policy input, has been conducted throughout the planning process. These processes will be described in the sections that follow.

2.1 Analytical Tools

The traffic data used to perform many of the analyses that follow was produced from output of the Chittenden County Metropolitan Planning Organization's Travel Demand Model (CCMPO Model) in coordination with the Vermont Statewide Transportation Model (Statewide Model). The selection and development of the various transportation analyses used in the Circ-Williston EIS are outlined below. A detailed summary of the accident analysis methodologies are also provided.

2.1.1 Transportation Models

Chittenden County Travel Demand Model (CCMPO Model)

The CCMPO Model is an integrated land use, transportation, and air quality model designed to support a wide range of analyses. The model is based on a four-step process: trip generation, trip distribution, mode choice, and trip assignment. At the start of a full model run, trip generation utilizes land use data to calculate trip ends at the transportation analysis zone (TAZ) level. These trip ends are then paired into origins and destinations in the distribution module. In the mode choice module, a mode of travel is selected for each trip. Vehicle trips are assigned to the highway network in the assignment module. This process was performed for both the weekday AM and PM peak hours.

The 2000 base model was recently converted from a TMODEL software platform to a TRANSCAD software platform, and was calibrated using 2000 land use information and travel patterns. More detail on the structure, parameter estimation, and calibration of the model modules, as well as information on the inputs and outputs of the base 2000 model run, are available in the *CCMPO Model Documentation Report* (see Appendix A). Since baseline conditions have changed since 2000, some modifications have been made to the 2000 base model and are documented in Appendix A.

The 2030 No Build model was created using the same structure and module parameters as the updated 2000 base calibrated model. Projected 2030 land use and traffic network assumptions were used to create the 2030 No Build model. The 2030 No Build model was modified for each of the Build Alternatives during the weekday AM and PM peak hours to create the future 2030 Build condition models. The change in traffic volume between the between the future 2030 No Build condition and each of the 2030 Build condition for the Build Alternatives was calculated for each individual movement at the critical intersections using the model results. These modeled changes in traffic volume were then added to the 2030 No Build condition volumes to develop the 2030 Build condition traffic volumes for each of the Build alternatives. The detailed modeling methodology for the 2030 No Build and Build conditions can be found in Appendix A.

Vermont Statewide Transportation Model (Statewide Model)

The CCMPO Model was used to evaluate traffic conditions and land use change for the transportation and Indirect and Cumulative Impact (ICI) assessment. Because the study area for ICI extends beyond Chittenden County to include all six counties in the Northwest Vermont region, the Statewide Model was used for two tasks related to transportation modeling and ICI:

- Confirming the growth rate for external-to-internal and external-to-external trips in the Chittenden County Transportation Model for the Future No Build Alternative (2030) and each Build Alternative.
- Developing an estimate of land use change (shift in households and employment) between Chittenden County and the surrounding counties based on the change in accessibility (reduction in travel times to job centers/residential centers) for each Build Alternative relative to the No Build Alternative.

The Statewide Model with a base year of 2000 was developed by Vermont Agency of Transportation (VTrans) for all counties in Vermont using a TRANPLAN software platform. In addition, the Statewide Model is based on land use and travel network assumptions for a 2020 forecast year. In order for the Statewide Model to be consistent with the CCMPO Model, the land use assumptions and the traffic network assumptions were updated through 2030. More detail on the base 2000 model is documented in Appendix A.

2.1.2 Traffic Analyses

The supporting rationale for each proposed methods and software to be used for detailed traffic analysis and simulation for the various types of travel facilities are provided in this section. The detailed traffic analysis was primarily performed using the methods of the *2000 Highway Capacity Manual* (HCM), published by the Transportation Research Board (TRB). This is the accepted practice in all 50 states. The methodology and measures of effectiveness vary for each different type of facility. Each of the Build Alternatives has several components. The types of facilities that will need to be analyzed as part of the Circ-Williston EIS include:

- Signalized intersections,
- Unsignalized (stop-controlled) intersections, and
- Modern roundabouts

Based on a review of the available software to perform capacity analysis and microsimulation of various types of facilities, several software packages were chosen to be used for the Circ-Williston EIS. The software packages include Synchro, aaSIDRA (SIDRA), and VISSIM. Table 2-1 summarizes the software that will be used for each facility type for capacity analysis and microsimulation. A detailed description of the proposed methods and software to be used for detailed traffic analysis and simulation for the various types of travel facilities included in the Build Alternatives with supporting rationale for each method can be found in the Traffic Analysis Methods White Paper in Appendix B.

Table 2-1
Capacity Analysis and Microsimulation Software

Software	Facility Type	
	Signalized & Unsignalized Intersections	Roundabouts
Capacity Analysis		
Synchro	√	
SIDRA		√
Simulation		
VISSIM	√	√

The Louis Berger Group, Inc. (2006)

Capacity Analysis

There are several software packages available to perform capacity analysis for the various types of facilities. For each type of facility, the applicable software packages are identified including consideration for the data input requirements, methodology, and the advantages and disadvantages for their application.

SYNCHRO

Synchro was developed by Trafficware Corporation to model traffic flow and optimize traffic signal timing plans. It can be used to analyze many different facilities, including arterials and intersections. Its primary function has been to analyze signalized intersections. For an intersection, inputs include traffic volumes, geometrics, and control data including STOP/YIELD, or green time and cycle length. The program explicitly outputs the Intersection Capacity Utilization (ICU) report and ICU level of service (LOS). These are based on the Percentile Delay Method, rather than the HCM methodology (Webster's Method). However, the program offers an HCM report for both signalized and unsignalized intersections that is based on the HCM methodology. The report details the delays, LOS, volume to capacity (v/c) ratio and average 95th percentile queues. The results on-screen do not exactly reflect the HCM methodology. However, the HCM report mirrors the Measures of Effectiveness (MOEs) and LOS as described in Chapters 16 and 17 of the HCM.

The LOS results from Synchro are similar to those from HCS+. However, Synchro has several advantages over HCS+ to analyze and simulate signalized and unsignalized intersections:

- Handles interactions between intersections such as queue spillback;
- Analyzes each intersection as a connected system and not separately as isolated locations;
- Has all of the input data for the network stored in one file, rather than requiring manipulation of individual files for each intersection; and
- Is VTrans' preferred software package for these types of applications and several sections of the Circ-Williston EIS project area roadway network were previously modeled in Synchro for existing conditions by VTrans.

For these reasons, Synchro was selected to analyze signalized and unsignalized intersections over HCS+.

SIDRA

SIDRA is a software package that was developed in Australia to analyze both one- and two-lane roundabouts. It has been commonly used in the U.S. to analyze roundabouts, particularly two-lane roundabouts. SIDRA is the roundabout analysis software accepted by VTrans. The inputs to SIDRA include the hourly volumes, as well as the intersection geometry. Although the intersection geometry is one of the inputs to SIDRA, it is not explicitly considered in the analysis. Because SIDRA can analyze other types of intersections, including both signalized and unsignalized intersections, particularly those with unusual geometry, such as five-legged intersections, the geometry is included in the inputs. However, in the case of roundabout analysis, the geometrics are not used in the analysis. The methodology included in the software is based on critical gaps, much like HCS+. The MOEs from SIDRA include average delay in seconds, LOS, v/c ratios, and queue lengths.

Recent studies have identified a difference between U.S. driving conditions and those in the United Kingdom (U.K.) and Australia, where drivers are more familiar with roundabouts. As a result, a calibration factor of 1.2 was developed to account for U.S. roundabout experience (NCHRP Report 3-65). The most-recent update of SIDRA includes this adjustment factor, called the U.S. capacity adjustment factor. This factor was used in the roundabout analysis performed within the Project Area.

Simulation

There are several software packages available to perform microsimulation for the various types of facilities. For each type of facility, the applicable software packages are identified including consideration for the data input requirements, methodology, and the advantages and disadvantages for their application.

VISSIM

VISSIM is a simulation program developed overseas and distributed in the U.S. VISSIM can simulate arterials with both signalized and roundabout intersections. The FHWA's research shows that the results of roundabout simulation correlate closely with empirical data gathered at roundabouts within the U.S. VISSIM's graphical interface makes it more user-friendly than some other simulation models. VISSIM can also simulate interaction with transit facilities, pedestrians, and other similar specialized cases. Simulation of special cases will be necessary for the Circ-Williston EIS at the Five Corners intersection, in Essex Junction, due to the proximity of at-grade rail crossings and pedestrian movements. The outputs from VISSIM include travel time, queue length, and delay, just to name a few. A specific path or paths can be defined in VISSIM, for which the program will explicitly output travel times. For these defined paths, the program will also output delays. Queue counters at specific locations can also be specified in VISSIM to determine queue lengths at key locations. VISSIM can report average queue length, maximum queue length, and the number of stops within the queue. VISSIM allows the user to import a CAD file or aerial photograph as the background, thus making it easier for the public to relate to the location that is being simulated.

Since SimTraffic and CORSIM do not explicitly handle two-lane roundabouts or railroad crossings as part of their simulation capabilities, VISSIM will be used for simulation of the Five Corners intersection in Essex Junction. The use of VISSIM as a microsimulation tool to determine the effect of roundabouts in close proximity on an arterial corridor (VT 2A, Circ, etc.) has merit and videos of the simulated scenarios are helpful aids in communicating analysis results to the general public.

2.1.3 Crash Analyses

Statewide crash data for routes under VTrans jurisdiction in the project area were obtained for the five-year period from January 1, 1999 to December 31, 2003 from the VTrans Program Development Division–Highway Research Unit. In terms of accident analyses, crash rates and high crash locations (HCL) were calculated within key corridors in the project area for each Build Alternative in the Circ-Williston EIS.

Crash Rates

Crash rates were calculated for the analyzed corridors and key intersections in the project area. As prescribed by VTrans, highway sections were analyzed based on a sliding 0.3-mile section at 0.1 mile increments, and computed for sections on the analyzed corridors within Williston and Essex Junction. Actual crash rates were calculated for each of the 0.3 mile sections and each intersection based upon the following formulas:

$$\text{Actual Crash Rate for Section} = \frac{\text{Number of Crashes/Year x 1,000,000}}{\text{Section Length (mile) x AADT Volume x 365}}$$

$$\text{Actual Crash Rate for Intersection} = \frac{\text{Number of Crashes/Year x 1,000,000}}{\text{Incoming AADT Volume x 365}}$$

Statewide crash rates for routes for the years 1999 through 2003 were obtained from VTrans. The statewide crash rates were identified for all reported crashes occurring at or between intersections. A copy of the statewide crash rates for each of the functional classification on the corridor mainline and intersections is provided in Appendix C.

High Crash Locations (HCL)

According to VTrans protocol, a roadway section or intersection must satisfy two criteria to be identified as a high crash location:

- The location must have experienced five or more crashes in a 5-year period, or the average of one crash per year; and
- The Actual/Critical ratio must be 1.000 or higher.

According to VTrans, the formula used to calculate the Critical Crash Rate is:

$$\text{Critical Crash Rate} = Ra + K * (\text{Sqrt}(Ra/M)) - (1/(2*M))$$

In order to calculate the critical crash rate, the following input is used:

- Ra = Statewide Average Crash Rate in crashes per million vehicle miles for the functional classification of the highway section under study,
- M = Vehicle exposure in million vehicle miles
  $M_{section}$ = (AADT*Section Length*365*Number of Year)/1,000,000
  $M_{intersection}$ = (Incoming AADT *365*Number of Year)/1,000,000
- K = A constant, the value of which determines the level of probability. A value of 2.58 is used in this report, which gives a 99.5 percent confidence level.

The Actual/Critical ratio is calculated by dividing the Actual Crash Rate by the Critical Crash Rate.

2.2 Analysis Methods and Performance Measures

Four criteria have been established as part of the project's Purpose and Need: 1) relieve congestion on VT 2A and at Five Corners and North Williston Road; 2) address mobility needs between Williston and Essex; 3) improve safety along VT 2A and at Five Corners and North Williston Road, and 4) reduce truck traffic on VT 2A and at Five Corners and North Williston Road. As a means to "test" how each of the Build Alternatives addresses the criteria, analysis methods and performance measures were developed for each of these categories and are described in the following sections.

2.2.1 Methods to Measure Congestion Relief

Intersections

The purpose of the capacity analysis is to determine the operational characteristics of key intersections (signalized, unsignalized, and modern roundabouts) within the project area. The capacity analysis methodology is based on the concepts and procedures in the *HCM*. The primary result of a capacity analysis is the assignment of LOS to intersections under various traffic flow conditions. LOS is a qualitative measure that describes operational conditions and provides an index to the quality of traffic flow. Levels of Service are defined in letter designations from LOS A to LOS F. LOS A represents the best operating condition, LOS C describes a stable flow condition, and LOS F represents the worst operating condition. To greater differentiate an extreme LOS F, a delay in excess of 120 seconds is identified as a LOS F-. Since the LOS of a traffic facility is a function of the traffic flows placed upon it, the LOS of a facility may vary greatly, depending on the time of day, day of week, or period of year.

LOS for signalized and unsignalized intersections is calculated using the operational analysis methodology of the HCM. The LOS criteria for signalized and unsignalized intersections are provided in Table 2-2.

Table 2-2
Intersection
Level of Service Criteria

Level of Service	Average Control Delay (seconds/vehicle)	
	Unsignalized Intersection	Signalized Intersection
A	0 to 10	≤10
B	>10 to 15	>10 to 20
C	>15 to 25	>20 to 35
D	>25 to 35	>35 to 55
E	>35 to 50	>55 to 80
F	>50	>80

Source: Highway Capacity Manual 2000.

The capacity analysis procedures for unsignalized intersections are provided for two-way stop-controlled (TWSC) intersections and all-way stop-controlled (AWSC) intersections. LOS for TWSC and AWSC intersections is based on average control delay. Average control delay includes initial deceleration delay, queue move-up time, stopped delay, and final acceleration delay. For TWSC intersections, LOS is defined for each minor street movement but is not defined for an intersection as a whole. LOS for an AWSC intersection is defined for each approach as well as for the intersection as a whole.

LOS for signalized intersections is defined in terms of average control delay, which is a measure of driver discomfort, frustration, fuel consumption, and lost travel time. The LOS criteria for traffic signals are stated in terms of average control delay per vehicle. The average control delay includes initial deceleration delay, queue move-up time, stopped delay, and final acceleration delay. Average control delay under signalized control is a complex measure and is dependent on a number of variables, including the quality of progression, the cycle length, the green ratio, and the v/c ratio for the lane group in question. The Vermont State Design Standard issued by VTrans (1997), provide that principal arterials in urban or village areas generally be designed for LOS C or better. However, the standards provide that in heavily developed village or urban areas, a reduced level of service as D or E may be appropriate as judged on a case-by-case basis.

The HCM does not define LOS for roundabouts, since the procedures for analysis of roundabouts only consider single-lane roundabouts. Other methodologies for analyzing roundabouts have been developed outside the United States to analyze both single-lane and two-lane roundabouts. For instance, SIDRA uses an empirical gap-acceptance method to model roundabout capacity and performance. The model accounts for the effects of both driver behavior and roundabout geometry. SIDRA defines LOS for roundabouts using the HCM criteria for signalized intersections, given previously in Table 2-2.

Roadway Segments

V/C ratios were calculated for mainline roadway segments using the projected 2030 No Build condition and Build Alternatives traffic volumes, and the theoretical capacities used as part of the CCMPO travel demand model. A V/C ratio of 1.00 represents conditions where traffic flow becomes restricted and travel speed is reduced by increasing volumes. A V/C ratio of 1.32 approximates conditions where the theoretical capacity of a roadway has been met within Chittenden County based on data from the travel demand model. In other words, traffic flow becomes unstable at this point and severe congestion would be experienced by motorists. The data were summarized and totaled for roadway links into three categories: V/C ratio below 1.00; V/C ratio equal to or above 1.00 and below 1.32; and V/C ratio at or above 1.32. The results for each alternative were compared to the No Build Alternative and the net change was calculated for each link LOS category.

2.2.2 Methods to Measure Mobility Improvement

The measure of improving mobility between Williston and Essex was based upon the implementation of physical improvements in the project area that would promote travel between Williston and Essex. The results of the analysis reflect zone-to-zone vehicular travel times for trips with origins and destinations in Williston, Essex, and Essex Junction during the AM and PM peak hours. Weighted averages were calculated for each alternative using the regional transportation model separately for travel times projected for trips between Williston and Essex and for trips between Essex and Williston. The travel times for each origin/destination pair were weighted by the number of vehicle trips between that origin/destination pair. The change in weighted average from one alternative to another is "the change in travel time experienced by the average vehicle." The results were also summarized in terms of percent change in travel time for each alternative as compared with the No Build Alternative.

Vehicle miles traveled (VMT) and vehicle hours traveled (VHT) were calculated as output from the CCMPO Model for all vehicles projected to travel in Chittenden County during the AM and

PM peak hours. The net percentage change was calculated between the No Build Alternative and each of the Build Alternatives.

2.2.3 Methods to Measure Safety Improvement

Safety improvement was based primarily upon the implementation of physical improvements on VT 2A and at Five Corners that have specific safety benefits and secondarily on the direct or indirect reduction of traffic volumes on VT 2A and at Five Corners. Travel patterns in the project area would be affected by the Circ alternatives and traffic volumes on major corridors could increase or decrease depending upon their relevance to the new Circ highway. Crash analyses were performed on sections of key corridors and intersections for each alternative to test the effectiveness of changes in link volumes and design countermeasures to address hazardous conditions.

2.2.4 Methods to Measure Truck Volume Reduction

One of the goals of the project is to reduce the number of medium and heavy trucks along local roads within the Project Area. The net change in truck traffic on roadways within the Project Area was assumed to mirror the net percentage change in total vehicular traffic for the same roadway based upon output from the CCMPO travel demand model during the AM and PM peak hours.

2.3 Agency Consultation and Coordination

The transportation planning component of the Circ-Williston EIS has included a comprehensive agency consultation and coordination process. This program was designed to provide a foundation for informed agency decision-making. Specifically, it encouraged dialogue between VTrans, interested agencies, and the consulting team in terms of data input, policy input, schedule, and comments on work completed.

VTrans staff has been an integral part of planning process by providing accident, traffic count, signal timing, roadway project, and rail data. In addition, VTrans staff has assisted in the application of the Statewide Model into the planning process. CCMPO staff has played an important role in providing traffic data and planning studies relevant to the planning process. They have also played a key role in the application of the CCMPO Model into the process and have provided crucial input on the way the model is used in the transportation and ICI analyses. The local towns within the project area include Williston, Essex, and Essex Junction. Staffs from these towns have provided critical traffic data, planning studies, and planned project and development data throughout the planning process.