Appendix D: Interchange Justification Report

Interchange Justification Report

I-93 Exit 4A

Prepared for:

Town of Derry
Town of Londonderry
New Hampshire Department of Transportation

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ABBREVIATIONS AND ACRONYMS

AASHTO	American Association of State Highway Transportation Officials
AAWDT	average annual weekday daily traffic
ADT	average daily traffic
ATR	automatic traffic recorder
CFR	Code of Federal Regulations
DEIS	Draft Environmental Impact Statement
FHWA	Federal Highway Administration
HCM	Highway Capacity Manual
HCS	Highway Capacity Software
I	Interstate
IJR	Interchange Justification Report
LOS	level of service
MEV	million entering vehicles
mph	miles per hour
NEPA	National Environmental Policy Act
NH	New Hampshire
NHDOT	New Hampshire Department of Transportation
PUD	Planned Unit Development
ROW	right-of-way
RPC	Rockingham Planning Commission
SDEIS	Supplemental Draft Environmental Impact Statement
SEIS	I-93 Supplemental EIS
SNHPC	Southern New Hampshire Planning Commission
TAZ	Traffic Analysis Zone
TIA	Traffic Impact Assessment
TIP	Transportation Improvement Plan
TSM	Transportation Systems Management
TWSC	two-way, STOP-controlled (intersection)
U.S.C.	United States Code

1.0 INTRODUCTION

The objective of this Interchange Justification Report (IJR) is to provide the necessary background for justifying the addition of a new interchange along Interstate 93 (I-93) between Exit 4 and Exit 5 in the Town of Londonderry, New Hampshire. The information included within this document will help determine if the proposed interchange improvements satisfy the Federal Highway Administration's (FHWA) two policy requirements that were developed to aid compliance with Title 23, United States Code, Highways Section 111 (23 United States Code [U.S.C.] 111), which requires all interstate construction projects to not add any points of access or exit from the project without prior FHWA approval. The FHWA Division office has been delegated approval authority for new Interstate access points involving freeway to crossroad interchanges. FHWA Headquarters approval is not required.

The two specific requirements that must be met to receive approval for the development of new or revised interstate access points are described in FHWA's May 2017 *Policy on Access to the Interstate System* (FHWA, 2017a). The intent of this policy is to "preserve and enhance the Interstate System to meet the needs of the 21st Century by assuring that it provides the highest level of service in terms of safety and mobility" (FHWA, 2017a).

Section 8, *Policy Analysis*, of this document describes the FHWA interstate access policy requirements and describes how the proposed changes at the new I-93 service interchange would fulfill them.

1.1 Project Description

The proposed Project consists of a new, diamond interchange on I-93 in the Town of Londonderry, New Hampshire, between Exit 4 and Exit 5 (Figure 1-1). A connector roadway would be built on a new alignment from the new interchange to the east toward State Route 28 (NH 28) with a connection to State Route 102 (NH 102) at the east side of Derry following upgraded existing roadways, creating new roadways, or a mixture of both improvement types, depending on the alternative. Section 6.0 describes the four proposed alternatives.

Concurrently with this IJR, FHWA, NHDOT and the Towns of Londonderry and Derry are conducting an Environmental Impact Statement (EIS) for the Project under the National Environmental Policy Act.

The I-93 Exit 4A Supplemental Draft EIS (SDEIS) and IJR assumed four-lanes in each direction would be in operation between I-93 Exits 4 and 5 by 2040. The widening of I-93 to four-lanes in each direction is included in the NHDOT 2019-2028 Ten-Year Plan; however, the opening of the fourth lane to traffic is dependent on a resolution of chloride commitments made in the I-93 Salem to Manchester Improvements Supplemental Record of Decision and Section 401(c) Water Quality Certification. As a result, a sensitivity analysis was conducted to forecast I-93 freeway operations under a scenario in which there are only three-lanes in each direction. The results concluded that it is possible that I-93 Exit 4A could be constructed before four-lanes in each direction are operational. The analysis shows that the traffic changes predicted by the construction of Exit 4A do not "force" construction of the fourth lane and that the Exit 4A project is appropriately considered independently from decisions about the timing of construction of the fourth lane. Appendix N contains the sensitivity analysis.

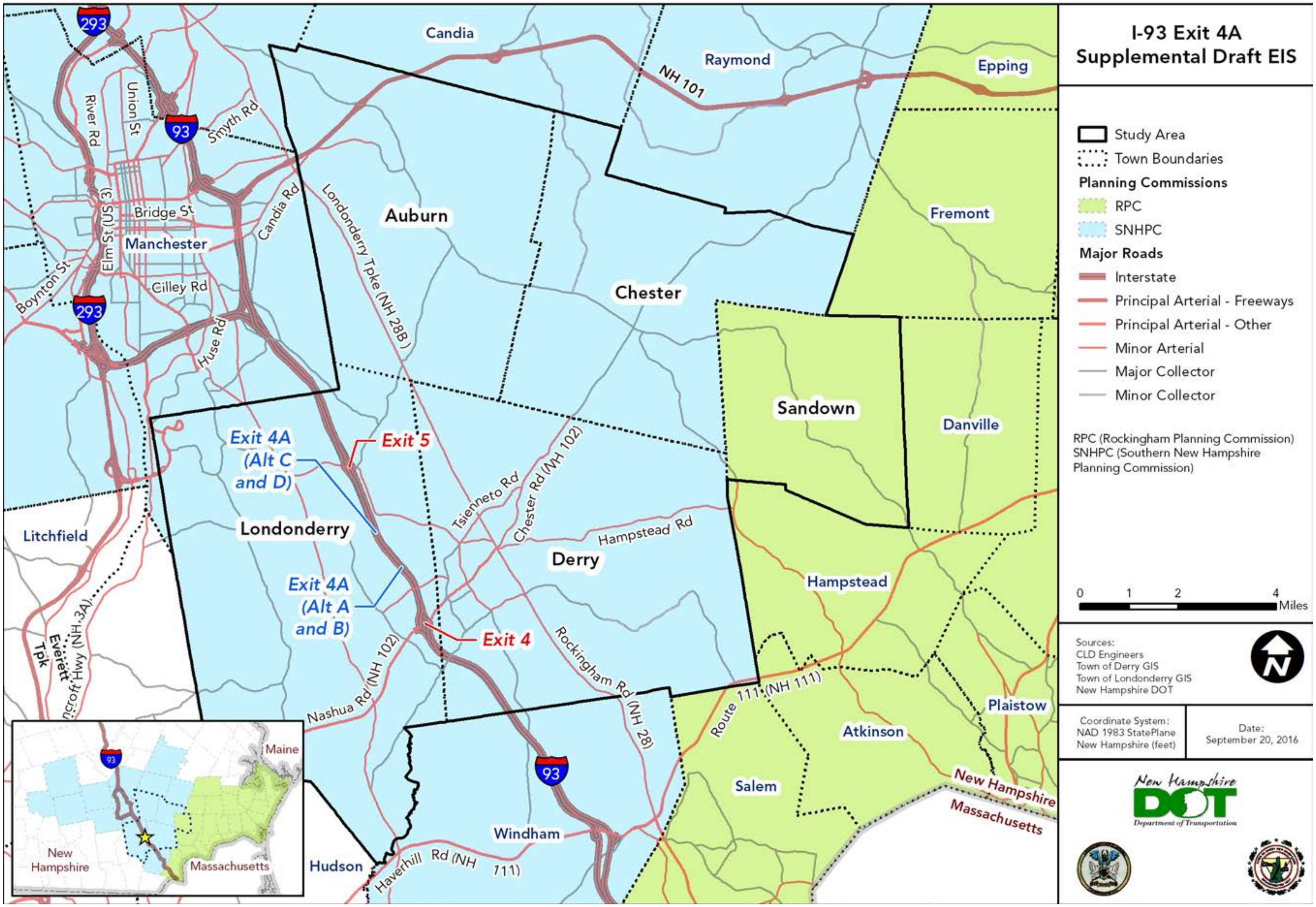


Figure 1-1. Regional map

1.2 Purpose and Need

The purpose and need for the project was identified early in project planning taking into consideration agency and public input. As noted in the SDEIS Appendix A, for purposes of meeting the guidelines of the U.S. Army Corps of Engineers (USACE) Highway Methodology (USACE, 1993), the basic purpose of the project is: to reduce congestion and improve safety along NH 102 from I-93 easterly through downtown Derry, and to promote economic vitality in the Derry-Londonderry area. This project purpose statement was used throughout the planning process for the identification, evaluation, and screening of potential alternatives (CLD, 2000; CLD, 2001).

1.2.1 Purpose

The purpose of this project includes:

- providing for the safe and efficient movement of people, goods, and services between I-93 and the towns served by NH 102, specifically Derry and Londonderry, that are immediately adjacent to I-93 Exit 4;
- providing an alternative route to the Interstate system for traffic using NH 102 to and from the east, thus removing a large volume of through traffic from the heavily congested downtown Derry street network;
- providing improved Interstate access for commercial and industrially-zoned lands near NH 28 in both Derry and Londonderry, thus allowing for the planned and orderly development of such lands to further locally-defined economic development goals and tax base diversification; and
- enhancing and promoting the economic vitality of the downtown Derry area, presently characterized by traffic congestion and decreasing vehicular and pedestrian safety, by separating local, destination-oriented traffic from through traffic destined for the Interstate system.

1.2.2 Need

The Towns of Derry and Londonderry, working with the FHWA, NHDOT, and CATF[1], identified several factors demonstrating the need for transportation improvements within the study area, including traffic congestion in downtown Derry, economic vitality, and safety. Each of these aspects of the need for the project is discussed below taking into account changes in traffic data and economic development opportunities since the 2007 DEIS.

[1] The CATF was formed to offer opportunities for stakeholders to provide input into the project planning process. The CATF included local officials, interested citizens, and Federal and State agency staff. A list of the CATF members, and a summary of the highlights for the project meetings, including the scoping meetings, are provided in Chapter 11.

Traffic congestion in downtown Derry

NH 102, known as Broadway, is the principal east-west roadway through both Derry and Londonderry and serves as the major route for traffic accessing I-93 via Exit 4. The section of NH 102 passing through downtown Derry serves as its “main street.” It is currently a two-lane road from I-93 easterly through the downtown area, with several traffic signals and numerous intersections with side streets, on-street parallel parking, and a steady flow of pedestrian traffic. As a result of these complicating and often conflicting functions, downtown Derry experiences considerable congestion, as locally-oriented traffic intermingles with Interstate-bound through-traffic. Traffic routinely backs up throughout the downtown area in the morning peak periods as the steady flow of westbound traffic from Derry tries to access the Interstate and local highway systems. In the evening peak periods, eastbound traffic on NH 102 backs up through most of the downtown area of Derry, often all the way to the I-93 Exit 4 ramps because the existing two-lane roadway and associated intersections cannot accommodate the existing traffic demands. As such, travelers attempt to find alternative routes to bypass the congestion in the downtown area, placing heavy traffic on local roads, which were not designed to have capacity for it, contributing to safety concerns in neighborhoods, and adding congestion to local roads and intersections.

The 2010 Derry Master Plan notes “The town is also continuing to pursue the I-93 Exit 4A project which is designed to relieve traffic on NH 102 and promote the safe and efficient movement of people, goods and services. Businesses in downtown Derry will benefit from the completion of the I-93 Exit 4A project through the reduction of traffic and related congestion and improved accessibility” (Town of Derry, 2010).

Although operating near capacity, the updated traffic analyses conducted for 2015 existing conditions and the 2040 No Build condition generally show acceptable peak hour Level of Service (LOS) D at the major intersections along NH 102 through downtown Derry, including the NH 102/NH 28 (Crystal Avenue/Birch Street) intersection. Traffic volumes in downtown Derry are projected to increase be approximately 15 percent between 2015 and 2040. Larger traffic increases and higher levels of congestion (LOS E or F) are not projected for Derry because of the availability of alternate routes to disperse traffic. The existing two-lane road is not capable of handling higher volumes without traffic flow breaking down. Therefore, traffic avoids the downtown NH 102 corridor, diverting to other local roads such as Folsom Road and Londonderry Road as alternate access routes to Exit 4. This situation has been observed on Folsom Road where traffic has increased from about 8,700 to 11,768 annual average daily traffic between 1998 and 2015.

The traffic diversions to avoid NH 102 result in congestion issues in additional portions of Derry, such as the intersection of N. High Street and Ash Street Extension, which is projected to operate at LOS F in the AM and PM peak hours in 2040. As traffic diverts around NH 102 to points easterly, it increases traffic on local streets not designed for high through traffic volumes. Table 1-1 provides a summary of existing and 2040 No Build Annual Average Weekday Daily Traffic (AAWDT) along key corridors in the study area.

Table 1-1. Summary of 2015 and 2040 No Build Average Annual Weekday Traffic on NH 102 and Roadways Used to Bypass NH 102

Roadway Segment	Adjusted 2015 AAWDT	2040 No Build AAWDT	2015 to 2040 Increase	Percent Increase
NH 102, East of Griffin Street	16,400	18,958	2,558	13%
NH 102, West of Abbot. Street	14,350	19,217	4,867	25%
NH 102, at Derry/Chester town line	8,200	9,671	1,471	15%
Folsom Road, West of NH 28	11,768	13,839	2,071	15%
Tsienneto Road, West of NH 102	5,394	8,636	3,242	38%
Tsienneto Road, East of Pinkerton Street	14,637	19,457	4,820	25%
Ash Street at Londonderry town line	6,765	15,716	8,951	57%

In addition to congestion in Derry, the Exit 4 interchange is projected to experience congestion issues by 2040, even with the improvements made by the I-93 widening project and intersection spot improvements proposed by Woodmont Commons. Specifically, the following intersections in the I-93 Exit 4 area would operate at LOS E or F in the 2040 No Build:

- NH 102 & Gilcreast Road in AM and PM Peak Hour
- NH 102 & I-93 Exit 4 Southbound Off-Ramp in PM Peak Hour
- NH 102 & I-93 Exit 4 Northbound On and Off-Ramp in AM and PM Peak Hour
- NH 102 & St. Charles Street/Londonderry Road PM Peak Hour

The I-93 Exit 4 southbound off-ramp to NH 102 is also projected to operate at LOS F in the 2040 PM peak hour.

Economic vitality

Economic development issues and opportunities in Derry and Londonderry are discussed in separate sections below. In Derry, constraints related through traffic are a concern to the accessibility of business downtown. In Londonderry, a large tract of undeveloped land on the east side of I-93 currently has poor highway access and is the subject of the Town’s Woodmont Commons Planned Unit Development Master Plan to attract regionally significant business opportunities.

Derry

Economic vitality is essential for the Derry downtown area to remain the center of community activity, a clear priority identified in the Derry Master Plan. Results from the community survey conducted as part of the 2010 Master Plan show that residents of Derry support attracting new businesses and industries to Derry. New businesses with the most support were office development, light industrial, an industrial park, and downtown revitalization. One of the recommendations of the Master Plan is to "Continue to research the benefits, challenges and feasibility of Exit 4A." The Master Plan notes the following potential benefits for Derry:

- A direct access route to I-93 for commercial and industrial areas of town
- A bypass for the downtown, which will alleviate some of the current traffic problems and enhance the downtown area
- Create more connections to existing commercial and industrial areas and open them up for more development

The Master Plan acknowledges that the existing heavy traffic on NH 102 influences the quality of the downtown area and the businesses located there. Traffic congestion creates a less pedestrian-friendly downtown and likely results in some drivers seeking alternate shopping opportunities and traffic routes. The Master Plan notes several actions that could be implemented to improve conditions for pedestrians and to promote a business-friendly environment downtown. In order to be implemented, many of the actions recommended in the Derry Master Plan will require that downtown traffic congestion be alleviated. The Master Plan states that "Businesses in downtown Derry will benefit from the completion of the I-93 Exit 4A project through the reduction of traffic and related congestion and improved accessibility." Further economic benefits to both Derry and Londonderry could also be realized by providing access to the existing industrial zoned land adjacent to the east side of I-93 between Exits 4 and 5.

The Exit 4 southbound off-ramp is operating at or near capacity (LOS D) in the AM peak hour and failing (LOS F) in the PM peak hour. The northbound on- and off-ramp is operating at LOS E in the AM peak hour and LOS F in the PM peak hour. This has consequences to the economic well-being of Derry because the Exit 4 Interchange currently provides the only direct access between the Interstate and most of Derry's developed area. Although further improvements to the Exit 4 Interchange were constructed as part of the I-93 widening project, traffic congestion and associated safety issues along NH 102 in downtown Derry will continue, as described later in this IJR.

Londonderry

There are large tracts of undeveloped land adjacent to the east side of I-93 between Exits 4 and 5, the economic value of which would be greatly enhanced by a direct connection to I-93. By providing direct access to the Interstate in this area, land value will increase as it will be better suited for larger scale commercial or industrial development. The proximity of the Manchester-Boston Regional Airport to this area also adds to the value and development potential of this land. As noted in the Land Use Scenarios Technical Report (Louis Berger, 2017), a new exit would provide accessibility to existing undeveloped land, thereby enhancing the development potential. The net effect of these development activities would likely be a number of new, high paying jobs and increased tax revenue for both towns.

Since the 2007 DEIS, additional local planning efforts have further defined the development opportunities near I-93 in Londonderry. In 2013, the Town of Londonderry approved the Woodmont Commons Planned Unit Development Master Plan covering approximately 630 acres bordering the east and west sides of I-93. The Master Plan envisions a mixed-use urban village being developed in several phases over 20 years. Portions of development on the east side of I-93 are under construction, with completion expected in 2020 (Woodmont Commons Phase I). The Master Plan restricts the quantity of development allowed on both the east and west sides of I-93 if Exit 4A is not constructed to limit traffic impacts of development. On the east side of I-93 specifically, coordination conducted during the Exit 4A land use study found that a predominately residential development pattern would occur in a No Build scenario (approx. 330 units). The provision of new interstate access to the east side of I-93 would allow for substantially higher-intensity of development, nearly 700,00 gsf of commercial and 420,00 gsf of institutional uses based on the land use study (Woodmont Planning Team, 2011).

1.2.3 Safety

Although the Exit 4 Interchange has been reconstructed to handle the projected design year traffic flows easterly into Derry as part of the I-93 widening project, the primary design intent is to address the north-south travel demands of the I-93 corridor and not the east-west demands along NH 102 in the study area. The section of NH 102 that runs easterly into downtown Derry from Exit 4 will continue to have an insufficient number of lanes, especially at the intersections, to handle the existing and future peak traffic flows. These peaks are especially high during the heavy evening commuting periods when both through traffic and traffic accessing local businesses are sharing the same roadway. Because the existing road has insufficient lanes to handle the peak traffic volumes, the traffic backs up into the Interchange area, which results in increased safety hazards for the traveling public. Several intersections with high crash rates based on analysis of 2013-2015 crash data are located along NH 102 in the study area, including at Gilcreast Road, Garden Lane/Hampton Drive and the I-93 Exit 4 Northbound Ramps.

Between 2010 and 2014, there were a total of 716 crashes in the DSEIS study area, including 240 crashes along NH 102 between Exit 4A and Tsienneto Road (NHDOT, 2010-2014). Of the total, approximately 24 percent resulted in injury or fatality. If traffic using NH 102 to the east could be moved away from the interchange area more efficiently, traffic congestion at the ramp intersections could be reduced and traffic flow improved, resulting in a more orderly and safer flow of traffic through the intersections, as well as elsewhere along NH 102.

The congestion in downtown Derry results in some vehicles seeking alternative routes, many of which result in additional traffic through residential neighborhoods, representing an additional safety concern. On Broadway itself, the congestion results in increased conflicts between through traffic, turning traffic, parked cars, pedestrians, and bicyclists.

1.2.4 Goals & Objectives

Purpose Statement	Objectives
Provide safety improvements	Provide for the safe and efficient movement of people, goods, and services between I-93 and the towns served by NH 102, specifically Derry and Londonderry, that are immediately adjacent to I-93
Reduce traffic congestion in downtown Derry and discourage traffic from diverting from NH 102 onto local streets to avoid downtown Derry	Provide an alternative route to the Interstate system for traffic using NH 102 to and from the east, thus removing a large volume of through traffic from the heavily congested downtown Derry street network
Improve economic vitality in the Towns of Derry and Londonderry	Enhance and promote the economic vitality of the downtown Derry area, presently characterized by traffic congestion and decreasing vehicular and pedestrian safety, by separating local, destination-oriented traffic from through traffic destined for the Interstate system
Increase Interstate access for commercial and industrial suppliers	Provide improved Interstate access for commercial and industrially-zoned lands near NH 28 in both Derry and Londonderry, thus allowing for the planned and orderly development of such lands to further locally defined economic development goals and tax base diversification

2.0 METHODS AND ASSUMPTIONS

2.1 Documentation

As required by New Hampshire Department of Transportation (NHDOT) and FHWA, the following two specific requirements are addressed in this document:

- Policy Requirement 1 – provides operational and collision analysis by evaluating the operation of existing interchanges in the study area for the base year (2015) and future year (2040) using the U.S. Department of Transportation's Highway Capacity Manual (HCM) analysis and the Southern New Hampshire Planning Commission (SNHPC) to forecast future volumes.
- Policy Requirement 2 – describes access connections and design for all four traffic movements.

2.2 Analysis Period

Operational analysis includes both AM and PM peak hours for the following years:

- Base Year: 2015
- Future Year: 2040

2.3 Study Area

This section defines the traffic study area based on FHWA guidance and describes the data collection methods. The Project study area includes a mixture of Interstate and intersection facilities. According to FHWA guidance, when performing an IJR for a new interchange, the closest existing interchange in each direction of a proposed new interchange must be included. In addition, the first major signalized intersections along the roadway (usually an arterial) serving the closest interchange must be included (FHWA, 2017a). To be conservative, the study includes signalized intersections within 0.5 miles of the interchange. This includes all interchange facilities such as merges, diverges, and weaves and intersections along the arterial. Based on this guidance, the Project study area includes the following:

- I-93 mainline between south of Exit 4 to north of Exit 5
- All merges and diverges at Exit 4 along I-93
- All merges and diverges at Exit 5 along I-93
- All proposed merges and diverges at the new proposed Exit 4A along I-93
- The following NH 102 intersections
  - I-93 Southbound off-ramp (signalized) – ramp terminus at interchange
  - I-93 Northbound off and on-ramp (signalized) – ramp termini at interchange
  - Fordway/ Madden Hill Road (signalized) – approximately 2/3 mile to the east
  - Londonderry Road/St. Charles Street (unsignalized) – approximately 1/3 mile to the east
  - Garden Lane/Hampton Drive (signalized) – approximately 1/3 mile to the west
  - Gilcreast Road (signalized) – approximately 1/2 mile to the west
- The following NH 28 Intersections
  - I-93 Southbound off and on-ramp termini (signalized)
  - I-93 Northbound off and on-ramp termini (signalized)
  - Symmes Drive/Vista Ridge Drive (signalized) – approximately 1/3 mile to the west
  - Liberty Drive (signalized) – approximately 1/3 mile to the east

Figure 2-1 shows the study area intersections.

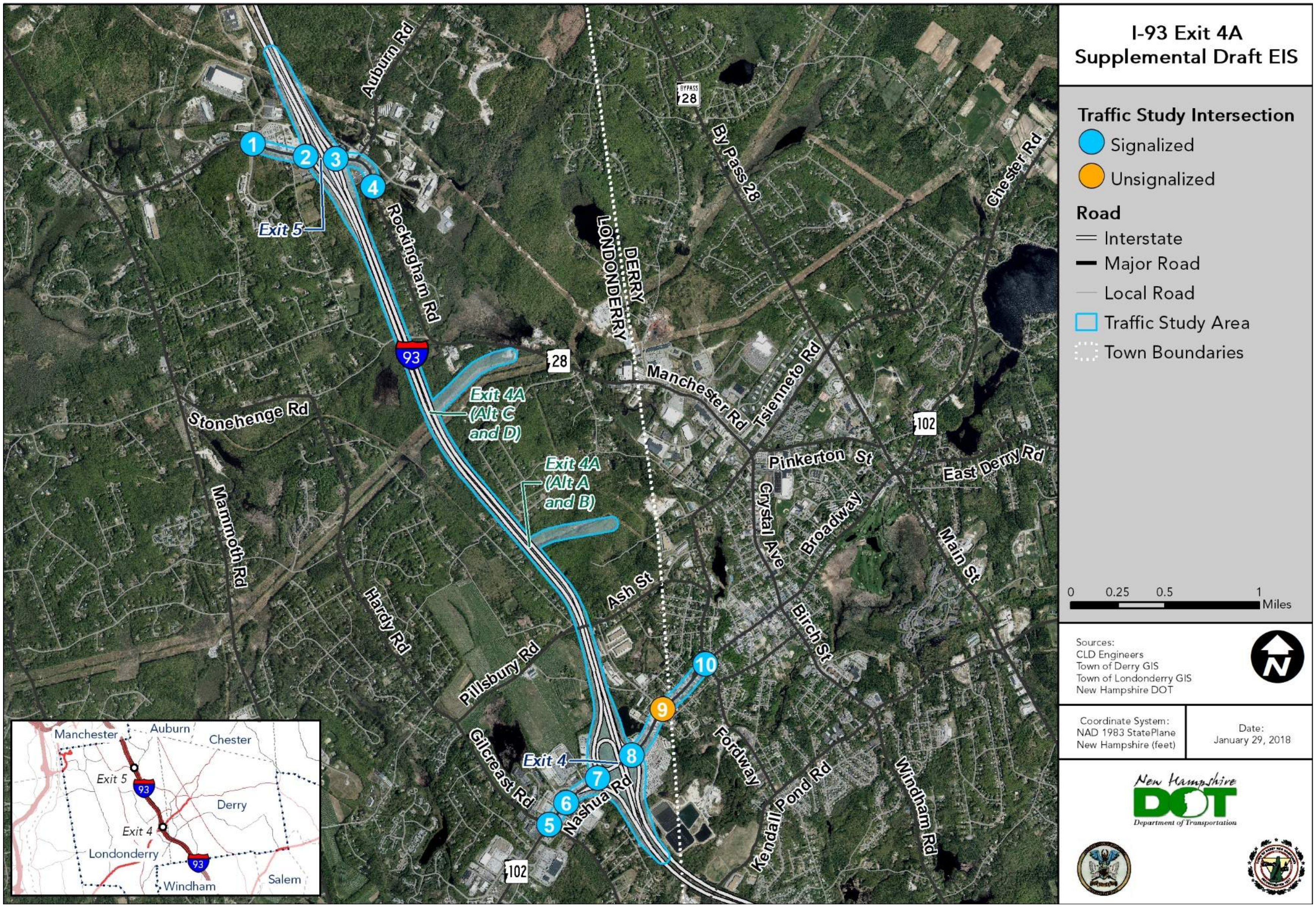


Figure 2-1. IJR Study area intersections

3.0 EXISTING CONDITIONS

The existing conditions describes the existing and future demographic forecasts, existing land use, roadway network, alternative travel modes, interchanges, traffic data sources, operational performance, and safety conditions.

3.1 Demographics

A total of 84 Transportation Analysis Zones (TAZ) covering 143 square miles were used to represent the SNHPC's subarea travel demand model. The demographic values assigned to each TAZ, including population, households, and employment, are based on the report titled Land Use Scenarios Technical Report, a report prepared as part of the current I-93 Exit 4A SDEIS project. These demographic values directly influence the number of trips produced at the residence locations and number of trips attracted to work locations in the travel demand model. The model then converts these production and attraction values into the number of trips assigned from each model origin TAZ to a model destination TAZ to form an origin-destination trip table.

The process to develop the existing and future demographic values included a review of existing federal, state, and regional, and local data sources as well as interviews with planners at the state, regional, and local levels. Primary sources included the following:

- U.S. Census Bureau
- New Hampshire Office of Strategic Initiatives
- SNHPC
- Neighboring Regional Agency, Rockingham Planning Commission (RPC)
- Derry
- Londonderry
- Neighboring Communities of Auburn, Chester, and Sandown

The future demographic forecasts were developed for the No Build Condition and the Build Conditions. They rely on a review of past trends; projections at the state, regional, and local levels; an active list of planned development; and additional demographic trend information learned through the interviews.

3.1.1 2040 No Build Condition

Past trends evaluated demographic changes from 1990 through 2014 and focused on positive and negative patterns by municipality. Population projections have been forecasted in 5-year intervals between 2015 and 2040 by the New Hampshire Office of Energy and Planning and the municipalities; household and employment projections have been forecasted between 2010 and 2040 by SNHPC and RPC. The report synthesized the various data sources and provided future No Build Condition background demographic forecasts.

There are a number of planned developments in Londonderry, including an extensive mixed used development called Woodmont Commons. The Woodmont Commons Planned Unit Development Master Plan includes land on both the west and east sides of I-93, as shown in Figures 3-1 and 3-2. The Woodmont Commons Phase I plan included as part of the No Build comprises 312,574 gross square feet of commercial, 510 units residential, and 135 hotel rooms. There is also a smaller, commercial development of 30,000 gross square feet and 1,094 gross square foot of industrial development. These developments are projected to create over 4,200 jobs and add over 3,800 in population and 1,345 households to the study area (Louis Berger, 2017).

The total 2040 No Build Condition demographic forecasts were developed by adding the existing values to the forecasted background growth and planned development projections. Tables 3-1, 3-2, and 3-3 contain the 2040 No Build Condition population, household, and employment projections for the study area, respectively.

Table 3-1. Total 2040 No Build population for study area

Municipality	Existing Population (2015 Projection)	Background Population Growth from the NH Office of Energy Planning/Chester Projections (2015–2040)	Population Growth from Known Development Proposals	Total 2040 No Build Population
Derry	32,948	274	0	33,222
Londonderry	24,891	2,145	3,849	30,885
Auburn	5,315	733	0	6,048
Chester	4,887	1,366	0	6,253
Sandown	6,255	991	0	7,246
Study Area Total	74,296	5,509	3,849	83,654

Source: Louis Berger (2017)

Table 3-2. Total 2040 No Build households for study area

Municipality	Existing Households (2015 Projection)	Background Household Growth (2015–2040)	Household Growth from Known Development Proposals	Total 2040 No Build Households
Derry	12,656	17	0	12,673
Londonderry	8,625	725	1,345	10,698
Auburn	1,923	264	0	2,187
Chester	1,621	456	0	2,077
Sandown	2,193	721	0	2,914
Study Area Total	27,018	2,183	1,345	30,548

Source: Louis Berger (2017)

Table 3-3. Total 2040 No Build employment for study area

Municipality	Existing Employment (2015 Projection)	Background Employment Growth from SNHPC/ RPC Projections (2015–2040)	Employment Growth From Known Development Proposals	Total 2040 No Build Employment
Derry	8,384	1,938	0	10,322
Londonderry	13,517	4,033	4,219	21,769
Auburn	1,846	914	0	2,760
Chester	368	267	0	635
Sandown	419	117	0	536
Total	24,534	7,269	4,219	36,022

Source: Louis Berger (2017)

3.1.2 2040 Build Condition

Creating a new connection from I-93 to Londonderry and Derry would provide better access to a number of parcels and could influence the type and/or intensity of future development. This development potential is referred to as indirect land use effects. The 2040 Build Condition incorporates indirect land use effects of constructing a new interchange.

In total, 398 new residential units, 200 hotel rooms, 1,015,400 gross square feet commercial, 460,000 gross square feet institutional, and 168 industrial jobs could be added as a result of the indirect land use effects of creating I-93 Exit 4A (Louis Berger, 2017). For Woodmont Commons, the developments on both sides of I-93 (referred to as full build-out) are included containing 9 residential units, 200 hotel rooms, 1,015,400 gross square feet of commercial, and 460,000 gross square feet of institutional.

Each proposed alternative assessed in this study incorporates different levels of demographic growth based on proposed transportation improvements. Each alternative and its demographic components are as follows:

- Alternative A: Woodmont Commons Full Build-out plus growth in Derry, Londonderry, Auburn, Chester, and Sandown
- Alternative B: Similar to Alternative A
- Alternative C: Woodmont Commons Phase I (same as No Build) plus growth in Chester and Sandown
- Alternative D: Similar to Alternative C
- Alternative F: Similar to the No Build Condition

The total 2040 Build Condition demographic forecasts were developed by adding the 2040 No Build values to the forecasted indirect effects of land use. Tables 3-4, 3-5, and 3-6 contain the Alternative A and B 2040 Build Condition population, household, and employment projections for the study area, respectively. Population, households, and employment are not expected to grow under Alternatives C and D in Derry, Londonderry, or Auburn, but would grow in Chester and Sandown in the same manner as Alternatives A and B, as shown in Tables 3-4 through 3-6.

Table 3-4. Alternative A and B 2040 Build condition population

Municipality	2040 No Build Population	2040 Build Incremental Development Project Population	Total 2040 Build Population	Percent Difference between No Build and Build
Derry	33,222	0	33,222	0.00%
Londonderry	30,885	25	30,910	0.08%
Auburn	6,048	0	6,048	0.00%
Chester	6,253	1,117	7,370	16.40%
Sandown	7,246	21	7,267	0.29%
Total	83,654	1,163	84,818	1.38%

Source: Louis Berger (2017)

Table 3-5. Alternative A and B 2040 Build condition households

Municipality	2040 No Build Households	2040 Build Incremental Development Project Households	Total 2040 Build Households	Percent Difference between No Build and Build
Derry	12,673	0	12,673	0.00%
Londonderry	10,698	9	10,707	0.09%
Auburn	2,187	0	2,187	0.00%
Chester	2,077	371	2,448	17.86%
Sandown	2,914	9	2,923	0.31%
Total	30,548	389	30,937	1.27%

Source: Louis Berger (2017)

Table 3-6. Alternative A and B 2040 Build condition employment

Municipality	2040 No Build Employment	2040 Build Incremental Development Employment	Total 2040 Build Employment	Percent Difference between No Build and Build
Derry	10,322	346	10,668	3.25%
Londonderry	21,769	4,335	26,104	18.81%
Auburn	2,760	0	2,760	0.00%
Chester	635	0	635	0.00%
Sandown	536	0	536	0.00%
Total	36,022	4,681	40,703	12.44%

Source: Louis Berger (2017)

Once the 2040 No Build and Build demographic values by municipality were developed, they were allocated to each TAZ representing the municipality. The anticipated population, household, and job growth associated with the known No Build developments was assigned to TAZs based on the percentage of the development land area in each TAZ. Only the TAZ that contained a proposed change in demographic data was updated. Out of the 84 TAZs, 17 TAZs were updated representing the zones in the municipalities where growth would occur based on background growth and planned development, or could occur based on indirect effects of land use. The I-93 Exit 4A SDEIS Land Use Scenarios Technical Report (Louis Berger, 2017) contains the detailed demographic data by TAZ.

3.2 Land Use

In New Hampshire, land use is regulated at the local level by municipalities through zoning and subdivision regulations. Zoning ordinances regulate land uses by area and the type and form of built improvements allowed within each land use. Subdivision ordinances seek to control the density of development on new parcels of land. Land use can also be influenced by other public policy goals expressed as part of land use, transportation, and infrastructure planning processes.

Current land use and zoning conditions were identified using geographic information systems datasets of land use by tax parcel and zoning district boundaries provided by the Towns of Derry and Londonderry. In addition, the data were supplemented with reference to the towns’ zoning ordinances (Town of Derry, 2016; Town of Londonderry, 2016). The land use within the study area was defined as the land area within 500 feet of the proposed alternative alignments (Figure 3-1). Field visits and windshield surveys were used to verify land use conditions.

Land use policies and plans for the Project area were identified through a review of the following comprehensive and master plans:

- Master Plan of Derry (Town of Derry, 2010)
- Comprehensive Master Plan of Londonderry (Town of Londonderry, 2013)
- Southern New Hampshire Planning Commission’s Moving Southern New Hampshire Forward: 2015-2035 Regional Comprehensive Plan (SNHPC, 2014)

Land use within the study area includes commercial, industrial, single- and multi-family residential, institutional, civic, open space, and recreational (golf course). Figure 3-1 also identifies the proposed Woodmont Commons Planned Unit Development (PUD).

The Woodmont Commons PUD is planned for construction on both the east and west sides of I-93 in Londonderry. Phase I is the only approved plan along the west side of I-93; it includes a Market Basket. Access to these parcels is available from John R. Michels Way and Pillsbury Road. Woodmont Commons East would be located north of Ash Street and directly serviced by a new I-93 Exit 4A under Alternatives A or B (See Section 6.1 for detailed alternative description). Pillsbury Road and Ash Street would provide a direct connection between the east and west sections of Woodmont Commons. Specific uses within the development have not been finalized but would include residential, office, medical, hotel, retail, and civic uses. Figure 3-2 illustrates the proposed Woodmont Commons PUD.

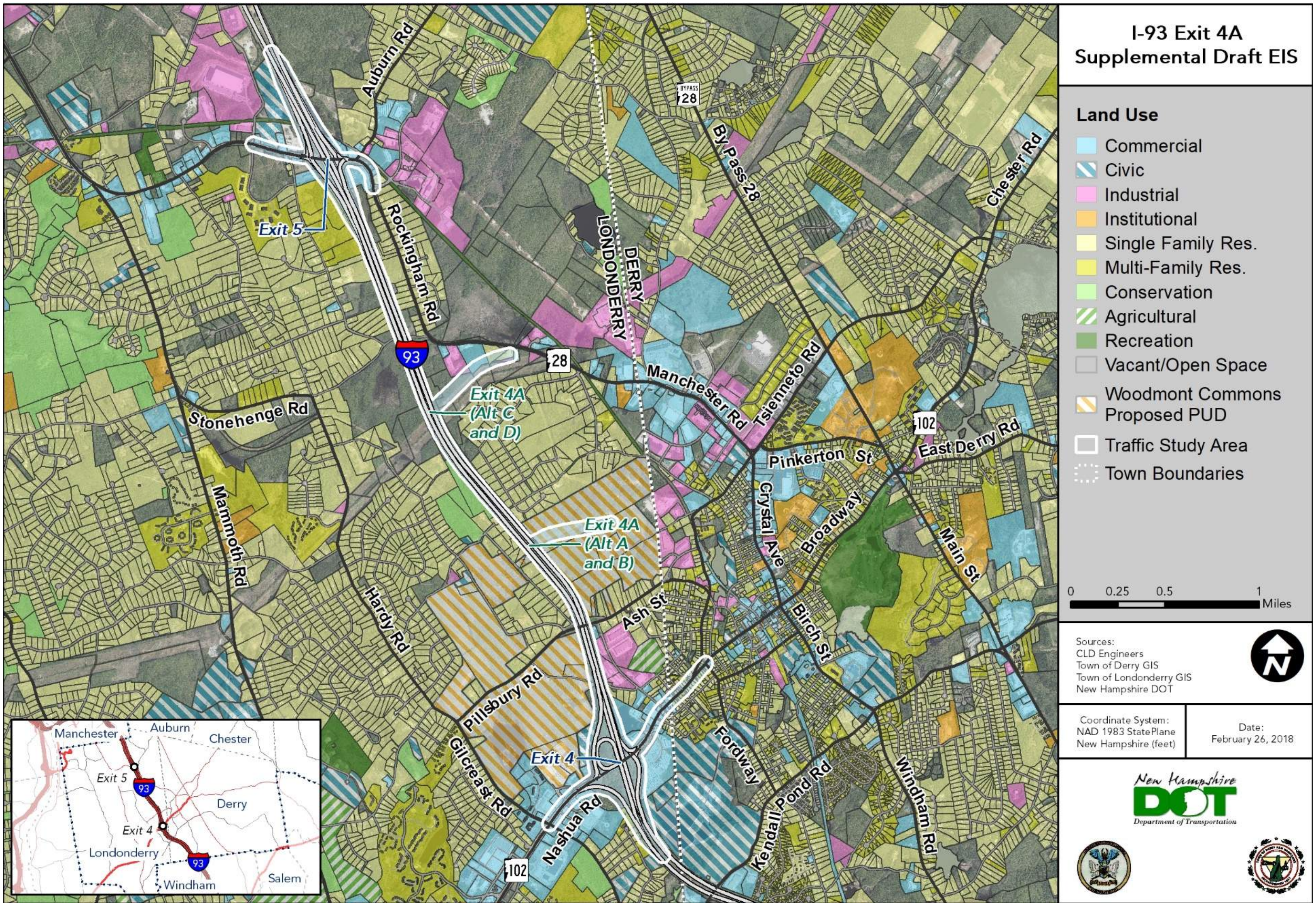


Figure 3-1. Land use in the study area

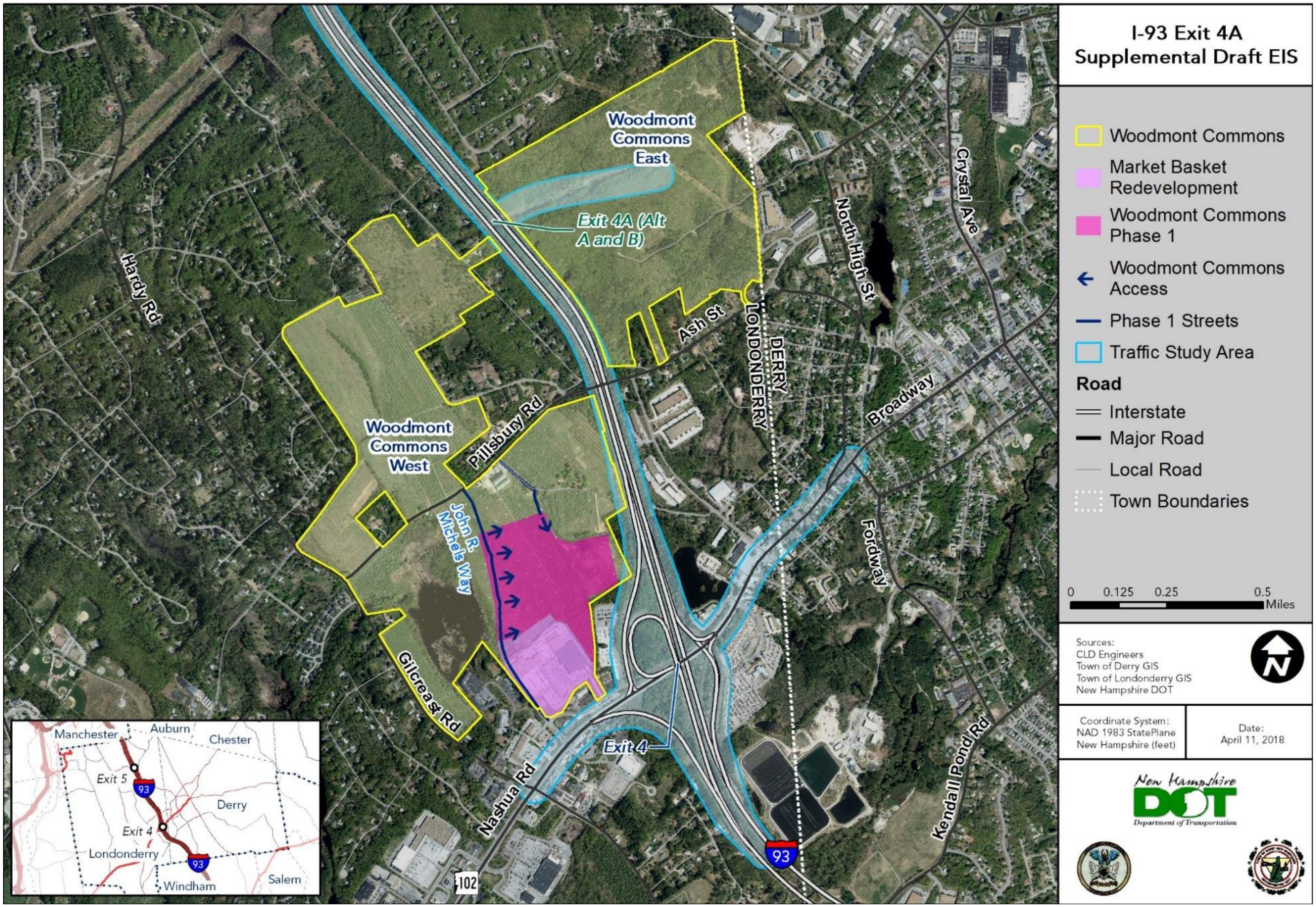


Figure 3-2. Proposed Woodmont Commons Planned Unit Development

3.3 Roadway Network

The roadway network in the study area contains a mix of Interstate, principal arterials, collectors, and local roadways.

Interstate 93 is a north-south oriented, full access control roadway part of the Eisenhower Interstate System connecting Massachusetts to Vermont. It has a posted speed limit of 65 miles per hour (mph) through the study area and four travel lanes, two in each direction. The average daily traffic (ADT) in 2015 was approximately 35,000 vehicles in each direction or 71,000 total vehicles per day and is functionally classified by NHDOT as a principal arterial, Interstate (NHDOT, 2016a; 2017a). Two interchanges exist in the study area serving NH 102 and NH 28.

NHDOT is in the process of upgrading I-93 from four to eight travel lanes, two in each direction to four in each direction, between Salem, New Hampshire, at the Massachusetts border and Manchester, New Hampshire, ending at Exit 6 at the I-293 interchange, more than 3 miles north of Exit 5. Exit 5 reconstruction was completed in 2014. Exit 4 reconstruction is currently ongoing with anticipated completion in fall 2020. Widening the I-93 mainline to six lanes is currently ongoing between Exits 4 and 5 with anticipated completion in fall 2020. Final construction of the fourth travel lane in each direction (eight lanes total) will be achieved with a separate project in the NHDOT Ten Year Plan with anticipated completion in fall 2020 (NHDOT, 2017b). The No Build and all Build alternatives under study for Exit 4A assume completion of the I-93 widening project.

NH 28 is a north-south oriented roadway with partial access control in the vicinity of the interchange connecting Massachusetts to Manchester, New Hampshire. It has a posted speed limit of 30 mph through the study area and four travel lanes, two in each direction from the I-93 interchange and north. To the south it has two travel lanes, one in each direction. The ADT in 2014 was approximately 16,000 total vehicles per day and is functionally classified by NHDOT as an urban minor arterial (NHDOT, 2016b; 2017a).

NH 102 is a northeast-southwest oriented roadway with partial access control west of I-93 and no access control east of I-93 connecting Nashua to Chester, New Hampshire. It has a posted speed limit of 30 mph through the study area and has four travel lanes, two in each direction from the I-93 interchange and west. To the east it has two travel lanes, one in each direction. The ADT in 2014 was approximately 18,000 total vehicles per day and is functionally classified by NHDOT as an urban principal arterial – other (NHDOT, 2016c; 2017a). The roadway travels through a more urban environment to the east of I-93, entering the outskirts of downtown Derry.

Symmes Drive/Vista Ridge Drive is a north-south oriented local roadway with no access control. It has two travel lanes, one in each direction.

Liberty Drive is a north-south orientated local roadway with no access control. It has two travel lanes, one in each direction.

Gilcreast Drive is a northwest-southeast oriented local roadway with no access control. It has a posted speed limit of 35 mph through the study area and has two travel lanes, one in each direction. It is functionally classified by NHDOT as an urban major collector (NHDOT, 2016c).

Garden Lane/Hampton Drive is a northwest-southeast oriented local roadway with no access control. It has two travel lanes, one in each direction.

Londonderry Road/St. Charles Street is a northwest-southeast oriented local roadway with no access control. It has a posted speed limit of 35 mph along Londonderry Road through the study area and has two travel lanes, one in each direction.

Figure 3-3 shows the functional classification of roadways in the study area.

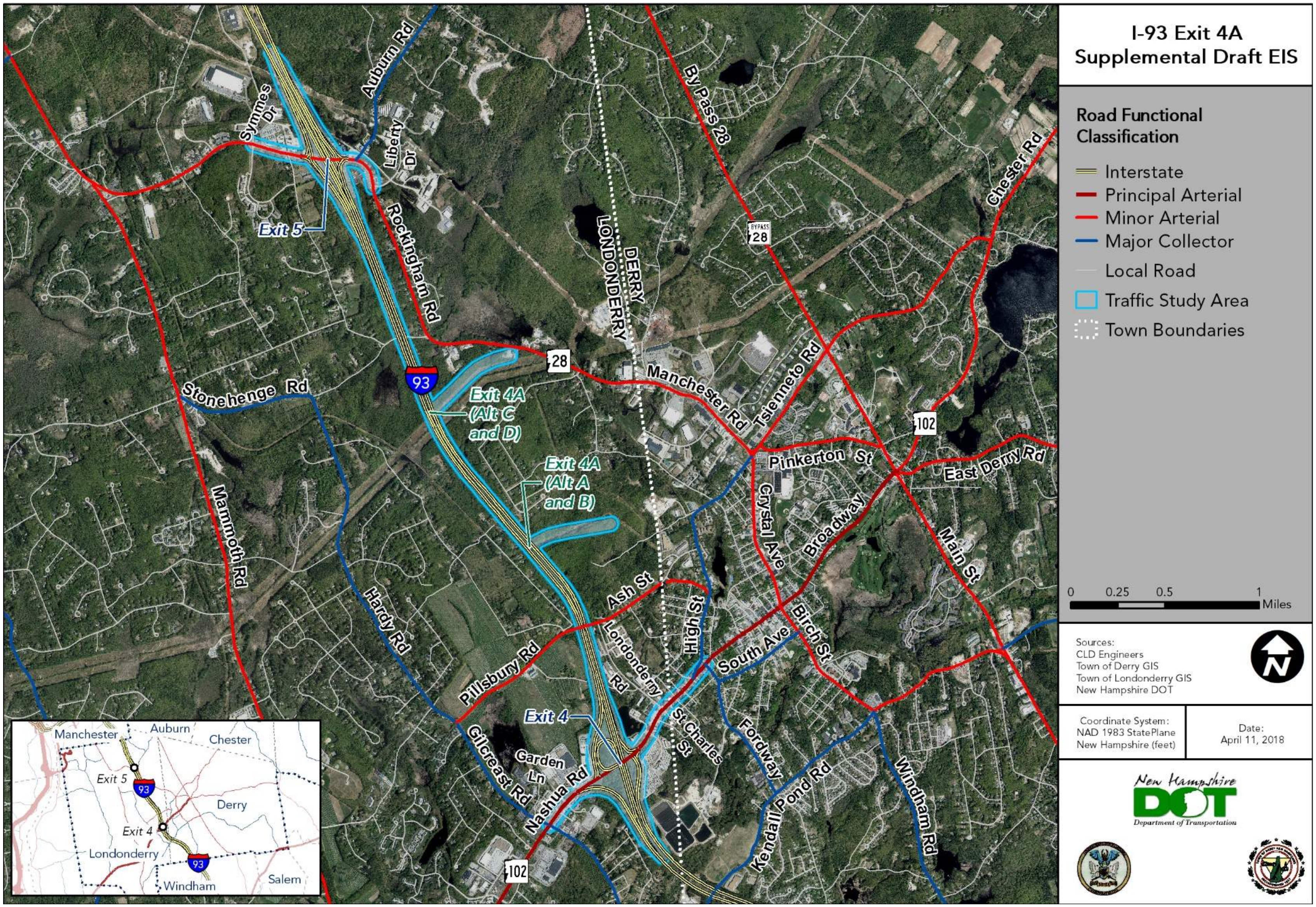


Figure 3-3. Functional classification of roadways in the study area

3.4 Alternative Travel Modes

There are three bus routes, two park and ride lots serviced by the buses, and a bicycle trail in the study area. Figure 3-4 shows the alternative travel modes in the study area. The bus operations include Boston Express, Concord Coach Lines, and Cooperative Alliance for Regional Transportation.

Boston Express operates express bus service between Concord New Hampshire and Boston, Massachusetts. There are two bus stops in the study area composed of North Londonderry at Exit 5 off NH 28 and Londonderry at Exit 4 off NH 102. Buses either service one stop, then express to Boston during the AM peak period, but stop at both Londonderry stops on the return trip. A total of nine inbound buses operate during the AM peak period (6:00 a.m. – 9:00 a.m.) from either stop and 12 buses operate in the return direction during the PM peak period (4:00 p.m. – 7:00 p.m.) (Boston Express, 2016).

Concord Coach Lines operates express bus service between northern New Hampshire and Boston, Massachusetts. There is one bus stop in the study area composed of North Londonderry at Exit 5 off NH 28. A total of six southbound buses operate over the course of the day and five northbound buses operate during the course of the day (Concord Coach Lines, 2017).

Cooperative Alliance for Regional Transportation is a specialty shuttle service that serves the study area by providing on-call rides and scheduled local shuttle routes to shopping and medical services. The routes can include deviations to accommodate patron requests (CART, n.d.).The two park and rides are located near I-93 at Exit 4 in Londonderry and Exit 5 in North Londonderry. Both are served by buses.

Londonderry Exit 4 Park and Ride is operated by Boston Express and Boston Express is the only bus that services the facility. It contains 452 parking spaces and provides a bus shelter and bicycle rack (NHGov, 2017a).

North Londonderry Park and Ride is operated by Boston Express and is served by Boston Express and Concord Coach Lines. It contains 728 parking spaces and provides a bus shelter and bicycle rack (NHGov, 2017b).

There is also a multiuse trail that traverses the study area called the Londonderry Rail Trail along the former Manchester and Lawrence Railroad. This trail is part of a larger trail initiative called the Granite State Rail Trail (Londonderry Trails, 2016).

New Hampshire does not have a high occupancy vehicle lane in the state.

3.5 Interchanges

Two existing interchanges in the study area serve Exits 4 and 5. I-93 at Exit 4 is a combination diamond interchange on the northbound side and partial cloverleaf or Parclo A on the southbound side (FHWA, 2012b). This interchange type provides a higher capacity for NH 102 in the westbound direction by allowing a free-flow move from NH 102 westbound to I-93 southbound. Exit 5 is a compressed diamond interchange, where the spacing between the two intersections at the ramp termini is less than 800 feet (FHWA, 2012b). This interchange was recently upgraded to provide partial access control along NH 28 between Liberty Drive and Symmes Drive. The distance between the two interchanges is approximately 3.6 miles.

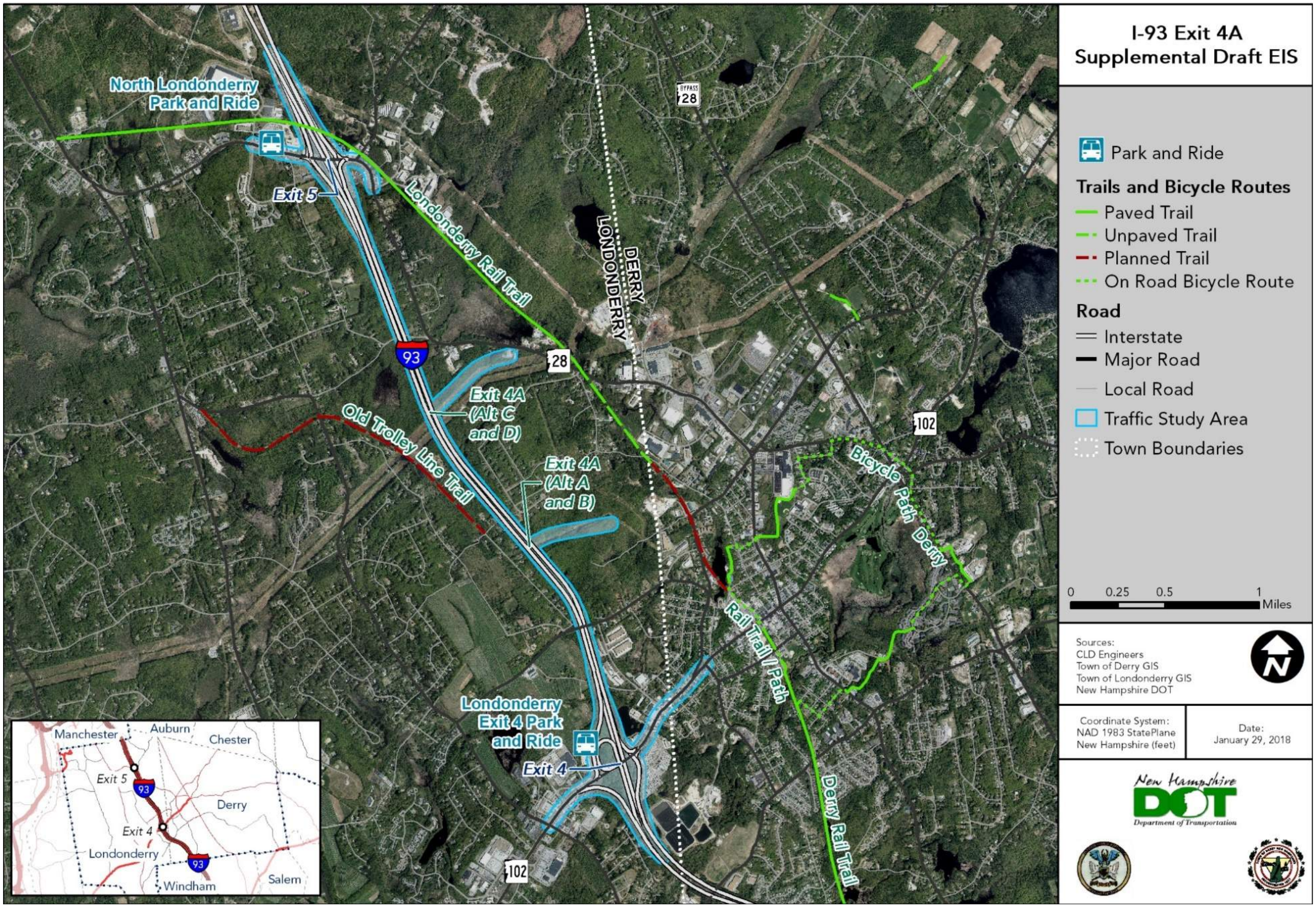


Figure 3-4. Alternative travel modes in the study area

Figure 3-5 shows the I-93 Exit 4 and Exit 5 interchanges.

3.6 Existing Data

3.6.1 Introduction

The primary tool to forecast the future volumes for the proposed I-93 Exit 4A was the SNHPC's travel demand model. The model's most recent base year, 2015, was developed to only forecast daily traffic volumes, not AM or PM peak periods. Therefore, the traffic data collection effort focused on developing both a 2015 balanced AM and PM peak hour network and a daily volume network. The AM and PM peak hour networks provided the percent adjustments between the peak hour volumes and daily volumes while the daily volume network provided the model's 2015 base year data. SNHPC created a 17 TAZ subarea of the model representing Chester, Derry, and Londonderry, the project study area, and calibrated the subarea to the 2015 daily volume balanced network. Once calibrated, the model was ready to test different 2040 future I-93 Exit 4A alternatives and produce the 2040 daily vehicle volumes, based on the land use growth projections. The percent vehicle adjustments between the 2015 AM and PM peak hour volumes and 2015 daily volumes provided the adjustment from the model's forecasted 2040 daily vehicle volume output and forecasted 2040 peak hour volumes. Traffic analysis tools relied on the peak hour volumes to assess the interstate facility and intersection operations.

3.6.2 Traffic Data Collection

Traffic data collection focused on collecting recent data to develop a balanced 2015 network. Data were collected from five sources: (1) Project team, (2) NHDOT permanent count stations, (3) the SNHPC's NH 102 Corridor Update Study Report, (4) the I-93 Supplemental EIS (SEIS), and (5) NHDOT intersection report. The first two sources provided counts in 2016 covering the I-93 mainline and ramp volumes as well as NH 102 and NH 28 turning movement counts for intersections serving I-93 ramp termini and a few intersections east of the interchange along NH 102.

The project team collected daily and hourly ramp volumes at the following intersections in May 2016:

- I-93 northbound off-ramp to NH 102 (Exit 4)
- I-93 northbound on-ramp from NH 102 (Exit 4)
- I-93 southbound off-ramp to NH 102 (Exit 4)
- I-93 southbound on-ramp from NH 102 westbound (Exit 4)
- I-93 southbound on-ramp from NH 102 eastbound (Exit 4)
- I-93 northbound off-ramp to NH 28 (Exit 5)

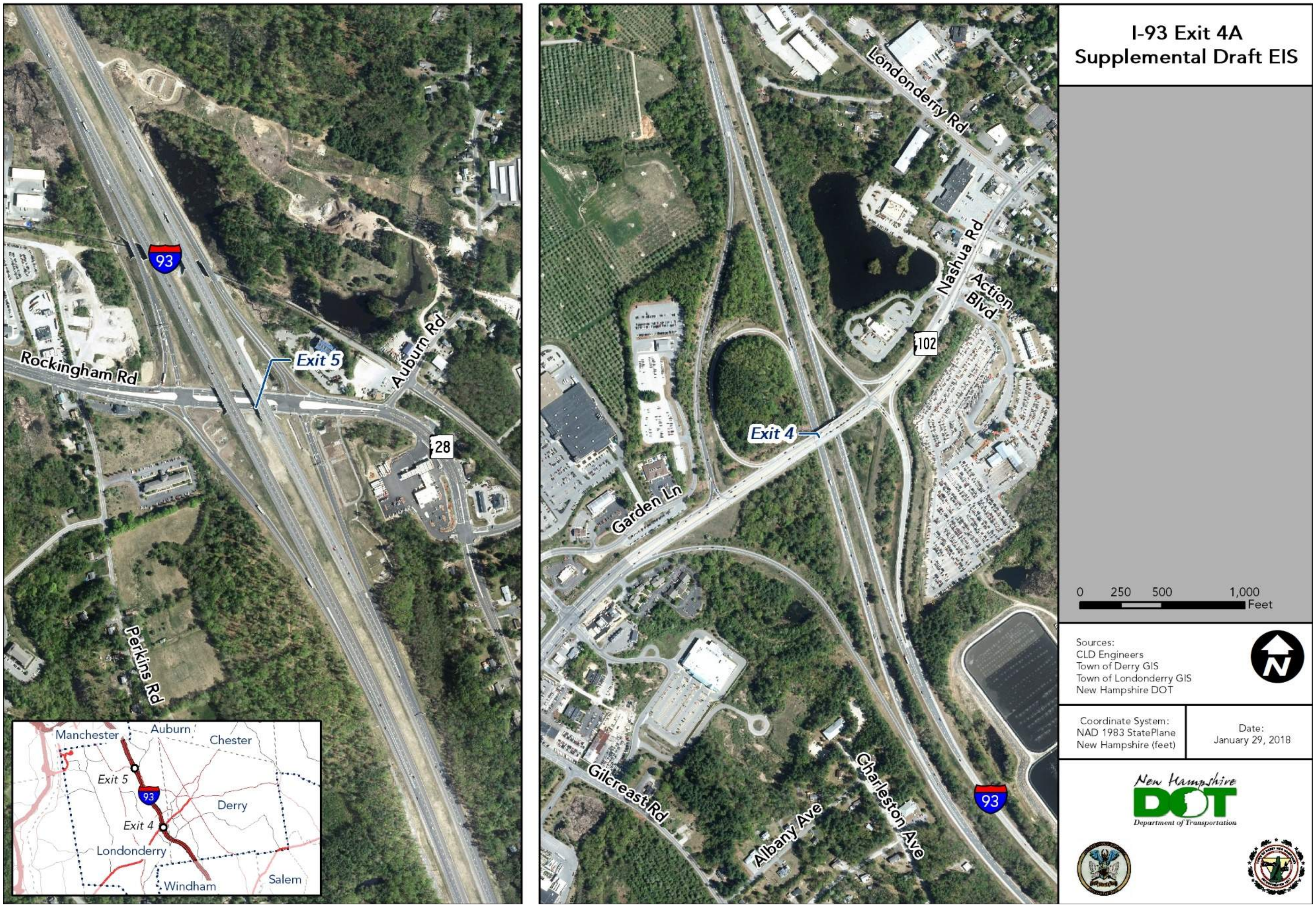


Figure 3-5. I-93 Exit 4 and Exit 5 interchanges

- I-93 northbound on-ramp from NH 28 (Exit 5)
- I-93 southbound off-ramp to NH 28 (Exit 5)
- I-93 southbound on-ramp from NH 28 (Exit 5)

The project team collected AM and PM peak period turning movement counts at the follow intersections in May 2016:

- I-93 northbound on and off-ramps at NH 102 (Exit 4)
- I-93 southbound off-ramp at NH 102 (Exit 4)
- I-93 northbound on and off-ramps at NH 28 (Exit 5)
- I-93 southbound on and off-ramps at NH 28 (Exit 5)
- NH 102 at Londonderry Road/St. Charles Street
- NH 102 at Fordway/Madden Hill Road

The project team obtained hourly and daily vehicle volumes at the follow intersections from April 2014, July 2015, or September 2015:

- NH 102 east of Griffin Street (east of Exit 4)
- NH 102 east of Hampton Drive (west of Exit 4)
- NH 28 east of Perkins Road (west of Exit 5)
- NH 28 north of Liberty Drive (east of Exit 5)

NHDOT provided permanent count station hourly volume data from 2015. The following station data were collected:

- I-93 northbound and southbound, between Exits 3 and 4
- I-93 northbound and southbound mainline, between Exits 4 and 5
- I-93 northbound and southbound mainline, between Exits 5 and 6

The Woodmont Commons Phases I and II Traffic Impact Assessment (TIA) provided turning movement counts for two intersections located west of I-93 at Exit 4 (TEC, 2016). These volumes were obtained in 2016 and used to calculate the vehicle percentage for each tuning movement and applying that percentage to the balanced 2015 traffic network at Exit 4 composed of the project team traffic data. The Woodmont Commons TIA provided data on the following intersections to the study area:

- NH 102 at Gilcreast Road
- NH 102 at Garden Lane/Hampton Drive

The I-93 SEIS provided turning movement counts for one intersection located west of I-93 at Exit 5 (NHDOT, 2009). This volume was obtained in 2005 and used to calculate the vehicle percentage for each tuning movement and applying that percentage to the balanced 2015 traffic network at Exit 5 composed of the project team traffic data. The I-93 SEIS provided data on the following intersection to the study area:

- NH 28 at Symmes Drive/Vista Ridge Drive

NHDOT provided a turning movement count for one intersection located east of I-93 at Exit 5. This volume was obtained in 2005 and used to calculate the vehicle percentage for each tuning movement and applying that percentage to a combination of the balanced 2015 traffic network at Exit 5 composed of the project team traffic data and NHDOT automatic traffic recorder (ATR) data representing NH 28 north of Liberty Drive intersection. NHDOT provided data on the following intersection to the study area:

- NH 28 at Liberty Drive

Figure 3-6 shows the existing condition study area turning movement counts covering the AM and PM peak hours.

As part of the field data collected, a detailed inventory of the lane geometry was conducted through field reconnaissance and a study of aerial imagery. Based on this information, the existing lane geometry and traffic control type (signalized or unsignalized) are shown in Figure 3-7.

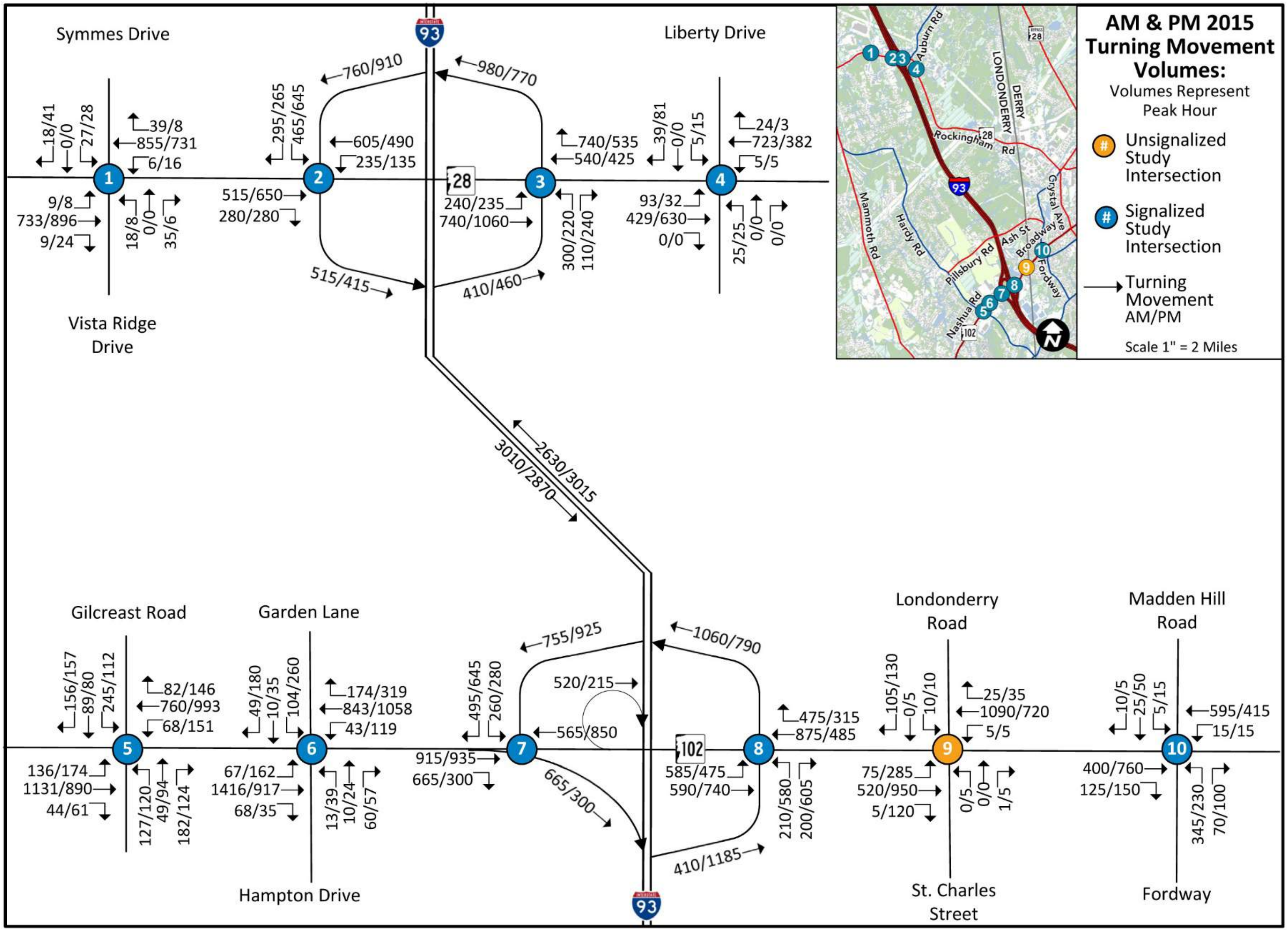


Figure 3-6. AM and PM 2015 existing turning movement volumes

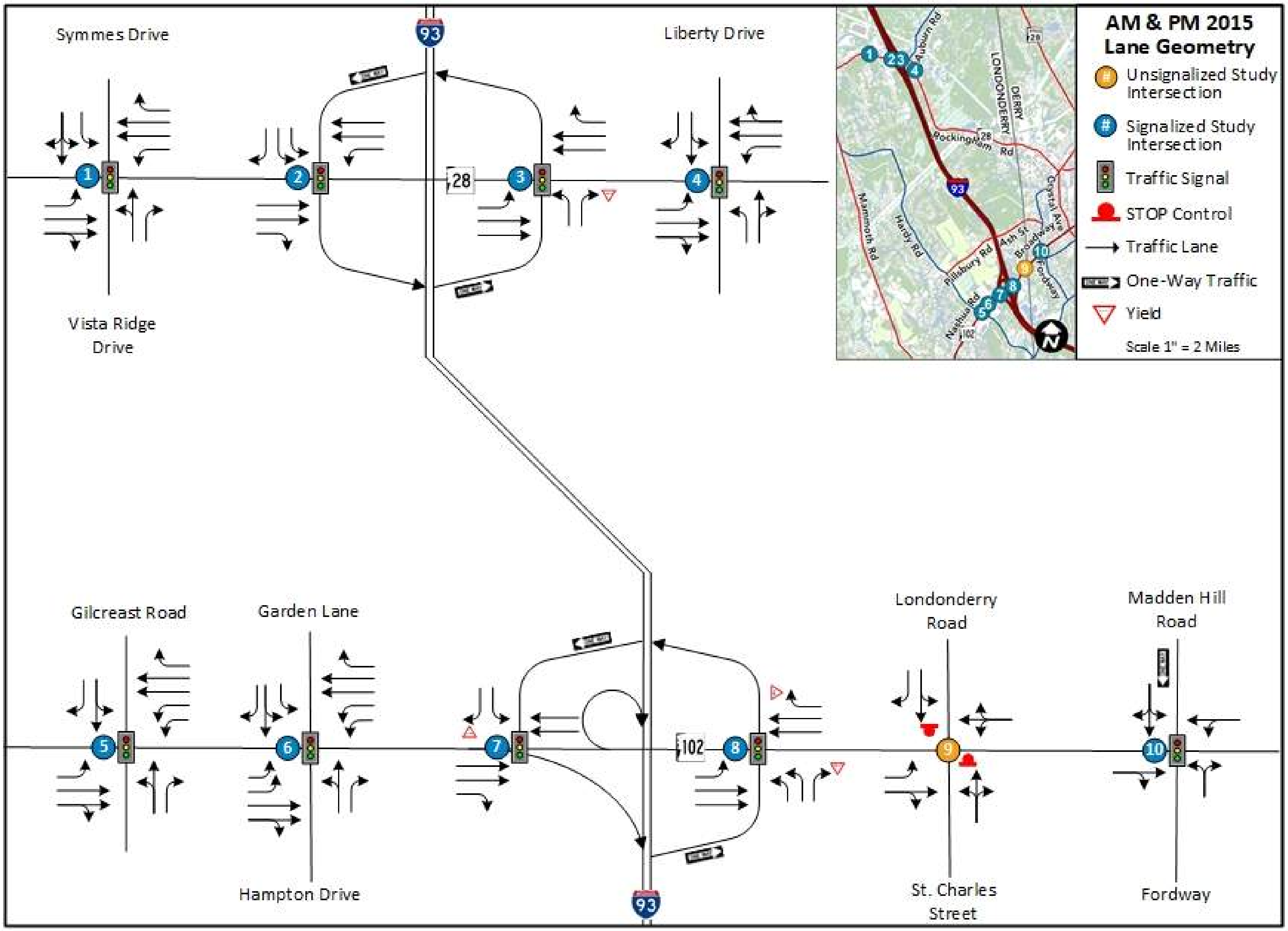


Figure 3-7. AM and PM 2015 existing lane geometry

3.6.3 Traffic Data Adjustments

The raw data from the daily counts were adjusted to create a 2015 base year balanced network using the following three processes. First, they were adjusted based on the count season to allow for seasonal traffic fluctuations and represent a more typical October or April time period. Second, the counts were adjusted to correct for the number of axles that triggered the counter to record a vehicle. Large trucks with more than two axles were counted as two or even three separate vehicles because the counter is programmed to record a vehicle every two axles that cross a sensor or tube. Third, the counts were increased or decreased following a growth factor calculated separately for I-93 mainline and all other roadways (including the I-93 ramps). The I-93 mainline applied a 1.1 percent growth per year based on comparing multiple years of data for a counter on I-93, and all other roadways applied a 2.5 percent growth per year rate based on comparing multiple years of data for a counter on NH 28. Counts were increased or decreased by the appropriate rate depending on whether the counts were before 2015 or after 2015 (no adjustment was applied to 2015 counts).

3.7 Operational Performance

This operational performance explains the concepts and definitions for analyzing the traffic operations, the process used to analyze the study area intersections and freeway facilities along I-93, and the results of the traffic analyses.

3.7.1 Analysis Tools

The study analyzed the study area intersections using Synchro™ Traffic Signal Coordination Software Version 10.0 (Build 1, Revision 26). Two analyses were performed for traffic, including an intersection capacity analysis and an intersection queueing analysis. The intersection capacity analysis used the Synchro™ software tool and various input values as described in the following sections to determine the level of service (LOS) or driver perception of an intersection's operation. The intersection queuing analysis used the Synchro™ tool to determine different levels of queuing or the length that vehicles may back up at an intersection.

The study analyzed the I-93 freeway facilities using Highway Capacity Software (HCS) 2010 (Version 6.90). Analyses were performed for ramp merge and diverge facilities. The HCS relied on various input values to determine the LOS or driver perception of a freeway segment's operation.

3.7.2 Intersection Operations Analysis

LOS is the primary measure of traffic operations for both signalized and unsignalized intersections. LOS is a standard performance measure developed by the transportation profession to quantify driver perception for such elements as travel time, number of stops, total amount of stopped delay, and impediments caused by other vehicles. LOS provides a scale that is intended to match motorists' perception of how a transportation facility operates and to provide a scale to compare different facilities. Detailed LOS descriptions are presented in Figure 3-7.

Signalized Intersection Level of Service

The LOS for signalized intersections is based on the HCM 2000 method and requires the same inputs to determine an accurate LOS (TRB, 2000). HCM 2010 methods were not followed because the signal timings and phasing were not HCM 2010 compliant, for example, signal timings included pedestrian-only phases. Primary inputs include:

- vehicular volumes
- pedestrian volumes
- traffic signal timings
- roadway geometry
- speed limits
- truck percentages
- peak hour factor (measure of vehicle 15-minute flow rate)

The average vehicle control delay, measured in seconds per vehicle, is calculated using these parameters with the Synchro™ procedures. This represents the average extra delay in seconds per vehicle caused by the presence of a traffic control device or traffic signal and includes the time required to decelerate, stop, and accelerate. The LOS can be characterized for the entire intersection, each intersection approach, and each lane group. Control delay is used to characterize the LOS for the entire intersection or an approach. The control delay and the volume-to-capacity ratio are used to characterize the LOS for a lane group. Delay quantifies the increase in travel time due to a traffic signal control. It is also a surrogate measure for driver discomfort and fuel consumption (TRB, 2010). Signalized intersections or approaches that exceed a delay of 55 seconds have LOS E and those that exceed a delay of 80 seconds have LOS F. Table 3-7 shows the average control delay and corresponding LOS for signalized intersections.

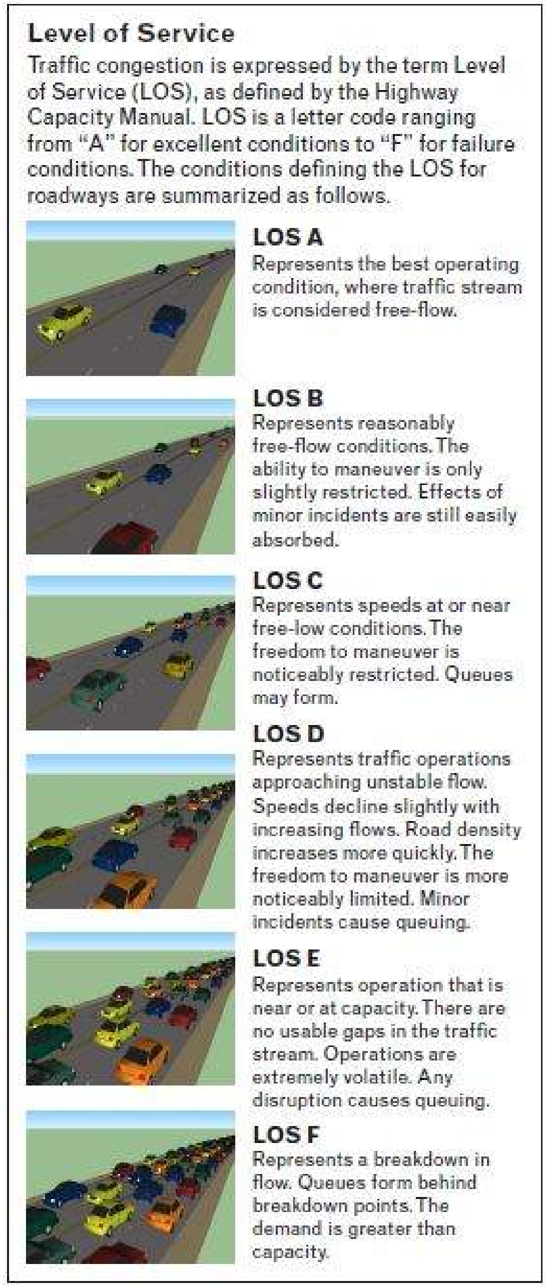


Figure 3-8. Level of service diagram

Table 3-7. Signalized intersection control delay and LOS thresholds – HCM 2000 method

LOS	Average Control Delay (seconds/vehicle)	Description
A	Less than or equal to 10	Stable conditions
B	>10-20	
C	>20-35	
D	>35-55	
E	>55-80	Unstable conditions
F	More than 80	Above capacity and unstable conditions

Source: TRB (2000)

To determine the LOS of an intersection, the critical input values were entered into the analysis software (Synchro™), and the average vehicle delay (seconds per vehicle) was calculated. Based on the average vehicle delay, the LOS was determined for all movements (left, through, and right), approaches, and the intersection as a whole.

Unsignalized Intersection Levels of Service

The LOS for unsignalized intersections (STOP-controlled intersections) is based on the HCM 2000 method to be consistent with the intersections analysis and requires several inputs, including:

- vehicular volumes
- pedestrian volumes
- roadway geometry
- speed limits
- truck percentages
- peak hour factor

The average vehicle control delay, in seconds per vehicle, was calculated using these parameters with the HCM 2000 procedures (TRB, 2010). Average vehicle control delay represents the average delay caused by the presence of a stop sign or roundabout and includes the time required to decelerate, stop, and accelerate.

The LOS for a two-way, STOP-controlled (TWSC) intersection (i.e., unsignalized intersection) is determined for each minor-street movement or shared movement and the major-street left turns. LOS F is assigned to the movement if the volume-to-capacity ratio for the movement exceeds 1.0 or if the movement's control delay exceeds 50 seconds. The criteria used to determine LOS for TWSC intersections are different from the criteria used for signalized intersections primarily because user perceptions differ among transportation facility types. The expectation is that a signalized intersection is designed to carry higher traffic volumes and presents greater delay than an unsignalized intersection. Unsignalized intersections are also associated with more uncertainty for users because delays are less predictable than at signals, which can reduce users' delay tolerance. LOS is not defined for the TWSC intersection as a whole or for major-street approaches for three primary reasons: (1) major-street through vehicles are assumed to experience zero delay; (2) the disproportionate number of major-street through vehicles at a typical TWSC intersection skews the weighted average of all movements, resulting in a very low overall average delay for all vehicles; and (3) the resulting low delay can mask important LOS deficiencies for minor movements (TRB, 2010).

The capacity of the controlled intersection legs is based primarily on three factors: the conflicting volume, the critical gap time (defined as the number of seconds between vehicles passing the same point along the major street approach), and the follow-up time (defined as the number of seconds between the departure of the first and second vehicle in queue along the minor street approach). The HCM-based capacity analysis procedure assumes that drivers are both consistent and homogeneous and assumes consistency for their critical gap time. Critical gap times are based on many factors, including delay experienced by drivers on the approaches controlled by STOP signs. As delay increases, drivers become less patient and accept shorter gaps, resulting in higher capacities for unsignalized intersections that are operating at LOS D or worse. The unsignalized intersection procedure uses fixed critical gap times. Unless the critical gap times are adjusted, the procedure tends to overestimate the delay at unsignalized intersections that are operating at LOS D or worse. Also, poor operations at an unsignalized intersection encourages some drivers to turn right and make a U-turn on the mainline or accept shorter critical gaps (safety issue) rather than attempt a left turn (TRB, 2010).

Table 3-8 shows the average control delay and corresponding LOS for unsignalized intersections. The worst LOS at one-way, STOP-controlled, and TWSC intersections represents the delay for the minor approach only.

Table 3-8. Unsignalized intersection control delay and LOS thresholds – HCM 2000 method

LOS	Average Control Delay (seconds/vehicle)	Description
A	Less than or equal to 10	Stable conditions
B	>10-15	
C	>15-25	
D	>25-35	
E	>35-50	Unstable conditions
F	More than 50	Above capacity and unstable conditions

Source: TRB (2010)

3.7.3 Freeway Operations Analysis

The LOS for freeway facilities is based on the HCM 2010 method and requires inputs to determine an accurate LOS. Primary inputs include:

- vehicular volumes

- roadway geometry
- speed limits
- truck percentages
- peak hour factor

Freeway facilities are evaluated based on the density of vehicles. The higher the density the slower the vehicles travel and the worse the operations. Based on the vehicle density, the HCM provides LOS equivalents to represent the driver's perception of the facility operation. Table 3-9 shows the density and corresponding LOS for signalized intersections.

Table 3-9. HCM freeway facility level of service

<table>
<tr><th rowspan="2">LOS</th><th>Freeway Merge and Diverge Facilities</th><th rowspan="2">Description</th></tr>
<tr><th>Density (passenger cars/ mile/ lane)</th></tr>
<tr><td>A</td><td>0-10</td><td rowspan="4">Passing operation</td></tr>
<tr><td>B</td><td>>10-20</td></tr>
<tr><td>C</td><td>>20-28</td></tr>
<tr><td>D</td><td>>28-35</td></tr>
<tr><td>E</td><td>>35</td><td>Unstable conditions</td></tr>
<tr><td>F</td><td>Demand Exceeds Capacity</td><td>Above capacity and unstable conditions</td></tr>
</table>

Source: TRB (2010)

3.7.4 Existing Condition Intersection Operations Analysis

Based on the Synchro™ signalized intersection analysis results, one signalized intersection at Gilcreast Road (Intersection #5) operates at unacceptable conditions (LOS E or LOS F) during the AM peak hour. The remaining signalized intersections in the traffic study area operate at acceptable overall conditions (LOS D or better is considered an acceptable operating level) during the peak hours analyzed (weekday AM and PM peak hours).

Based on the Synchro™ signalized intersection analysis results, one study area signalized intersection (Intersection #5) has overall approaches that operate at unacceptable conditions (LOS E or LOS F) during one or two evaluated periods. The following are the individual signalized intersection approaches in the traffic study area that operate under unacceptable conditions during peak hours:

- NH 102 at Gilcreast Road (Intersection #5)
  - Eastbound and Westbound NH 102 during the AM peak hour
  - Northbound Gilcreast Road during the PM peak hour
  - Southbound Gilcreast Road during the AM and PM peak hours

Based on the Synchro™ unsignalized intersection analysis results, the NH 102 at Saint Charles Street/Londonderry Road unsignalized intersection (Intersection #9) operates at acceptable conditions (LOS D or better is considered an acceptable operating level) during the two evaluated periods.

Based on the Synchro™ unsignalized intersection analysis results, the unsignalized Intersection #9 has overall approaches that operate at unacceptable conditions (LOS E or LOS F) during one or two evaluated periods. The following are the individual unsignalized intersection approaches in the traffic study area that operate under unacceptable conditions during peak hours:

- NH 102 at Saint Charles Street/Londonderry Road (Intersection #9)
  - Northbound Saint Charles Street during the PM peak hour
  - Southbound Londonderry Road during the AM and PM peak hours

The overall intersection LOS grades are depicted in Figure 3-9. Table 3-10 contains the results of the LOS capacity analysis and the intersection vehicle delay for the existing condition during the AM and PM peak hours. Appendix A contains the Synchro™ existing conditions intersection analysis reports.

3.7.5 Existing Condition Intersection Queuing Analysis

In addition to analyzing the vehicle delay, the vehicle queue lengths were calculated for each approach. The 95th percentile queue length is the worst-case scenario, calculated as the queue that has a 5% probability of being exceeded. A failing queue length is determined by a queue length exceeding the intersection approach storage capacity. Because the available storage for each intersection approach differs, these values reflect whether the existing storage provides enough space for vehicles waiting to pass through the intersection without blocking another lane or another intersection. The study used Synchro™ to calculate the 95th percentile queue lengths for the nine signalized intersections and one unsignalized intersection.

Based on the Synchro™ signalized intersection analysis results, five signalized intersections listed below experience queuing lengths that exceed the available storage capacity. The remaining signalized intersections in the traffic study area provide sufficient storage for the anticipated demand. The lane group in the approach that is operating under unacceptable conditions is noted in parentheses. Table 3-10 contains the queuing results. Appendix B contains the Synchro™ existing conditions intersection queuing reports.

- NH 28 at Symmes Drive/Vista Ridge Drive (Intersection #1)
  - Northbound Vista Ridge Drive (right turns) during the AM and the PM peak hours
- NH 102 at Gilcreast Road (Intersection #5)
  - Eastbound NH 102 (left turns) during the AM and PM peak hours
  - Eastbound NH 102 (right turns and through movements) during the AM peak hour
  - Westbound (right turns and through movements) during the PM peak hour
  - Southbound Gilcreast Road (left turns and through movements) during the AM peak hour
- NH 102 at Garden Lane (Intersection #6)

  - o Northbound Garden Lane (right turns) during the PM peak hour

- NH 102 at I-93 Southbound off-ramp (Exit 4) (Intersection #7)
  - o I-93 Southbound off-ramp (all movements) during the PM peak hour
- NH 102 at Fordway/Madden Hill Road (Intersection #10)
  - o Eastbound NH 102 (all movements) during the PM peak hour
  - o Westbound NH 102 (all movements) during the AM and PM peak hours

Based on the Synchro™ unsignalized intersection analysis results, the unsignalized intersection (Intersection #9) listed below experiences queuing lengths that exceed the available storage capacity.

- NH 102 at Saint Charles/Londonderry Road (Intersection #9)
  - o Eastbound NH 102 (left turns) during the PM peak hour

The remaining signalized intersections in the traffic study area provide sufficient storage for the anticipated demand. The lane group in the approach that is operating under unacceptable conditions is highlighted in red In Table 3-10, which contains the queuing results. Note that the percentile values are expressed in feet, and a car occupies about 25 linear feet of roadway, including the space between cars.

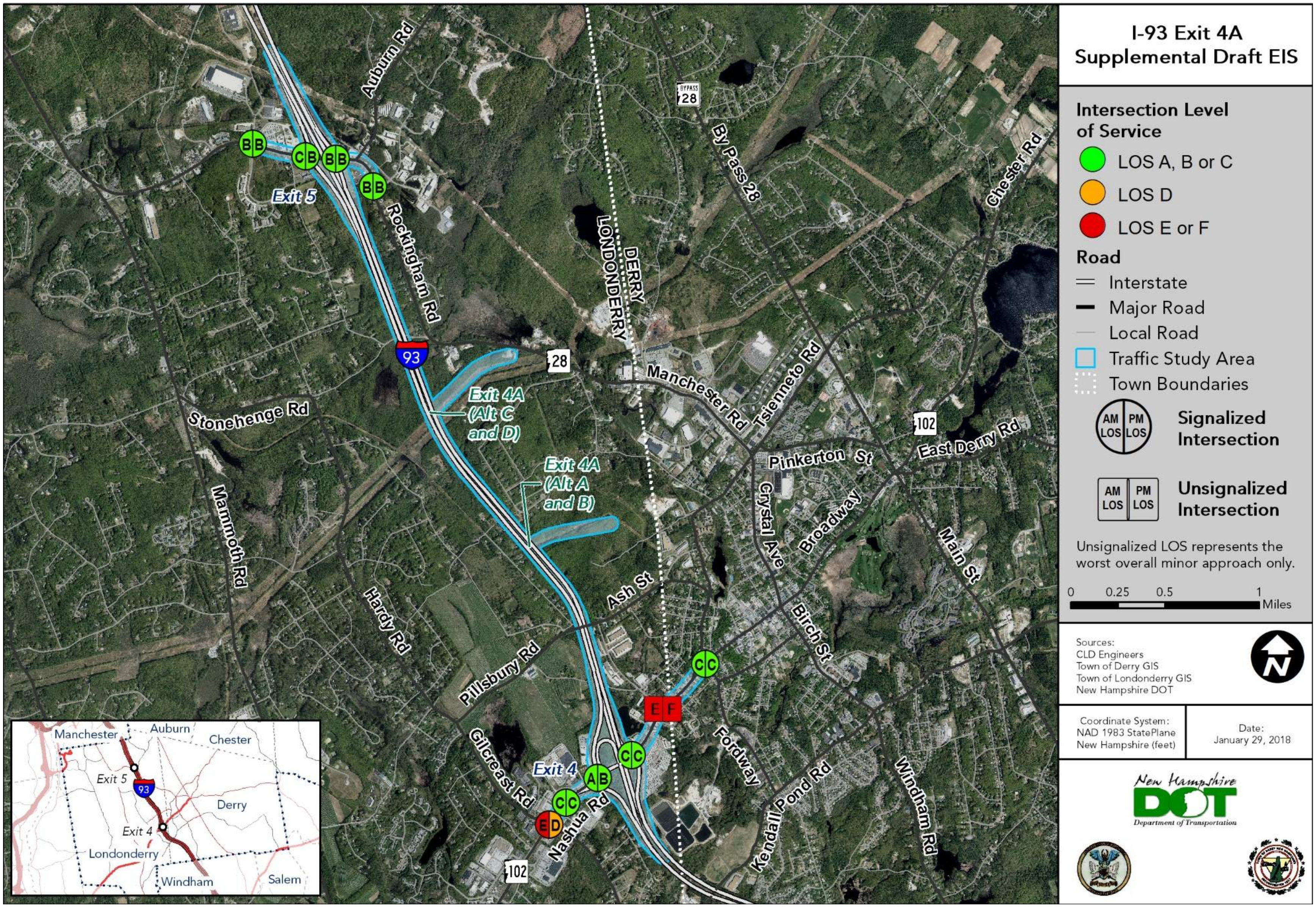


Figure 3-9. 2015 AM and PM peak hour LOS by intersection

Table 3-10. 2015 intersection capacity and queuing analyses

Intersection	Lane Groups	Turning Bay/Link Length (feet)	AM Peak Hour 95% queue (ft)	AM v/c ratio	AM Average Delay (sec/veh)	AM LOS	PM Peak Hour 95% queue (ft)	PM v/c ratio	PM Average Delay (sec/veh)	PM LOS
#1 NH 28 & Symmes Dr/Vista Ridge Dr (Signalized) [a]	EB L	402	24	0.42	46.0	D	24	0.35	46.4	D
	EB TR	726	145	0.47	10.3	B	142	0.54	11.2	B
	EB Overall				10.7	B			11.5	B
	WB L	450	18	0.30	42.1	D	35	0.35	41.4	D
	WB Thru	1,537	291	0.51	10.7	B	189	0.43	9.5	A
	WB R	500	16	0.03	7.7	A	7	0.01	7.0	A
	WB Overall				10.8	B			10.1	B
	NB LT	1,660	40	0.21	33.4	C	30	0.18	39.1	D
	NB R	10	#61	0.02	32.1	C	#26	0.00	37.3	D
	NB Overall				32.5	C			38.3	D
	SB L	270	33	0.28	34.0	C	34	0.22	35.4	D
	SB LTR	270	48	0.02	31.9	C	55	0.03	34.1	C
	SB Overall				33.0	C			34.6	C
	Intersection Overall			**0.47**	**12.0**	**B**		**0.49**	**12.0**	**B**
#2 NH 28 & I-93 SB On and Off-Ramp (Exit 5) (Signalized) [a]	EB Thru	1,537	221	0.73	34.1	C	270	0.59	27.7	C
	EB R	350	55	0.21	0.3	A	55	0.21	0.3	A
	EB Overall				22.2	C			19.5	B
	WB L	592	263	0.91	37.5	D	147	0.65	16.4	B
	WB Thru	592	142	0.47	6.7	A	121	0.29	3.3	A
	WB Overall				15.3	B			6.1	A
	SB L	502	186	0.59	23.4	C	254	0.67	31.3	C
	SB R	502	57	0.64	25.9	C	-	0.21	25.3	C
	SB Overall				24.4	C			29.6	C
	Intersection Overall			**0.74**	**20.3**	**C**		**0.63**	**19.6**	**B**
#3 NH 28 & I-93 NB On and Off-Ramp (Exit 5) (Signalized) [a]	EB L	592	255	0.85	19.8	B	252	0.68	16.0	B
	EB Thru	592	79	0.45	2.4	A	148	0.54	4.1	A
	EB Overall				6.7	A			6.2	A
	WB Thru	481	142	0.57	25.7	C	112	0.40	26.6	C
	WB R	-	-	0.53	1.3	A	-	0.38	0.7	A
	WB Overall				11.6	B			12.2	B
	NB L	798	302	0.86	42.6	D	253	0.71	38.1	D
	NB R	798	-	0.10	21.9	C	98	0.69	37.7	D
	NB Overall				37.0	D			37.9	D
	Intersection Overall			**0.78**	**14.1**	**B**		**0.65**	**15.1**	**B**

Table 3-10. 2015 intersection capacity and queuing analyses (continued)

Intersection	Lane Groups	Turning Bay/Link Length (feet)	AM Peak Hour 95% queue (ft)	AM Peak Hour v/c ratio	AM Peak Hour Average Delay (sec/veh)	AM Peak Hour LOS	PM Peak Hour 95% queue (ft)	PM Peak Hour v/c ratio	PM Peak Hour Average Delay (sec/veh)	PM Peak Hour LOS
#4 NH 28 & Liberty Dr	EB L	225	90	0.53	30.2	C	43	0.41	26.1	C
(Signalized) [a]	EB TR	841	64	0.22	4.6	A	98	0.41	8.1	A
	EB Overall				9.1	A			8.9	A
	WB L	250	21	0.33	42.9	D	19	0.19	27.2	C
	WB TR	332	145	0.45	9.0	A	85	0.27	8.3	A
	WB Overall				9.3	A			8.5	A
	NB L	154	50	0.25	30.7	C	48	0.16	20.0	B
	NB Overall				30.7	C			20.0	B
	SB LT	100	24	0.09	29.8	C	35	0.17	20.0	C
	SB R	502	78	0.05	29.5	C	90	0.09	19.6	B
	SB Overall				29.6	C			19.6	B
	Intersection Overall			**0.45**	**10.4**	**B**		**0.38**	**10.3**	**B**
#5 NH 102 & Gilcreast Rd	EB L	275	#394	0.79	64.1	E	#279	0.80	68.4	E
(Signalized) [a]	EB RT	1,140	#1385	1.04	71.4	E	374	0.79	40.9	D
	EB Overall				**70.7**	**E**			45.1	D
	WB L	250	70	0.29	25.2	C	198	0.31	25.2	C
	WB Thru	666	281	1.06	63.1	E	#769	1.07	62.9	E
	WB R	375	85	0.06	173.6	F	#513	0.10	4.1	A
	WB Overall				**70.2**	**E**			51.8	D
	NB LT	499	185	0.77	55.3	E	240	0.81	64.7	E
	NB R	499	226	0.13	38.1	D	158	0.08	43.4	D
	NB Overall				46.5	D			**56.9**	**E**
	SB LT	303	#339	0.96	73.3	E	247	0.82	68.4	E
	SB R	303	220	0.11	31.9	C	194	0.11	45.3	D
	SB Overall				**60.1**	**E**			**58.0**	**E**
	Intersection Overall			**1.02**	**66.1**	**E**		**0.96**	**50.7**	**D**

Table 3-10. 2015 intersection capacity and queuing analyses (continued)

Intersection	Lane Groups	Turning Bay/Link Length (feet)	AM Peak Hour				PM Peak Hour			
			95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS
#6 NH 102 & Hampton Dr/Garden Ln (Signalized) [a]	EB L	250	118	0.30	56.2	E	118	0.49	68.1	E
	EB TR	666	612	0.97	17.5	B	224	0.60	8.5	A
	EB Overall				19.2	B			17.2	B
	WB L	300	45	0.23	35.5	D	179	0.43	61.4	E
	WB Thru	969	278	0.60	26.5	C	410	0.71	21.4	C
	WB R	364	153	0.13	45.7	D	253	0.28	12.3	B
	WB Overall				30.0	C			22.6	C
	NB LT	630	50	0.11	39.3	D	100	0.48	56.4	E
	NB R	100	74	0.04	38.4	D	#106	0.04	51.3	D
	NB Overall				38.7	D			54.0	D
	SB L	303	85	0.42	46.0	D	191	0.63	53.5	D
	SB LT	303	73	0.42	45.9	D	161	0.64	53.9	D
	SB R	303	57	0.03	41.9	D	192	0.12	44.6	D
	SB Overall				44.7	D			50.3	D
	Intersection Overall			**0.70**	**25.3**	**C**		**0.64**	**26.0**	**C**
#7 NH 102 & I-93 SB Off-Ramp (Exit 4) (Signalized) [a]	EB Thru	969	109	0.43	2.0	A	312	0.42	14.4	B
	EB Overall				2.0	A			14.4	B
	WB Thru	1,033	83	0.29	2.4	A	239	0.39	13.7	B
	WB Overall				2.4	A			13.7	B
	SB L	294	244	0.77	45.8	D	#301	0.79	55.7	E
	SB R	294	138	0.36	0.7	A	#335	0.45	0.9	A
	SB Overall				16.2	B			17.5	B
	Intersection Overall			**0.54**	**7.0**	**A**		**0.57**	**15.2**	**B**
#8 NH 102 & I-93 NB On and Off-Ramp (Exit 4) (Signalized) [a]	EB L	700	629	0.92	38.2	D	494	0.89	60.5	E
	EB Thru	1,033	411	0.25	2.5	A	266	0.33	9.1	A
	EB Overall				20.3	C			29.2	C
	WB Thru	1,095	592	0.97	57.8	E	242	0.54	37.4	D
	WB R	758	294	0.33	0.6	A	-	0.23	0.3	A
	WB Overall				37.7	D			22.8	C
	NB L	1,440	141	0.51	41.3	D	282	0.75	46.8	D
	NB R	1,440	-	0.15	0.2	A	182	0.41	0.8	A
	NB Overall				21.3	C			23.3	C
	Intersection Overall			**0.86**	**28.4**	**C**		**0.73**	**25.3**	**C**

Table 3-10. 2015 intersection capacity and queuing analyses (continued)

Intersection	Lane Groups	Turning Bay/Link Length (feet)	AM Peak Hour 95% queue (ft)	AM v/c ratio	AM Average Delay (sec/veh)	AM LOS	PM Peak Hour 95% queue (ft)	PM v/c ratio	PM Average Delay (sec/veh)	PM LOS
#9 NH 102 & St Charles St/Londonderry Rd (TWSC) [b]	EB L	150	72	0.14	12.3	B	#180	0.35	11.7	B
	EB TR	1,434	-	-	-	-	545	-	-	-
	EB Overall				1.5	-			2.5	-
	WB LTR	463	35	0.01	8.6	A	276	0.01	10.7	B
	WB Overall				0.0	-			0.1	-
	NB LTR	412	10	0.01	11.9	B	88	1.23	*	F
	NB Overall				11.9	B			*	F
	SB LT	780	35	0.25	115.0	F	109	1.13	*	F
	SB R	150	100	0.51	36.1	E	114	0.40	19.9	C
	SB Overall				**43.0**	**E**			**79.8**	**F**
#10 NH 102 & Fordway/Madden Hill Rd (Signalized) [a]	EB TR	455	277	0.72	15.5	B	#1315	0.99	41.5	D
	EB Overall				15.5	B			41.5	D
	WB LT	165	#413	0.85	22.3	C	#693	0.79	18.5	B
	WB Overall				22.3	C			18.5	B
	NB LR	375	248	0.94	47.1	D	196	0.82	33.8	C
	NB Overall				47.1	D			33.8	C
	SB LTR	120	46	0.10	13.8	B	63	0.17	16.5	B
	SB Overall				13.8	B			16.5	B
	Intersection Overall			**0.89**	**25.7**	**C**		**0.93**	**33.0**	**C**

Notes:

95th percentile volume exceeds capacity, queue may be longer.

EB = Eastbound, WB = Westbound, NB= Northbound, SB = Southbound

LOS = Level of Service

LTR = left / through / right lanes

TWSC = Two-way STOP-Controlled unsignalized intersection (TWSC intersections do not have an overall LOS)

V/C = Volume-to-Capacity ratio

Delay is Measured in Seconds Per Vehicle.

Red cells denote intersections or approaches operating at unacceptable conditions or denote approaches and lane groups whose queuing length exceeds capacity

* Calculated delay exceeds 300 seconds

[a] Highway Capacity Manual 2000 results (Signalized intersections)

[b] Highway Capacity Manual 2010 results (Unsignalized intersection)

3.7.6 Existing Condition Freeway Operations Analysis

Based on the analysis performed using HCS, all the freeway facilities operate below capacity, operating with a LOS D or better condition during the AM and PM peak hours. In addition, the demand to capacity ratio did not exceed 0.80 where 1.00 equates to the facility operating at capacity. Table 3-11 contains the Exit 4 existing condition freeway analysis and Table 3-12 contains the Exit 5 existing freeway analysis. Appendix C contains the existing conditions HCS freeway operation reports.

Table 3-11. I-93 Exit 4 existing freeway analysis

Freeway Analysis	Facility Type	Time Period	Demand to Capacity Ratio		Density (pc/mi/ln)	LOS
			Freeway	Ramp		
I-93 Northbound to NH 102	Diverge	AM	0.45	0.26	15.4	B
		PM	0.77	0.62	28.8	D
NH 102 to I-93 Northbound	Merge	AM	0.60	0.57	18.8	B
		PM	0.70	0.44	22.3	C
I-93 Southbound to NH 102	Diverge	AM	0.69	0.39	26.0	C
		PM	0.65	0.49	24.3	C
NH 102 Westbound to I-93 Southbound	Merge	AM	0.65	0.34	20.0	B
		PM	0.50	0.14	14.5	B
NH 102 Eastbound to I-93 Southbound	Merge	AM	0.80	0.40	26.3	C
		PM	0.57	0.18	17.7	B

Notes: LOS = Level of Service; Density = Passenger cars per mile per lane (pc/mi/ln)

Table 3-12. I-93 Exit 5 existing freeway analysis

Freeway Analysis	Facility Type	Time Period	Demand to Capacity Ratio		Density (pc/mi/ln)	LOS
			Freeway	Ramp		
I-93 Northbound to NH 28	Diverge	AM	0.60	0.27	24.9	C
		PM	0.68	0.34	27.9	C
NH 28 to I-93 Northbound	Merge	AM	0.76	0.58	28.8	D
		PM	0.76	0.42	28.7	D
I-93 Southbound to NH 28	Diverge	AM	0.74	0.50	30.3	D
		PM	0.76	0.50	30.9	D
NH 28 to I-93 Southbound	Merge	AM	0.70	0.31	26.0	C
		PM	0.66	0.25	24.6	C

Notes: LOS = Level of Service; Density = Passenger cars per mile per lane (pc/mi/ln)

3.8 Safety Conditions

Crash ratings are used in transportation analyses to help determine where additional attention or examination of safety should be undertaken. Crash ratings are evaluated based on recorded crash information collected by jurisdiction, in this case 3 years of data from NHDOT (2013–2015), and calculated using the crash information and daily volume of vehicles that travel through the intersection. Crash and injury ratings are calculated based on the number of crashes or injuries that would occur per million entering vehicles (MEV) using the following formula:

$$\text{Rate} = \frac{C * 1{,}000{,}000}{n * 365 * V}$$

In this formula, C is the total number of intersection-related crashes or injuries in the study period, *n* is the number of years of data (i.e., study period), and *V* is the traffic volumes entering the intersection daily. NHDOT provided the crash information over a 3-year period. Daily traffic volumes were calculated by applying a K factor to the 2015 balanced study area intersection traffic counts (the K factor is defined as the percent of the 24-hour daily vehicle volume that represents the AM or PM peak hour). ATR data covering NH 28 and NH 102 were used to calculate the K factor. Table 3-13 contains the AM and PM K factors for NH 28 and NH 102.

Table 3-13. NH 28 and NH 102 K factors

ATR Location	Average Daily Vehicle Volume	Average AM Peak Hour Volume	Average PM Peak Hour Volume	AM K Factor	PM K Factor
NH 28 North of Liberty Drive	16,852	1,437	1,232	0.085	0.073
NH 102, East of Hampton Drive	36,771	2,531	2,896	0.069	0.079

Table 3-14 presents crash ratings for intersections in the study area using NHDOT crash data (NHDOT 2013–2015). The intersections with the highest crash rating are along NH 102 at the I-93 NB off-ramp, Garden Lane/Hampton Drive, and Gilcreast Road. These locations had crash rates greater than 1.00 crashes per MEV. No intersections had injury rates greater than 1.00.

Table 3-14. Intersection crash summary

	Intersection Name	Number of Crashes	Number of Crashes with Injuries	Crash Rate	Injury Rate
				Crashes per million entering vehicles	
1	NH 28 & Symmes Drive/Vista Ridge Drive	3	0	0.12	0.00
2	NH 28 and I-93 SB ramps	22	10	0.65	0.29
3	NH 28 & I-93 NB Ramps	6	5	0.16	0.13
4	NH 28 and Liberty Drive	9	4	0.52	0.23
5	NH 102 & Gilcreast Road	59	14	1.29	0.31
6	NH 102 & Garden Lane/Hampton Drive	72	16	1.60	0.36
7	NH 102 & I-93 SB off-ramp	23	8	0.52	0.18
8	NH 102 & I-93 NB Ramps	81	34	1.78	0.75
9	NH 102 & Londonderry Road/St. Charles Street	13	5	0.43	0.1
10	NH 102 & Madden Hill Road/Fordway	7	1	0.28	0.04

Locations with crash rates over 1.0 are highlighted in orange.

Intersections that have a crash rating of greater than 1.0 may warrant further examination to determine if one or more particular causes can be gleaned from the detailed intersection crash data, and if mitigation is advisable, what mitigation measures would help to improve the safety of the intersection. Of the intersections for which sufficient data are available for analysis (a minimum of 3 years of data), three of the intersections have a crash rating of greater than 1.0.

All study area intersections are shown in more detail in Table 3-15, which helps to examine whether there is a high percentage of a particular type of crash. True reasons for a high crash rating cannot solely be determined with crash data because each situation has unique circumstances that are not reflected in the crash study. However, general trends can be determined or certain causes can be eliminated by examining the available crash-specific information. Collisions can be caused by the following roadway factors (FHWA, 2011):

- Access control: too many driveways causing potential conflict points
- Speed: drivers speeding through a congested corridor
- Roadway cross section: lane and shoulder widths do not match facility type
- Traffic volumes: high volume of traffic increasing exposure to more vehicles
- Pavement condition: ruts, potholes, and bumps causing drivers to swerve to avoid obstacles

A number of human and vehicle factors can also lead to crashes.

The data indicate that most crashes between motor vehicles involve rear-end crashes. Rear-end collisions are often the result of two vehicles traveling in the same direction in close proximity where the leading vehicle stops to avoid hitting a vehicle entering the same lane, runs a RED light, or stops or slows down to avoid roadway obstruction or a pavement condition issue. If the trailing vehicle is driving in close proximity not enough space may be available to avoid the collision.

Based on the location of the crashes along NH 102 and the crash types, most of the crashes seem to indicate that access control and pavement condition were not factors because the crashes were spaced out and not all clumped together near a specific driveway junction or other spot. The roadway is designed with a standard cross section with 12-foot lanes, a shoulder, and the intersections are located along relatively straight sections of roadway. Therefore, the cause of the crashes could be a result of speeding through an area with high traffic volume or potentially distracted drivers not paying attention. Crash data that may provide clues about crash trends are highlighted in orange.

Table 3-15. Detailed intersection crash analysis

	Intersection Name	Crash Rate crashes/ MEV	Rear End	Angle	Head On	Side Swipe - Same Direction	Crash Type not Reported	Fixed Object in Road	Fixed Object Off Road	Pedestrian	Other	Total
			Other Vehicle									
1	NH 28 & Symmes Drive/Vista Ridge Drive	0.12	1	0	0	0	2	0	0	0	0	3
2	NH 28 and I-93 SB ramps	0.65	4	1	0	0	14	0	3	0	0	22
3	NH 28 & I-93 NB Ramps	0.16	1	0	0	0	3	1	1	0	0	6
4	NH 28 and Liberty Drive	0.52	4	0	1	1	2	0	1	0	0	9
5	NH 102 & Gilcreast Road	1.29	18	6	2	5	26	0	2	0	0	59
6	NH 102 & Garden Lane/Hampton Drive	1.60	15	5	3	8	37	0	3	1	0	72
7	NH 102 & I-93 SB off-ramp	0.52	12	0	0	1	10	0	0	0	0	23
8	NH 102 & I-93 NB Ramps	1.78	36	1	0	1	34	1	2	0	6	81
9	NH 102 & Londonderry Road/St. Charles Street	0.43	2	2	0	1	7	0	1	0	0	13
10	NH 102 & Madden Hill Road/Fordway	0.28	0	0	0	0	7	0	0	0	0	7

Sources: NHDOT crash data from 2013-2015, received August 30, 2017

Notes: MEV = Million entering vehicles

Crash data that may provide clues about crash trends are highlighted in orange

The freeway crash analysis follows a similar method as the intersection crash analysis to determine the freeway crash rate. A crash rate was calculated for each freeway facility (diverge and merge) and for the I-93 freeway mainline between Exits 4 and 5 by mile. In 2015, Massachusetts calculated an average crash rate for freeways in an urban and rural area of 0.61 and 0.40, respectively (MassDOT, 2018). Following the more conservative rural measure, all freeway facilities and the two mainline I-93 segments between Exits 4 and 5 had crash rates below 0.40. All locations are shown in Table 3-16.

Table 3-16. Freeway crash summary

Intersection Name	Number of Crashes	Number of Crashes with Injuries	Crash Rate	Injury Rate
			Crashes per million entering vehicles	
I-93 NB at Exit 4 Diverge	8	0	0.20	0.00
I-93 NB at Exit 4 Merge	8	0	0.18	0.00
I-93 SB at Exit 4 Diverge	7	3	0.14	0.06
I-93 SB at Exit 4 First Merge	10	3	0.24	0.07
I-93 SB at Exit 4 Second Merge	10	3	0.20	0.06
I-93 NB at Exit 5 Diverge	6	2	0.13	0.04
I-93 NB at Exit 5 Merge	7	2	0.13	0.04
I-93 SB at Exit 5 Diverge	5	1	0.09	0.02
I-93 SB at Exit 5 Merge	5	0	0.10	0.00
I-93 NB between Exit 4 and Exit 5 (2.5 miles)	44	15	0.39	0.13
I-93 SB between Exit 4 and Exit 5 (2.0 miles)	28	8	0.29	0.08

The detailed data identify a high number of crashes with another vehicle and a majority of crashes in the northbound direction occurring during the evening commute period. Most of the crashes occurred on dry pavement on clear days and were scattered along the roadway sections and not clumped in one particular area. Similar to the findings of the intersection analysis, roadway design does not seem to be an issue, rather driver speeding or distracted drivers may be the main reason for the crashes. Another possibility is that heavy rush hour traffic constrained to two lanes could create crashes from aggressive drivers trying to pass slower-moving vehicles by frequently switching lanes. Crash data that may provide clues about crash trends have been highlighted in orange. Table 3-17 provides specific crash types by interstate facility.

Table 3-17. Detailed freeway crash analysis

Intersection Name	Crash Rate crashes/MEV	Other Vehicle: Rear End	Other Vehicle: Angle	Other Vehicle: Head On	Other Vehicle: Side Swipe - Same Direction	Other Vehicle: Crash Type not Reported	Fixed Object in Road	Fixed Object Off Road	Pedestrian	Other	Total
I-93 NB at Exit 4 Diverge	0.20	0	0	0	0	5	0	2	0	1	8
I-93 NB at Exit 4 Merge	0.18	0	0	0	0	6	0	2	0	0	8
I-93 SB at Exit 4 Diverge	0.14	0	0	1	0	3	0	2	0	1	7
I-93 SB at Exit 4 First Merge	0.24	1	0	0	0	9	0	0	0	0	10
I-93 SB at Exit 4 Second Merge	0.20	0	0	0	0	5	0	4	0	1	10
I-93 NB at Exit 5 Diverge	0.13	0	0	0	0	5	0	1	0	0	6
I-93 NB at Exit 5 Merge	0.13	0	0	0	0	6	0	1	0	0	7
I-93 SB at Exit 5 Diverge	0.09	0	0	0	0	4	0	0	0	1	5
I-93 SB at Exit 5 Merge	0.10	0	0	0	0	3	0	1	0	1	5
I-93 NB between Exit 4 and Exit 5 (2.5 miles)	0.39	1	0	0	0	23	0	13	0	7	44
I-93 SB between Exit 4 and Exit 5 (2.0 miles)	0.29	0	0	0	0	14	0	8	0	6	28

Sources: NHDOT crash data from 2013-2015, received August 30, 2017

Notes: MEV = Million entering vehicles

Crash data that may provide clues about crash trends are highlighted in orange

4.0 EVALUATION METRICS

The study developed evaluation criteria to provide a comparison between the different alternatives to help assess the pros and cons of each and support the need to construct a new I-93 Exit 4A interchange. Evaluation criteria include traffic and accessibility. The study also evaluates each policy requirement's pros and cons following the detailed assessment section. Traffic focuses on an operational assessment of the study area facilities (12 intersections and 13 freeway facilities). Accessibility reviews changes in the connectivity of the roadway network to improve or prohibit connections between I-93 and the Londonderry/Derry study area. Table 4-1 summarizes the evaluation criteria. Section 7.0 contains the evaluation criteria and policy requirement summary.

Table 4-1. Evaluation criteria summary

Criteria	Definition
Traffic	The intersection and freeway facility LOS
Accessibility	Change in the roadway system to provide connections in the Londonderry/Derry study area

5.0 THE NO BUILD CONDITION

5.1 Introduction

The No Build condition represents the future conditions in the project design year of 2040 if all planned roadway improvements are implemented, Woodmont Commons is partially built out, and other background growth would follow the demographic projections contained in Tables 3-1, 3-2, and 3-3. I-93 Exit 4A would not occur, and downtown Derry would continue to experience traffic issues. This section summarizes the planned roadway improvements, development of the future traffic volumes, traffic operations, and queuing for the No Build Condition.

5.2 No Build Roadway Improvements

The No Build condition planned roadway improvements include six upgrades along I-93 and NH 102. Improvements 1 through 3 are currently under construction. Improvements 4 through 6 are options presented as part of the Woodmont Commons PUD. The six improvements are as follows:

1. Widening of the I-93 mainline from two to four travel lanes in each direction
2. Construction of a new NH 102 bridge over I-93 at Exit 4
3. Upgrade of NH 102 and I-93 ramp termini intersections at Exit 4 (Intersections #7 and #8) to include additional turning lanes and align with the revised Exit 4 ramp termini

4. Widening of NH 102 from two through lanes to three through lanes in each direction between Hampton Drive/Garden Lane (Intersection #6) and Gilcreast Road (Intersection #5)
5. Additional turning lanes added at NH 102 intersections at Gilcreast Road (Intersection #5) and Hampton Drive/Garden Lane (Intersection #6)
6. Upgrade of NH 102 and Londonderry Road/St. Charles Street (Intersection #9) from unsignalized to a signalized intersections and add additional turning lanes.

Figure 5-1 illustrates improvements 1 through 3, Figure 5-2 illustrates improvements 4 and 5, and Figure 5-3 illustrates improvement 6.

5.3 Development of No Build Volumes

The future No Build condition volumes for the intersections and freeway facilities serving Exits 4 and 5, as well as the two intersections east of Exit 4, NH 102 at Saint Charles/Londonderry Road & NH 102 at Fordway/Madden Hill Road (Intersections #9 and #10), relied on a custom subarea travel demand model built by the SNHPC. The model values represent 24-hour vehicle volumes. The AM and PM peak hour volumes were calculated by applying AM and PM peak hour percentages to the 2040 No Build 24-hour model volume results. These percentages were computed by comparing the existing condition peak hour volumes to the 2015 base year 24-hour travel demand model volumes.

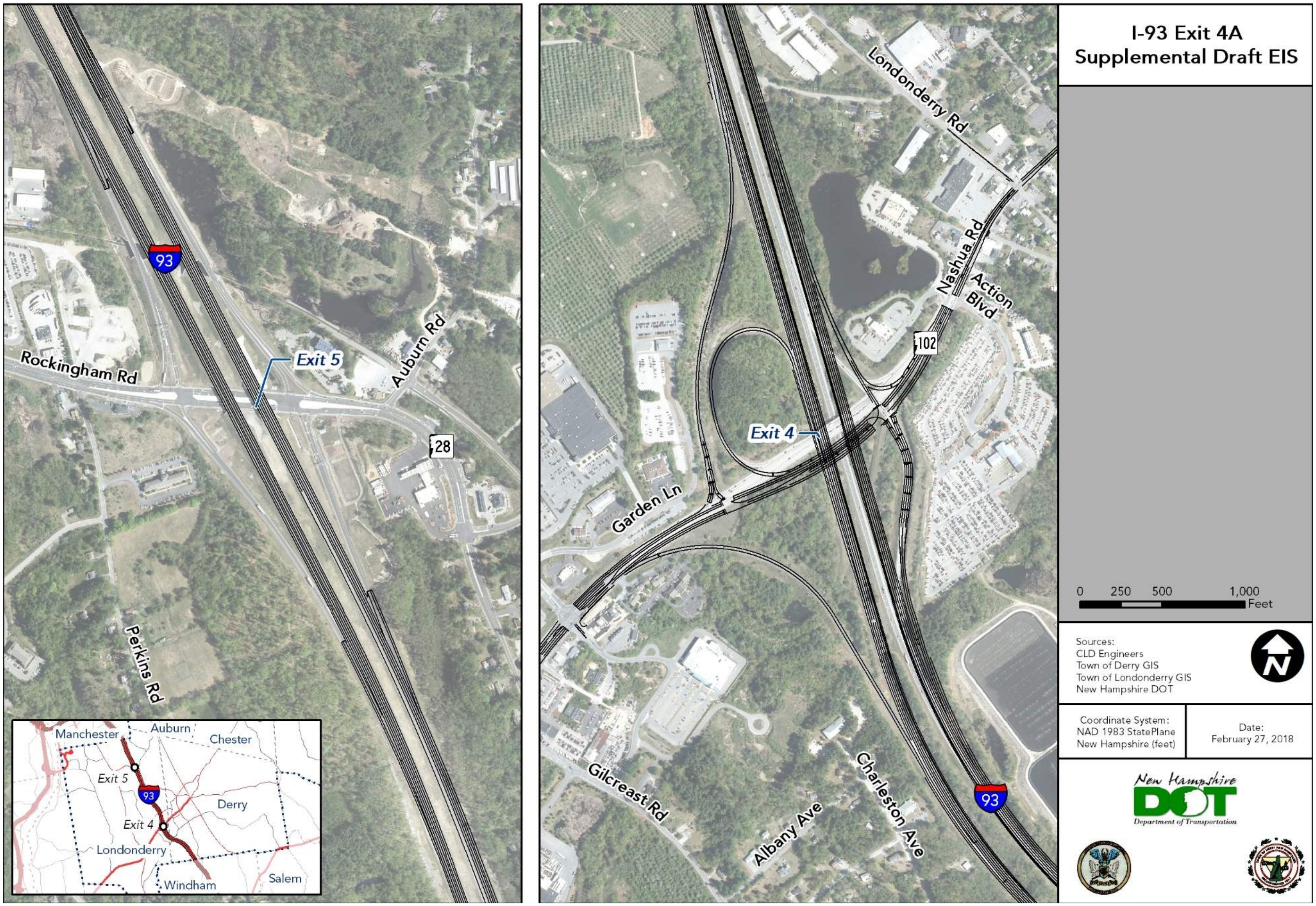
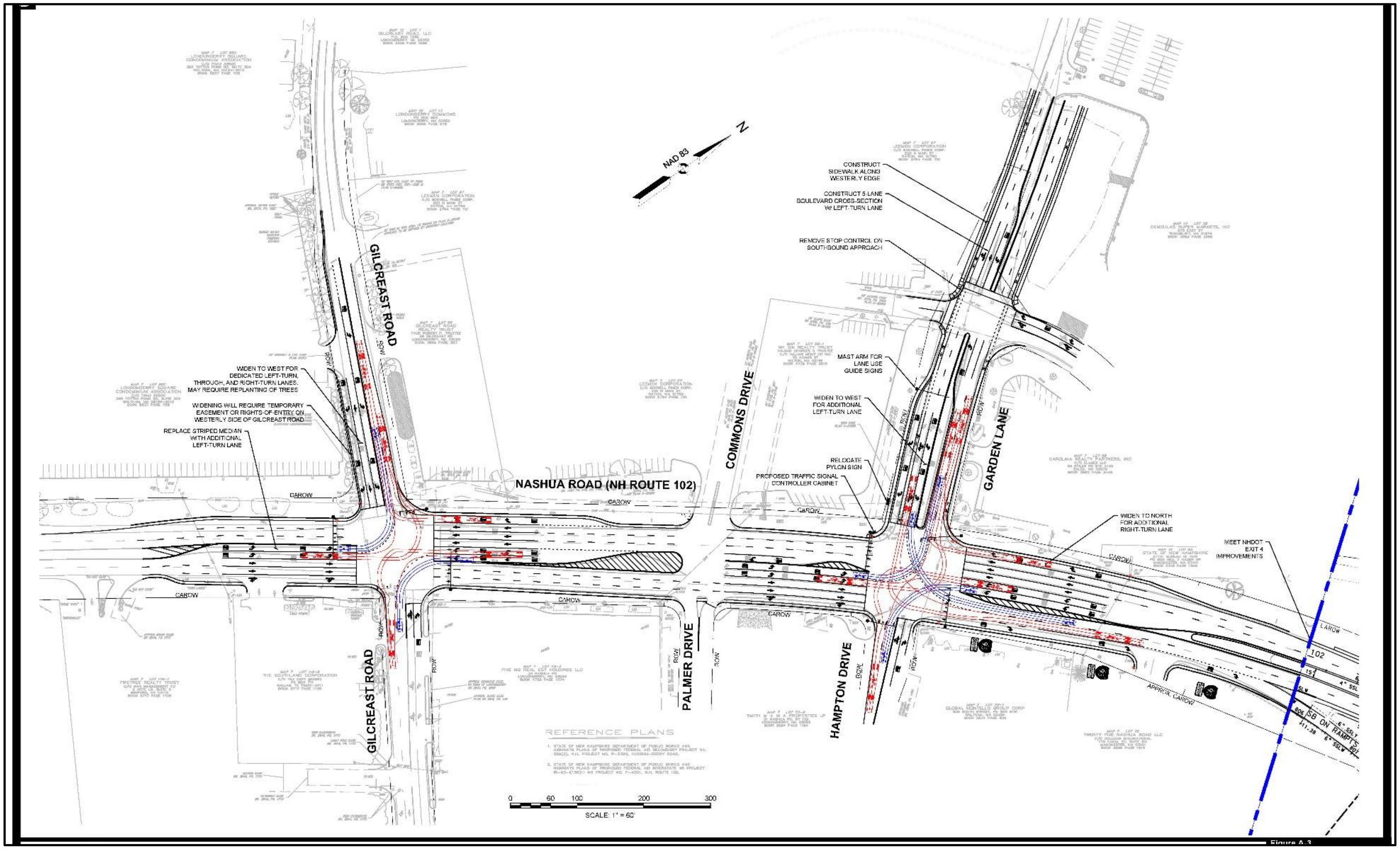
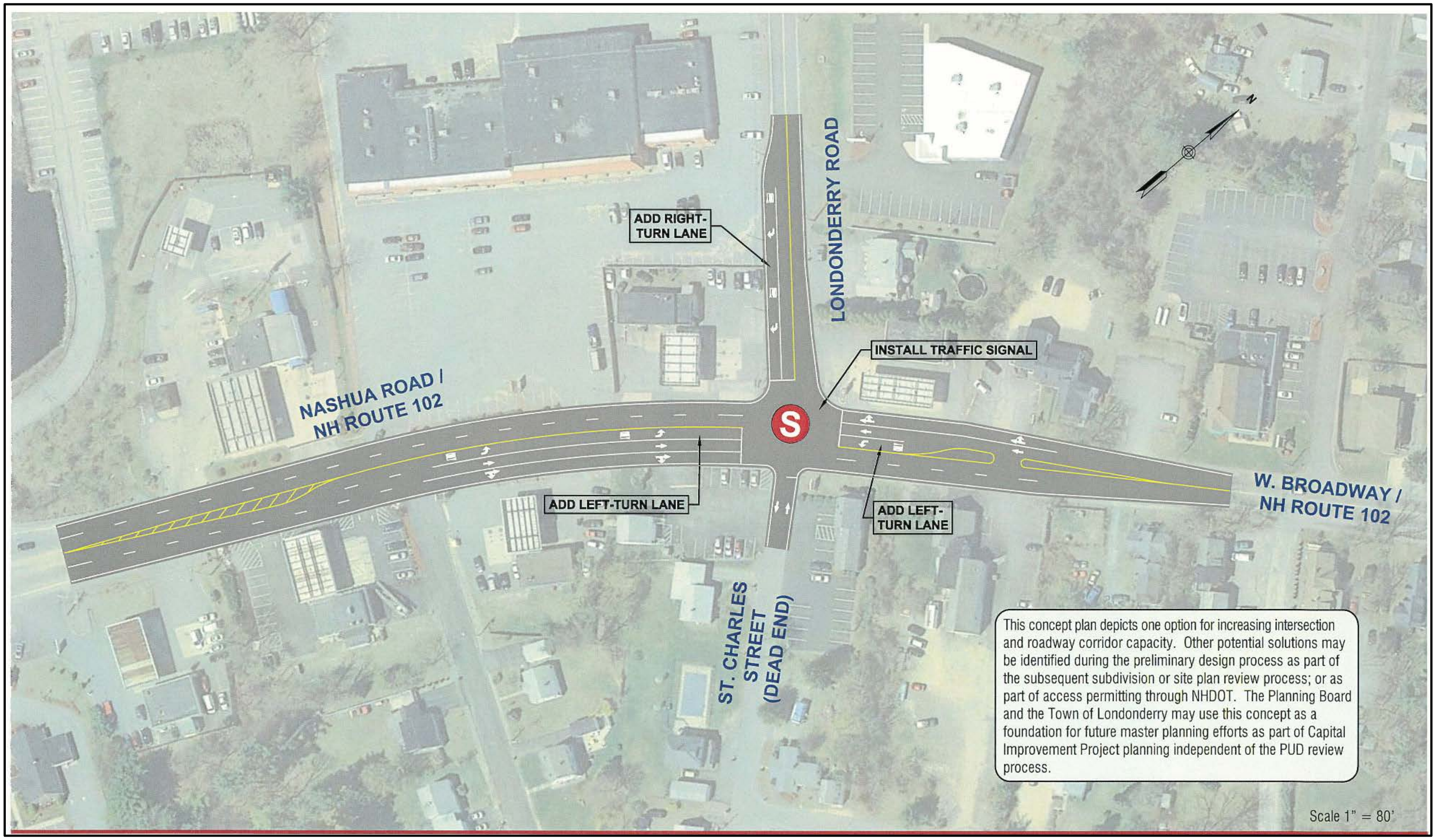


Figure 5-1. Planned improvement at I-93 Exits 4 and 5



Source: TEC, 2016

Figure 5-2. Planned improvement along NH 102 between Gilcreast Road and Hampton Drive/Garden Lane



Source: TEC, 2016

Figure 5-3. Planned improvement at NH 102 and Londonderry Road/St. Charles Street

Following the same procedure as the existing conditions, the Woodmont Commons Phases I and II TIA was used to provide turning movement counts for the two intersections located west of the I-93 at Exit 4: NH 102 at Gilcreast Road & NH 102 at Garden Lane (Intersections #5 and #6). The volumes in the TIA were forecasted for a partial build-out of the development with roadway mitigation in place by 2017 and were used to calculate the vehicle percentage for each tuning movement. These turning movement percentages were applied to the balanced 2040 No Build condition traffic network at Exit 4 determined by the SNHPC travel demand model.

Following the same procedure as the existing conditions, the I-93 SEIS was used to provide turning movement counts for NH 28 at Symmes Drive/Vista Ridge Drive (Intersection #1) located west of I-93 at Exit 5. The No Build condition volume was calculated by applying the vehicle percentage for each tuning movement based on the I-93 SEIS 2030 forecasted vehicle volumes and applying that percentage to the balanced 2040 No Build condition traffic network at Exit 5 determined by the SNHPC travel demand model.

Following the same procedure as the existing conditions, NHDOT provided a turning movement count for NH 28 and Liberty Drive (Intersection #4) located east of I-93 at Exit 5. This volume was obtained in 2005 and used to calculate the vehicle percentage for each tuning movement and applying that percentage to the balanced 2040 No Build condition traffic network at Exit 5 determined by the SNHPC travel demand model.

Figure 5-4 shows the 2040 No Build condition tuning movement volumes. Figure 5-5 shows the 2040 No Build condition lane geometry. The changes in the lane geometry are based on the proposed mitigation as part of the Woodmont Commons development and affect Intersections #5, #6, #7, and #8. This is the Phase I Woodmont Commons build-out scenario and includes 312,574 gross square feet of commercial, 510 units residential, and 135 hotel rooms.

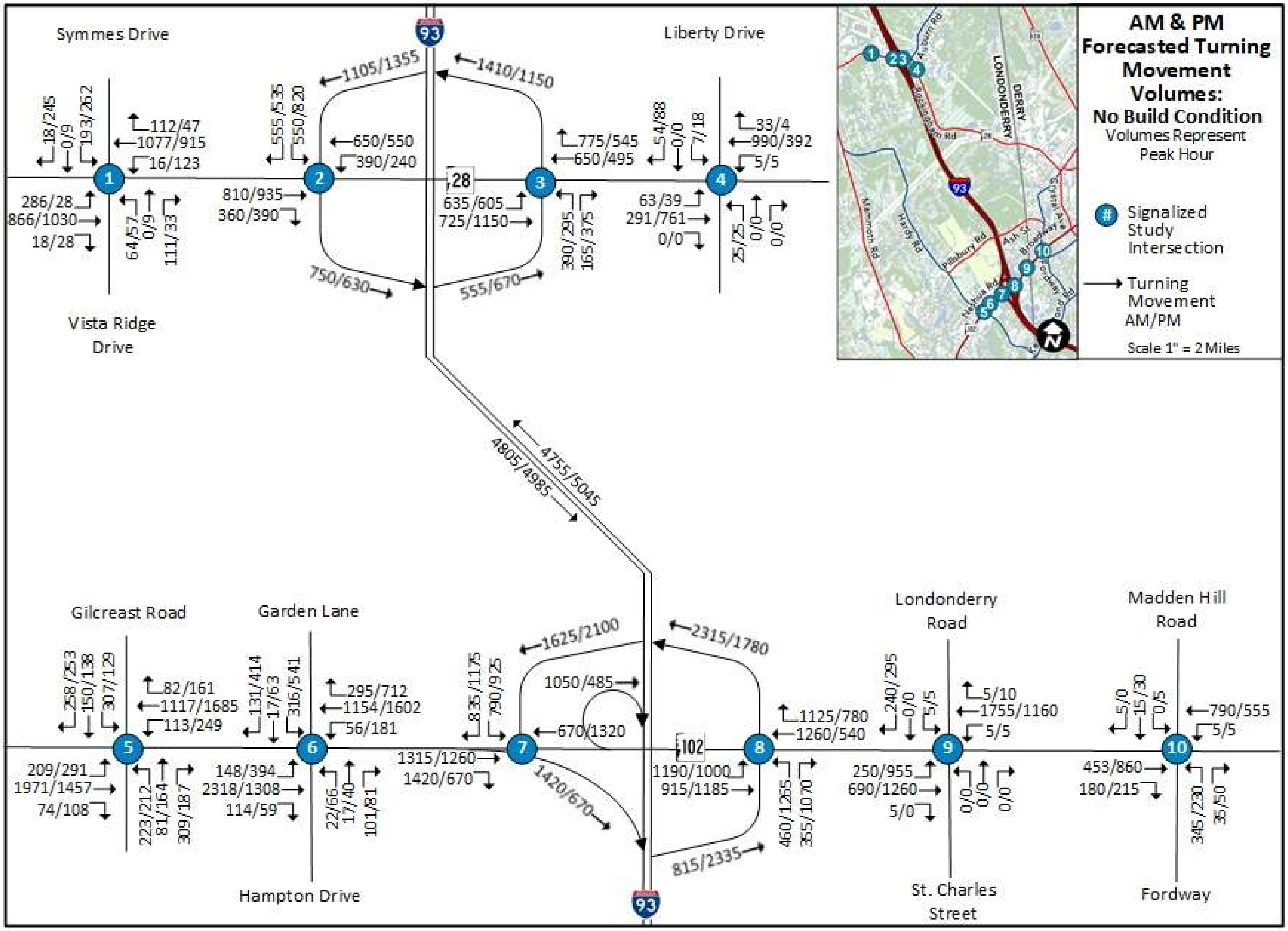


Figure 5-4. AM and PM 2040 No Build condition turning movement volumes

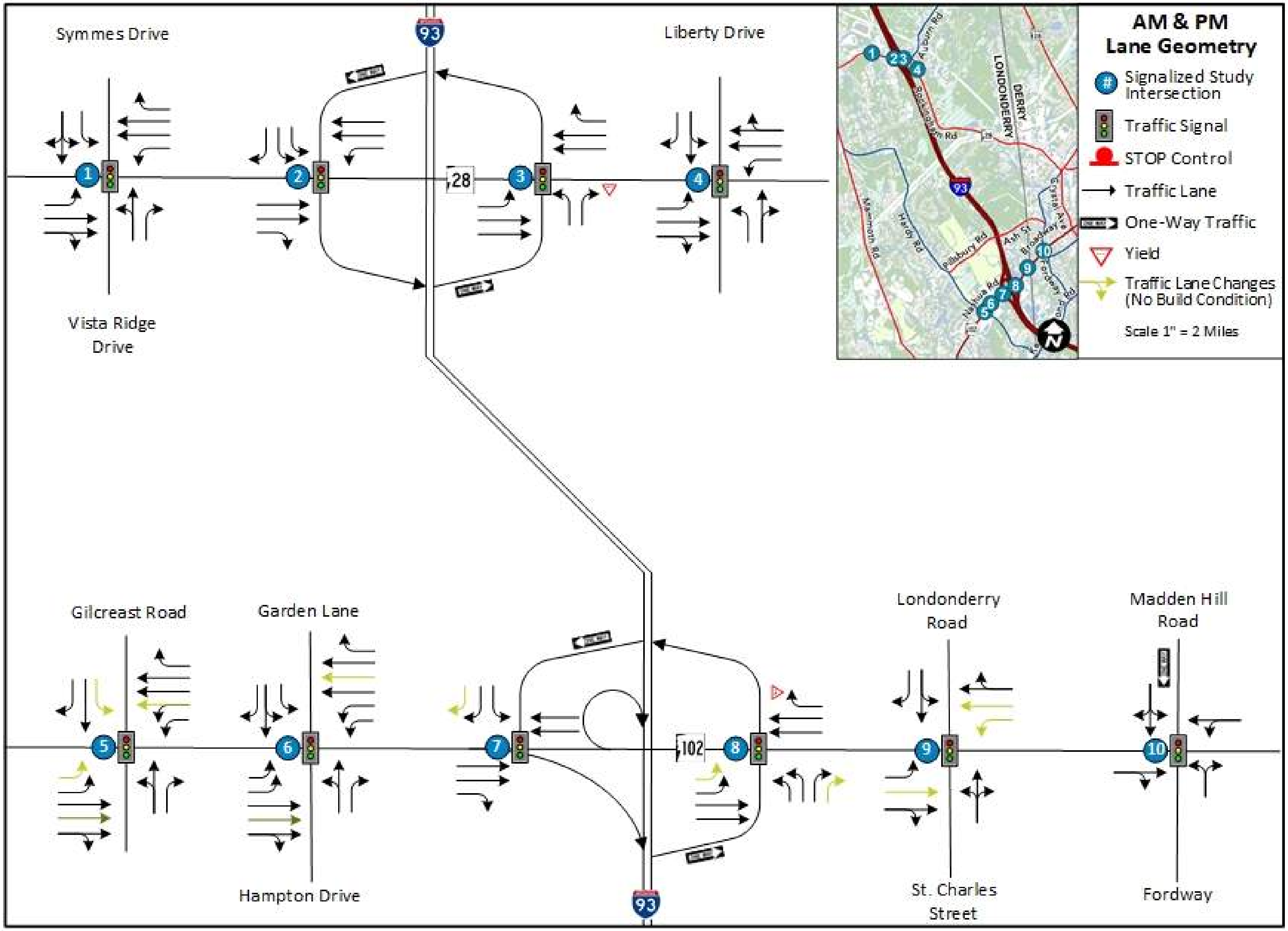


Figure 5-5. AM and PM 2040 No Build condition lane geometry

5.4 2040 No Build Condition Intersection Operations Analysis

Based on the Synchro™ signalized intersection analysis results, five signalized intersections (Intersections #2, #5, #7, #8, and #9) would operate at unacceptable conditions (LOS E or LOS F) during the AM or PM peak hours. The remaining signalized intersections in the traffic study area would operate at acceptable overall conditions (LOS D or better is considered an operating level) during the peak hours analyzed (weekday AM and PM peak hours).

Based on the Synchro™ signalized intersection analysis results, all the study area signalized intersections, with the exception of Intersection #4, have overall approaches that would operate at unacceptable conditions (LOS E or LOS F) during one or two evaluated periods. The following individual signalized intersection approaches in the traffic study area would operate under unacceptable conditions during peak hours:

- NH 28 at Symmes Drive/Vista Ridge Drive (Intersection #1)
  - Southbound Symmes Drive during the AM peak hour
- NH 28 at I-93 Southbound on and off-ramp (Exit 5) (Intersection #2)
  - I-93 Southbound off-ramp during the AM peak hour
- NH 28 at I-93 Northbound on and off-ramp (Exit 5) (Intersection #3)
  - I-93 Northbound off-ramp during the AM and PM peak hours
- NH 102 at Gilcreast Road (Intersection #5)
  - Eastbound NH 102 during the AM and PM peak hours
  - Westbound NH 102 during the PM peak hour
  - Northbound Gilcreast Road during the AM and PM peak hours
  - Southbound NH 102 during the AM and PM peak hours
- NH 102 at Hampton Drive/Garden Lane (Intersection #6)
  - Northbound Hampton Drive during the PM peak hour
  - Southbound Garden Lane during the AM and PM peak hours
- NH 102 at I-93 Southbound off-ramp (Exit 4) (Intersection #7)
  - Eastbound and Westbound NH 102 during the PM peak hour
  - I-93 Southbound off-ramp during the PM peak hour
- NH 102 at I-93 Northbound on and off-ramp (Exit 4) (Intersection #8)
  - Eastbound NH 102 during the PM peak hour
- NH 102 at St Charles Street/Londonderry Road (Intersection #9)
  - Eastbound and Westbound NH 102 during the PM peak hour
- NH 102 at Fordway/Madden Hill Road (Intersection #10)
  - Northbound Fordway during the AM and PM peak hours

The overall intersection LOS grades are depicted in Figure 5-6 for AM and PM peak hours. Table 5-1 shows the results of the LOS capacity analysis and the intersection vehicle delay for the No Build condition during the AM and PM peak hours. Appendix D contains the Synchro™ No Build condition intersection analysis reports.

5.5 2040 No Build Queuing Analysis

Based on the Synchro™ signalized intersection analysis results, all the signalized intersections within the study area, with the exception of NH 28 at Liberty Drive (Intersection #4), would experience queuing lengths that would exceed the available storage capacity. Intersection #4 would provide sufficient storage for the anticipated demand. The lane group in the approach that would operate under unacceptable conditions is noted in parentheses in the following list. Table 5-1 contains the queuing results. Appendix E contains the Synchro™ No Build condition intersection queuing reports.

- NH 28 at Symmes Drive/Vista Ridge Drive (Intersection #1)
  - Northbound Vista Ridge Drive (right turns) during the AM and the PM peak hours
  - Southbound Symmes Drive (left turns, right turns, and through movements) during the PM peak hour
- NH 28 at I-93 Southbound on and off-ramp (Exit 5) (Intersection #2)
  - Eastbound NH 28 (through movements) during the AM peak hour
  - Eastbound NH 28 (right turns) during the AM and PM peak hours
  - Westbound NH 28 (left turns) during the AM peak hour
  - Southbound I-93 off-ramp (right turns) during the AM peak hour
- NH 28 at I-93 Northbound on and off-ramp (Exit 5) (Intersection #3)
  - Eastbound NH 28 (left turns) during the AM and PM peak hours
  - Eastbound NH 28 (through movements) during the AM peak hour
  - Westbound NH 28 (through movements) during the AM peak hour
- NH 102 at Gilcreast Road (Intersection #5)
  - Eastbound NH 102 (left turns) during the PM peak hour
  - Northbound Gilcreast Road (all movements) during the AM and PM peak hours
  - Southbound Gilcreast Road (left turns) during the AM peak hour
  - Southbound Gilcreast Road (right turns and through movements) during the AM and PM peak hours
- NH 102 at Hampton Drive/Garden Lane (Intersection #6)
  - Westbound NH 102 (right turns) during the PM peak hour
  - Northbound Hampton Drive (right turns) during the AM and PM peak hours
  - Southbound Garden Lane (all movements) during the AM and PM peak hours

- NH 102 at I-93 Southbound off-ramp (Exit 4) (Intersection #7)
  - I-93 Southbound off-ramp (all movements) during the AM ad PM peak hours
- NH 102 at I-93 Northbound on and off-ramp (Exit 4) (Intersection #8)
  - Westbound NH 102 (right turns) during the AM peak hour
- NH 102 at St Charles Street/Londonderry Road (Intersection #9)
  - Eastbound NH 102 (left turns) during the PM peak hour
- NH 102 at Fordway/Madden Hill Road (Intersection #10)
  - Eastbound NH 102 (all movements) during the PM peak hour
  - Westbound NH 102 (all movements) during the AM and PM peak hours

Intersection #4 is the only signalized intersection in the traffic study area that would provide sufficient storage for the anticipated demand. The lane group in the approach that would operate under unacceptable conditions is highlighted in red in Table 5-1, which contains the queuing results.

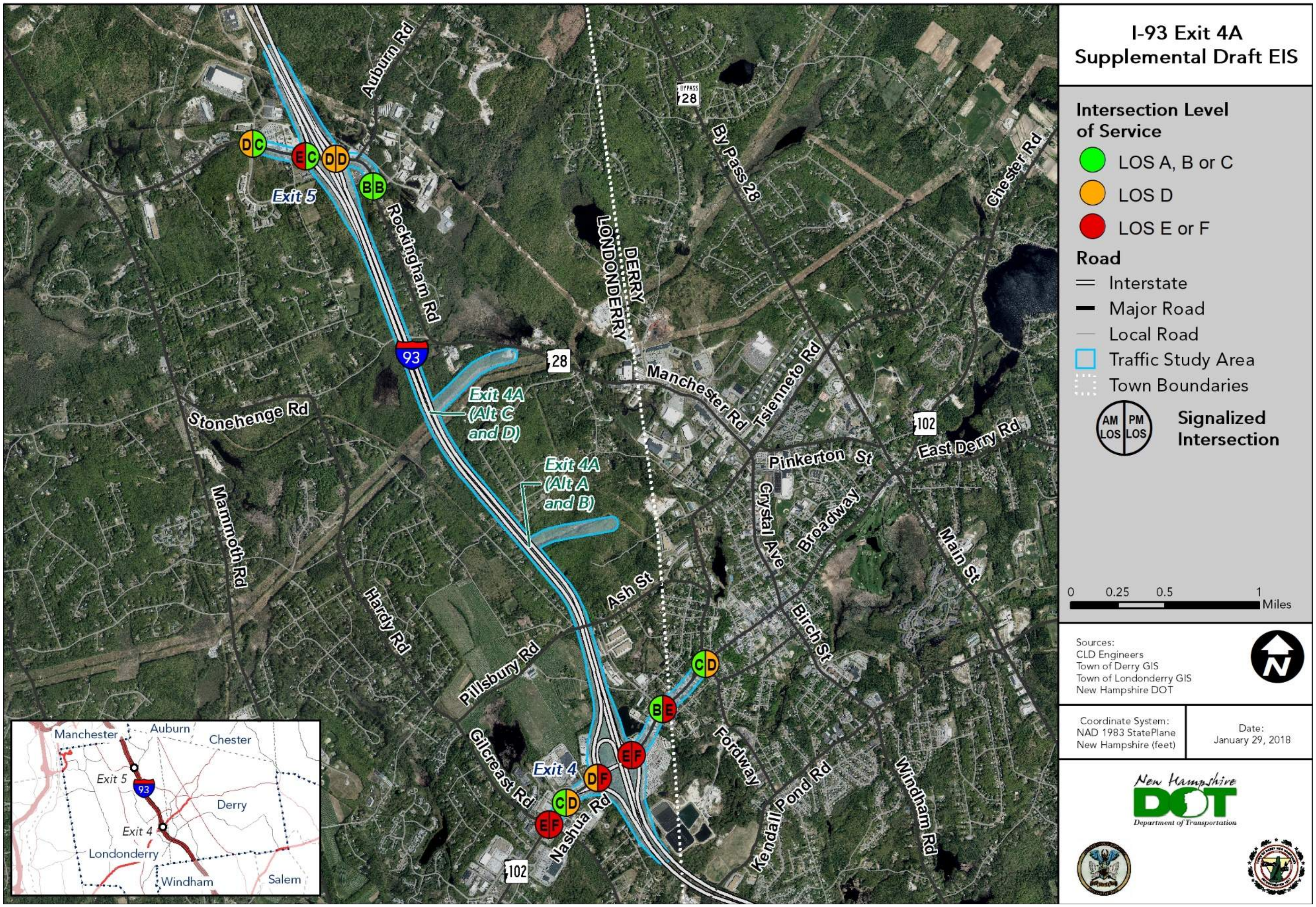


Figure 5-6. 2040 No Build AM and PM peak hour LOS by intersection

Table 5-1. 2040 No Build intersection capacity and queuing analyses

Intersection	Lane Groups	Turning Bay/Link Length (feet)	AM Peak Hour 95% queue (ft)	AM v/c ratio	AM Average Delay (sec/veh)	AM LOS	PM Peak Hour 95% queue (ft)	PM v/c ratio	PM Average Delay (sec/veh)	PM LOS
#1 NH 28 & Symmes Dr/Vista Ridge Dr (Signalized) [a]	EB L	408	353	0.97	85.5	F	50	0.76	111.3	F
	EB TR	729	414	0.51	13.0	B	458	0.81	31.9	C
	EB Overall				30.8	C			33.9	C
	WB L	450	40	0.55	71.3	E	154	0.81	74.0	E
	WB Thru	1,537	409	0.84	33.8	C	298	0.61	20.4	C
	WB R	500	137	0.08	19.5	B	31	0.04	14.0	B
	WB Overall				32.9	C			26.2	C
	NB LT	1,660	330	0.43	48.5	D	120	0.55	55.5	E
	NB R	10	#101	0.08	45.4	D	#79	0.02	49.0	D
	NB Overall				46.5	D			53.3	D
	SB L	270	181	0.93	110.8	F	267	0.84	63.6	E
	SB LTR	270	191	0.07	47.1	D	#368	0.39	42.0	D
	SB Overall				**79.0**	**E**			51.9	D
	Intersection Overall			**0.84**	**36.4**	**D**		**0.79**	**34.7**	**C**
#2 NH 28 & I-93 SB On and Off-Ramp (Exit 5) (Signalized) [a]	EB Thru	1,537	#1904	0.97	73.6	E	1243	0.88	39.4	D
	EB R	350	#546	0.28	0.5	A	#463	0.29	0.5	A
	EB Overall				51.1	D			27.9	C
	WB L	592	#632	1.17	111.5	F	280	0.92	20.7	C
	WB Thru	592	101	0.44	1.8	A	59	0.32	0.2	A
	WB Overall				42.9	D			6.4	A
	SB L	502	492	0.72	44.8	D	406	0.92	48.2	D
	SB R	502	#526	1.35	217.5	F	109	0.89	52.5	D
	SB Overall				**131.6**	**F**			49.9	D
	Intersection Overall			**1.17**	**77.0**	**E**		**0.90**	**31.2**	**C**
#3 NH 28 & I-93 NB On and Off-Ramp (Exit 5) (Signalized) [a]	EB L	592	#729	1.11	67.9	E	#706	1.07	53.5	D
	EB Thru	592	#789	0.39	0.6	A	316	0.62	6.1	A
	EB Overall				32.0	C			22.5	C
	WB Thru	481	#580	1.05	104.5	F	217	0.91	61.7	E
	WB R	481	171	0.56	1.5	A	-	0.38	0.7	A
	WB Overall				48.5	D			29.7	C
	NB L	798	685	1.11	128.2	F	337	0.86	47.1	D
	NB R	798	349	0.23	39.9	D	213	1.08	98.8	F
	NB Overall				**101.9**	**F**			**76.0**	**E**
	Intersection Overall			**1.10**	**51.7**	**D**		**1.04**	**37.7**	**D**

Table 5-1. 2040 No Build intersection capacity and queuing analyses (continued)

Intersection	Lane Groups	Turning Bay/Link Length (feet)	AM Peak Hour 95% queue (ft)	AM v/c ratio	AM Average Delay (sec/veh)	AM LOS	PM Peak Hour 95% queue (ft)	PM v/c ratio	PM Average Delay (sec/veh)	PM LOS
#4 NH 28 & Liberty Dr	EB L	225	79	0.51	42.4	D	50	0.49	30.6	C
(Signalized) [a]	EB TR	841	46	0.13	3.9	A	116	0.47	8.8	A
	EB Overall				10.7	B			9.9	A
	WB L	250	19	0.29	51.2	D	17	0.22	31.7	C
	WB TR	332	178	0.52	8.5	A	88	0.27	8.7	A
	WB Overall				8.7	A			9.0	A
	NB L	154	51	0.29	41.6	D	52	0.14	21.4	C
	NB Overall				41.6	D			21.4	C
	SB LT	100	29	0.15	40.6	D	38	0.17	21.6	C
	SB R	502	96	0.07	39.7	D	97	0.10	21.1	C
	SB Overall				39.8	D			21.2	C
	Intersection Overall			**0.50**	**11.3**	**B**		**0.43**	**11.2**	**B**
#5 - NH 102 & Gilcreast Rd	EB L	275	255	1.00	117.3	F	#345	1.24	193.4	F
(Signalized) [a]	EB RT	852	373	1.10	88.9	F	386	0.81	35.9	D
	EB Overall				**91.5**	**F**			**60.6**	**E**
	WB L	275	86	0.78	53.7	D	135	0.79	32.0	C
	WB Thru	669	150	0.97	33.7	C	266	1.27	134.1	F
	WB R	225	40	0.06	24.2	C	117	0.14	0.2	A
	WB Overall				34.9	C			**111.7**	**F**
	NB LT	488	#610	1.16	155.1	F	#567	1.29	200.5	F
	NB R	488	#598	0.63	47.0	D	#682	0.19	32.8	C
	NB Overall				**100.5**	**F**			**144.8**	**F**
	SB L	356	#442	1.13	142.9	F	314	0.95	114.4	F
	SBT	356	#483	0.53	47.3	D	#433	0.97	116.8	F
	SB R	225	#291	0.35	45.0	D	#303	0.55	49.0	D
	SB Overall				**87.6**	**F**			**83.2**	**F**
	Intersection Overall			**1.14**	**76.3**	**E**		**1.24**	**94.0**	**F**

Table 5-1. 2040 No Build intersection capacity and queuing analyses (continued)

Intersection	Lane Groups	Turning Bay/Link Length (feet)	AM Peak Hour 95% queue (ft)	AM v/c ratio	AM Average Delay (sec/veh)	AM LOS	PM Peak Hour 95% queue (ft)	PM v/c ratio	PM Average Delay (sec/veh)	PM LOS
#6 NH 102 & Hampton Dr/	EB L	275	179	0.58	61.3	E	242	1.08	125.2	F
Garden Ln (Signalized) [a]	EB TR	669	615	1.00	14.9	B	239	0.76	18.9	B
	EB Overall				17.6	B			42.7	D
	WB L	275	62	0.47	62.2	E	182	0.61	51.4	D
	WB Thru	715	221	0.55	16.9	B	367	0.99	44.7	D
	WB R	275	133	0.22	20.4	C	#329	0.81	26.1	C
	WB Overall				19.3	B			39.9	D
	NB LT	630	78	0.28	56.2	E	175	0.77	84.4	F
	NB R	100	#110	0.11	47.0	D	#137	0.06	51.5	D
	NB Overall				49.5	D			**70.1**	**E**
	SB L	175	#258	0.91	92.2	F	#242	1.02	104.3	F
	SB LT	291	#374	0.93	96.9	F	#323	1.00	99.1	F
	SB R	175	#266	0.10	34.2	C	#210	0.79	59.4	E
	SB Overall				**77.5**	**E**			**84.5**	**F**
	Intersection Overall			**0.92**	**24.9**	**C**		**0.99**	**49.9**	**D**
#7 NH 102 & I-93 SB Off-Ramp	EB Thru	895	540	1.06	53.2	D	565	1.12	87.4	F
(Exit 4) (Signalized) [a]	EB Overall				53.2	D			**87.4**	**F**
	WB Thru	1,057	193	0.58	13.4	B	420	1.26	146.7	F
	WB Overall				13.4	B			**146.7**	**F**
	SB L	138	#203	1.10	81.8	F	#205	1.20	116.3	F
	SB R	138	#167	0.84	21.4	C	#192	1.09	72.2	E
	SB Overall				50.8	D			**91.7**	**F**
	Intersection Overall			**1.08**	**44.5**	**D**		**1.22**	**106.4**	**F**
#8 NH 102 & I-93 NB On	EB L	550	529	1.11	85.6	F	475	1.20	127.6	F
and Off-Ramp (Exit 4)	EB Thru	1,057	238	0.37	5.7	A	357	0.69	21.2	C
(Signalized) [a]	EB Overall				50.9	D			**69.9**	**E**
	WB Thru	1,462	767	1.07	82.8	F	266	0.77	51.8	D
	WB R	786	#1006	0.78	3.9	A	230	0.54	1.3	A
	WB Overall				45.6	D			22.0	C
	NB L	1,440	496	1.14	137.6	F	897	1.21	140.7	F
	NB R	1,440	231	1.08	122.3	F	937	1.26	163.5	F
	NB Overall				**130.9**	**F**			**151.2**	**F**
	Intersection Overall			**1.10**	**61.4**	**E**		**1.12**	**92.8**	**F**

Table 5-1. 2040 No Build intersection capacity and queuing analyses (continued)

Intersection	Lane Groups	Turning Bay/Link Length (feet)	AM Peak Hour 95% queue (ft)	AM v/c ratio	AM Average Delay (sec/veh)	AM LOS	PM Peak Hour 95% queue (ft)	PM v/c ratio	PM Average Delay (sec/veh)	PM LOS
#9 NH 102 & St Charles St/Londonderry Rd (Signalized) [a]	EB L	350	202	0.85	58.1	E	#422	1.31	176.0	F
	EB TR	1,462	63	0.27	2.7	A	853	0.49	3.5	A
	EB Overall				17.4	B			**77.9**	**E**
	WBL	100	44	0.31	59.1	E	25	0.31	59.4	E
	WB LTR/TR	410	320	0.87	19.0	B	324	1.01	59.5	E
	WB Overall				19.1	B			**59.5**	**E**
	NB LTR	-	-	-	-	-	-	-	-	-
	NB Overall				0.0	A			0.0	A
	SB LT	780	70	0.23	53.2	D	22	0.21	52.4	D
	SB R	225	194	0.17	7.8	A	141	0.20	22.2	C
	SB Overall				8.7	A			22.6	C
	Intersection Overall			**0.85**	**17.7**	**B**		**1.16**	**67.5**	**E**
#10 NH 102 & Fordway/Madden Hill Rd (Signalized) [a]	EB TR	455	332	0.73	17.0	B	#734	1.05	55.2	E
	EB Overall				17.0	B			**55.2**	**E**
	WB LT	165	#519	0.91	29.2	C	#535	0.71	12.2	B
	WB Overall				29.2	C			12.2	B
	NB LR	375	298	0.94	60.4	E	277	1.02	96.3	F
	NB Overall				**60.4**	**E**			**96.3**	**F**
	SB LTR	120	40	0.05	21.8	C	61	0.16	30.2	C
	SB Overall				21.8	C			30.2	C
	Intersection Overall			**0.92**	**30.8**	**C**		**1.04**	**47.3**	**D**

Notes:

95th percentile volume exceeds capacity, queue may be longer.

EB = Eastbound, WB = Westbound, NB= Northbound, SB = Southbound

LOS = Level of Service

LTR = left / through / right lanes

V/C = Volume-to-Capacity ratio

Delay is Measured in Seconds Per Vehicle.

Red cells denote intersections or approaches operating at unacceptable conditions or denote approaches and lane groups whose queuing length exceeds capacity

[a] Highway Capacity Manual 2000 results (Signalized intersections)

5.6 2040 No Build Condition Freeway Operations Analysis

Based on the analysis performed using HCS, one freeway facility would operate above capacity. This includes the I-93 SB off-ramp to NH 102 that would operate at LOS F. This facility would fail due to the off-ramp operating over capacity, thus queueing onto the I-93 mainline. The NH 102 on-ramp to I-93 NB would operate above capacity potentially creating a queue into the NH 102 mainline. Table 5-2 contains the Exit 4 No Build condition freeway analysis, and Table 5-3 contains the Exit 5 No Build freeway analysis. Appendix F contains the No Build condition HCS freeway operation reports.

Table 5-2. I-93 Exit 4 2040 No Build freeway analysis

Freeway Analysis	Facility Type	Time Period	Demand to Capacity Ratio		Density (pc/mi/ln)	LOS
			Freeway	Ramp		
I-93 Northbound to NH 102	Diverge	AM	0.37	0.26	0.0	A
		PM	0.63	0.61	12.3	B
NH 102 to I-93 Northbound	Merge	AM	0.55	1.25[a]	21.9	C
		PM	0.59	0.99	23.0	C
I-93 Southbound to NH 102	Diverge	AM	0.55	0.84	25.9	C
		PM	0.56	1.10	29.2	F
NH 102 Westbound to I-93 Southbound	Merge	AM	0.50	0.69	17.3	B
		PM	0.39	0.32	11.0	B
NH 102 Eastbound to I-93 Southbound	Merge	AM	0.66	0.85	24.2	C
		PM	0.47	0.40	14.5	B

Notes: LOS = Level of Service; Density = Passenger cars per mile per lane (pc/mi/ln)

Red denotes interstate facilities that would result in failing operations and produce a queue extending to the I-93 mainline.

[a] Because the demand of the on-ramp exceeds the capacity, the ramp could produce a queue extending to NH 102.

Table 5-3. I-93 Exit 5 2040 No build freeway analysis

Freeway Analysis	Facility Type	Time Period	Demand to Capacity Ratio		Density (pc/mi/ln)	LOS
			Freeway	Ramp		
I-93 Northbound to NH 28	Diverge	AM	0.55	0.37	20.7	C
		PM	0.57	0.49	25.4	C
NH 28 to I-93 Northbound	Merge	AM	0.66	0.83	24.4	C
		PM	0.63	0.62	24.2	C
I-93 Southbound to NH 28	Diverge	AM	0.59	0.73	26.2	C
		PM	0.64	0.74	28.2	D
NH 28 to I-93 Southbound	Merge	AM	0.56	0.45	17.3	B
		PM	0.57	0.38	16.9	B

Notes: LOS = Level of Service; Density = Passenger cars per mile per lane (pc/mi/ln)

6.0 ALTERNATIVE DESCRIPTION

The proposed Project would entail the construction of a new interchange between I-93 Exit 4 and Exit 5 in Londonderry, New Hampshire. The location of the new interchange has been narrowed to two locations, the first option is located approximately 1.5 miles north of Exit 4 and 2.3 miles south of Exit 5, and the second option is located 2 miles north of Exit 4 and 1.5 miles south of Exit 5. For each option, a diamond interchange would be constructed with two signalized intersections located on either side of I-93 serving the ramp termini. Four proposed alternatives include a new interchange along I-93 as follows:

- **Alternative A**: New I-93 interchange 1.5 miles north of Exit 4, connects to the east to Folsom Road and includes improvements along Folsom Road and Tsienneto Road providing a new direct connection between I-93 and NH 102, east of Beaver Lake. The land use assumptions for the traffic analysis of this alternative assume the Woodmont Commons full build-out.
- **Alternative B**: New I-93 interchange 1.5 miles north of Exit 4, creates a new alignment 0.5 mile north of Folsom Road that runs parallel, then follows a power line ROW before connecting to NH 102 east of Beaver Lake. The land use assumptions for the traffic analysis of this alternative assume the Woodmont Commons full build-out
- **Alternative C**: New I-93 interchange 2 miles north of Exit 4, creates a new alignment along a power line ROW before connecting to NH 28, then follows the same ROW as Alternative B beginning at Ashleigh Drive, connecting to NH 102 east of Beaver Lake. Because Alternative C would not provide access to the undeveloped land on the east side of I-93 within the Woodmont Commons PUD, the Woodmont Commons development under Alternative C would be the same as the No Build Alternative.
- **Alternative D**: New I-93 interchange 2 miles north of Exit 4, creates a new alignment along a power line ROW before connecting to NH 28, then follows the same ROW as Alternative A beginning at Folsom Road, connecting to NH 102 east of Beaver Lake. The Woodmont Commons Phase I scenario is included in this alternative. Similar to Alternative C, this alternative would not provide access to the undeveloped land on the east side of I-93 within the Woodmont Commons PUD; therefore, the Woodmont Commons development under Alternative D would be the same as the No Build Alternative.

There is also **Alternative F** that can be considered the Transportation Systems Management (TSM) alternative composed of intersection improvements along NH 102 between Londonderry Road and Londonderry Turnpike that does not contain a new I-93 interchange. The next section contains detailed descriptions for each alternative.

Figure 6-1 illustrates the five SDEIS alternatives.

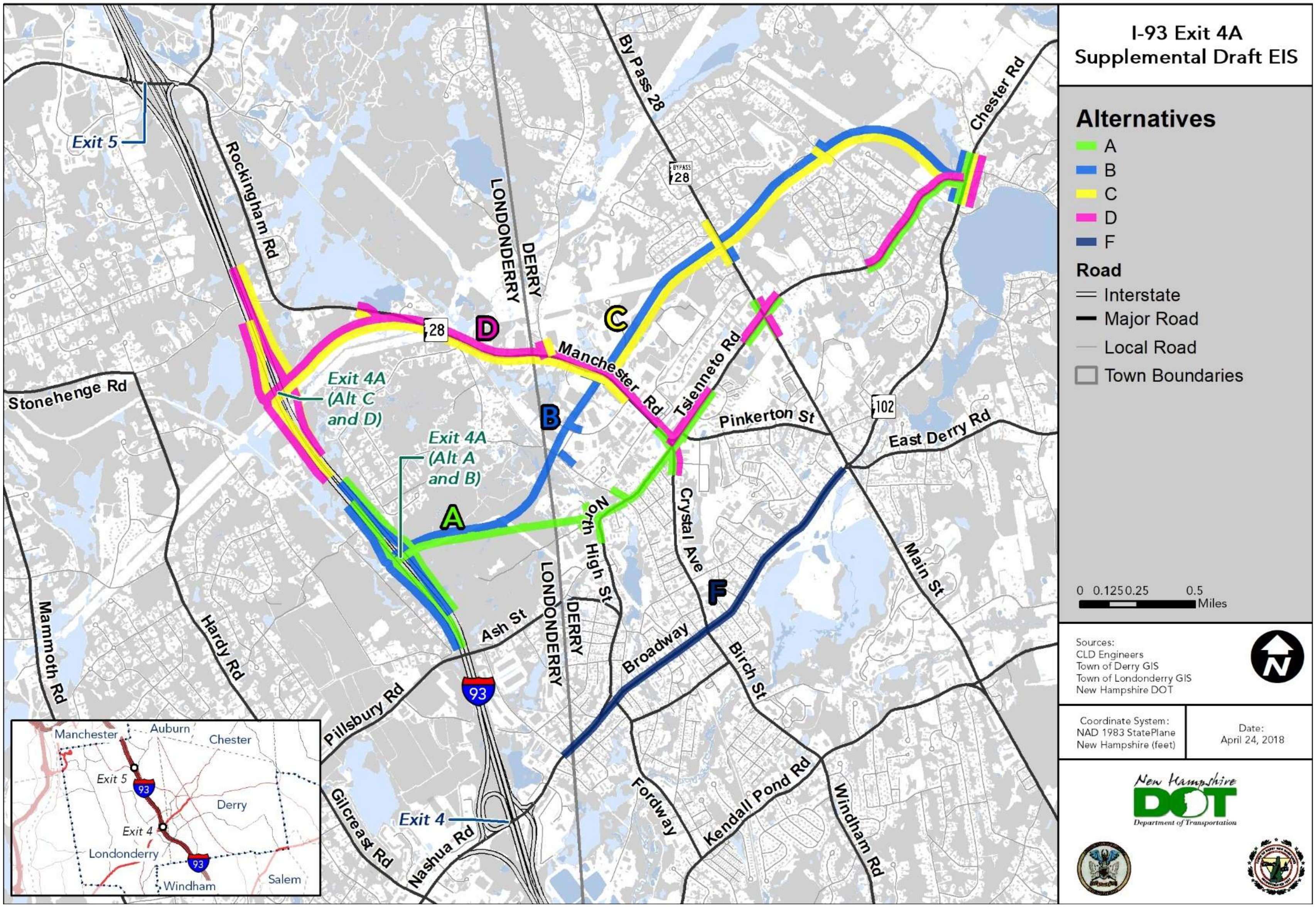


Figure 6-1. I-93 Exit 4A SDEIS alternatives

6.1 Build Alternatives Description

6.1.1 Alternative A

Alternative A was the Preferred Alternative in the 2007 DEIS (FHWA, 2007). This alternative includes a corridor that is approximately 3.2 miles in length between the new proposed I-93 Exit 4A interchange and eastern Derry. There would be approximately one mile of roadway construction on a new alignment and approximately 1.6 miles of existing roadway reconstruction, and approximately 0.6 mile of roadway with no improvements. It would originate from the southern I-93 Exit 4A interchange location and travel northeast along new alignment through a wooded area to Folsom Road, near its intersection with North High Street and Madden Road. This alternative would continue to follow Folsom Road past Ross' Corner (Manchester Road/NH 28) and continue on Tsienneto Road across NH 28 Bypass to its end at NH 102, adjacent to Beaver Lake. Specific improvements are outlined below:

I-93 Exit 4A to Ross' Corner

The section would contain five lanes of mostly new construction.

Ross' Corner Reconstruction

Ross' Corner would require additional eastbound through and left-turn lanes and an additional westbound through-lane to handle the traffic added by Alternative A. The intersection of Tsienneto Road and Pinkerton Street would also require additional through-lanes and would be signalized.

Tsienneto Road from Ross' Corner to NH 28 Bypass

The portion is an existing three-lane roadway (one lane in each direction with a middle turn lane) that would not be altered with this Project.

NH 28 Bypass/Tsienneto Road Intersection Reconstruction

This intersection would also require an additional through-lane in each direction on Tsienneto Road.

Tsienneto Road from NH 28 Bypass to NH 102

This section would require completion of minor safety improvements on the east end of Tsienneto Road.

Tsienneto Road/NH 102 Intersection Reconstruction

This intersection would need to be signalized, with added turning lanes on NH 102 and Tsienneto Road.

6.1.2 Alternative B

The Alternative B corridor is approximately 3.4 miles in length between the new proposed I-93 Exit 4A interchange and eastern Derry. The entire 3.4-mile corridor would consist of roadway construction on new alignment. It would originate from a new southern I-93 Exit 4A interchange and travel northeast along a new alignment through a wooded area to the intersection of Ashleigh Drive and NH 28. From this intersection, this alternative would extend northeast towards the intersection of London Road and NH 28 Bypass and then continue on new alignment to the intersection of Tsienneto Road and NH 102. Specific improvements would be as follows:

I-93 Exit 4A to Ashleigh Drive/NH 28 Intersection

The section leading from the new southern I-93 Exit 4A interchange to the intersection of Ashleigh Drive and NH 28 would contain five lanes of mostly new construction.

Ashleigh Drive/NH 28 Intersection Reconstruction

This intersection would require addition eastbound left-turn lane and a new through lane and westbound through lane and shared through/right-turn lane. The NH 28 northbound approach would include a minor change to the lane geometry with the removal of the exclusive right-turn lane.

Corridor from NH 28 to NH 28 Bypass

The portion would follow a new alignment following Ashleigh Drive to the power line ROW, then following the power line ROW to the NH 28 Bypass. This section would be a three-lane roadway (one lane in each direction with a middle turn lane).

NH 28 Bypass Intersection Construction

There would be a new signalized intersection constructed with all four approaches containing a left-turn lane. The southbound approach would contain a right-turn lane, and the remaining approaches would contain shared through/right-turn lanes.

Corridor from NH 28 Bypass to NH 102

This section would follow the power line ROW, then head southeast through a wooded section to intersect with Tsienneto Road and NH 102. It would contain two lanes.

Tsienneto Road/NH 102 Intersection Reconstruction

This intersection would need to be signalized, with added turning lanes on NH 102 and Tsienneto Road.

6.1.3 Alternative C

The Alternative C corridor is approximately 3.7 miles in length between the new proposed I-93 Exit 4A interchange and eastern Derry. Approximately 2.9 miles of corridor would be on new alignment, while approximately 0.8 mile would reconstruct existing roadways. The alternative would start from a new northern I-93 Exit 4A interchange and travel east approximately 0.7 mile along a power line ROW to NH 28. Following NH 28 south to the intersection of Ashleigh Drive, it would follow the same alignment as Alternative B to the intersection of Tsienneto Road and NH 102. Specific improvements would be as follows:

I-93 Exit 4A to Ashleigh Drive/NH 28 Intersection

The section leading from the northern I-93 Exit 4A interchange option to the intersection of Ashleigh Drive and NH 28 would contain five lanes. Between Exit 4A and Scobie Pond Road, there would be new roadway construction that would tie into NH 28, an existing five-lane roadway.

Ashleigh Drive/NH 28 Intersection Reconstruction

This intersection would require a minor change to the westbound approach lane geometry by changing the left-turn lane into a shared left/through lane and the right lane into a right-turn lane. The NH 28 northbound approach would include a minor change to the lane geometry with the removal of the exclusive right-turn lane.

Corridor from NH 28 to NH 28 Bypass

This portion would be the same as Alternative B.

NH 28 Bypass Intersection Construction

This intersection would be the same as Alternative B.

Corridor from NH 28 Bypass to NH 102

This portion would be the same as Alternative B.

Tsienneto Road/NH Route 102 Intersection Reconstruction

This intersection would need to be signalized, with added turning lanes on NH 102 and Tsienneto Road.

6.1.4 Alternative D

The Alternative D corridor is approximately 3.9 miles in length between the new proposed I-93 Exit 4A interchange and eastern Derry. Within this corridor, approximately 0.8 mile would be on new alignment, 2.5 mile on existing roadways would be reconstructed, and 0.6 mile would have no improvements. The alternative would commence from a new northern I-93 Exit 4A interchange and travel east approximately 0.7 mile along a power line ROW to NH 28. Following NH 28 south to Ross' Corner, the corridor would then follow the same path as Alternative A to the intersection of Tsienneto Road and NH 102. Specific improvements would be as follows:

I-93 Exit 4A to Ross' Corner

Alternative D, originating from the northern I-93 Exit 4A interchange option, would traverse south on NH Route 28 to Ross' Corner. The section leading from the northern I-93 Exit 4A interchange option to the intersection at Ross' Corner would contain five lanes. Between Exit 4A and Scobie Pond Road, there would be new roadway construction that would tie into NH 28, an existing five-lane roadway.

Ross' Corner Reconstruction

Ross' Corner would require an additional eastbound through-lane, and an additional southbound through-lane to handle the traffic. The intersection of Tsienneto Road and Pinkerton Street would also require additional through-lanes on Tsienneto Road, in addition to being signalized.

Tsienneto Road from Ross' Corner to NH 28 Bypass

This portion would be the same as Alternative A.

NH 28 Bypass/Tsienneto Road Intersection Reconstruction

This intersection would be the same as Alternative A.

Tsienneto Road from NH 28 Bypass to NH 102

This portion would be the same as Alternative A.

Tsienneto Road/NH 102 Intersection Reconstruction

This intersection would be the same as Alternative A.

6.1.5 Alternative F

Alternative F focuses all improvements along the existing NH 102 corridor between Exit 4 at I-93 and downtown Derry. A two-way center left-turn lane would be constructed from Londonderry Road to NH Route 28. The majority of existing on-street parking spaces would be lost to accommodate the center turn lane. Additional improvements included in the study area would be as follows:

NH 102/Londonderry Road/St. Charles Street

There would be improvements to three approaches. The eastbound and westbound approaches would include a new left-turn lane and an additional through lane. The southbound approach would include an extension to the existing right-turn lane. The signal would be upgraded to operate the new lane geometry.

NH 102/Fordway/Madden Hill Road

There would be improvements to two approaches. The eastbound approach would include a new right-turn lane, and the northbound approach would include a new left-turn lane. The signal would be upgraded to operate the new lane geometry. There would also be a three-lane cross section along NH 102 between Fordway and Crystal Avenue and additional lanes added to the NH 102 and Crystal Avenue/Birch Street intersection.

7.0 THE 2040 BUILD CONDITION

7.1 Introduction

The Build condition represents the future conditions with one of the five alternatives constructed. This section summarizes development of the future traffic volumes, traffic operations, and queuing for the Build condition.

7.2 Development of 2040 Build Condition Volumes

The 2040 Build conditions represent the future conditions if all planned roadway improvements are implemented, Woodmont Commons is either fully built out or partially built out, and other background growth would follow the demographic projections contained in Tables 3-4, 3-5, and 3-6. I-93 Exit 4A would occur, and, under four of the alternatives, downtown Derry’s traffic congestion would be improved. This section summarizes the development of the future traffic volumes, traffic operations, and queuing for the Build conditions.

The study relied on the SNHPC travel demand model, especially for modeling future forecasted traffic volumes generated by the Woodmont Commons PUD. Woodmont Commons is planned to include a variety of land uses such as residential, commercial, and office that could encourage a reduced number of daily work-based vehicle trips. The reduction in work-based trips is called internal capture and refers to a pedestrian or bicycle trip replacing a vehicle trip based on the origin and destination both located at Woodmont Commons. Because the travel demand model was unable to account for internal capture trips, the model likely forecasted more daily vehicle trips than might occur.

The future 2040 Build condition volumes for the intersections and freeway facilities serving Exits 4 and 5, as well as the two intersections east of Exit 4, NH 102 at Saint Charles/Londonderry Road & NH 102 at Fordway/Madden Hill Road (Intersections #9 and #10), relied on a custom travel demand model built by SNHPC to represent each alternative, resulting in five models. The model values represent 24-hour vehicle volumes; therefore, the AM and PM peak hour volumes were calculated by applying AM and PM peak hour percentages to each of the five 2040 Build 24-hour model volume results. These percentages were computed by comparing the existing condition peak hour volumes to the 2015 base year 24-hour travel demand model volumes.

Following a procedure similar to that used for the existing conditions, the Woodmont Commons TIA published Phases I and II traffic counts or Woodmont Commons PUD traffic counts were used to provide turning movement counts for the two intersections located west of I-93 at Exit 4, NH 102 at Gilcreast Road & NH 102 at Garden Lane (Intersections #5 and #6). The volumes in the TIA were used to calculate the vehicle percentage for each tuning movement as follows: (1) Alternatives A and B used the PUD traffic counts representing the full Woodmont Commons build-out; and (2) Alternatives C, D, and F used the Phase I and II traffic counts representing the partial Woodmont Commons build-out. These turning movement percentages were applied to the five balanced 2040 Build condition traffic networks at Exit 4 determined by the five SNHPC travel demand models representing each alternative.

Following the same procedure used for the existing conditions, the I-93 SEIS was used to provide turning movement counts for NH 28 at Symmes Drive/Vista Ridge Drive (Intersection #1) located west of I-93 at Exit 5. The Build condition volumes were calculated by applying the vehicle percentage for each tuning movement based on the I-93 SEIS 2030 forecasted vehicle volumes and applying that percentage to the five (Alternatives A, B, C, D, and F) balanced 2040 Build condition traffic networks at Exit 5 determined by the five SNHPC travel demand models representing each alternative.

Following the same procedure as the existing conditions, NHDOT provided a turning movement count for NH 28 and Liberty Drive (Intersection #4) located east of I-93 at Exit 5. This volume was obtained in 2005 and used to calculate the vehicle percentage for each tuning movement and applying that percentage to the five (Alternatives A, B, C, D, and F) balanced 2040 Build condition traffic networks at Exit 5 determined by the five SNHPC travel demand model representing each alternative.

The proposed new interchange (I-93 Exit 4A) would contain two new intersections with the same lane geometry regardless of the alternative chosen (A, B, C, or D). The Connector Road and I-93 SB on and off-ramp (Intersection # 11) would be signalized and contain two approaches. The other intersection, Connector Road and I-93 NB on and off-ramp (Intersection #12) would be signalized and contain three approaches.

Figures 7-1 through 7-5 show the 2040 Build condition turning movement volumes representing Alternatives A, B, C, D, and F. Figure 7-6 shows the Alternatives A and B lane geometry. Figure 7-7 shows the Alternatives C and D lane geometry. Figure 7-8 shows the Alternative F lane geometry. The location of Exit 4A differs between the alternatives; however, the lane geometry remains the same for Alternatives A through D.

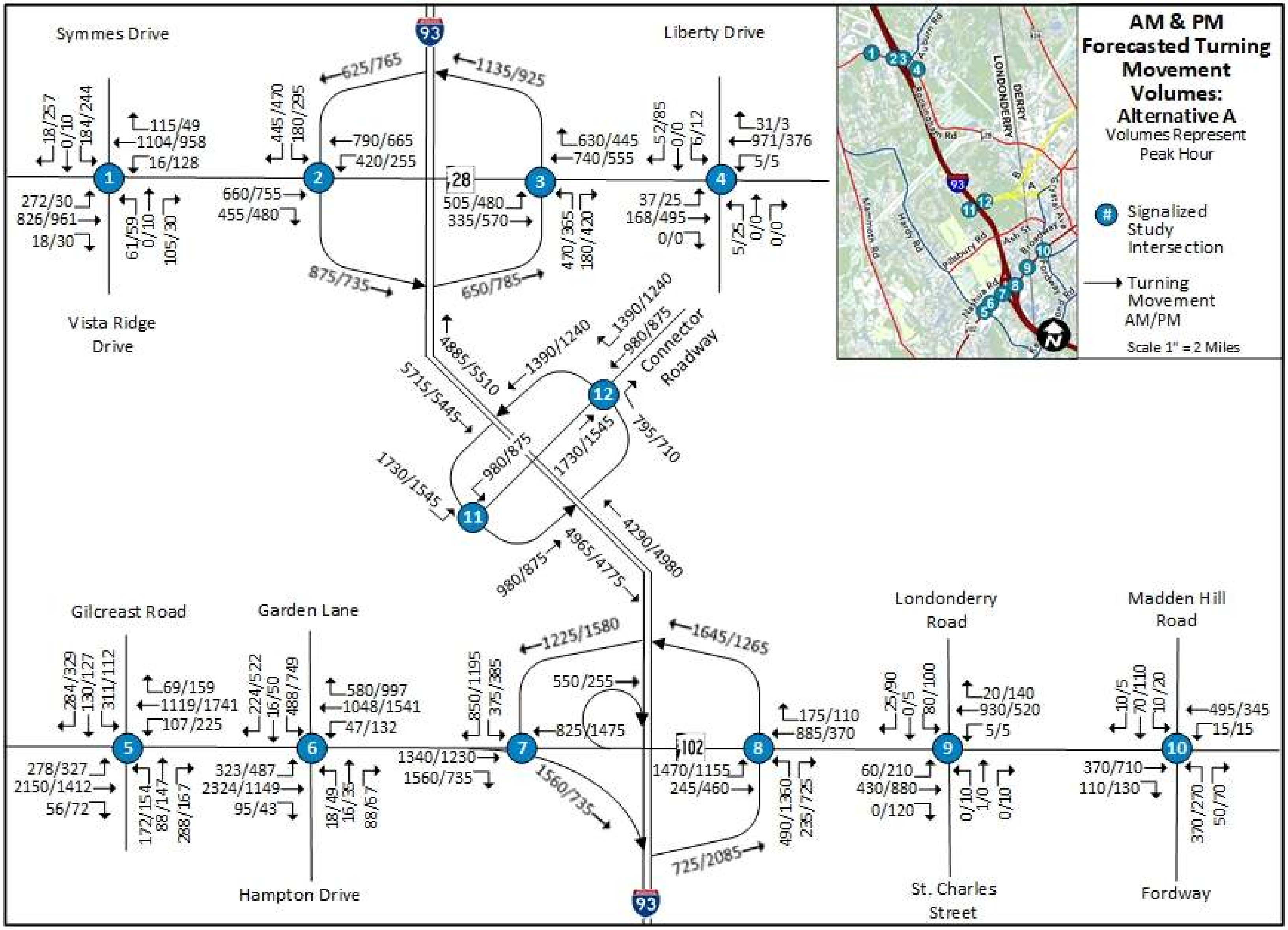


Figure 7-1. Alternative A 2040 Build turning movement volumes

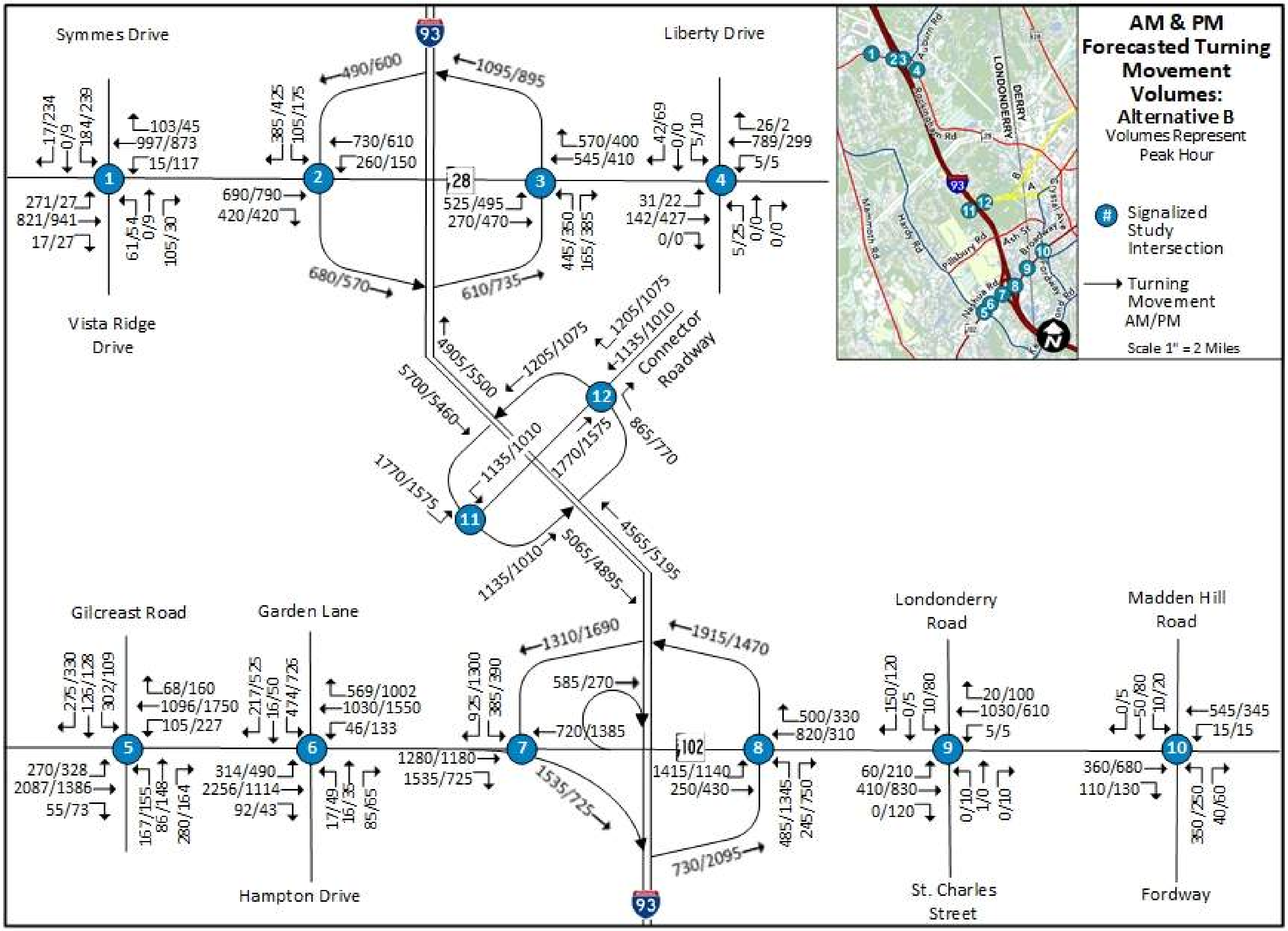


Figure 7-2. Alternative B 2040 Build turning movement volumes

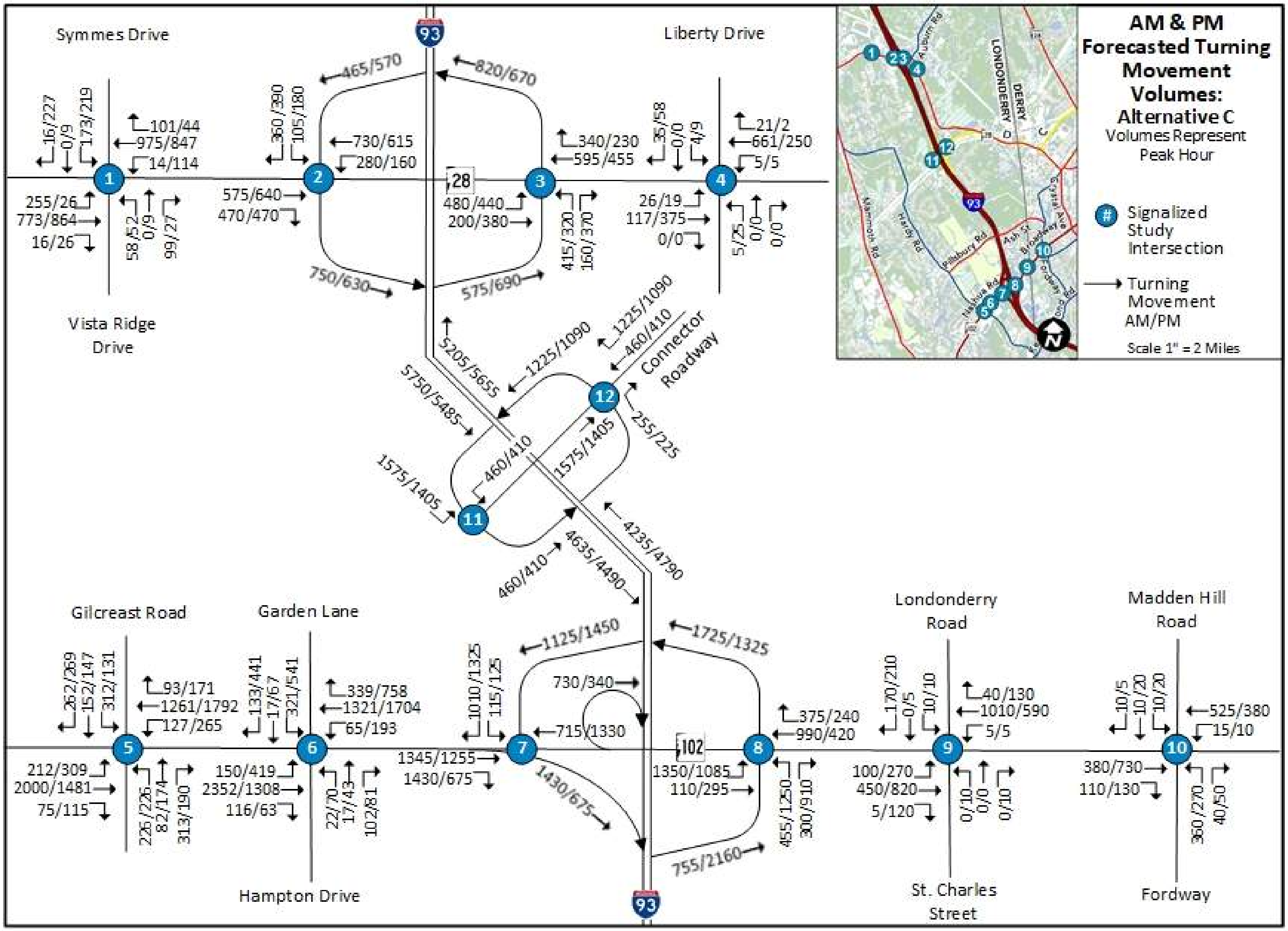


Figure 7-3. Alternative C 2040 Build turning movement volumes

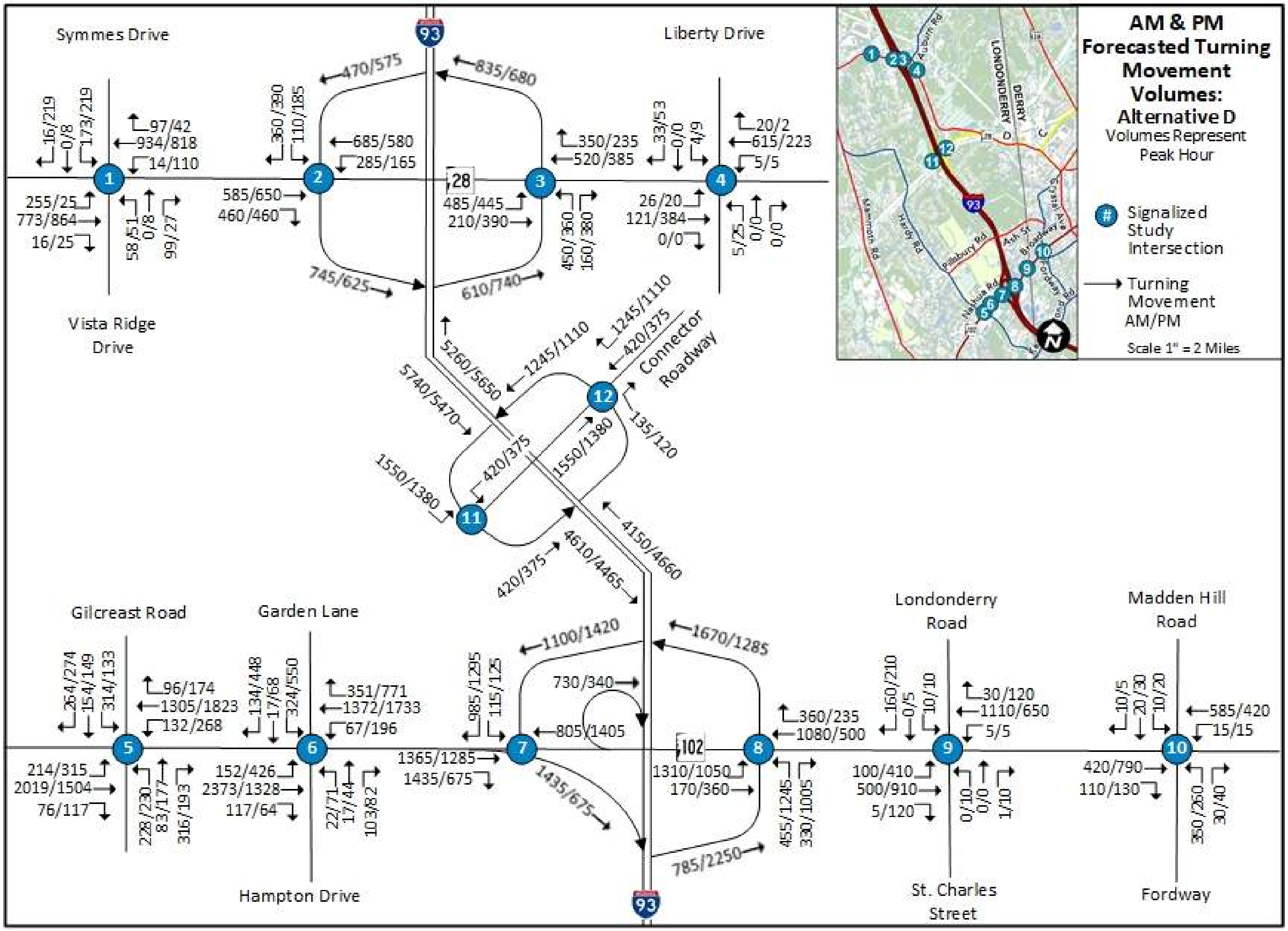


Figure 7-4. Alternative D 2040 Build turning movement volumes

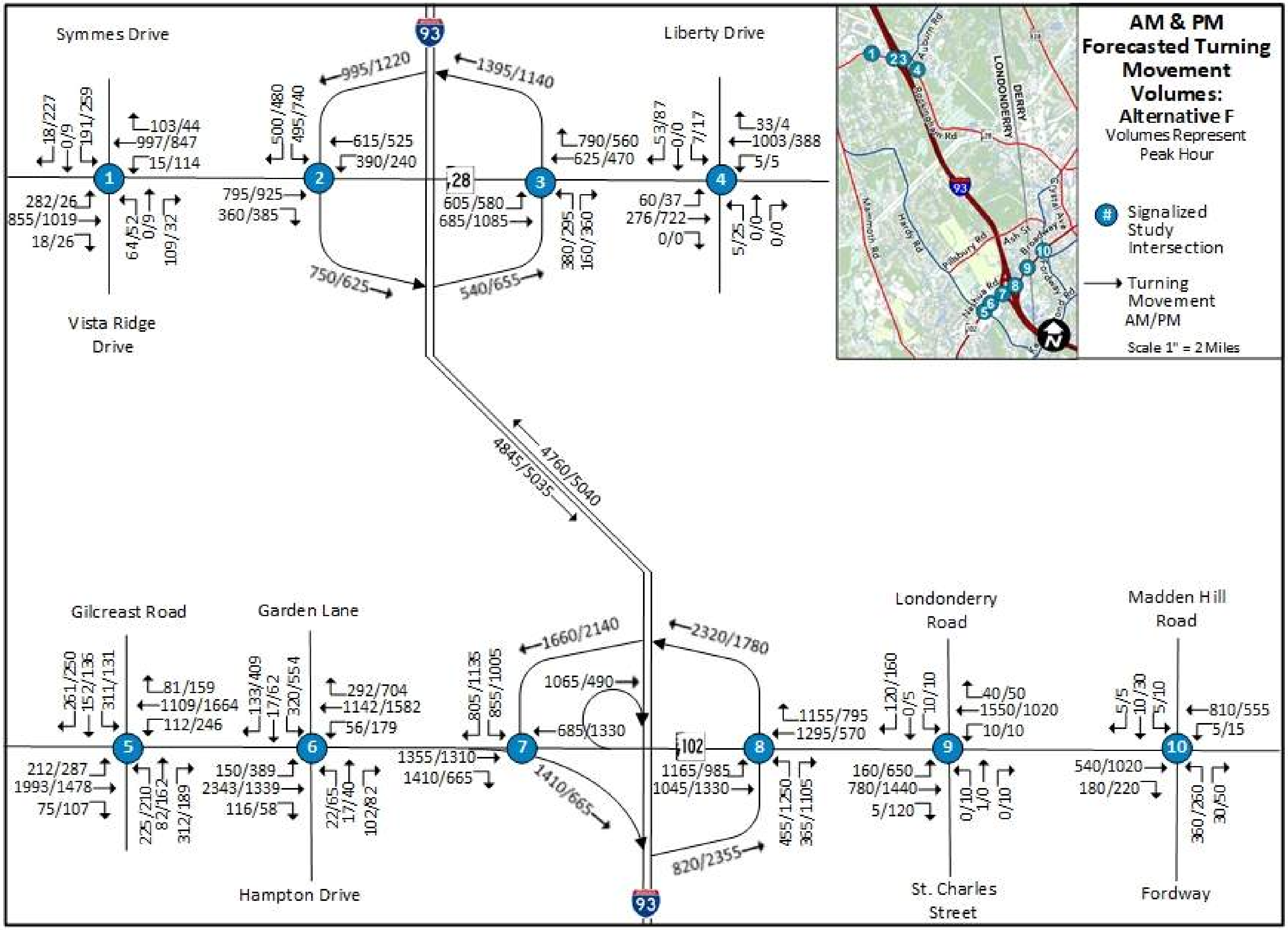


Figure 7-5. Alternative F 2040 Build turning movement volumes

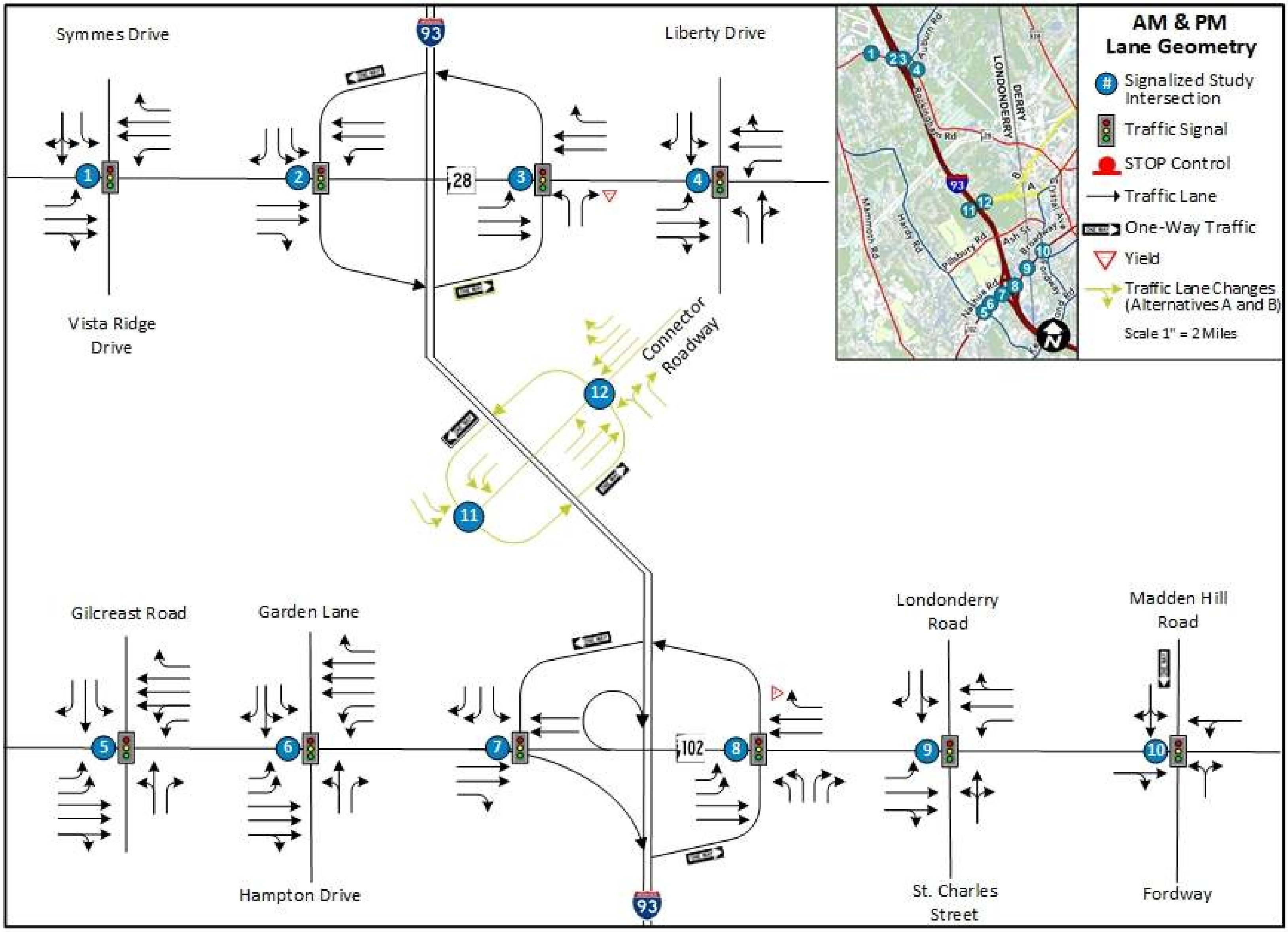


Figure 7-6. Alternatives A & B 2040 Build lane geometry

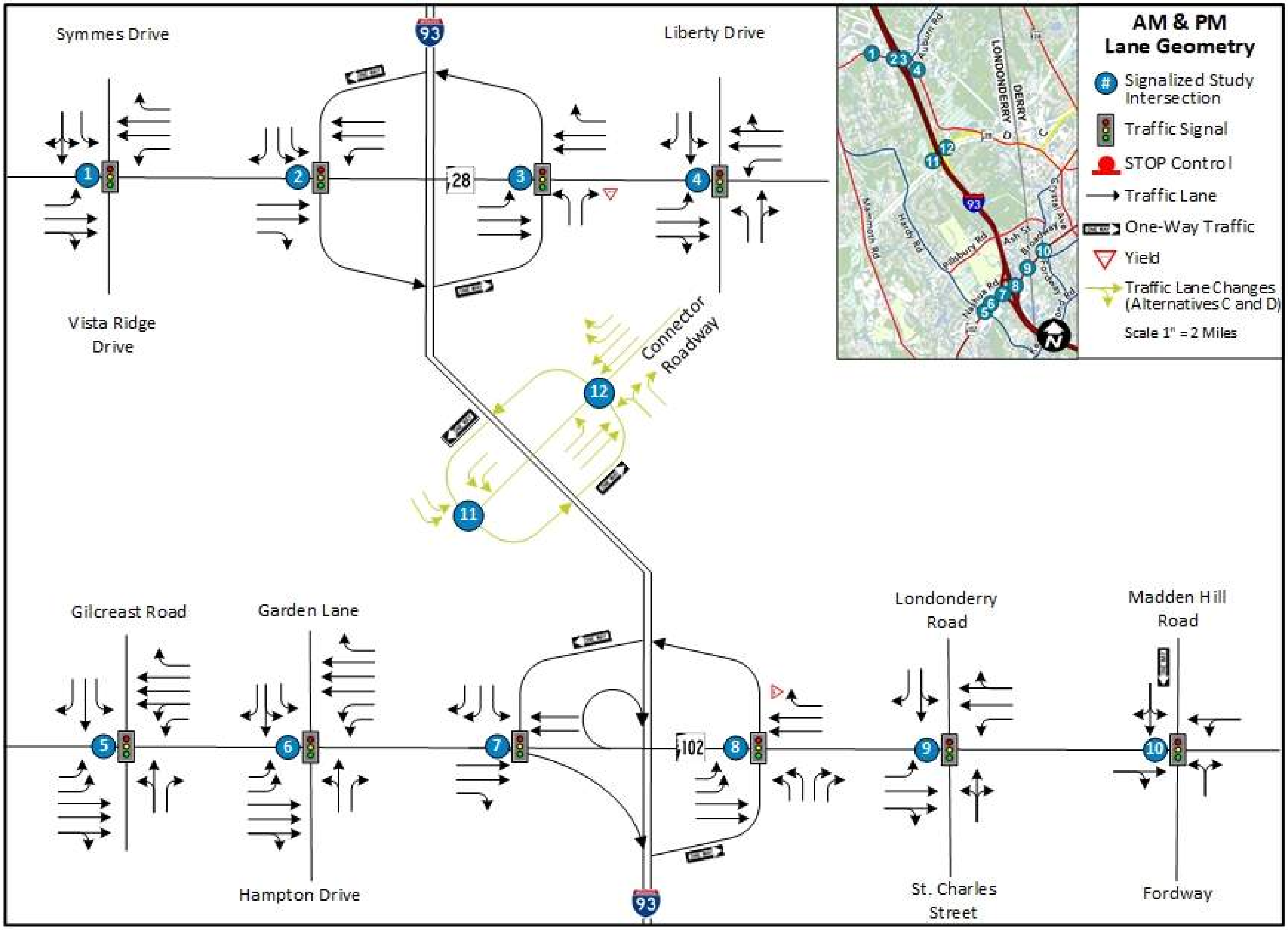


Figure 7-7. Alternatives C & D 2040 Build lane geometry

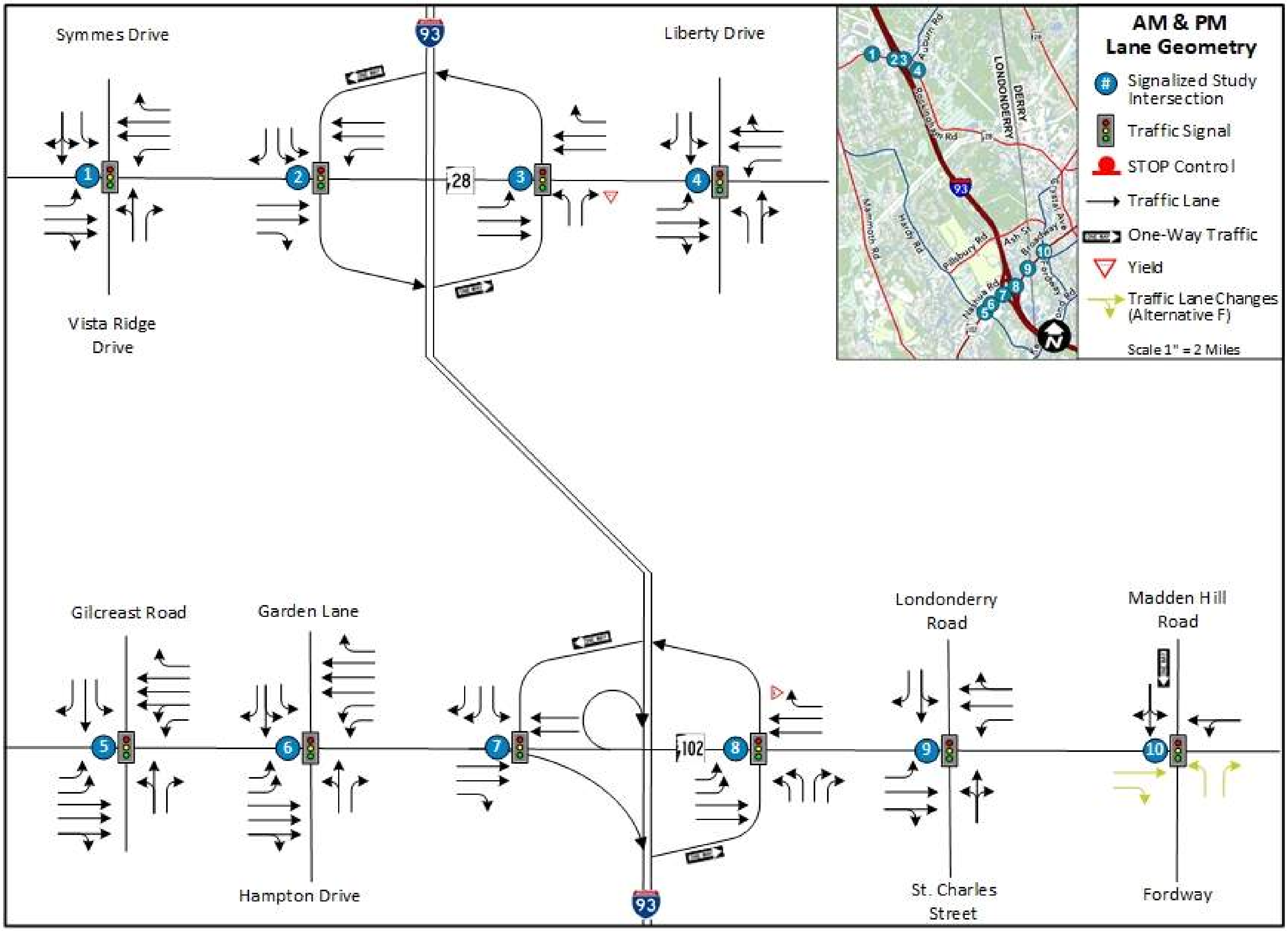


Figure 7-8. Alternative F 2040 Build lane geometry

7.3 2040 Build Alternative A Intersection Operations Analysis

Based on the Synchro™ signalized intersection analysis results, four signalized intersections (Intersections #3, #5, #6, and #8) would operate at unacceptable conditions (LOS E or LOS F) during the AM or PM peak hours. The remaining signalized intersections in the traffic study area would operate at acceptable overall conditions (LOS D or better is considered an operating level) during the peak hours analyzed (weekday AM and PM peak hours).

Based on the Synchro™ signalized intersection analysis results, eight of the study area signalized intersections have overall approaches that would operate at unacceptable conditions (LOS E or LOS F) during one or two evaluated periods. The following individual signalized intersection approaches in the traffic study area would operate under unacceptable conditions during peak hours:

- NH 28 at I-93 Southbound on and off-ramp (Exit 5) (Intersection #2)
  - I-93 Southbound off-ramp during the AM peak hour
- NH 28 at I-93 Northbound on and off-ramp (Exit 5) (Intersection #3)
  - Westbound NH 28 during the AM peak hour.
  - I-93 Northbound off-ramp during the AM and PM peak hours
- NH 102 at Gilcreast Road (Intersection #5)
  - Eastbound NH 102 during the AM and PM peak hours
  - Westbound NH 102 during the PM peak hour
  - Northbound Gilcreast Road during the AM and PM peak hours
  - Southbound Gilcreast Road during the AM and PM peak hours
- NH 102 at Hampton Drive/Garden Lane (Intersection #6)
  - Eastbound NH 102 during the PM peak hour
  - Westbound NH 102 during the PM peak hour
  - Northbound Hampton Drive during the AM and PM peak hours
  - Southbound Garden Lane during the AM and PM peak hours
- NH 102 at I-93 Southbound off-ramp (Exit 4) (Intersection #7)
  - I-93 Southbound off-ramp during the PM peak hour
- NH 102 at I-93 Northbound on and off-ramp (Exit 4) (Intersection #8)
  - Eastbound NH 102 during the AM and PM peak hours
  - Westbound NH 102 during the AM peak hour
  - I-93 Northbound on-ramp during the AM and PM peak hours
- NH 102 at Fordway/Madden Hill Road (Intersection #10)
  - Northbound Fordway during the AM and PM peak hours

- Connector Roadway and I-93 Southbound on and off-ramp (Exit 4A) (Intersection #11)
  - Westbound Connector Roadway during the AM peak hour

The overall Alternative A intersection LOS grades are depicted in Figure 7-9 for AM and PM peak hours. Table 7-1 shows the comparison between Alternative A and No Build condition LOS capacity analysis and the intersection vehicle delay results during the AM and PM peak hours. Appendices G, H, and I contain the Synchro™ Build condition intersection analysis reports.

7.4 2040 Build Alternative A Queuing Analysis

Based on the Synchro™ signalized intersection analysis results, nine of the signalized intersections within the study area would experience queuing lengths that would exceed the available storage capacity. Intersections #4, #8, and #9 would provide sufficient storage for the anticipated demand. The lane group in the approach that would operate under unacceptable conditions is noted in parentheses. Table 7-1 contains the queuing results. Appendices J, K, and L contain the Synchro™ Build condition intersection queuing reports.

- NH 28 at Symmes Drive/Vista Ridge Drive (Intersection #1)
  - Northbound Vista Ridge Drive (right turns) during the AM and the PM peak hours
  - Southbound Symmes Drive (left turns, right turns, and through movements) during the PM peak hour
- NH 28 at I-93 Southbound on and off-ramp (Exit 5) (Intersection #2)
  - Eastbound NH 28 (right turns) during the AM peak hour
  - Westbound NH 28 (left turns) during the AM peak hour
- NH 28 at I-93 Northbound on and off-ramp (Exit 5) (Intersection #3)
  - Eastbound NH 28 (left turns) during the AM peak hour
  - Westbound NH 28 (through movements) during the AM peak hour
- NH 102 at Gilcreast Road (Intersection #5)
  - Eastbound NH 102 (left turns) during the AM and PM peak hours
  - Northbound Gilcreast Road (all movements) during the AM and PM peak hours
  - Southbound Gilcreast Road (left turns) during the AM peak hour
  - Southbound Gilcreast Road (right turns and through movements) during the AM and PM peak hours
- NH 102 at Hampton Drive/Garden Lane (Intersection #6)
  - Eastbound NH 102 (left turns) during the AM and PM peak hours
  - Eastbound NH 102 (right turns and through movements) during the AM peak hour
  - Westbound NH 102 (right turns) during the AM and PM peak hours

  - Northbound Hampton Drive (right turns) during the AM and PM peak hours
  - Southbound Garden Lane (all movements) during the AM and PM peak hours
- NH 102 at I-93 Southbound off-ramp (Exit 4) (Intersection #7)
  - I-93 Southbound off-ramp (all movements) during the AM ad PM peak hours
- NH 102 at Fordway/Madden Hill Road (Intersection #10)
  - Eastbound NH 102 (all movements) during the PM peak hour
  - Westbound NH 102 (all movements) during the AM and PM peak hours
  - Southbound Madden Hill Road during the PM peak hour
- Connector Roadway and I-93 Southbound on and off-ramp (Exit 4A) (Intersection #11)
  - Westbound Connector Roadway (left turns) during the AM peak hour
- Connector Roadway and I-93 Northbound on and off-ramp (Exit 4A) (Intersection #12)
  - Westbound Connector Roadway (right turns) during the AM and PM peak hours

The remaining signalized intersections in the traffic study area would provide sufficient storage for the anticipated demand. The lane group in the approach that would operate under unacceptable conditions is highlighted in red in Table 7-1, which contains a comparison between Alternative A and No Build condition queuing results.

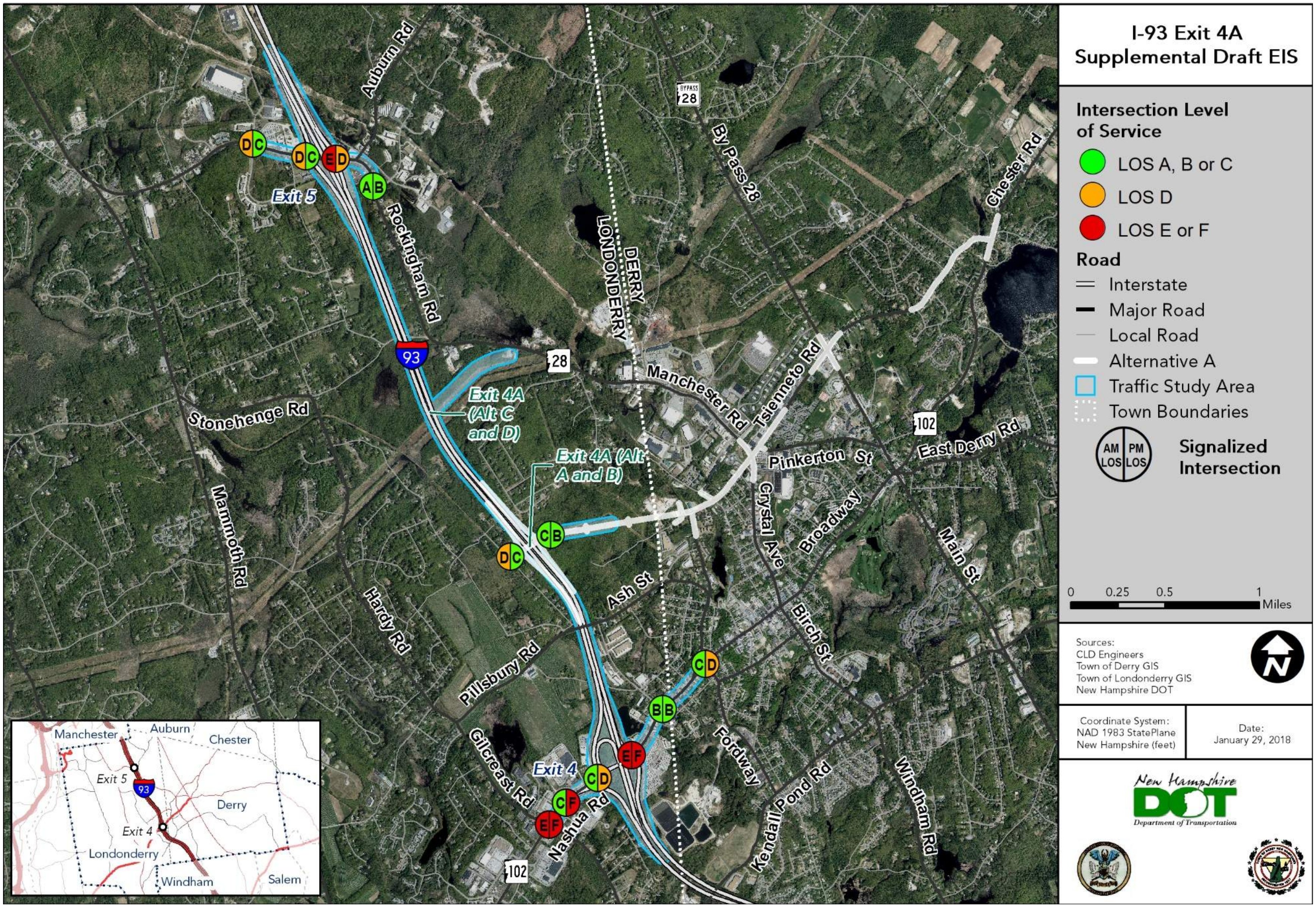


Figure 7-9. 2040 Build Alternative A AM and PM peak hour LOS by intersection

Table 7-1. Comparison between Alternative A and No Build condition intersection capacity and queuing analyses

		No Build Condition										Alternative A									
		Turning Bay/ Link	AM Peak Hour				PM Peak Hour					Turning Bay/ Link	AM Peak Hour				PM Peak Hour				
Intersection	Lane Groups	Length (feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS		Length (feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	
#1 NH 28 & Symmes Dr/ Vista Ridge Dr (Signalized) [a]	EB L	408	353	0.97	85.5	F	50	0.76	111.3	F		408	349	1.07	110.4	F	58	0.59	54.9	D	
	EB TR	729	414	0.51	13.0	B	458	0.81	31.9	C		408	233	0.54	13.6	B	313	0.86	29.9	C	
	EB Overall				30.8	C			33.9	C					37.2	D			30.6	C	
	WB L	450	40	0.55	71.3	E	154	0.81	74.0	E		450	85	0.46	50.6	D	182	0.92	85.6	F	
	WB Thru	1,537	409	0.84	33.8	C	298	0.61	20.4	C		755	474	0.93	37.9	D	288	0.73	21.3	C	
	WB R	500	137	0.08	19.5	B	31	0.04	14.0	B		500	214	0.08	17.1	B	46	0.04	13.4	B	
	WB Overall				32.9	C			26.2	C					36.1	D			28.2	C	
	NB LT	1,660	330	0.43	48.5	D	120	0.55	55.5	E		1,660	128	0.44	39.6	D	94	0.48	39.5	D	
	NB R	10	#101	0.08	45.4	D	#79	0.02	49.0	D		10	#90	0.07	36.6	D	#70	0.02	35.7	D	
	NB Overall				46.5	D			53.3	D					37.7	D			38.3	D	
	SB L	270	181	0.93	110.8	F	267	0.84	63.6	E		270	115	0.82	70.6	E	#369	0.93	72.2	E	
	SB LTR	270	191	0.07	47.1	D	#368	0.39	42.0	D		270	122	0.07	36.9	D	#631	0.35	33.3	C	
	SB Overall				**79.0**	**E**			51.9	D					54.1	D			50.0	D	
	Intersection Overall			**0.84**	**36.4**	**D**		**0.79**	**34.7**	**C**				**0.89**	**38.0**	**D**		**0.84**	**33.3**	**C**	

Table 7-1. Comparison between Alternative A and No Build condition intersection capacity and queuing analyses (continued)

		No Build Condition										Alternative A									
		Turning Bay/ Link Length (feet)	AM Peak Hour				PM Peak Hour					Turning Bay/ Link Length (feet)	AM Peak Hour				PM Peak Hour				
Intersection	Lane Groups		95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS			95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	
#2 **NH 28 & I-93 SB On and Off-Ramp (Exit 5) (Signalized)** [a]	EB Thru	1,537	#1904	0.97	73.6	E	1243	0.88	39.4	D		1,537	842	0.95	71.3	E	274	0.77	32.7	C	
	EB R	350	#546	0.28	0.5	A	#463	0.29	0.5	A		350	#426	0.35	0.7	A	-	0.36	0.6	A	
	EB Overall				51.1	D			27.9	C					42.4	D			20.2	C	
	WB L	592	#632	1.17	111.5	F	280	0.92	20.7	C		592	#645	1.06	66.0	E	208	0.86	11.6	B	
	WB Thru	592	101	0.44	1.8	A	59	0.32	0.2	A		592	84	0.53	1.8	A	96	0.38	0.2	A	
	WB Overall				42.9	D			6.4	A					24.1	C			3.3	A	
	SB L	502	492	0.72	44.8	D	406	0.92	48.2	D		502	128	0.25	34.5	C	145	0.35	26.4	C	
	SB R	502	#526	1.35	217.5	F	109	0.89	52.5	D		502	332	1.16	138.4	F	43	0.89	50.7	D	
	SB Overall				**131.6**	**F**			49.9	D					**108.5**	**F**			41.3	D	
	Intersection Overall			**1.17**	**77.0**	**E**		**0.90**	**31.2**	**C**				**1.06**	**49.3**	**D**		**0.83**	**20.1**	**C**	
#3 **NH 28 & I-93 NB On and Off-Ramp (Exit 5) (Signalized)** [a]	EB L	592	#729	1.11	67.9	E	#706	1.07	53.5	D		592	#752	1.12	70.9	E	573	1.03	42.8	D	
	EB Thru	592	#789	0.39	0.6	A	316	0.62	6.1	A		592	452	0.20	0.3	A	183	0.32	2.2	A	
	EB Overall				32.0	C			22.5	C					42.7	D			20.7	C	
	WB Thru	481	#580	1.05	104.5	F	217	0.91	61.7	E		481	#598	1.07	104.4	F	179	0.87	48.8	D	
	WB R	481	171	0.56	1.5	A	-	0.38	0.7	A		481	169	0.46	1.0	A	-	0.31	0.5	A	
	WB Overall				48.5	D			29.7	C					**56.9**	**E**			27.3	C	
	NB L	798	685	1.11	128.2	F	337	0.86	47.1	D		798	746	1.13	122.8	F	533	1.03	78.1	E	
	NB R	798	349	0.23	39.9	D	213	1.08	98.8	F		798	273	0.24	32.5	C	286	0.95	59.7	E	
	NB Overall				**101.9**	**F**			**76.0**	**E**					**97.8**	**F**			**68.3**	**E**	
	Intersection Overall			**1.10**	**51.7**	**D**		**1.04**	**37.7**	**D**				**1.11**	**63.0**	**E**		**0.99**	**39.2**	**D**	

Table 7-1. Comparison between Alternative A and No Build condition intersection capacity and queuing analyses (continued)

		No Build Condition									Alternative A								
		Turning Bay/ Link Length	AM Peak Hour				PM Peak Hour				Turning Bay/ Link Length	AM Peak Hour				PM Peak Hour			
Intersection	Lane Groups	(feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	(feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS
#4 NH 28 &	EB L	225	79	0.51	42.4	D	50	0.49	30.6	C	225	53	0.48	41.2	D	35	0.69	62.9	E
Liberty Dr	EB TR	841	46	0.13	3.9	A	116	0.47	8.8	A	841	30	0.08	4.0	A	83	0.37	8.7	A
(Signalized) [a]	EB Overall				10.7	B			9.9	A				10.6	B			11.2	B
	WB L	250	19	0.29	51.2	D	17	0.22	31.7	C	250	22	0.29	46.5	D	19	0.19	23.9	C
	WB TR	332	178	0.52	8.5	A	88	0.27	8.7	A	332	148	0.51	7.3	A	92	0.30	8.4	A
	WB Overall				8.7	A			9.0	A				7.5	A			8.6	A
	NB L	154	51	0.29	41.6	D	52	0.14	21.4	C	154	23	0.05	35.1	D	48	0.14	16.7	B
	NB Overall				41.6	D			21.4	C				35.1	D			16.7	B
	SB LT	100	29	0.15	40.6	D	38	0.17	21.6	C	100	34	0.12	35.8	D	29	0.12	16.6	B
	SB R	502	96	0.07	39.7	D	97	0.10	21.1	C	502	89	0.07	35.3	D	83	0.09	16.4	B
	SB Overall				39.8	D			21.2	C				35.3	D			16.5	B
	Intersection Overall			**0.50**	**11.3**	**B**		**0.43**	**11.2**	**B**			**0.47**	**9.6**	**A**		**0.33**	**11.1**	**B**

Table 7-1. Comparison between Alternative A and No Build condition intersection capacity and queuing analyses (continued)

		No Build Condition									Alternative A								
			AM Peak Hour				PM Peak Hour					AM Peak Hour				PM Peak Hour			
Intersection	Lane Groups	Turning Bay/ Link Length (feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	Turning Bay/ Link Length (feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS
#5 **NH 102 & Gilcreast Rd (Signalized)** [a]	EB L	275	255	1.00	117.3	F	#345	1.24	193.4	F	275	#280	0.95	105.7	F	#338	1.24	193.6	F
	EB RT	852	373	1.10	88.9	F	386	0.81	35.9	D	852	383	1.05	76.3	E	374	0.71	31.7	C
	EB Overall				**91.5**	**F**			**60.6**	**E**				**79.6**	**E**			**60.9**	**E**
	WB L	275	86	0.78	53.7	D	135	0.79	32.0	C	275	110	0.79	76.5	E	102	0.63	31.9	C
	WB Thru	669	150	0.97	33.7	C	266	1.27	134.1	F	669	200	0.92	37.6	D	212	1.19	99.9	F
	WB R	225	40	0.06	24.2	C	117	0.14	0.2	A	225	64	0.05	29.5	C	83	0.14	0.7	A
	WB Overall				34.9	C			**111.7**	**F**				40.4	D			**85.2**	**F**
	NB LT	488	#610	1.16	155.1	F	#567	1.29	200.5	F	488	#609	1.07	139.8	F	#615	1.23	189.0	F
	NB R	488	#598	0.63	47.0	D	#682	0.19	32.8	C	488	#601	0.68	62.0	E	#661	0.17	36.5	D
	NB Overall				**100.5**	**F**			**144.8**	**F**				**98.9**	**F**			**134.5**	**F**
	SB L	356	#442	1.13	142.9	F	314	0.95	114.4	F	356	#444	1.10	144.5	F	313	0.90	106.6	F
	SBT	356	#483	0.53	47.3	D	#433	0.97	116.8	F	356	#478	0.44	56.4	E	#451	0.97	123.9	F
	SB R	225	#291	0.35	45.0	D	#303	0.55	49.0	D	225	#278	0.43	56.5	E	#277	0.91	86.1	F
	SB Overall				**87.6**	**F**			**83.2**	**F**				**94.2**	**F**			**98.6**	**F**
	Intersection Overall			**1.14**	**76.3**	**E**		**1.24**	**94.0**	**F**			**1.08**	**73.3**	**E**		**1.18**	**82.7**	**F**

Table 7-1. Comparison between Alternative A and No Build condition intersection capacity and queuing analyses (continued)

		No Build Condition									Alternative A								
		Turning Bay/ Link Length	AM Peak Hour				PM Peak Hour				Turning Bay/ Link Length	AM Peak Hour				PM Peak Hour			
Intersection	Lane Groups	(feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	(feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS
#6 NH 102 & Hampton Dr/Garden Ln (Signalized) [a]	EB L	275	179	0.58	61.3	E	242	1.08	125.2	F	275	#277	0.75	84.4	F	#318	1.27	212.8	F
	EB TR	669	615	1.00	14.9	B	239	0.76	18.9	B	669	#785	0.98	13.5	B	577	0.68	16.7	B
	EB Overall				17.6	B			42.7	D				21.8	C			**73.6**	**E**
	WB L	275	62	0.47	62.2	E	182	0.61	51.4	D	275	52	0.48	77.0	E	192	0.60	58.6	E
	WB Thru	715	221	0.55	16.9	B	367	0.99	44.7	D	715	234	0.57	27.5	C	462	1.08	84.3	F
	WB R	275	133	0.22	20.4	C	#329	0.81	26.1	C	275	#277	0.56	10.8	B	#341	1.14	97.0	F
	WB Overall				19.3	B			39.9	D				23.1	C			**87.8**	**F**
	NB LT	630	78	0.28	56.2	E	175	0.77	84.4	F	630	99	0.31	73.3	E	150	0.65	79.9	E
	NB R	100	#110	0.11	47.0	D	#137	0.06	51.5	D	100	#116	0.06	61.3	E	#127	0.05	56.3	E
	NB Overall				49.5	D			**70.1**	**E**				**64.7**	**E**			**69.4**	**E**
	SB L	175	#258	0.91	92.2	F	#242	1.02	104.3	F	175	#244	0.91	91.2	F	#236	1.01	95.1	F
	SB LT	291	#374	0.93	96.9	F	#323	1.00	99.1	F	291	#328	0.89	86.7	F	#320	1.02	96.1	F
	SB R	175	#266	0.10	34.2	C	#210	0.79	59.4	E	175	#276	0.29	34.3	C	#217	0.96	81.8	F
	SB Overall				**77.5**	**E**			**84.5**	**F**				**72.1**	**E**			**90.2**	**F**
	Intersection Overall			**0.92**	**24.9**	**C**		**0.99**	**49.9**	**D**			**0.93**	**30.1**	**C**		**1.11**	**83.9**	**F**

Table 7-1. Comparison between Alternative A and No Build condition intersection capacity and queuing analyses (continued)

		No Build Condition									Alternative A								
		Turning Bay/ Link Length	AM Peak Hour				PM Peak Hour				Turning Bay/ Link Length	AM Peak Hour				PM Peak Hour			
Intersection	Lane Groups	(feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	(feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS
#7 NH 102 &	EB Thru	895	540	1.06	53.2	D	565	1.12	87.4	F	895	765	0.92	24.4	C	387	0.84	23.9	C
I-93 SB Off-	EB Overall				53.2	D			**87.4**	**F**				24.4	C			23.9	C
Ramp	WB Thru	1,057	193	0.58	13.4	B	420	1.26	146.7	F	1,057	317	0.61	22.0	C	247	1.08	43.9	D
(Exit 4)	WB Overall				13.4	B			**146.7**	**F**				22.0	C			43.9	D
(Signalized) [a]	SB L	138	#203	1.10	81.8	F	#205	1.20	116.3	F	138	#217	0.56	19.0	B	#219	0.49	25.4	C
	SB R	138	#167	0.84	21.4	C	#192	1.09	72.2	E	138	#222	0.92	34.8	C	#244	1.10	94.5	F
	SB Overall				50.8	D			**91.7**	**F**				30.0	C			**77.7**	**E**
	Intersection Overall			**1.08**	**44.5**	**D**		**1.22**	**106.4**	**F**			**0.92**	**25.9**	**C**		**1.09**	**50.9**	**D**
#8 NH 102 &	EB L	550	529	1.11	85.6	F	475	1.20	127.6	F	550	493	1.05	65.4	E	544	1.26	158.2	F
I-93 NB On	EB Thru	1,057	238	0.37	5.7	A	357	0.69	21.2	C	1,057	78	0.10	9.0	A	324	0.26	7.7	A
and Off-Ramp	EB Overall				50.9	D			**69.9**	**E**				**57.3**	**E**			**115.3**	**F**
(Exit 4)	WB Thru	1,462	767	1.07	82.8	F	266	0.77	51.8	D	1,462	815	1.03	92.4	F	234	0.57	50.4	D
(Signalized) [a]	WB R	786	#1006	0.78	3.9	A	230	0.54	1.3	A	786	233	0.12	0.2	A	-	0.08	0.1	A
	WB Overall				45.6	D			22.0	C				**77.2**	**E**			38.8	D
	NB L	1,440	496	1.14	137.6	F	897	1.21	140.7	F	1,440	348	1.03	109.6	F	843	1.29	178.2	F
	NB R	1,440	231	1.08	122.3	F	937	1.26	163.5	F	1,440	173	0.61	60.4	E	894	0.85	44.7	D
	NB Overall				**130.9**	**F**			**151.2**	**F**				**93.6**	**F**			**131.8**	**F**
	Intersection Overall			**1.10**	**61.4**	**E**		**1.12**	**92.8**	**F**			**1.04**	**71.2**	**E**		**1.11**	**115.1**	**F**

Table 7-1. Comparison between Alternative A and No Build condition intersection capacity and queuing analyses (continued)

			No Build Condition									Alternative A								
			AM Peak Hour				PM Peak Hour					AM Peak Hour				PM Peak Hour				
Intersection	Lane Groups	Turning Bay/ Link Length (feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	Turning Bay/ Link Length (feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS
#9 NH 102 & St Charles St/ Londonderry Rd (Signalized) [a]	EB L	350	202	0.85	58.1	E	#422	1.31	176.0	F	350	60	0.42	33.0	C	169	0.64	30.3	C
	EB TR	1,462	63	0.27	2.7	A	853	0.49	3.5	A	1,462	78	0.21	5.7	A	181	0.50	8.0	A
	EB Overall				17.4	B			**77.9**	**E**				9.1	A			11.9	B
	WB L	100	44	0.31	59.1	E	25	0.31	59.4	E	100	35	0.26	42.8	D	30	0.26	43.0	D
	WB TR	410	320	0.87	19.0	B	324	1.01	59.5	E	410	171	0.53	10.4	B	194	0.48	15.4	B
	WB Overall				19.1	B			**59.5**	**E**				10.6	B			15.6	B
	NB LTR	-	-	-	-	-	-	-	-	-	400	7	0.02	28.8	C	46	0.06	28.0	C
	NB Overall				0.0	A			0.0	A				28.8	C			28.0	C
	SB LT	780	70	0.23	53.2	D	22	0.21	52.4	D	780	85	0.57	35.4	D	87	0.61	35.9	D
	SB R	225	194	0.17	7.8	A	141	0.20	22.2	C	225	42	0.02	7.3	A	53	0.06	12.5	B
	SB Overall				8.7	A			22.6	C				28.8	C			25.1	C
	Intersection Overall			**0.85**	**17.7**	**B**		**1.16**	**67.5**	**E**			**0.52**	**11.4**	**B**		**0.58**	**14.8**	**B**
#10 NH 102 & Fordway/ Madden Hill Rd (Signalized) [a]	EB TR	455	332	0.73	17.0	B	#734	1.05	55.2	E	455	323	0.70	20.1	C	#562	0.98	43.2	D
	EB Overall				17.0	B			**55.2**	**E**				20.1	C			43.2	D
	WB LT	165	#519	0.91	29.2	C	#535	0.71	12.2	B	165	#430	0.76	22.1	C	#339	0.59	14.6	B
	WB Overall				29.2	C			12.2	B				22.1	C			14.6	B
	NB LR	375	298	0.94	60.4	E	277	1.02	96.3	F	375	323	0.83	32.1	C	336	1.01	84.2	F
	NB Overall				**60.4**	**E**			**96.3**	**F**				32.1	C			**84.2**	**F**
	SB LTR	120	40	0.05	21.8	C	61	0.16	30.2	C	120	83	0.21	15.2	B	#124	0.42	25.1	C
	SB Overall				21.8	C			30.2	C				15.2	B			25.1	C
	Intersection Overall			**0.92**	**30.8**	**C**		**1.04**	**47.3**	**D**			**0.79**	**23.4**	**C**		**0.99**	**42.5**	**D**

Table 7-1. Comparison between Alternative A and No Build condition intersection capacity and queuing analyses (continued)

		No Build Condition									**Alternative A**								
		Turning Bay/ Link Length	AM Peak Hour				PM Peak Hour				Turning Bay/ Link Length	AM Peak Hour				PM Peak Hour			
Intersection	Lane Groups	(feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	(feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS
#11 **Connector Rd & I-93 SB On and Off-Ramp (Exit 4A) (Signalized)** [a]	WBL	-	-	-	-	-	-	-	-	-	320	#364	0.98	55.7	E	303	0.83	36.1	D
	WB Overall				-	-			-	-				**55.7**	**E**			36.1	D
	SB L	-	-	-	-	-	-	-	-	-	531	487	0.96	33.0	C	402	0.91	24.8	C
	SB Overall				-	-			-	-				33.0	C			24.8	C
	Intersection Overall			-	-	-		-	-	-			**0.97**	**41.2**	**D**		**0.88**	**28.9**	**C**
#12 **Connector Rd & I-93 NB On and Off-Ramp (Exit 4A) (Signalized)** [a]	EB T	-	-	-	-	-	-	-	-	-	320	89	0.92	3.0	A	98	0.86	3.5	A
	EB Overall				-	-			-	-				3.0	A			3.5	A
	WB T	-	-	-	-	-	-	-	-	-	3,362	1520	0.52	13.0	B	223	0.49	12.5	B
	WB R	-	-	-	-	-	-	-	-	-	200	#271	0.93	28.5	C	#267	0.86	22.4	C
	WB Overall				-	-			-	-				22.0	C			18.3	B
	NB LR	-	-	-	-	-	-	-	-	-	473	371	0.89	48.8	D	296	0.77	35.6	D
	NB R	-	-	-	-	-	-	-	-	-	473	320	0.94	57.8	E	265	0.80	38.7	D
	NB Overall				-	-			-	-				53.3	D			37.2	D
	Intersection Overall			-	-	-		-	-	-			**0.93**	**20.4**	**C**		**0.84**	**16.1**	**B**

Notes:

95th percentile volume exceeds capacity, queue may be longer.

EB = Eastbound, WB = Westbound, NB= Northbound, SB = Southbound

LOS = Level of Service

LTR = left / through / right lanes

V/C = Volume-to-Capacity ratio

Delay is Measured in Seconds Per Vehicle.

Red cells denote intersections or approaches operating at unacceptable conditions or denote approaches and lane groups whose queuing length exceeds capacity

[a] Highway Capacity Manual 2000 results (Signalized intersections)

7.5 2040 Build Alternative A Freeway Operations Analysis

Analysis performed using HCS shows all freeway facilities would operate below capacity. The one failing freeway facility under the No Build condition (the I-93 SB off-ramp to NH 102) would improve to LOS A. Table 7-2 contains the Exit 4 Alternative A freeway analysis compared to the No Build condition, and Table 7-3 contains the Exit 5 Alternative A freeway analysis compared to the No Build condition. Table 7-4 contains the Exit 4A Alternative A freeway analysis. Appendix M contains the Build condition HCS freeway operation reports.

Table 7-2. I-93 Exit 4 2040 Build Alternative A freeway analysis compared to the No Build condition

Freeway Analysis	Facility Type	Time Period	Demand to Capacity Ratio		Density (pc/mi/ln)	Alt A LOS	No Build LOS
			Freeway	Ramp			
I-93 Northbound to NH 102	Diverge	AM	0.38	0.23	0.0	A	A
		PM	0.66	0.54	11.0	B	B
NH 102 to I-93 Northbound	Merge	AM	0.49	0.89	19.3	B	C
		PM	0.57	0.70	20.1	C	C
I-93 Southbound to NH 102	Diverge	AM	0.57	0.76	25.8	C	C
		PM	0.54	0.91	26.4	C	F
NH 102 Westbound to I-93 Southbound	Merge	AM	0.49	0.36	14.6	B	B
		PM	0.39	0.17	10.0	A	B
NH 102 Eastbound to I-93 Southbound	Merge	AM	0.69	0.93	25.7	C	C
		PM	0.49	0.46	15.2	B	B

Notes: LOS = Level of Service; Density = Passenger cars per mile per lane (pc/mi/ln)

Red denotes interstate facilities that would result in failing operations and would produce a queue extending to the I-93 mainline.

Table 7-3. I-93 Exit 5 2040 Build Alternative A freeway analysis compared to the No Build condition

Freeway Analysis	Facility Type	Time Period	Demand to Capacity Ratio		Density (pc/mi/ln)	Alt A LOS	No Build LOS
			Freeway	Ramp			
I-93 Northbound to NH 28	Diverge	AM	0.56	0.43	24.5	C	C
		PM	0.62	0.58	28.1	D	C
NH 28 to I-93 Northbound	Merge	AM	0.63	0.67	25.7	C	C
		PM	0.64	0.50	24.4	C	C
I-93 Southbound to NH 28	Diverge	AM	0.62	0.41	24.2	C	C
		PM	0.62	0.42	24.0	C	D
NH 28 to I-93 Southbound	Merge	AM	0.67	0.52	21.2	C	B
		PM	0.63	0.44	19.3	B	B

Notes: LOS = Level of Service; Density = Passenger cars per mile per lane (pc/mi/ln)

Table 7-4. I-93 Exit 4A 2040 Build Alternative A freeway analysis

Freeway Analysis	Facility Type	Time Period	Demand to Capacity Ratio		Density (pc/mi/ln)	LOS
			Freeway	Ramp		
I-93 Northbound to Connector Roadway	Diverge	AM	0.49	0.48	20.2	C
		PM	0.56	0.41	21.8	C
Connector Roadway to I-93 Northbound	Merge	AM	0.59	0.84	24.9	C
		PM	0.64	0.72	25.3	C
I-93 Southbound to Connector Roadway	Diverge	AM	0.65	0.53	19.0	B
		PM	0.61	0.45	15.9	B
Connector Roadway to I-93 Southbound	Merge	AM	0.59	0.60	23.3	C
		PM	0.55	0.51	21.4	C

Notes: LOS = Level of Service; Density = Passenger cars per mile per lane (pc/mi/ln)

7.6 2040 Build Alternative B Intersection Operations Analysis

Based on the Synchro™ signalized intersection analysis results, three signalized intersections (Intersections #5, #6, and #8) would operate at unacceptable conditions (LOS E or LOS F) during the AM or PM peak hours. The remaining signalized intersections in the traffic study area would operate at acceptable overall conditions (LOS D or better is considered an operating level) during the peak hours analyzed (weekday AM and PM peak hours).

Based on the Synchro™ signalized intersection analysis results, eight of the study area signalized intersections have overall approaches that would operate at unacceptable conditions (LOS E or LOS F) during one or two evaluated periods. The following individual signalized intersection approaches in the traffic study area would operate under unacceptable conditions during peak hours:

- NH 28 at I-93 Southbound on and off-ramp (Exit 5) (Intersection #2)
  - I-93 Southbound off-ramp during the AM peak hour
- NH 28 at I-93 Northbound on and off-ramp (Exit 5) (Intersection #3)
  - I-93 Northbound off-ramp during the AM peak hour
- NH 102 at Gilcreast Road (Intersection #5)
  - Eastbound NH 102 during the AM and PM peak hours
  - Westbound NH 102 during the PM peak hour
  - Northbound Gilcreast Road during the AM and PM peak hours
  - Southbound Gilcreast Road during the AM and PM peak hours
- NH 102 at Hampton Drive/Garden Lane (Intersection #6)
  - Eastbound NH 102 during the PM peak hour
  - Westbound NH 102 during the PM peak hour
  - Northbound Hampton Drive during the AM and PM peak hours
  - Southbound Garden Lane during the AM and PM peak hours
- NH 102 at I-93 Southbound off-ramp (Exit 4) (Intersection #7)
  - I-93 Southbound off-ramp during the PM peak hour
- NH 102 at I-93 Northbound on and off-ramp (Exit 4) (Intersection #8)
  - Eastbound NH 102 during the PM peak hour
  - I-93 Northbound off-ramp during the AM and PM peak hours
- Connector Roadway and I-93 Southbound on and off-ramp (Exit 4A) (Intersection #11)
  - I-93 Southbound off-ramp during the AM peak hour
- Connector Roadway and I-93 Northbound on and off-ramp (Exit 4A) (Intersection #12)
  - I-93 Northbound on-ramp during the AM and PM peak hours

The overall Alternative B intersection LOS grades are depicted in Figure 7-10 for AM and PM peak hours. Table 7-5 shows the comparison between Alternative B and No Build condition LOS capacity analysis and the intersection vehicle delay results during the AM and PM peak hours. Appendices G, H, and I contain the Synchro™ Build condition intersection analysis reports.

7.7 2040 Build Alternative B Queuing Analysis

Based on the Synchro™ signalized intersection analysis results, eight of the signalized intersections within the study area would experience queuing lengths that would exceed the available storage capacity. Intersections #2, #4, #8, and #9 would provide sufficient storage for the anticipated demand. The lane group in the approach that would operate under unacceptable conditions is noted in parentheses. Table 7-5 contains the queuing results. Appendices J, K, and L contain the Synchro™ Build condition intersection queuing reports.

- NH 28 at Symmes Drive/Vista Ridge Drive (Intersection #1)
    - Northbound Vista Ridge Drive (right turns) during the AM and the PM peak hours
    - Southbound Symmes Drive (left turns, right turns, and through movements) during the PM peak hour
- NH 28 at I-93 Northbound on and off-ramp (Exit 5) (Intersection #3)
    - Eastbound NH 28 (left turns) during the AM and PM peak hours
- NH 102 at Gilcreast Road (Intersection #5)
    - Eastbound NH 102 (left turns) during the AM and PM peak hours
    - Northbound Gilcreast Road (left turns) during the AM and PM peak hours
    - Northbound Gilcreast Road (right turns) during the PM peak hour
    - Southbound Gilcreast Road (left turns) during the AM peak hour
    - Southbound Gilcreast Road (right turns and through movements) during the AM and PM peak hours
- NH 102 at Hampton Drive/Garden Lane (Intersection #6)
    - Eastbound NH 102 (left turns) during the AM and PM peak hours
    - Eastbound NH 102 (right turns and through movements) during the AM peak hour
    - Westbound NH 102 (right turns) during the AM and PM peak hours
    - Northbound Hampton Dr. (right turns) during the AM and PM peak hours
    - Southbound Garden Lane (all movements) during the AM and PM peak hours
- NH 102 at I-93 Southbound off-ramp (Exit 4) (Intersection #7)
    - I-93 Southbound off-ramp (all movements) during the AM and PM peak hours
- NH 102 at Fordway/Madden Hill Road (Intersection #10)
    - Eastbound NH 102 (right turns and through movements) during the PM peak hour
    - Westbound NH 102 (all movements) during the AM and PM peak hours
- Connector Roadway and I-93 Southbound on and off-ramp (Exit 4A) (Intersection #11)
    - Westbound Connector Roadway (left turns) during the AM and PM peak hours
    - I-93 Southbound off-ramp (left turns) during the AM peak hour

- Connector Roadway and I-93 Northbound on and off-ramp (Exit 4A) (Intersection #12)
  - Westbound Connector Roadway (right turns) during the AM and PM peak hours
  - I-93 Northbound on-ramp (all movements) during the AM peak hour

The remaining signalized intersections in the traffic study area would provide sufficient storage for the anticipated demand. The lane group in the approach that would operate under unacceptable conditions is highlighted in red in Table 7-5, which contains a comparison between Alternative B and No Build condition queuing results.

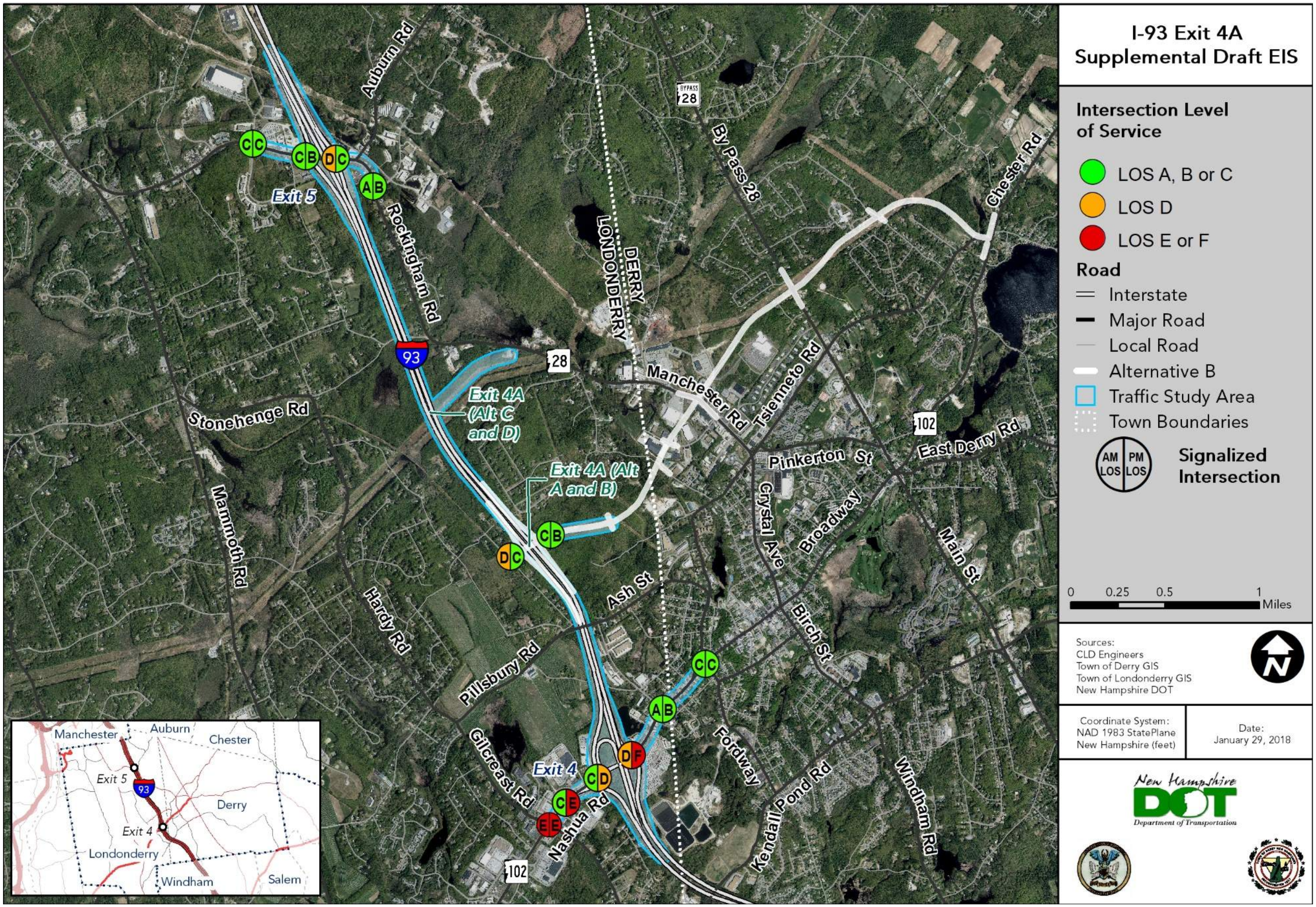


Figure 7-10. 2040 Build Alternative B AM and PM peak hour LOS by intersection

Table 7-5. Comparison between Alternative B and No Build condition intersection capacity and queuing analyses

		No Build Condition										Alternative B									
		Turning Bay/ Link Length (feet)	AM Peak Hour				PM Peak Hour					Turning Bay/ Link Length (feet)	AM Peak Hour				PM Peak Hour				
Intersection	Lane Groups		95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS			95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	
#1 NH 28 & Symmes Dr/ Vista Ridge Dr (Signalized) [a]	EB L	408	353	0.97	85.5	F	50	0.76	111.3	F		408	299	1.02	93.1	F	58	0.53	48.7	D	
	EB TR	729	414	0.51	13.0	B	458	0.81	31.9	C		729	224	0.52	12.7	B	341	0.84	28.5	C	
	EB Overall				30.8	C			33.9	C					32.4	C			29.1	C	
	WB L	450	40	0.55	71.3	E	154	0.81	74.0	E		450	34	0.94	231.9	F	136	0.83	67.1	E	
	WB Thru	1,537	409	0.84	33.8	C	298	0.61	20.4	C		1,537	428	0.85	30.6	C	239	0.66	19.7	B	
	WB R	500	137	0.08	19.5	B	31	0.04	14.0	B		500	96	0.07	17.5	B	36	0.03	13.3	B	
	WB Overall				32.9	C			26.2	C					32.1	C			24.8	C	
	NB LT	1,660	330	0.43	48.5	D	120	0.55	55.5	E		1,660	131	0.44	40.2	D	95	0.45	39.3	D	
	NB R	10	#101	0.08	45.4	D	#79	0.02	49.0	D		10	#89	0.07	37.2	D	#70	0.02	35.8	D	
	NB Overall				46.5	D			53.3	D					38.3	D			38.1	D	
	SB L	270	181	0.93	110.8	F	267	0.84	63.6	E		270	121	0.82	71.2	E	225	0.91	67.8	E	
	SB LTR	270	191	0.07	47.1	D	#368	0.39	42.0	D		270	121	0.07	37.5	D	#325	0.32	32.9	C	
	SB Overall				**79.0**	**E**			51.9	D					54.5	D			48.5	D	
	Intersection Overall			**0.84**	**36.4**	**D**		**0.79**	**34.7**	**C**				**0.84**	**34.3**	**C**		**0.81**	**31.1**	**C**	

Table 7-5. Comparison between Alternative B and No Build condition intersection capacity and queuing analyses (continued)

		No Build Condition									Alternative B								
		Turning Bay/ Link Length	AM Peak Hour				PM Peak Hour				Turning Bay/ Link Length	AM Peak Hour				PM Peak Hour			
Intersection	Lane Groups	(feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	(feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS
#2 NH 28 & I-93 SB On and Off-Ramp (Exit 5) (Signalized) [a]	EB Thru	1,537	#1904	0.97	73.6	E	1243	0.88	39.4	D	1,537	571	0.76	46.2	D	300	0.65	23.8	C
	EB R	350	#546	0.28	0.5	A	#463	0.29	0.5	A	350	284	0.32	0.6	A	-	0.31	0.5	A
	EB Overall				51.1	D			27.9	C				28.9	C			15.7	B
	WB L	592	#632	1.17	111.5	F	280	0.92	20.7	C	592	390	0.89	36.9	D	164	0.71	17.0	B
	WB Thru	592	101	0.44	1.8	A	59	0.32	0.2	A	592	91	0.50	2.7	A	79	0.34	0.3	A
	WB Overall				42.9	D			6.4	A				11.7	B			3.6	A
	SB L	502	492	0.72	44.8	D	406	0.92	48.2	D	502	91	0.14	31.9	C	93	0.23	26.8	C
	SB R	502	#526	1.35	217.5	F	109	0.89	52.5	D	502	268	0.93	67.0	E	35	0.79	41.4	D
	SB Overall				**131.6**	**F**			49.9	D				**59.4**	**E**			37.2	D
	Intersection Overall			**1.17**	**77.0**	**E**		**0.90**	**31.2**	**C**			**0.86**	**28.0**	**C**		**0.70**	**16.9**	**B**
#3 NH 28 & I-93 NB On and Off-Ramp (Exit 5) (Signalized) [a]	EB L	592	#729	1.11	67.9	E	#706	1.07	53.5	D	592	#756	1.04	52.6	D	#610	1.02	48.7	D
	EB Thru	592	#789	0.39	0.6	A	316	0.62	6.1	A	592	481	0.16	2.7	A	212	0.26	3.3	A
	EB Overall				32.0	C			22.5	C				35.7	D			26.6	C
	WB Thru	481	#580	1.05	104.5	F	217	0.91	61.7	E	481	301	1.00	89.2	F	131	0.66	38.3	D
	WB R	481	171	0.56	1.5	A	-	0.38	0.7	A	-	-	0.41	0.8	A	-	0.28	0.4	A
	WB Overall				48.5	D			29.7	C				44.0	D			19.6	B
	NB L	798	685	1.11	128.2	F	337	0.86	47.1	D	798	624	1.04	93.9	F	387	1.01	72.8	E
	NB R	798	349	0.23	39.9	D	213	1.08	98.8	F	798	86	0.20	31.4	C	27	0.73	33.9	C
	NB Overall				**101.9**	**F**			**76.0**	**E**				**77.0**	**E**			52.4	D
	Intersection Overall			**1.10**	**51.7**	**D**		**1.04**	**37.7**	**D**			**1.03**	**50.2**	**D**		**0.93**	**33.9**	**C**

Table 7-5. Comparison between Alternative B and No Build condition intersection capacity and queuing analyses (continued)

		No Build Condition									Alternative B								
		Turning Bay/ Link Length	AM Peak Hour				PM Peak Hour				Turning Bay/ Link Length	AM Peak Hour				PM Peak Hour			
Intersection	Lane Groups	(feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	(feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS
#4 NH 28 &	EB L	225	79	0.51	42.4	D	50	0.49	30.6	C	225	46	0.54	40.2	D	32	0.60	42.3	D
Liberty Dr	EB TR	841	46	0.13	3.9	A	116	0.47	8.8	A	841	26	0.07	4.1	A	71	0.33	8.6	A
(Signalized) [a]	EB Overall				10.7	B			9.9	A				10.6	B			10.2	B
	WB L	250	19	0.29	51.2	D	17	0.22	31.7	C	250	18	0.23	37.1	D	15	0.16	22.3	C
	WB TR	332	178	0.52	8.5	A	88	0.27	8.7	A	332	114	0.43	6.2	A	71	0.24	8.3	A
	WB Overall				8.7	A			9.0	A				6.4	A			8.5	A
	NB L	154	51	0.29	41.6	D	52	0.14	21.4	C	154	24	0.05	30.1	C	43	0.14	16.2	B
	NB Overall				41.6	D			21.4	C				30.1	C			16.2	B
	SB LT	100	29	0.15	40.6	D	38	0.17	21.6	C	100	22	0.10	30.6	C	26	0.10	16.0	B
	SB R	502	96	0.07	39.7	D	97	0.10	21.1	C	502	81	0.05	30.3	C	83	0.08	15.9	B
	SB Overall				39.8	D			21.2	C				30.4	C			15.9	B
Intersection Overall				**0.50**	**11.3**	**B**		**0.43**	**11.2**	**B**			**0.41**	**8.4**	**A**		**0.30**	**10.5**	**B**

Table 7-5. Comparison between Alternative B and No Build condition intersection capacity and queuing analyses (continued)

		No Build Condition									Alternative B								
		Turning Bay/ Link	AM Peak Hour				PM Peak Hour				Turning Bay/ Link	AM Peak Hour				PM Peak Hour			
Intersection	Lane Groups	Length (feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	Length (feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS
#5 NH 102 &	EB L	275	255	1.00	117.3	F	#345	1.24	193.4	F	275	#276	0.92	99.0	F	#338	1.21	191.8	F
Gilcreast Rd	EB RT	852	373	1.10	88.9	F	386	0.81	35.9	D	852	373	1.04	71.3	E	373	0.65	31.5	C
(Signalized) [a]	EB Overall				**91.5**	**F**			**60.6**	**E**				**74.4**	**E**			**60.9**	**E**
	WB L	275	86	0.78	53.7	D	135	0.79	32.0	C	275	84	0.60	40.9	D	134	0.65	39.8	D
	WB Thru	669	150	0.97	33.7	C	266	1.27	134.1	F	669	142	0.88	21.4	C	201	1.13	73.4	E
	WB R	225	40	0.06	24.2	C	117	0.14	0.2	A	225	26	0.05	6.4	A	60	0.15	1.0	A
	WB Overall				34.9	C			**111.7**	**F**				22.2	C			**64.4**	**E**
	NB LT	488	#610	1.16	155.1	F	#567	1.29	200.5	F	488	#539	1.09	147.7	F	#600	1.18	176.6	F
	NB R	488	#598	0.63	47.0	D	#682	0.19	32.8	C	488	464	0.63	59.0	E	#586	0.19	42.0	D
	NB Overall				**100.5**	**F**			**144.8**	**F**				**101.1**	**F**			**129.3**	**F**
	SB L	356	#442	1.13	142.9	F	314	0.95	114.4	F	356	#431	1.07	133.8	F	273	1.00	152.9	F
	SBT	356	#483	0.53	47.3	D	#433	0.97	116.8	F	356	#478	0.43	56.2	E	#385	1.12	187.0	F
	SB R	225	#291	0.35	45.0	D	#303	0.55	49.0	D	225	#287	0.40	56.0	E	#250	1.03	128.0	F
	SB Overall				**87.6**	**F**			**83.2**	**F**				**89.5**	**F**			**146.1**	**F**
	Intersection Overall			**1.14**	**76.3**	**E**		**1.24**	**94.0**	**F**			**1.06**	**65.4**	**E**		**1.15**	**78.4**	**E**

Table 7-5. Comparison between Alternative B and No Build condition intersection capacity and queuing analyses (continued)

		No Build Condition									Alternative B								
		Turning Bay/ Link Length (feet)	AM Peak Hour				PM Peak Hour				Turning Bay/ Link Length (feet)	AM Peak Hour				PM Peak Hour			
Intersection	Lane Groups		95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS		95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS
#6 NH 102 & Hampton Dr/Garden Ln (Signalized) [a]	EB L	275	179	0.58	61.3	E	242	1.08	125.2	F	275	#282	0.74	84.8	F	#325	1.18	192.5	F
	EB TR	669	615	1.00	14.9	B	239	0.76	18.9	B	669	#762	0.97	12.3	B	384	0.64	18.7	B
	EB Overall				17.6	B			42.7	D				20.9	C			**70.4**	**E**
	WB L	275	62	0.47	62.2	E	182	0.61	51.4	D	275	72	0.47	78.8	E	198	0.60	67.7	E
	WB Thru	715	221	0.55	16.9	B	367	0.99	44.7	D	715	326	0.56	35.9	D	450	1.08	86.6	F
	WB R	275	133	0.22	20.4	C	#329	0.81	26.1	C	275	#314	0.55	31.6	C	#340	1.12	86.0	F
	WB Overall				19.3	B			39.9	D				35.6	D			**85.4**	**F**
	NB LT	630	78	0.28	56.2	E	175	0.77	84.4	F	630	95	0.29	72.6	E	196	0.76	104.3	F
	NB R	100	#110	0.11	47.0	D	#137	0.06	51.5	D	100	#115	0.06	61.3	E	#138	0.05	66.3	E
	NB Overall				49.5	D			**70.1**	**E**				**64.4**	**E**			**87.7**	**F**
	SB L	175	#258	0.91	92.2	F	#242	1.02	104.3	F	175	#249	0.86	79.6	E	#234	0.89	70.4	E
	SB LT	291	#374	0.93	96.9	F	#323	1.00	99.1	F	291	#352	0.84	76.9	E	#325	0.90	71.5	E
	SB R	175	#266	0.10	34.2	C	#210	0.79	59.4	E	175	#278	0.27	33.4	C	#215	0.89	70.8	E
	SB Overall				**77.5**	**E**			**84.5**	**F**				**64.5**	**E**			**70.9**	**E**
Intersection Overall				**0.92**	**24.9**	**C**		**0.99**	**49.9**	**D**			**0.90**	**32.7**	**C**		**1.10**	**78.1**	**E**

Table 7-5. Comparison between Alternative B and No Build condition intersection capacity and queuing analyses (continued)

		No Build Condition									Alternative B								
		Turning Bay/ Link Length	AM Peak Hour				PM Peak Hour				Turning Bay/ Link Length	AM Peak Hour				PM Peak Hour			
Intersection	Lane Groups	(feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	(feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS
#7 NH 102 & I-93 SB Off-Ramp (Exit 4) (Signalized) [a]	EB Thru	895	540	1.06	53.2	D	565	1.12	87.4	F	895	760	0.93	25.8	C	590	0.86	31.0	C
	EB Overall				53.2	D			**87.4**	**F**				25.8	C			31.0	C
	WB Thru	1,057	193	0.58	13.4	B	420	1.26	146.7	F	1,057	256	0.56	22.5	C	287	1.08	40.7	D
	WB Overall				13.4	B			**146.7**	**F**				22.5	C			40.7	D
	SB L	138	#203	1.10	81.8	F	#205	1.20	116.3	F	138	#215	0.54	17.4	B	#219	0.46	25.3	C
	SB R	138	#167	0.84	21.4	C	#192	1.09	72.2	E	138	#238	0.94	35.4	D	#248	1.10	96.5	F
	SB Overall				50.8	D			**91.7**	**F**				30.1	C			**80.1**	**F**
	Intersection Overall			**1.08**	**44.5**	**D**		**1.22**	**106.4**	**F**			**0.93**	**26.8**	**C**		**1.09**	**53.9**	**D**
#8 NH 102 & I-93 NB On and Off-Ramp (Exit 4) (Signalized) [a]	EB L	550	529	1.11	85.6	F	475	1.20	127.6	F	550	468	1.01	50.8	D	486	1.19	124.3	F
	EB Thru	1,057	238	0.37	5.7	A	357	0.69	21.2	C	1,057	112	0.10	8.9	A	257	0.26	8.1	A
	EB Overall				50.9	D			**69.9**	**E**				44.5	D			**92.5**	**F**
	WB Thru	1,462	767	1.07	82.8	F	266	0.77	51.8	D	1,462	612	0.95	74.3	E	201	0.56	60.3	E
	WB R	786	#1006	0.78	3.9	A	230	0.54	1.3	A	786	378	0.35	0.6	A	38	0.23	0.3	A
	WB Overall				45.6	D			22.0	C				46.4	D			29.4	C
	NB L	1,440	496	1.14	137.6	F	897	1.21	140.7	F	1,440	345	1.02	106.5	F	913	1.18	133.8	F
	NB R	1,440	231	1.08	122.3	F	937	1.26	163.5	F	1,440	179	0.63	61.2	E	995	0.81	44.6	D
	NB Overall				**130.9**	**F**			**151.2**	**F**				**91.3**	**F**			**101.9**	**F**
	Intersection Overall			**1.10**	**61.4**	**E**		**1.12**	**92.8**	**F**			**0.99**	**54.8**	**D**		**1.06**	**88.0**	**F**

Table 7-5. Comparison between Alternative B and No Build condition intersection capacity and queuing analyses (continued)

Intersection	Lane Groups	No Build Condition									Alternative B								
		Turning Bay/ Link Length (feet)	AM Peak Hour				PM Peak Hour				Turning Bay/ Link Length (feet)	AM Peak Hour				PM Peak Hour			
			95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS		95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS
#9 NH 102 & St Charles St/ Londonderry Rd (Signalized) [a]	EB L	350	202	0.85	58.1	E	#422	1.31	176.0	F	350	70	0.41	32.3	C	154	0.65	31.3	C
	EB TR	1,462	63	0.27	2.7	A	853	0.49	3.5	A	1,462	56	0.18	3.3	A	165	0.46	7.2	A
	EB Overall				17.4	B			**77.9**	**E**				7.0	A			11.5	B
	WBL	100	44	0.31	59.1	E	25	0.31	59.4	E	100	26	0.26	42.0	D	23	0.26	43.7	D
	WB TR	410	320	0.87	19.0	B	324	1.01	59.5	E	410	180	0.51	7.0	A	205	0.49	14.8	B
	WB Overall				19.1	B			**59.5**	**E**				7.2	A			15.0	B
	NB LTR	-	-	-	-	-	-	-	-	-	400	7	0.12	35.8	D	43	0.06	29.6	C
	NB Overall				0.0	A			0.0	A				35.8	D			29.6	C
	SB LT	780	70	0.23	53.2	D	22	0.21	52.4	D	780	31	0.32	39.8	D	94	0.55	34.8	C
	SB R	225	194	0.17	7.8	A	141	0.20	22.2	C	225	83	0.10	5.0	A	60	0.08	11.9	B
	SB Overall				8.7	A			22.6	C				7.2	A			21.4	C
	Intersection Overall			**0.85**	**17.7**	**B**		**1.16**	**67.5**	**E**			**0.48**	**7.2**	**A**		**0.54**	**14.2**	**B**
#10 NH 102 & Fordway/ Madden Hill Rd (Signalized) [a]	EB TR	455	332	0.73	17.0	B	#734	1.05	55.2	E	455	289	0.64	17.1	B	#529	0.92	29.3	C
	EB Overall				17.0	B			**55.2**	**E**				17.1	B			29.3	C
	WB LT	165	#519	0.91	29.2	C	#535	0.71	12.2	B	165	#418	0.78	21.5	C	#355	0.49	11.3	B
	WB Overall				29.2	C			12.2	B				21.5	C			11.3	B
	NB LR	375	298	0.94	60.4	E	277	1.02	96.3	F	375	266	0.84	34.7	C	254	0.90	54.2	D
	NB Overall				**60.4**	**E**			**96.3**	**F**				34.7	C			54.2	D
	SB LTR	120	40	0.05	21.8	C	61	0.16	30.2	C	120	70	0.16	16.2	B	110	0.36	24.6	C
	SB Overall				21.8	C			30.2	C				16.2	B			24.6	C
	Intersection Overall			**0.92**	**30.8**	**C**		**1.04**	**47.3**	**D**			**0.80**	**23.0**	**C**		**0.91**	**29.1**	**C**

Table 7-5. Comparison between Alternative B and No Build condition intersection capacity and queuing analyses (continued)

		No Build Condition									Alternative B								
		Turning Bay/ Link Length	AM Peak Hour				PM Peak Hour				Turning Bay/ Link Length	AM Peak Hour				PM Peak Hour			
Intersection	Lane Groups	(feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	(feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS
#11 **Connector Rd & I-93 SB On and Off-Ramp (Exit 4A) (Signalized)** [a]	WBL	-	-	-	-	-	-	-	-	-	319	#351	1.02	44.3	D	#344	0.93	40.7	D
	WB Overall				-	-	-	-	-	-				44.3	D			40.7	D
	SB L	-	-	-	-	-	-	-	-	-	525	#578	1.05	57.5	E	505	0.95	30.7	C
	SB Overall				-	-	-	-	-	-				**57.5**	**E**			30.7	C
	Intersection Overall			-	-	-	-	-	-	-			**1.04**	**52.3**	**D**		**0.94**	**34.6**	**C**
#12 **Connector Rd & I-93 NB On and Off-Ramp (Exit 4A) (Signalized)** [a]	EB L	-	-	-	-	-	-	-	-	-	100	-	-	-	-	-	-	-	-
	EB T	-	-	-	-	-	-	-	-	-	319	95	0.96	23.1	C	108	0.90	3.4	A
	EB Overall				-	-			-	-				23.1	C			3.4	A
	WB T	-	-	-	-	-	-	-	-	-	3,359	2873	0.61	14.9	B	251	0.58	14.3	B
	WB R	-	-	-	-	-	-	-	-	-	200	#265	0.82	21.2	C	#257	0.76	18.8	B
	WB Overall				-	-			-	-				18.2	B			16.6	B
	NB LR	-	-	-	-	-	-	-	-	-	467	#568	0.93	55.2	E	370	0.80	36.8	D
	NB R	-	-	-	-	-	-	-	-	-	467	#581	0.99	68.2	E	316	0.84	40.8	D
	NB Overall				-	-			-	-				**61.7**	**E**			38.8	D
	Intersection Overall			-	-	-		-	-	-			**0.97**	**27.5**	**C**		**0.88**	**15.8**	**B**

Notes:

95th percentile volume exceeds capacity, queue may be longer.

EB = Eastbound, WB = Westbound, NB= Northbound, SB = Southbound

LOS = Level of Service

LTR = left / through / right lanes

V/C = Volume-to-Capacity ratio

Delay is Measured in Seconds Per Vehicle.

Red cells denote intersections or approaches operating at unacceptable conditions or denote approaches and lane groups whose queuing length exceeds capacity

[a] Highway Capacity Manual 2000 results (Signalized intersections)

7.8 2040 Build Alternative B Freeway Operations Analysis

Based on the analysis performed using HCS, all freeway facilities would operate below capacity. The one failing freeway facility under the No Build condition would improve to LOS C. This includes the I-93 SB off-ramp to NH 102. The NH 102 on-ramp to I-93 NB would operate above capacity potentially creating a queue into the NH 102 mainline. Table 7-6 contains the Exit 4 Alternative B freeway analysis compared to the No Build condition, and Table 7-7 contains the Exit 5 Alternative B freeway analysis compared to the No Build condition. Table 7-8 contains the Exit 4A Alternative B freeway analysis. Appendix M contains the Build condition HCS freeway operation reports.

Table 7-6. I-93 Exit 4 2040 Build Alternative B freeway analysis compared to the No Build condition

Freeway Analysis	Facility Type	Time Period	Demand to Capacity Ratio		Density (pc/mi/ln)	Alt B LOS	No Build LOS
			Freeway	Ramp			
I-93 Northbound to NH 102	Diverge	AM	0.38	0.23	0.0	A	A
		PM	0.66	0.55	11.2	B	B
NH 102 to I-93 Northbound	Merge	AM	0.53	1.03[a]	20.8	C	C
		PM	0.60	0.81	21.9	C	C
I-93 Southbound to NH 102	Diverge	AM	0.58	0.81	26.7	C	C
		PM	0.55	0.98	27.5	C	F
NH 102 Westbound to I-93 Southbound	Merge	AM	0.50	0.39	15.0	B	B
		PM	0.40	0.18	10.2	B	B
NH 102 Eastbound to I-93 Southbound	Merge	AM	0.69	0.92	25.6	C	C
		PM	0.49	0.45	15.2	B	B

Notes: LOS = Level of Service; Density = Passenger cars per mile per lane (pc/mi/ln)

Red denotes interstate facilities that would result in failing operations and would produce a queue extending to the I-93 mainline.

a The demand of the on-ramp exceeds the capacity; therefore, the ramp would produce a queue extending to NH 102.

Table 7-7. I-93 Exit 5 2040 Build Alternative B freeway analysis compared to the No Build condition

Freeway Analysis	Facility Type	Time Period	Demand to Capacity Ratio		Density (pc/mi/ln)	Alt B LOS	No Build LOS
			Freeway	Ramp			
I-93 Northbound to NH 28	Diverge	AM	0.56	0.41	23.6	C	C
		PM	0.62	0.54	27.7	C	C
NH 28 to I-93 Northbound	Merge	AM	0.64	0.65	24.4	C	C
		PM	0.64	0.48	24.3	C	C
I-93 Southbound to NH 28	Diverge	AM	0.63	0.32	23.5	C	C
		PM	0.62	0.33	23.2	C	D
NH 28 to I-93 Southbound	Merge	AM	0.66	0.40	20.0	B	B
		PM	0.63	0.34	18.4	B	B

Notes: LOS = Level of Service; Density = Passenger cars per mile per lane (pc/mi/ln)

Table 7-8. I-93 Exit 4A 2040 Build Alternative B freeway analysis

Freeway Analysis	Facility Type	Time Period	Demand to Capacity Ratio		Density (pc/mi/ln)	LOS
			Freeway	Ramp		
I-93 Northbound to Connector Roadway	Diverge	AM	0.52	0.52	20.8	C
		PM	0.58	0.44	23.1	C
Connector Roadway to I-93 Northbound	Merge	AM	0.59	0.73	22.7	C
		PM	0.63	0.62	24.4	C
I-93 Southbound to Connector Roadway	Diverge	AM	0.65	0.55	19.3	B
		PM	0.62	0.46	16.2	B
Connector Roadway to I-93 Southbound	Merge	AM	0.60	0.70	24.6	C
		PM	0.57	0.58	22.5	C

Notes: LOS = Level of Service; Density = Passenger cars per mile per lane (pc/mi/ln)

7.9 2040 Build Alternative C Intersection Operations Analysis

Based on the Synchro™ signalized intersection analysis results, three signalized intersections (Intersections #5, #7, and #8) would operate at unacceptable conditions (LOS E or LOS F) during the AM or PM peak hours. The remaining signalized intersections in the traffic study area would operate at acceptable overall conditions (LOS D or better is considered an operating level) during the peak hours analyzed (weekday AM and PM peak hours).

Based on the Synchro™ signalized intersection analysis results, six study area signalized intersections have overall approaches that would operate at unacceptable conditions (LOS E or LOS F) during one or two evaluated periods. The following are the individual signalized intersection approaches in the traffic study area that would operate under unacceptable conditions during peak hours:

- NH 28 at I-93 Northbound on and off-ramp (Exit 5) (Intersection #3)
    - I-93 Northbound off-ramp during the AM peak hour
- NH 102 at Gilcreast Road (Intersection #5)
    - Eastbound NH 102 during the AM and PM peak hours
    - Westbound NH 102 during the PM peak hour
    - Northbound Gilcreast Road during the AM and PM peak hours
    - Southbound NH 102 during the AM and PM peak hours
- NH 102 at Hampton Drive/Garden Lane (Intersection #6)
    - Northbound Hampton Drive during the AM and PM peak hours
    - Southbound Garden Lane during the AM and PM peak hours
- NH 102 at I-93 Southbound off-ramp (Exit 4) (Intersection #7)
    - I-93 Southbound off-ramp during the PM peak hour
- NH 102 at I-93 Northbound on and off-ramp (Exit 4) (Intersection #8)
    - Eastbound NH 102 during the PM peak hour
    - Westbound NH 102 during the AM peak hour
    - I-93 Northbound off-ramp during the AM and PM peak hours
- NH 102 at Fordway/Madden Hill Road (Intersection #10)
    - Northbound Fordway during the PM peak hour

The overall Alternative C intersection LOS grades are depicted in Figure 7-11 for AM and PM peak hours. Table 7-9 shows the comparison between Alternative C and No Build condition LOS capacity analysis and the intersection vehicle delay results during the AM and PM peak hours. Appendices G, H, and I contain the Synchro™ Build condition intersection analysis reports.

7.10 2040 Build Alternative C Queuing Analysis

Based on the Synchro™ signalized intersection analysis results, seven signalized intersections within the study area, would experience queuing lengths that would exceed the available storage capacity. Intersections #2, #4, #8, #9, and #11 would provide sufficient storage for the anticipated demand. The lane group in the approach that would operate under unacceptable conditions is noted in parentheses. Table 7-9 contains the queuing results. Appendices J, K, and L contain the Synchro™ Build condition intersection queuing reports.

- NH 28 at Symmes Drive/Vista Ridge Drive (Intersection #1)
    - Northbound Vista Ridge Drive (right turns) during the AM and the PM peak hours
- NH 28 at I-93 Northbound on and off-ramp (Exit 5) (Intersection #3)

- Eastbound NH 28 (left turns) during the AM peak hour

- NH 102 at Gilcreast Road (Intersection #5)
  - Eastbound NH 102 (left turns) during the PM peak hour
  - Northbound Gilcreast Road (all movements) during the AM and PM peak hours
  - Southbound Gilcreast Road (all movements) during the AM and PM peak hours
- NH 102 at Hampton Drive/Garden Lane (Intersection #6)
  - Eastbound NH 102 (left turns) during the PM peak hour
  - Eastbound NH 102 (right turns and through movements) during the AM peak hour
  - Westbound NH 102 (right turns) during the PM peak hour
  - Northbound Hampton Drive (right turns) during the AM and PM peak hours
  - Southbound Garden Lane (all movements) during the AM and PM peak hours
- NH 102 at I-93 Southbound off-ramp (Exit 4) (Intersection #7)
  - I-93 Southbound off-ramp (right turns) during the AM ad PM peak hours
- NH 102 at Fordway/Madden Hill Road (Intersection #10)
  - Eastbound NH 102 (all movements) during the PM peak hour
  - Westbound NH 102 (all movements) during the AM and PM peak hours
- Connector Roadway and I-93 Northbound on and off-ramp (Exit 4A) (Intersection #12)
  - Westbound Connector Roadway (right turns) during the AM and PM peak hours

The remaining signalized intersections in the traffic study area would provide sufficient storage for the anticipated demand. The lane group in the approach that would operate under unacceptable conditions is highlighted in red in Table 7-9, which contains a comparison between Alternative C and No Build condition queuing results.

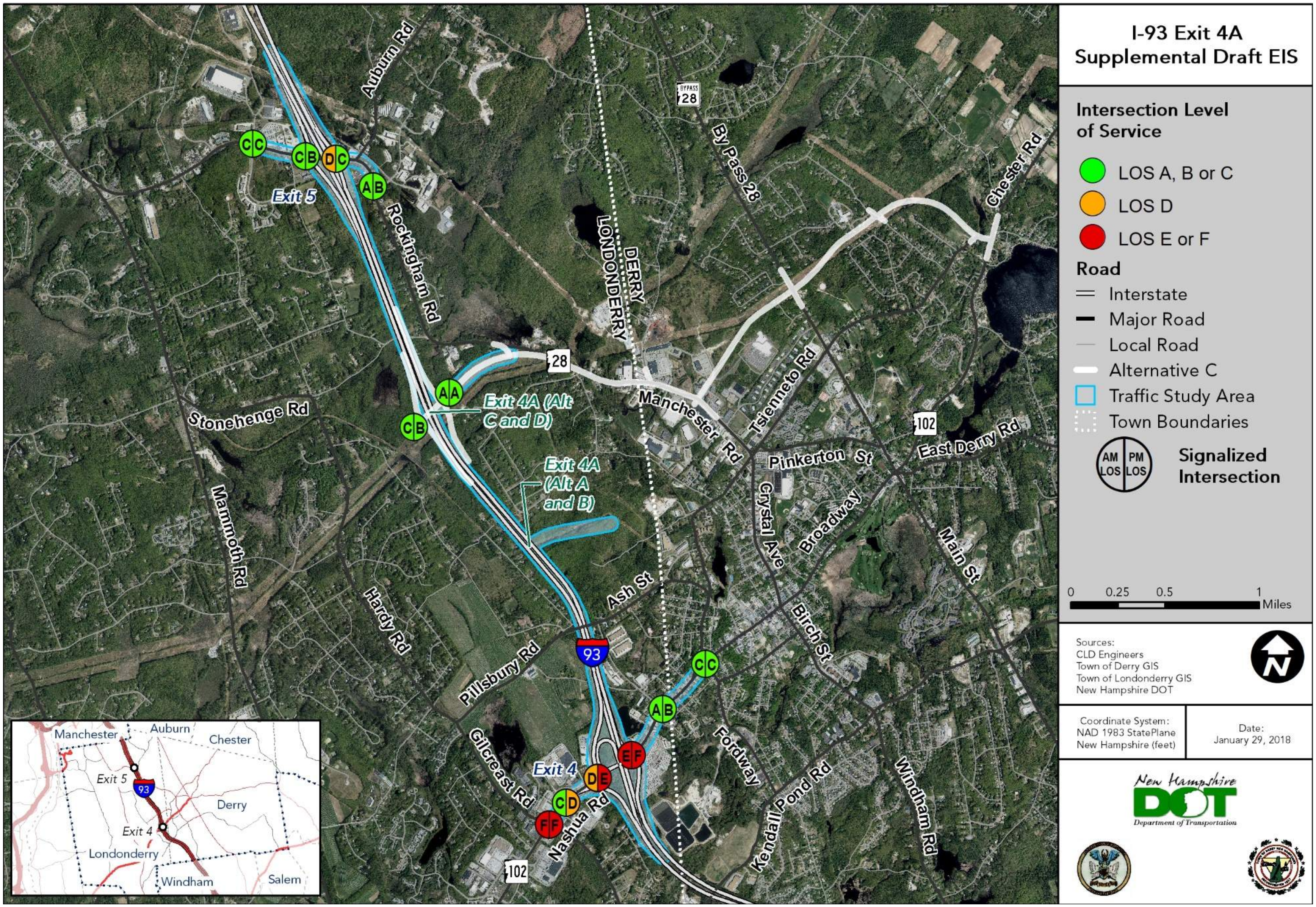


Figure 7-11. 2040 Build Alternative C AM and PM peak hour LOS by intersection

Table 7-9. Comparison between Alternative C and No Build condition intersection capacity and queuing analyses

		No Build Condition									Alternative C								
		Turning Bay/ Link Length	AM Peak Hour				PM Peak Hour				Turning Bay/ Link Length	AM Peak Hour				PM Peak Hour			
Intersection	Lane Groups	(feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	(feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS
#1 NH 28 & Symmes Dr/ Vista Ridge Dr (Signalized) [a]	EB L	408	353	0.97	85.5	F	50	0.76	111.3	F	408	270	0.95	75.0	E	48	0.53	48.6	D
	EB TR	729	414	0.51	13.0	B	458	0.81	31.9	C	729	208	0.49	12.3	B	280	0.77	25.6	C
	EB Overall				30.8	C			33.9	C				27.6	C			26.3	C
	WB L	450	40	0.55	71.3	E	154	0.81	74.0	E	450	29	0.88	203.0	F	130	0.81	61.5	E
	WB Thru	1,537	409	0.84	33.8	C	298	0.61	20.4	C	1,537	356	0.83	29.4	C	241	0.64	19.1	B
	WB R	500	137	0.08	19.5	B	31	0.04	14.0	B	500	84	0.07	17.4	B	45	0.03	13.1	B
	WB Overall				32.9	C			26.2	C				30.5	C			23.6	C
	NB LT	1,660	330	0.43	48.5	D	120	0.55	55.5	E	1,660	130	0.43	40.1	D	90	0.45	38.8	D
	NB R	10	#101	0.08	45.4	D	#79	0.02	49.0	D	10	#90	0.07	37.2	D	#63	0.02	35.5	D
	NB Overall				46.5	D			53.3	D				38.3	D			37.8	D
	SB L	270	181	0.93	110.8	F	267	0.84	63.6	E	270	108	0.77	62.3	E	175	0.84	55.6	E
	SB LTR	270	191	0.07	47.1	D	#368	0.39	42.0	D	270	114	0.06	37.4	D	267	0.31	32.6	C
	SB Overall				**79.0**	**E**			51.9	D				49.9	D			42.5	D
	Intersection Overall			**0.84**	**36.4**	**D**		**0.79**	**34.7**	**C**			**0.81**	**31.2**	**C**		**0.76**	**28.4**	**C**

Table 7-9. Comparison between Alternative C and No Build condition intersection capacity and queuing analyses (continued)

		No Build Condition									Alternative C								
		Turning Bay/ Link Length	AM Peak Hour				PM Peak Hour				Turning Bay/ Link Length	AM Peak Hour				PM Peak Hour			
Intersection	Lane Groups	(feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	(feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS
#2 **NH 28 & I-93 SB On and Off-Ramp (Exit 5) (Signalized)** [a]	EB Thru	1,537	#1904	0.97	73.6	E	1243	0.88	39.4	D	1,537	492	0.69	39.0	D	244	0.53	21.9	C
	EB R	350	#546	0.28	0.5	A	#463	0.29	0.5	A	350	224	0.36	0.7	A	57	0.35	0.6	A
	EB Overall				51.1	D			27.9	C				21.8	C			12.9	B
	WB L	592	#632	1.17	111.5	F	280	0.92	20.7	C	592	327	0.89	32.5	C	167	0.69	17.3	B
	WB Thru	592	101	0.44	1.8	A	59	0.32	0.2	A	592	75	0.50	1.7	A	91	0.33	0.4	A
	WB Overall				42.9	D			6.4	A				10.3	B			3.9	A
	SB L	502	492	0.72	44.8	D	406	0.92	48.2	D	502	75	0.15	28.7	C	108	0.24	27.7	C
	SB R	502	#526	1.35	217.5	F	109	0.89	52.5	D	502	170	0.91	59.9	E	-	0.74	38.8	D
	SB Overall				**131.6**	**F**			49.9	D				52.9	D			35.3	D
	Intersection Overall			**1.17**	**77.0**	**E**		**0.90**	**31.2**	**C**			**0.83**	**22.9**	**C**		**0.62**	**15.0**	**B**
#3 **NH 28 & I-93 NB On and Off-Ramp (Exit 5) (Signalized)** [a]	EB L	592	#729	1.11	67.9	E	#706	1.07	53.5	D	592	#661	1.03	50.8	D	508	0.91	27.2	C
	EB Thru	592	#789	0.39	0.6	A	316	0.62	6.1	A	592	321	0.12	1.6	A	106	0.21	3.6	A
	EB Overall				32.0	C			22.5	C				36.3	D			16.3	B
	WB Thru	481	#580	1.05	104.5	F	217	0.91	61.7	E	481	302	0.96	69.8	E	140	0.75	41.8	D
	WB R	481	171	0.56	1.5	A	-	0.38	0.7	A	-	-	0.25	0.4	A	-	0.16	0.2	A
	WB Overall				48.5	D			29.7	C				44.6	D			27.8	C
	NB L	798	685	1.11	128.2	F	337	0.86	47.1	D	798	493	1.04	88.9	F	303	0.91	49.0	D
	NB R	798	349	0.23	39.9	D	213	1.08	98.8	F	798	65	0.14	27.6	C	41	0.56	27.3	C
	NB Overall				**101.9**	**F**			**76.0**	**E**				**71.9**	**E**			37.4	D
	Intersection Overall			**1.10**	**51.7**	**D**		**1.04**	**37.7**	**D**			**1.02**	**49.9**	**D**		**0.87**	**27.7**	**C**

Table 7-9. Comparison between Alternative C and No build condition intersection capacity and queuing analyses (continued)

		No Build Condition									Alternative C								
		Turning Bay/ Link Length (feet)	AM Peak Hour				PM Peak Hour				Turning Bay/ Link Length (feet)	AM Peak Hour				PM Peak Hour			
Intersection	Lane Groups		95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS		95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS
#4 NH 28 & Liberty	EB L	225	79	0.51	42.4	D	50	0.49	30.6	C	225	39	0.42	31.8	C	32	0.51	30.6	C
Dr (Signalized) [a]	EB TR	841	46	0.13	3.9	A	116	0.47	8.8	A	841	20	0.06	4.5	A	58	0.29	8.4	A
	EB Overall				10.7	B			9.9	A				9.4	A			9.5	A
	WB L	250	19	0.29	51.2	D	17	0.22	31.7	C	250	21	0.23	33.1	C	13	0.16	22.2	C
	WB TR	332	178	0.52	8.5	A	88	0.27	8.7	A	332	87	0.38	6.5	A	50	0.20	8.1	A
	WB Overall				8.7	A			9.0	A				6.7	A			8.4	A
	NB L	154	51	0.29	41.6	D	52	0.14	21.4	C	154	17	0.04	26.1	C	42	0.14	16.2	B
	NB Overall				41.6	D			21.4	C				26.1	C			16.2	B
	SB LT	100	29	0.15	40.6	D	38	0.17	21.6	C	100	21	0.07	26.4	C	22	0.09	16.0	B
	SB R	502	96	0.07	39.7	D	97	0.10	21.1	C	502	75	0.05	26.2	C	67	0.06	15.8	B
	SB Overall				39.8	D			21.2	C				26.2	C			15.8	B
	Intersection Overall			**0.50**	**11.3**	**B**		**0.43**	**11.2**	**B**			**0.36**	**8.2**	**A**		**0.27**	**10.1**	**B**

Table 7-9. Comparison between Alternative C and No Build condition intersection capacity and queuing analyses (continued)

		No Build Condition									Alternative C								
		Turning Bay/ Link Length (feet)	AM Peak Hour				PM Peak Hour				Turning Bay/ Link Length (feet)	AM Peak Hour				PM Peak Hour			
Intersection	Lane Groups		95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS		95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS
#5 NH 102 & Gilcreast Rd (Signalized) [a]	EB L	275	255	1.00	117.3	F	#345	1.24	193.4	F	275	262	1.02	134.8	F	#338	1.26	207.4	F
	EB RT	852	373	1.10	88.9	F	386	0.81	35.9	D	852	390	1.08	91.7	F	387	0.78	37.5	D
	EB Overall				**91.5**	**F**			**60.6**	**E**				**95.7**	**F**			**65.0**	**E**
	WB L	275	86	0.78	53.7	D	135	0.79	32.0	C	275	104	0.82	62.3	E	133	0.80	38.2	D
	WB Thru	669	150	0.97	33.7	C	266	1.27	134.1	F	669	156	1.05	51.7	D	261	1.26	131.6	F
	WB R	225	40	0.06	24.2	C	117	0.14	0.2	A	225	63	0.07	1.0	A	138	0.17	0.6	A
	WB Overall				34.9	C			**111.7**	**F**				49.4	D			**110.4**	**F**
	NB LT	488	#610	1.16	155.1	F	#567	1.29	200.5	F	488	#625	1.08	135.1	F	#551	1.29	210.0	F
	NB R	488	#598	0.63	47.0	D	#682	0.19	32.8	C	488	#642	0.67	57.5	E	#681	0.23	37.1	D
	NB Overall				**100.5**	**F**			**144.8**	**F**				**96.0**	**F**			**154.2**	**F**
	SB L	356	#442	1.13	142.9	F	314	0.95	114.4	F	356	#418	1.07	130.5	F	#419	1.13	183.4	F
	SBT	356	#483	0.53	47.3	D	#433	0.97	116.8	F	356	#485	0.49	56.5	E	#440	1.20	207.7	F
	SB R	225	#291	0.35	45.0	D	#303	0.55	49.0	D	225	#309	0.48	56.4	E	#299	0.73	67.5	E
	SB Overall				**87.6**	**F**			**83.2**	**F**				**88.3**	**F**			**133.0**	**F**
	Intersection Overall			**1.14**	**76.3**	**E**		**1.24**	**94.0**	**F**			**1.10**	**80.8**	**F**		**1.26**	**101.6**	**F**

Table 7-9. Comparison between Alternative C and No Build condition intersection capacity and queuing analyses (continued)

Intersection	Lane Groups	No Build Condition: Turning Bay/ Link Length (feet)	No Build AM Peak Hour: 95% queue (ft)	No Build AM: v/c ratio	No Build AM: Average Delay (sec/veh)	No Build AM: LOS	No Build PM Peak Hour: 95% queue (ft)	No Build PM: v/c ratio	No Build PM: Average Delay (sec/veh)	No Build PM: LOS	Alternative C: Turning Bay/ Link Length (feet)	Alt C AM Peak Hour: 95% queue (ft)	Alt C AM: v/c ratio	Alt C AM: Average Delay (sec/veh)	Alt C AM: LOS	Alt C PM Peak Hour: 95% queue (ft)	Alt C PM: v/c ratio	Alt C PM: Average Delay (sec/veh)	Alt C PM: LOS
#6 NH 102 & Hampton Dr/Garden Ln (Signalized) [a]	EB L	275	179	0.58	61.3	E	242	1.08	125.2	F	275	259	0.62	76.0	E	#306	1.04	127.9	F
	EB TR	669	615	1.00	14.9	B	239	0.76	18.9	B	669	#804	0.93	10.7	B	515	0.69	14.1	B
	EB Overall				17.6	B			42.7	D				14.4	B			40.7	D
	WB L	275	62	0.47	62.2	E	182	0.61	51.4	D	275	88	0.66	89.3	F	238	0.66	61.2	E
	WB Thru	715	221	0.55	16.9	B	367	0.99	44.7	D	715	295	0.58	24.9	C	423	0.99	47.0	D
	WB R	275	133	0.22	20.4	C	#329	0.81	26.1	C	275	150	0.25	18.0	B	#344	0.86	26.7	C
	WB Overall				19.3	B			39.9	D				26.0	C			42.3	D
	NB LT	630	78	0.28	56.2	E	175	0.77	84.4	F	630	107	0.35	74.8	E	274	0.95	132.4	F
	NB R	100	#110	0.11	47.0	D	#137	0.06	51.5	D	100	#120	0.25	63.3	E	#155	0.06	61.5	E
	NB Overall				49.5	D			**70.1**	**E**				**66.4**	**E**			**102.8**	**F**
	SB L	175	#258	0.91	92.2	F	#242	1.02	104.3	F	175	#225	0.77	77.7	E	#219	0.98	98.8	F
	SB LT	291	#374	0.93	96.9	F	#323	1.00	99.1	F	291	#333	0.79	79.8	E	#317	0.98	97.9	F
	SB R	175	#266	0.10	34.2	C	#210	0.79	59.4	E	175	#237	0.18	43.0	D	#211	0.92	85.0	F
	SB Overall				**77.5**	**E**			**84.5**	**F**				**68.6**	**E**			**92.7**	**F**
	Intersection Overall			**0.92**	**24.9**	**C**		**0.99**	**49.9**	**D**			**0.87**	**25.1**	**C**		**1.00**	**53.0**	**D**

Table 7-9. Comparison between Alternative C and No Build condition intersection capacity and queuing analyses (continued)

		No Build Condition									Alternative C								
		Turning Bay/ Link	AM Peak Hour				PM Peak Hour				Turning Bay/ Link	AM Peak Hour				PM Peak Hour			
Intersection	Lane Groups	Length (feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	Length (feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS
#7 NH 102 & I-93 SB Off-Ramp (Exit 4) (Signalized) [a]	EB Thru	895	540	1.06	53.2	D	565	1.12	87.4	F	895	742	0.98	32.0	C	841	0.95	39.6	D
	EB Overall				53.2	D			**87.4**	**F**				32.0	C			39.6	D
	WB Thru	1,057	193	0.58	13.4	B	420	1.26	146.7	F	1,057	174	0.56	20.0	B	340	1.09	45.0	D
	WB Overall				13.4	B			**146.7**	**F**				20.0	B			45.0	D
	SB L	138	#203	1.10	81.8	F	#205	1.20	116.3	F	138	117	0.16	13.9	B	118	0.14	18.4	B
	SB R	138	#167	0.84	21.4	C	#192	1.09	72.2	E	138	#215	1.02	55.4	E	#220	1.09	89.1	F
	SB Overall				50.8	D			**91.7**	**F**				51.2	D			**83.0**	**F**
	Intersection Overall			**1.08**	**44.5**	**D**		**1.22**	**106.4**	**F**			**1.00**	**36.1**	**D**		**1.09**	**57.2**	**E**
#8 NH 102 & I-93 NB On and Off-Ramp (Exit 4) (Signalized) [a]	EB L	550	529	1.11	85.6	F	475	1.20	127.6	F	550	404	1.03	48.2	D	286	1.15	96.4	F
	EB Thru	1,057	238	0.37	5.7	A	357	0.69	21.2	C	1,057	41	0.04	8.0	A	54	0.17	2.7	A
	EB Overall				50.9	D			**69.9**	**E**				45.2	D			**76.4**	**E**
	WB Thru	1,462	767	1.07	82.8	F	266	0.77	51.8	D	1,462	717	1.00	79.9	E	253	0.70	59.6	E
	WB R	786	#1006	0.78	3.9	A	230	0.54	1.3	A	786	291	0.26	0.4	A	-	0.17	0.2	A
	WB Overall				45.6	D			22.0	C				**58.1**	**E**			38.0	D
	NB L	1,440	496	1.14	137.6	F	897	1.21	140.7	F	1,440	431	1.04	114.7	F	1008	1.14	114.5	F
	NB R	1,440	231	1.08	122.3	F	937	1.26	163.5	F	1,440	237	0.85	76.8	E	989	1.02	76.0	E
	NB Overall				**130.9**	**F**			**151.2**	**F**				**99.6**	**F**			**98.3**	**F**
	Intersection Overall			**1.10**	**61.4**	**E**		**1.12**	**92.8**	**F**			**1.02**	**62.1**	**E**		**1.05**	**82.0**	**F**

Table 7-9. Comparison between Alternative C and No Build condition intersection capacity and queuing analyses (continued)

		No Build Condition									Alternative C								
		Turning Bay/ Link Length	AM Peak Hour				PM Peak Hour				Turning Bay/ Link Length	AM Peak Hour				PM Peak Hour			
Intersection	Lane Groups	(feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	(feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS
#9 NH 102 & St	EB L	350	202	0.85	58.1	E	#422	1.31	176.0	F	350	107	0.57	34.2	C	216	0.71	31.0	C
Charles St/	EB TR	1,462	63	0.27	2.7	A	853	0.49	3.5	A	1,462	57	0.19	3.3	A	139	0.43	5.6	A
Londonderry Rd	EB Overall				17.4	B			**77.9**	**E**				8.9	A			11.2	B
(Signalized) [a]	WBL	100	44	0.31	59.1	E	25	0.31	59.4	E	100	28	0.25	41.1	D	18	0.26	42.7	D
	WB TR	410	320	0.87	19.0	B	324	1.01	59.5	E	410	172	0.52	7.7	A	178	0.49	14.3	B
	WB Overall				19.1	B			**59.5**	**E**				7.9	A			14.4	B
	NB LTR	-	-	-	-	-	-	-	-	-	400	-	-	-	-	52	0.05	31.9	C
	NB Overall				0.0	A			0.0	A				0.0	A			31.9	C
	SB LT	780	70	0.23	53.2	D	22	0.21	52.4	D	780	31	0.35	41.2	D	37	0.15	32.5	C
	SB R	225	194	0.17	7.8	A	141	0.20	22.2	C	225	88	0.12	5.5	A	79	0.14	11.8	B
	SB Overall				8.7	A			22.6	C				7.5	A			13.1	B
	Intersection Overall			**0.85**	**17.7**	**B**		**1.16**	**67.5**	**E**			**0.52**	**8.2**	**A**		**0.53**	**13.1**	**B**
#10 NH 102 &	EB TR	455	332	0.73	17.0	B	#734	1.05	55.2	E	455	374	0.68	17.9	B	#550	0.92	28.6	C
Fordway/ Madden	EB Overall				17.0	B			**55.2**	**E**				17.9	B			28.6	C
Hill Rd	WB LT	165	#519	0.91	29.2	C	#535	0.71	12.2	B	165	#415	0.76	20.5	C	#277	0.47	9.8	A
(Signalized) [a]	WB Overall				29.2	C			12.2	B				20.5	C			9.8	A
	NB LR	375	298	0.94	60.4	E	277	1.02	96.3	F	375	266	0.82	31.5	C	244	0.93	62.5	E
	NB Overall				**60.4**	**E**			**96.3**	**F**				31.5	C			**62.5**	**E**
	SB LTR	120	40	0.05	21.8	C	61	0.16	30.2	C	120	49	0.07	15.1	B	72	0.17	25.1	C
	SB Overall				21.8	C			30.2	C				15.1	B			25.1	C
	Intersection Overall			**0.92**	**30.8**	**C**		**1.04**	**47.3**	**D**			**0.78**	**22.3**	**C**		**0.92**	**30.0**	**C**

Table 7-9. Comparison between Alternative C and No Build condition intersection capacity and queuing analyses (continued)

		No Build Condition									Alternative C								
		Turning Bay/ Link Length	AM Peak Hour				PM Peak Hour				Turning Bay/ Link Length	AM Peak Hour				PM Peak Hour			
Intersection	Lane Groups	(feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	(feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS
#11 Connector Rd & I-93 SB On and Off-Ramp (Exit 4A) (Signalized) [a]	WBL	-	-	-	-	-	-	-	-	-	585	190	0.61	39.3	D	171	0.54	38.1	D
	WB Overall				-	-	-		-	-				39.3	D			38.1	D
	SB L	-	-	-	-	-	-	-	-	-	520	345	0.77	14.5	B	303	0.69	12.5	B
	SB Overall				-	-	-	-	-	-				14.5	B			12.5	B
	Intersection Overall			**-**	**-**	**-**	**-**	**-**	**-**	**-**			**0.73**	**20.1**	**C**		**0.65**	**18.3**	**B**
#12 Connector Rd & I-93 NB On and Off-Ramp (Exit 4A) (Signalized) [a]	EB L	-	-	-	-	-	-	-	-	-	100	-	-	-	-	-	-	-	-
	EB T	-	-	-	-	-	-	-	-	-	585	172	0.66	3.9	A	146	0.59	3.5	A
	EB Overall				-	-			-	-				3.9	A			3.5	A
	WB T	-	-	-	-	-	-	-	-	-	1,588	901	0.19	4.4	A	374	0.17	4.2	A
	WB R	-	-	-	-	-	-	-	-	-	200	#268	0.60	7.8	A	#306	0.51	6.6	A
	WB Overall				-	-			-	-				3.9	A			5.9	A
	NB LR	-	-	-	-	-	-	-	-	-	470	176	0.57	38.4	D	159	0.52	37.3	D
	NB R	-	-	-	-	-	-	-	-	-	470	120	0.59	39.6	D	102	0.54	38.0	D
	NB Overall				-	-			-	-				**39.0**	**D**			37.6	D
	Intersection Overall			**-**	**-**	**-**		**-**	**-**	**-**			**0.65**	**7.9**	**A**		**0.58**	**7.1**	**A**

Notes:

95th percentile volume exceeds capacity, queue may be longer.

EB = Eastbound, WB = Westbound, NB= Northbound, SB = Southbound

LOS = Level of Service

LTR = left / through / right lanes

V/C = Volume-to-Capacity ratio

Delay is Measured in Seconds Per Vehicle.

Red cells denote intersections or approaches operating at unacceptable conditions or denote approaches and lane groups whose queuing length exceeds capacity

[a] Highway Capacity Manual 2000 results (Signalized intersections)

7.11 2040 Build Alternative C Freeway Operations Analysis

Based on the analysis performed using HCS, all freeway facilities would operate below capacity and result in LOS D or better. The one failing freeway facility under the No Build condition would improve to LOS C. This includes the I-93 SB off-ramp to NH 102. Table 7-10 contains the Exit 4 Alternative C freeway analysis compared to the No Build condition and Table 7-11 contains the Exit 5 Alternative C freeway analysis compared to the No Build condition. Table 7-12 contains the Exit 4A Alternative C freeway analysis. Appendix M contains the Build condition HCS freeway operation reports.

Table 7-10. I-93 Exit 4 2040 Build Alternative C freeway analysis compared to the No Build condition

Freeway Analysis	Facility Type	Time Period	Demand to Capacity Ratio		Density (pc/mi/ln)	Alt C LOS	No Build LOS
			Freeway	Ramp			
I-93 Northbound to NH 102	Diverge	AM	0.37	0.24	0.0	A	A
		PM	0.64	0.56	11.1	B	B
NH 102 to I-93 Northbound	Merge	AM	0.49	0.93	19.5	B	C
		PM	0.55	0.73	19.8	B	C
I-93 Southbound to NH 102	Diverge	AM	0.52	0.58	22.4	C	C
		PM	0.51	0.76	23.6	C	F
NH 102 Westbound to I-93 Southbound	Merge	AM	0.49	0.48	15.5	B	B
		PM	0.39	0.22	10.2	B	B
NH 102 Eastbound to I-93 Southbound	Merge	AM	0.67	0.86	24.3	C	C
		PM	0.47	0.40	14.4	B	B

Notes: LOS = Level of Service; Density = Passenger cars per mile per lane (pc/mi/ln)

Red denotes interstate facilities that would result in failing operations and would produce a queue extending to the I-93 mainline.

Table 7-11. I-93 Exit 5 2040 Build Alternative C freeway analysis compared to the No Build condition

Freeway Analysis	Facility Type	Time Period	Demand to Capacity Ratio		Density (pc/mi/ln)	Alt C LOS	No Build LOS
			Freeway	Ramp			
I-93 Northbound to NH 28	Diverge	AM	0.60	0.38	25.4	C	C
		PM	0.64	0.51	28.0	C	C
NH 28 to I-93 Northbound	Merge	AM	0.64	0.48	24.2	C	C
		PM	0.64	0.36	23.1	C	C
I-93 Southbound to NH 28	Diverge	AM	0.62	0.31	23.1	C	C
		PM	0.61	0.31	22.7	C	D
NH 28 to I-93 Southbound	Merge	AM	0.67	0.45	20.6	C	B
		PM	0.63	0.38	18.8	B	B

Notes: LOS = Level of Service; Density = Passenger cars per mile per lane (pc/mi/ln)

Table 7-12. I-93 Exit 4A 2040 Build Alternative C freeway analysis

Freeway Analysis	Facility Type	Time Period	Demand to Capacity Ratio		Density (pc/mi/ln)	LOS
			Freeway	Ramp		
I-93 Northbound to Connector Roadway	Diverge	AM	0.49	0.15	16.7	B
		PM	0.54	0.13	18.4	B
Connector Roadway to I-93 Northbound	Merge	AM	0.62	0.74	21.9	C
		PM	0.65	0.63	21.8	C
I-93 Southbound to Connector Roadway	Diverge	AM	0.66	0.92	32.9	D
		PM	0.62	0.79	30.2	D
Connector Roadway to I-93 Southbound	Merge	AM	0.54	0.27	15.1	B
		PM	0.51	0.23	14.0	B

Notes: LOS = Level of Service; Density = Passenger cars per mile per lane (pc/mi/ln)

7.12 2040 Build Alternative D Intersection Operations Analysis

Based on the Synchro™ signalized intersection analysis results, four signalized intersections (Intersections #5, #6, #7, and #8) would operate at unacceptable conditions (LOS E or LOS F) during the AM or PM peak hours. The remaining signalized intersections in the traffic study area would operate at acceptable overall conditions (LOS D or better is considered an operating level) during the peak hours analyzed (weekday AM and PM peak hours).

Based on the Synchro™ signalized intersection analysis results, six of the study area signalized intersections have overall approaches that would operate at unacceptable conditions (LOS E or LOS F) during one or two evaluated periods. The following are the individual signalized intersection approaches in the traffic study area that would operate under unacceptable conditions during peak hours:

- NH 28 at I-93 Northbound on and off-ramp (Exit 5) (Intersection #3)
  - I-93 Northbound off-ramp during the AM peak hour
- NH 102 at Gilcreast Road (Intersection #5)
  - Eastbound NH 102 during the AM and PM peak hours
  - Westbound NH 102 during the AM and PM peak hours
  - Northbound Gilcreast Road during the AM and PM peak hours
  - Southbound NH 102 during the AM and PM peak hours
- NH 102 at Hampton Drive/Garden Lane (Intersection #6)
  - Northbound Hampton Drive during the AM and PM peak hours
  - Southbound Garden Lane during the AM and PM peak hours
- NH 102 at I-93 Southbound off-ramp (Exit 4) (Intersection #7)
  - I-93 Southbound off-ramp during the PM peak hour
- NH 102 at I-93 Northbound on and off-ramp (Exit 4) (Intersection #8)
  - Eastbound NH 102 during the PM peak hour
  - Westbound NH 102 during the AM peak hour
  - I-93 Northbound off-ramp during the AM and PM peak hours
- NH 102 at Fordway/Madden Hill Road (Intersection #10)
  - Northbound Fordway during the PM peak hour

The overall Alternative D intersection LOS grades are depicted in Figure 7-12 for AM and PM peak hours. Table 7-13 shows the comparison between Alternative D and No Build condition LOS capacity analysis and the intersection vehicle delay results during the AM and PM peak hours. Appendices G, H, and I contain the Synchro™ Build condition intersection analysis reports.

7.13 2040 Build Alternative D Queuing Analysis

Based on the Synchro™ signalized intersection analysis results, seven signalized intersections within the study area would experience queuing lengths that would exceed the available storage capacity. Intersections #2, #4, #8, #9, and #11 would provide sufficient storage for the anticipated demand. The lane group in the approach that would operate under unacceptable conditions is noted in parentheses. Table 7-13 contains the queuing results. Appendices J, K, and L contain the Synchro™ Build condition intersection queuing reports.

- NH 28 at Symmes Drive/Vista Ridge Drive (Intersection #1)
  - Northbound Vista Ridge Drive (right turns) during the AM and the PM peak hours

    - Southbound Symmes Drive (left turns, right turns, and through movements) during the PM peak hour
- NH 28 at I-93 Northbound on and off-ramp (Exit 5) (Intersection #3)
    - Eastbound NH 28 (left turns) during the AM peak hour
- NH 102 at Gilcreast Road (Intersection #5)
    - Eastbound NH 102 (left turns) during the PM peak hour
    - Northbound Gilcreast Road (all movements) during the AM and PM peak hours
    - Southbound Gilcreast Road (all movements) during the AM and PM peak hours
- NH 102 at Hampton Drive/Garden Lane (Intersection #6)
    - Eastbound NH 102 (right turns and through movements) during the AM peak hour
    - Westbound NH 102 (right turns) during the PM peak hour
    - Northbound Hampton Drive (right turns) during the AM and PM peak hours
    - Southbound Garden Lane (all movements) during the AM and PM peak hours
- NH 102 at I-93 Southbound off-ramp (Exit 4) (Intersection #7)
    - I-93 Southbound off-ramp (right turns) during the AM ad PM peak hours
- NH 102 at Fordway/Madden Hill Road (Intersection #10)
    - Eastbound NH 102 (all movements) during the PM peak hour
    - Westbound NH 102 (all movements) during the AM and PM peak hours
- Connector Roadway and I-93 Northbound on and off-ramp (Exit 4A) (Intersection #12)
    - Westbound Connector Roadway (right turns) during the AM and PM peak hours

The remaining signalized intersections in the traffic study area would provide sufficient storage for the anticipated demand. The lane group in the approach that would operate under unacceptable conditions is highlighted in red in Table 7-13, which contains a comparison between Alternative D and No Build condition queuing results.

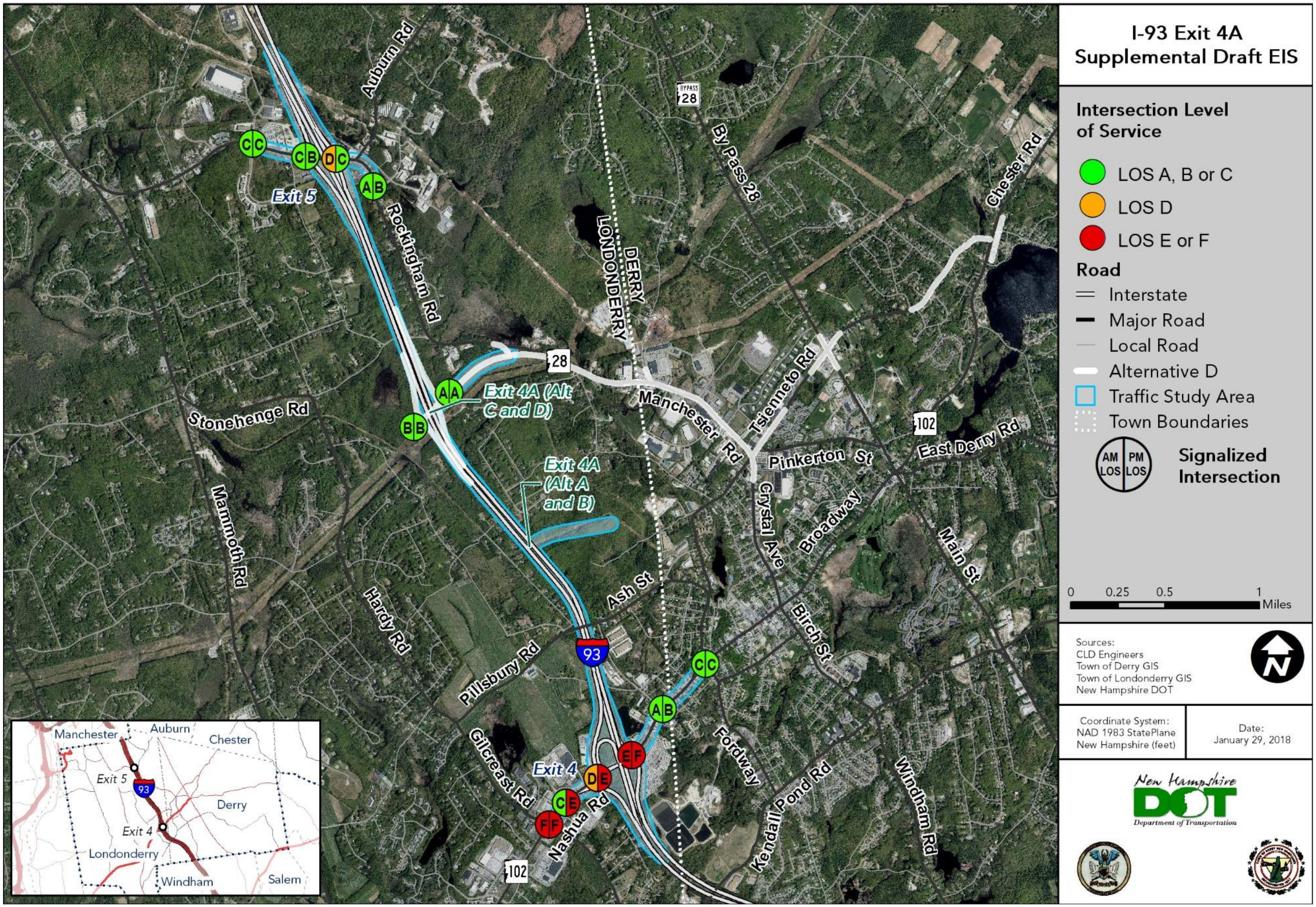


Figure 7-12. 2040 Build Alternative D AM and PM peak hour LOS by intersection

Table 7-13. Comparison between Alternative D and No Build condition intersection capacity and queuing analyses

		No Build Condition									Alternative D								
			AM Peak Hour				PM Peak Hour					AM Peak Hour				PM Peak Hour			
Intersection	Lane Groups	Turning Bay/ Link Length (feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	Turning Bay/ Link Length (feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS
#1 **NH 28 & Symmes Dr/ Vista Ridge Dr (Signalized)** [a]	EB L	408	353	0.97	85.5	F	50	0.76	111.3	F	408	326	0.95	75.0	E	48	0.76	102.1	F
	EB TR	729	414	0.51	13.0	B	458	0.81	31.9	C	408	217	0.49	12.3	B	266	0.74	23.7	C
	EB Overall				30.8	C			33.9	C				27.6	C			25.8	C
	WB L	450	40	0.55	71.3	E	154	0.81	74.0	E	450	33	0.88	203.0	F	144	0.90	83.8	F
	WB Thru	1,537	409	0.84	33.8	C	298	0.61	20.4	C	755	330	0.80	27.7	C	209	0.60	17.6	B
	WB R	500	137	0.08	19.5	B	31	0.04	14.0	B	500	98	0.07	17.4	B	39	0.03	12.5	B
	WB Overall				32.9	C			26.2	C				29.1	C			24.9	C
	NB LT	1,660	330	0.43	48.5	D	120	0.55	55.5	E	1,660	134	0.43	40.1	D	82	0.44	39.3	D
	NB R	10	#101	0.08	45.4	D	#79	0.02	49.0	D	10	#88	0.07	37.2	D	#56	0.02	35.9	D
	NB Overall				46.5	D			53.3	D				38.3	D			38.2	D
	SB L	270	181	0.93	110.8	F	267	0.84	63.6	E	270	109	0.77	62.3	E	184	0.85	57.7	E
	SB LTR	270	191	0.07	47.1	D	#368	0.39	42.0	D	270	116	0.06	37.4	D	263	0.30	32.9	C
	SB Overall				**79.0**	**E**			51.9	D				49.9	D			43.8	D
	Intersection Overall			**0.84**	**36.4**	**D**		**0.79**	**34.7**	**C**			**0.79**	**30.7**	**C**		**0.74**	**29.0**	**C**

Table 7-13. Comparison between Alternative D and No Build condition intersection capacity and queuing analyses (continued)

		No Build Condition									**Alternative D**								
			AM Peak Hour				PM Peak Hour					AM Peak Hour				PM Peak Hour			
Intersection	Lane Groups	Turning Bay/ Link Length (feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	Turning Bay/ Link Length (feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS
#2 NH 28 & I-93 SB On and Off-Ramp (Exit 5) (Signalized) [a]	EB Thru	1,537	#1904	0.97	73.6	E	1243	0.88	39.4	D	1,537	349	0.69	38.7	D	233	0.52	21.1	C
	EB R	350	#546	0.28	0.5	A	#463	0.29	0.5	A	350	123	0.35	0.7	A	-	0.34	0.6	A
	EB Overall				51.1	D			27.9	C				22.0	C			12.6	B
	WB L	592	#632	1.17	111.5	F	280	0.92	20.7	C	592	270	0.88	31.4	C	185	0.70	18.0	B
	WB Thru	592	101	0.44	1.8	A	59	0.32	0.2	A	592	73	0.46	1.3	A	97	0.31	0.4	A
	WB Overall				42.9	D			6.4	A				10.1	B			4.3	A
	SB L	502	492	0.72	44.8	D	406	0.92	48.2	D	502	70	0.16	29.7	C	93	0.27	28.8	C
	SB R	502	#526	1.35	217.5	F	109	0.89	52.5	D	502	166	0.91	60.4	E	-	0.71	38.7	D
	SB Overall				**131.6**	**F**			49.9	D				53.2	D			35.5	D
	Intersection Overall			**1.17**	**77.0**	**E**		**0.90**	**31.2**	**C**			**0.82**	**23.3**	**C**		**0.61**	**15.2**	**B**
#3 NH 28 & I-93 NB On and Off-Ramp (Exit 5) (Signalized) [a]	EB L	592	#729	1.11	67.9	E	#706	1.07	53.5	D	592	#637	1.04	53.5	D	495	1.00	47.5	D
	EB Thru	592	#789	0.39	0.6	A	316	0.62	6.1	A	592	301	0.13	2.1	A	118	0.22	3.9	A
	EB Overall				32.0	C			22.5	C				38.0	D			27.1	C
	WB Thru	481	#580	1.05	104.5	F	217	0.91	61.7	E	481	315	0.97	76.5	E	115	0.62	37.3	D
	WB R	481	171	0.56	1.5	A	-	0.38	0.7	A	-	-	0.25	0.4	A	-	0.16	0.2	A
	WB Overall				48.5	D			29.7	C				45.9	D			23.2	C
	NB L	798	685	1.11	128.2	F	337	0.86	47.1	D	798	692	1.04	84.2	F	365	0.97	59.2	E
	NB R	798	349	0.23	39.9	D	213	1.08	98.8	F	798	387	0.15	25.7	C	0	0.60	27.4	C
	NB Overall				**101.9**	**F**			**76.0**	**E**				**68.9**	**E**			42.9	D
	Intersection Overall			**1.10**	**51.7**	**D**		**1.04**	**37.7**	**D**			**1.02**	**50.5**	**D**		**0.89**	**32.6**	**C**

Table 7-13. Comparison between Alternative D and No Build condition intersection capacity and queuing analyses (continued)

		No Build Condition										Alternative D									
		Turning Bay/ Link Length	AM Peak Hour				PM Peak Hour					Turning Bay/ Link Length	AM Peak Hour				PM Peak Hour				
Intersection	Lane Groups	(feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS		(feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	
#4 NH 28 &	EB L	225	79	0.51	42.4	D	50	0.49	30.6	C		225	38	0.41	30.2	C	28	0.50	29.1	C	
Liberty Dr	EB TR	841	46	0.13	3.9	A	116	0.47	8.8	A		841	26	0.07	4.7	A	58	0.29	8.3	A	
(Signalized) [a]	EB Overall				10.7	B			9.9	A					9.2	A			9.3	A	
	WB L	250	19	0.29	51.2	D	17	0.22	31.7	C		250	16	0.22	31.6	C	14	0.16	22.5	C	
	WB TR	332	178	0.52	8.5	A	88	0.27	8.7	A		332	89	0.37	6.6	A	54	0.18	7.9	A	
	WB Overall				8.7	A			9.0	A					6.8	A			8.3	A	
	NB L	154	51	0.29	41.6	D	52	0.14	21.4	C		154	22	0.04	25.0	C	46	0.14	16.6	B	
	NB Overall				41.6	D			21.4	C					25.0	C			16.6	B	
	SB LT	100	29	0.15	40.6	D	38	0.17	21.6	C		100	19	0.07	25.2	C	22	0.09	16.3	B	
	SB R	502	96	0.07	39.7	D	97	0.10	21.1	C		502	67	0.04	25.1	C	55	0.06	16.1	B	
	SB Overall				39.8	D			21.2	C					25.1	C			16.2	B	
Intersection Overall				**0.50**	**11.3**	**B**		**0.43**	**11.2**	**B**				**0.34**	**8.3**	**A**		**0.27**	**10.1**	**B**	

Table 7-13. Comparison between Alternative D and No Build condition intersection capacity and queuing analyses (continued)

		No Build Condition									Alternative D								
			AM Peak Hour				PM Peak Hour					AM Peak Hour				PM Peak Hour			
Intersection	Lane Groups	Turning Bay/ Link Length (feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	Turning Bay/ Link Length (feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS
#5 NH 102 & Gilcreast Rd (Signalized) [a]	EB L	275	255	1.00	117.3	F	#345	1.24	193.4	F	275	267	1.03	137.3	F	#334	1.28	218.0	F
	EB RT	852	373	1.10	88.9	F	386	0.81	35.9	D	852	380	1.09	95.8	F	387	0.80	38.0	D
	EB Overall				**91.5**	**F**			**60.6**	**E**				**99.7**	**F**			**67.3**	**E**
	WB L	275	86	0.78	53.7	D	135	0.79	32.0	C	275	134	0.85	68.7	E	150	0.81	38.9	D
	WB Thru	669	150	0.97	33.7	C	266	1.27	134.1	F	669	212	1.09	65.7	E	248	1.29	141.9	F
	WB R	225	40	0.06	24.2	C	117	0.14	0.2	A	225	118	0.07	1.9	A	121	0.17	0.7	A
	WB Overall				34.9	C			**111.7**	**F**				**62.0**	**E**			**118.8**	**F**
	NB LT	488	#610	1.16	155.1	F	#567	1.29	200.5	F	488	#602	1.09	138.2	F	#553	1.32	218.6	F
	NB R	488	#598	0.63	47.0	D	#682	0.19	32.8	C	488	#624	0.68	57.9	E	#664	0.24	37.2	D
	NB Overall				**100.5**	**F**			**144.8**	**F**				**97.8**	**F**			**160.2**	**F**
	SB L	356	#442	1.13	142.9	F	314	0.95	114.4	F	356	#431	1.07	132.5	F	#358	1.15	191.4	F
	SBT	356	#483	0.53	47.3	D	#433	0.97	116.8	F	356	#495	0.50	56.6	E	#406	1.22	213.2	F
	SB R	225	#291	0.35	45.0	D	#303	0.55	49.0	D	225	#308	0.49	56.6	E	#266	0.76	69.8	E
	SB Overall				**87.6**	**F**			**83.2**	**F**				**89.1**	**F**			**137.4**	**F**
	Intersection Overall			**1.14**	**76.3**	**E**		**1.24**	**94.0**	**F**			**1.12**	**86.5**	**F**		**1.28**	**107.1**	**F**

Table 7-13. Comparison between Alternative D and No Build condition intersection capacity and queuing analyses (continued)

		No Build Condition										Alternative D									
		Turning Bay/ Link Length (feet)	AM Peak Hour				PM Peak Hour					Turning Bay/ Link Length (feet)	AM Peak Hour				PM Peak Hour				
Intersection	Lane Groups		95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS			95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	
#6 NH 102 & Hampton Dr/Garden Ln (Signalized) [a]	EB L	275	179	0.58	61.3	E	242	1.08	125.2	F		275	258	0.63	76.2	E	270	1.06	131.4	F	
	EB TR	669	615	1.00	14.9	B	239	0.76	18.9	B		669	#816	0.94	10.9	B	227	0.69	14.0	B	
	EB Overall				17.6	B			42.7	D					14.7	B			41.5	D	
	WB L	275	62	0.47	62.2	E	182	0.61	51.4	D		275	101	0.69	92.1	F	227	0.67	61.2	E	
	WB Thru	715	221	0.55	16.9	B	367	0.99	44.7	D		715	310	0.60	24.8	C	418	0.99	45.6	D	
	WB R	275	133	0.22	20.4	C	#329	0.81	26.1	C		275	199	0.26	14.7	B	#351	0.88	26.4	C	
	WB Overall				19.3	B			39.9	D					25.3	C			41.3	D	
	NB LT	630	78	0.28	56.2	E	175	0.77	84.4	F		630	133	0.35	74.8	E	303	0.97	136.2	F	
	NB R	100	#110	0.11	47.0	D	#137	0.06	51.5	D		100	#125	0.25	63.5	E	#155	0.06	**61.5**	**E**	
	NB Overall				49.5	D			**70.1**	**E**					**66.6**	**E**			**105.1**	**F**	
	SB L	175	#258	0.91	92.2	F	#242	1.02	104.3	F		175	#235	0.78	78.0	E	#222	1.03	115.6	F	
	SB LT	291	#374	0.93	96.9	F	#323	1.00	99.1	F		291	#345	0.79	79.1	E	#317	1.03	113.4	F	
	SB R	175	#266	0.10	34.2	C	#210	0.79	59.4	E		175	#239	0.18	43.0	D	#217	0.98	102.3	F	
	SB Overall				**77.5**	**E**			**84.5**	**F**					**68.5**	**E**			**109.3**	**F**	
	Intersection Overall			**0.92**	**24.9**	**C**		**0.99**	**49.9**	**D**				**0.88**	**25.0**	**C**		**1.02**	**55.8**	**E**	

Table 7-13. Comparison between Alternative D and No Build condition intersection capacity and queuing analyses (continued)

		No Build Condition									Alternative D								
		Turning Bay/ Link Length	AM Peak Hour				PM Peak Hour				Turning Bay/ Link Length	AM Peak Hour				PM Peak Hour			
Intersection	Lane Groups	(feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	(feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS
#7 NH 102 & I-93 SB Off-Ramp (Exit 4) (Signalized) [a]	EB Thru	895	540	1.06	53.2	D	565	1.12	87.4	F	895	734	0.99	34.6	C	783	0.93	35.8	D
	EB Overall				53.2	D			**87.4**	**F**				34.6	C			35.8	D
	WB Thru	1,057	193	0.58	13.4	B	420	1.26	146.7	F	1,057	221	0.63	22.4	C	383	1.09	47.1	D
	WB Overall				13.4	B			**146.7**	**F**				22.4	C			47.1	D
	SB L	138	#203	1.10	81.8	F	#205	1.20	116.3	F	138	113	0.16	13.9	B	103	0.15	20.0	C
	SB R	138	#167	0.84	21.4	C	#192	1.09	72.2	E	138	#240	1.00	48.6	D	#214	1.12	99.8	F
	SB Overall				50.8	D			**91.7**	**F**				45.0	D			**92.8**	**F**
	Intersection Overall			**1.08**	**44.5**	**D**		**1.22**	**106.4**	**F**			**0.99**	**35.1**	**D**		**1.11**	**59.6**	**E**
#8 NH 102 & I-93 NB On and Off-Ramp (Exit 4) (Signalized) [a]	EB L	550	529	1.11	85.6	F	475	1.20	127.6	F	550	391	1.04	56.0	E	299	1.12	81.8	F
	EB Thru	1,057	238	0.37	5.7	A	357	0.69	21.2	C	1,057	49	0.07	7.5	A	91	0.21	3.9	A
	EB Overall				50.9	D			**69.9**	**E**				50.5	D			**61.9**	**E**
	WB Thru	1,462	767	1.07	82.8	F	266	0.77	51.8	D	1,462	956	1.03	84.0	F	319	0.87	71.1	E
	WB R	786	#1006	0.78	3.9	A	230	0.54	1.3	A	786	401	0.25	0.4	A	-	0.16	0.2	A
	WB Overall				45.6	D			22.0	C				**63.1**	**E**			48.4	D
	NB L	1,440	496	1.14	137.6	F	897	1.21	140.7	F	1,440	364	1.04	114.7	F	948	1.11	104.2	F
	NB R	1,440	231	1.08	122.3	F	937	1.26	163.5	F	1,440	253	0.93	90.7	F	902	1.10	103.7	F
	NB Overall				**130.9**	**F**			**151.2**	**F**				**104.6**	**F**			**103.9**	**F**
	Intersection Overall			**1.10**	**61.4**	**E**		**1.12**	**92.8**	**F**			**1.04**	**67.3**	**E**		**1.06**	**81.8**	**F**

Table 7-13. Comparison between Alternative D and No Build condition intersection capacity and queuing analyses (continued)

		No Build Condition										Alternative D									
		Turning Bay/ Link Length (feet)	AM Peak Hour				PM Peak Hour				Turning Bay/ Link Length (feet)	AM Peak Hour				PM Peak Hour			
Intersection	Lane Groups		95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS		95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS
#9 NH 102 & St Charles St/ Londonderry Rd (Signalized) [a]	EB L	350	202	0.85	58.1	E	#422	1.31	176.0	F	350	105	0.57	34.2	C	274	0.82	34.5	C
	EB TR	1,462	63	0.27	2.7	A	853	0.49	3.5	A	1,462	66	0.21	3.3	A	145	0.46	5.5	A
	EB Overall				17.4	B			**77.9**	**E**				8.5	A			13.8	B
	WBL	100	44	0.31	59.1	E	25	0.31	59.4	E	100	24	0.26	42.5	D	21	0.25	44.2	D
	WB TR	410	320	0.87	19.0	B	324	1.01	59.5	E	410	197	0.56	8.2	A	235	0.60	19.2	B
	WB Overall				19.1	B			**59.5**	**E**				8.3	A			19.3	B
	NB LTR	-	-	-	-	-	-	-	-	-	400	8	0.00	34.7	C	53	0.05	34.1	C
	NB Overall				0.0	A			0.0	A				34.7	C			34.1	C
	SB LT	780	70	0.23	53.2	D	22	0.21	52.4	D	780	32	0.35	41.8	D	38	0.15	34.8	C
	SB R	225	194	0.17	7.8	A	141	0.20	22.2	C	225	94	0.11	5.5	A	83	0.14	15.0	B
	SB Overall				8.7	A			22.6	C				7.7	A			16.3	B
	Intersection Overall			**0.85**	**17.7**	**B**		**1.16**	**67.5**	**E**			**0.56**	**8.3**	**A**		**0.65**	**16.3**	**B**
#10 NH 102 & Fordway/ Madden Hill Rd (Signalized) [a]	EB TR	455	332	0.73	17.0	B	#734	1.05	55.2	E	455	350	0.69	17.6	B	#561	0.94	29.1	C
	EB Overall				17.0	B			**55.2**	**E**				17.6	B			29.1	C
	WB LT	165	#519	0.91	29.2	C	#535	0.71	12.2	B	165	#401	0.79	21.4	C	#428	0.55	9.6	A
	WB Overall				29.2	C			12.2	B				21.4	C			9.6	A
	NB LR	375	298	0.94	60.4	E	277	1.02	96.3	F	375	261	0.84	36.1	D	315	0.94	67.9	E
	NB Overall				**60.4**	**E**			**96.3**	**F**				36.1	D			**67.9**	**E**
	SB LTR	120	40	0.05	21.8	C	61	0.16	30.2	C	120	56	0.10	17.0	B	80	0.24	28.0	C
	SB Overall				21.8	C			30.2	C				17.0	B			28.0	C
	Intersection Overall			**0.92**	**30.8**	**C**		**1.04**	**47.3**	**D**			**0.81**	**23.2**	**C**		**0.94**	**30.2**	**C**

Table 7-13. Comparison between Alternative D and No Build condition intersection capacity and queuing analyses (continued)

		No Build Condition									Alternative D								
		Turning Bay/ Link Length (feet)	AM Peak Hour				PM Peak Hour				Turning Bay/ Link Length (feet)	AM Peak Hour				PM Peak Hour			
Intersection	Lane Groups		95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS		95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS
#11 Connector Rd &	WBL	-	-	-	-	-	-	-	-	-	585	174	0.59	40.9	D	152	0.48	37.2	D
I-93 SB On	WB Overall				-	-	-	-	-	-				40.9	D			37.2	D
and Off-Ramp	SB L	-	-	-	-	-	-		-	-	520	317	0.75	13.3	B	297	0.69	13.0	B
(Exit 4A)	SB Overall				-	-	-	-	-	-				13.3	B			13.0	B
(Signalized) [a]	**Intersection Overall**			-	-	-	-	-	-	-			**0.70**	**19.2**	**B**		**0.63**	**18.2**	**B**
#12 Connector Rd	EB L	-	-	-	-	-	-	-	-	-	100	-	-	-	-	-	-	-	-
& I-93 NB On	EB T	-	-	-	-	-	-	-	-	-	585	183	0.62	3.4	A	142	0.55	2.9	A
and Off-Ramp	EB Overall				-	-			-	-				3.4	A			2.9	A
(Exit 4A)	WB T	-	-	-	-	-	-	-	-	-	1,588	335	0.17	3.4	A	280	0.15	3.2	A
(Signalized) [a]	WB R	-	-	-	-	-	-	-	-	-	200	#290	0.54	5.8	A	#313	0.46	4.9	A
	WB Overall				-	-			-	-				5.2	A			4.5	A
	NB LR	-	-	-	-	-	-	-	-	-	470	127	0.38	37.9	D	109	0.36	38.1	D
	NB R	-	-	-	-	-	-	-	-	-	470	52	0.40	38.2	D	48	0.38	38.4	D
	NB Overall				-	-			-	-				**38.1**	**D**			38.2	D
	Intersection Overall			-	-	-		-	-	-			**0.59**	**5.7**	**A**		**0.53**	**5.1**	**A**

Notes:

95th percentile volume exceeds capacity, queue may be longer.

EB = Eastbound, WB = Westbound, NB= Northbound, SB = Southbound

LOS = Level of Service

LTR = left / through / right lanes

V/C = Volume-to-Capacity ratio

Delay is Measured in Seconds Per Vehicle.

Red cells denote intersections or approaches operating at unacceptable conditions or denote approaches and lane groups whose queuing length exceeds capacity

[a] Highway Capacity Manual 2000 results (Signalized intersections)

7.14 2040 Build Alternative D Freeway Operations Analysis

Based on the analysis performed using HCS, all freeway facilities would operate below capacity and result in LOS D or better. The one failing freeway facility under the No Build condition would improve to LOS C. This includes the I-93 SB off-ramp to NH 102. Table 7-14 contains the Exit 4 Alternative D freeway analysis compared to the No Build condition and Table 7-15 contains the Exit 5 Alternative D freeway analysis compared to the No Build condition. Table 7-16 contains the Exit 4A Alternative D freeway analysis. Appendix M contains the Build condition HCS freeway operation reports.

Table 7-14. I-93 Exit 4 2040 Build Alternative D freeway analysis compared to the No Build condition

Freeway Analysis	Facility Type	Time Period	Demand to Capacity Ratio		Density (pc/mi/ln)	Alt D LOS	No Build LOS
			Freeway	Ramp			
I-93 Northbound to NH 102	Diverge	AM	0.37	0.25	0.0	A	A
		PM	0.64	0.59	11.8	B	B
NH 102 to I-93 Northbound	Merge	AM	0.48	0.90	19.0	B	C
		PM	0.54	0.71	19.1	B	C
I-93 Southbound to NH 102	Diverge	AM	0.52	0.57	22.1	C	C
		PM	0.50	0.75	23.4	C	F
NH 102 Westbound to I-93 Southbound	Merge	AM	0.49	0.48	15.5	B	B
		PM	0.39	0.22	10.3	B	B
NH 102 Eastbound to I-93 Southbound	Merge	AM	0.67	0.85	24.2	C	C
		PM	0.47	0.40	14.4	B	B

Notes: LOS = Level of Service; Density = Passenger cars per mile per lane (pc/mi/ln)

Red denotes interstate facilities that would result in failing operations and would produce a queue extending to the I-93 mainline.

Table 7-15. I-93 Exit 5 2040 Build Alternative D freeway analysis compared to the No Build condition

Freeway Analysis	Facility Type	Time Period	Demand to Capacity Ratio		Density (pc/mi/ln)	Alt D LOS	No Build LOS
			Freeway	Ramp			
I-93 Northbound to NH 28	Diverge	AM	0.60	0.41	25.8	C	C
		PM	0.64	0.55	28.4	D	C
NH 28 to I-93 Northbound	Merge	AM	0.64	0.49	24.4	C	C
		PM	0.64	0.37	23.0	C	C
I-93 Southbound to NH 28	Diverge	AM	0.62	0.31	23.1	C	C
		PM	0.61	0.32	22.7	C	D
NH 28 to I-93 Southbound	Merge	AM	0.67	0.44	20.5	C	B
		PM	0.63	0.38	18.7	B	B

Notes: LOS = Level of Service; Density = Passenger cars per mile per lane (pc/mi/ln)

Table 7-16. I-93 Exit 4A 2040 Build Alternative D freeway analysis

Freeway Analysis	Facility Type	Time Period	Demand to Capacity Ratio		Density (pc/mi/ln)	LOS
			Freeway	Ramp		
I-93 Northbound to Connector Roadway	Diverge	AM	0.48	0.08	15.7	B
		PM	0.52	0.07	17.2	B
Connector Roadway to I-93 Northbound	Merge	AM	0.63	0.76	22.2	C
		PM	0.65	0.64	21.9	C
I-93 Southbound to Connector Roadway	Diverge	AM	0.66	0.91	32.7	D
		PM	0.62	0.78	30.0	D
Connector Roadway to I-93 Southbound	Merge	AM	0.53	0.25	14.8	B
		PM	0.51	0.21	13.7	B

Notes: LOS = Level of Service; Density = Passenger cars per mile per lane (pc/mi/ln)

7.15 2040 Build Alternative F Intersection Operations Analysis

Based on the Synchro™ signalized intersection analysis results, four signalized intersections (Intersections #2, #5, #7, and #8) would operate at unacceptable conditions (LOS E or LOS F) during the AM or PM peak hours. The remaining signalized intersections in the traffic study area would operate at acceptable overall conditions (LOS D or better is considered an operating level) during the peak hours analyzed (weekday AM and PM peak hours).

Based on the Synchro™ signalized intersection analysis results, all the study area signalized intersections, with the exception of Intersection #4, have overall approaches that would operate at unacceptable conditions (LOS E or LOS F) during one or two evaluated periods. The following are the individual signalized intersection approaches in the traffic study area that would operate under unacceptable conditions during peak hours:

- NH 28 at Symmes Drive/Vista Ridge Drive (Intersection #1)

    - Southbound Symmes Drive during the AM peak hour
- NH 28 at I-93 Southbound on and off-ramp (Exit 5) (Intersection #2)
    - Eastbound NH 28 during the AM peak hour
    - I-93 Southbound off-ramp during the AM peak hour
- NH 28 at I-93 Northbound on and off-ramp (Exit 5) (Intersection #3)
    - I-93 Northbound off-ramp during the AM and PM peak hours
- NH 102 at Gilcreast Road (Intersection #5)
    - Eastbound NH 102 during the AM and PM peak hours
    - Westbound NH 102 during the PM peak hour
    - Northbound Gilcreast Road during the AM and PM peak hours
    - Southbound NH 102 during the AM and PM peak hours
- NH 102 at Hampton Drive/Garden Lane (Intersection #6)
    - Northbound Hampton Drive during the AM and PM peak hours
    - Southbound Garden Lane during the AM and PM peak hours
- NH 102 at I-93 Southbound off-ramp (Exit 4) (Intersection #7)
    - Eastbound and Westbound NH 102 during the AM peak hour
    - I-93 Southbound off-ramp during the PM peak hour
- NH 102 at I-93 Northbound on and off-ramp (Exit 4) (Intersection #8)
    - Eastbound NH 102 during the PM peak hour
    - I-93 Northbound off-ramp during the AM and PM peak hours
- NH 102 at St Charles Street/Londonderry Road (Intersection #9)
    - Northbound St Charles Street during the PM peak hour
- NH 102 at Fordway/Madden Hill Road (Intersection #10)
    - Northbound Fordway during the AM and PM peak hours

The overall Alternative F intersection LOS grades are depicted in Figure 7-13 for AM and PM peak hours. Table 7-17 shows the comparison between Alternative F and No Build condition LOS capacity analysis and the intersection vehicle delay results during the AM and PM peak hours. Appendices G, H, and I contain the Synchro™ Build condition intersection analysis reports.

7.16 2040 Build Alternative F Queuing Analysis

Based on the Synchro™ signalized intersection analysis results, all the signalized intersections within the study area with the exception of NH 28 at liberty Drive (Intersection #4), would experience queuing lengths that would exceed the available storage capacity. Intersection #4 would provide sufficient storage for the anticipated demand. The lane group in the approach that would operate under unacceptable conditions is noted in parentheses. Table 7-17 contains the queuing results. Appendices J, K, and L contain the Synchro™ Build condition intersection queuing reports.

- NH 28 at Symmes Drive/Vista Ridge Drive (Intersection #1)
  - Northbound Vista Ridge Drive (right turns) during the AM and the PM peak hours
  - Southbound Symmes Drive (left turns, right turns, and through movements) during the PM peak hour
- NH 28 at I-93 Southbound on and off-ramp (Exit 5) (Intersection #2)
  - Eastbound NH 28 (all movements) during the AM peak hour
- NH 28 at I-93 Northbound on and off-ramp (Exit 5) (Intersection #3)
  - Eastbound NH 28 (left turns) during the AM and PM peak hours
  - Eastbound NH 28 (through movements) during the AM peak hour
  - Westbound NH 28 (through movements) during the AM peak hour
- NH 102 at Gilcreast Road (Intersection #5)
  - Eastbound NH 102 (left turns) during the PM peak hour
  - Northbound Gilcreast Road (all movements) during the AM and PM peak hours
  - Southbound Gilcreast Road (left turns) during the AM peak hour
  - Southbound Gilcreast Road (right turns and through movements) during the AM and PM peak hours
- NH 102 at Hampton Drive/Garden Lane (Intersection #6)
  - Westbound NH 102 (right turns) during the PM peak hour
  - Northbound Hampton Drive (right turns) during the AM and PM peak hours
  - Southbound Garden Lane (all movements) during the AM and PM peak hours
- NH 102 at I-93 Southbound off-ramp (Exit 4) (Intersection #7)
  - I-93 Southbound off-ramp (all movements) during the AM ad PM peak hours
- NH 102 at I-93 Northbound on and off-ramp (Exit 4) (Intersection #8)
  - Westbound NH 102 (right turns) during the AM peak hour
- NH 102 at St Charles Street/Londonderry Road (Intersection #9)
  - Eastbound NH 102 (left turns) during the PM peak hour
- NH 102 at Fordway/Madden Hill Road (Intersection #10)
  - Eastbound NH 102 (through movements) during the PM peak hour
  - Eastbound NH 102 (right turns) during the AM and PM peak hours
  - Westbound NH 102 (all movements) during the AM and PM peak hours

Intersection #4 is the only signalized intersection in the traffic study area that would provide sufficient storage for the anticipated demand. The lane group in the approach that would operate under unacceptable conditions is highlighted in red in Table 7-17, which contains a comparison between Alternative F and No Build condition queuing results.

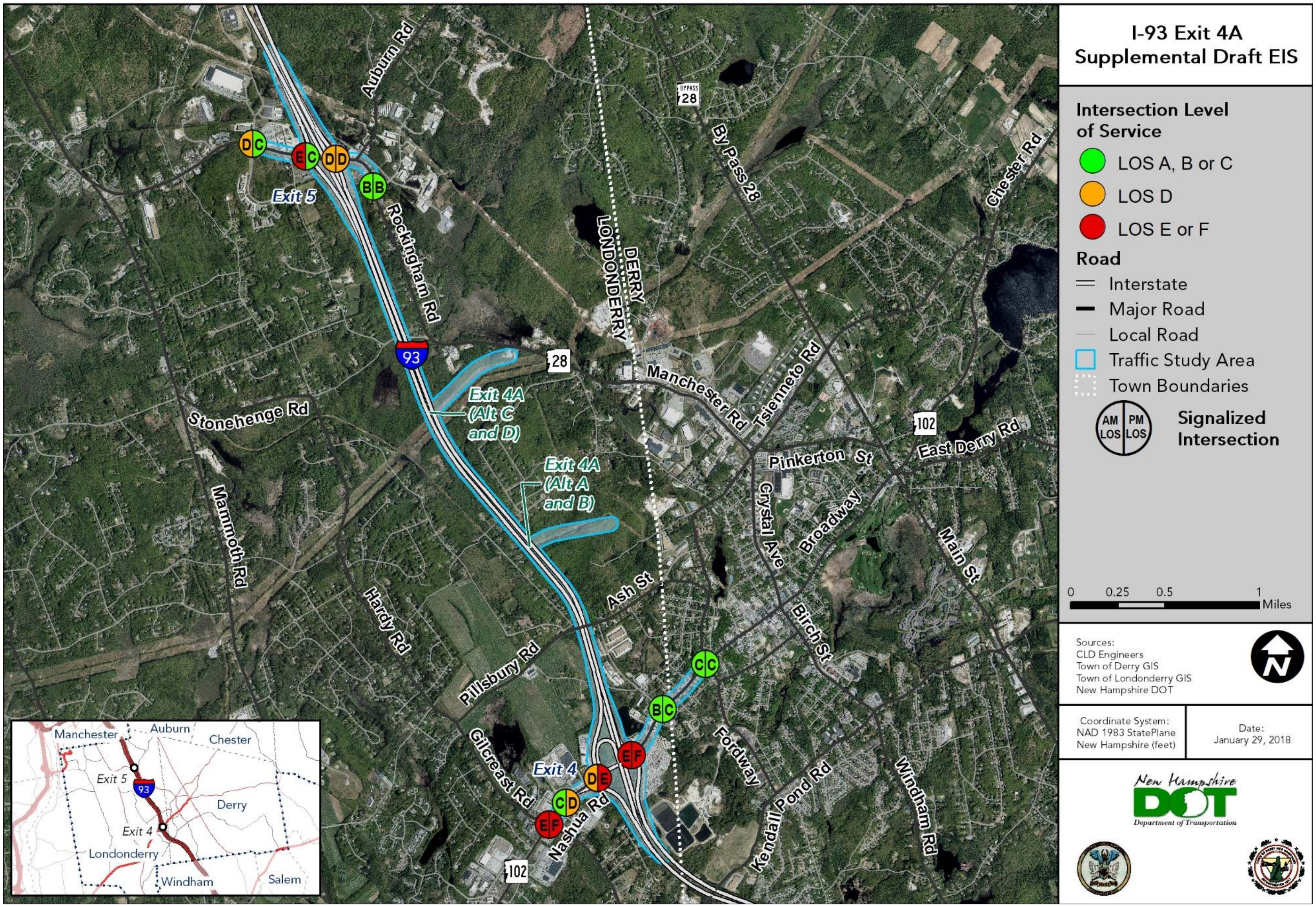


Figure 7-13. 2040 Build Alternative F AM and PM peak hour LOS by intersection

Table 7-17. Comparison between Alternative F and No Build condition intersection capacity and queuing analyses

		No Build Condition									Alternative F								
			AM Peak Hour				PM Peak Hour					AM Peak Hour				PM Peak Hour			
Intersection	Lane Groups	Turning Bay/ Link Length (feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	Turning Bay/ Link Length (feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS
#1 NH 28 & Symmes Dr/ Vista Ridge Dr (Signalized) [a]	EB L	408	353	0.97	85.5	F	50	0.76	111.3	F	408	369	1.07	107.5	F	55	0.51	47.2	D
	EB TR	729	414	0.51	13.0	B	458	0.81	31.9	C	729	364	0.58	14.9	B	380	0.90	32.9	C
	EB Overall				30.8	C			33.9	C				37.5	D			33.2	C
	WB L	450	40	0.55	71.3	E	154	0.81	74.0	E	450	37	0.44	51.0	D	130	0.94	97.3	F
	WB Thru	1,537	409	0.84	33.8	C	298	0.61	20.4	C	1,537	405	0.89	35.0	D	251	0.66	20.2	C
	WB R	500	137	0.08	19.5	B	31	0.04	14.0	B	500	87	0.07	18.5	B	44	0.03	13.9	B
	WB Overall				32.9	C			26.2	C				33.7	C			28.7	C
	NB LT	1,660	330	0.43	48.5	D	120	0.55	55.5	E	1,660	200	0.38	38.0	D	93	0.44	39.2	D
	NB R	10	#101	0.08	45.4	D	#79	0.02	49.0	D	10	#96	0.07	35.7	D	#69	0.02	35.8	D
	NB Overall				46.5	D			53.3	D				36.6	D			38.0	D
	SB L	270	181	0.93	110.8	F	267	0.84	63.6	E	270	129	0.86	78.5	E	214	0.91	67.1	E
	SB LTR	270	191	0.07	47.1	D	#368	0.39	42.0	D	270	139	0.07	37.7	D	#316	0.31	32.0	C
	SB Overall				**79.0**	**E**			51.9	D				**58.1**	**E**			48.5	D
	Intersection Overall			**0.84**	**36.4**	**D**		**0.79**	**34.7**	**C**			**0.86**	**37.5**	**D**		**0.86**	**34.3**	**C**

Table 7-17. Comparison between Alternative F and No Build condition intersection capacity and queuing analyses (continued)

		No Build Condition									Alternative F								
		Turning Bay/ Link Length	AM Peak Hour				PM Peak Hour				Turning Bay/ Link Length	AM Peak Hour				PM Peak Hour			
Intersection	Lane Groups	(feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	(feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS
#2 NH 28 & I-93 SB On and Off-Ramp (Exit 5) (Signalized) [a]	EB Thru	1,537	#1904	0.97	73.6	E	1243	0.88	39.4	D	1,537	#1764	1.01	81.9	F	492	0.84	35.6	D
	EB R	350	#546	0.28	0.5	A	#463	0.29	0.5	A	350	#536	0.28	0.5	A	239	0.29	0.5	A
	EB Overall				51.1	D			27.9	C				**56.5**	**E**			25.3	C
	WB L	592	#632	1.17	111.5	F	280	0.92	20.7	C	592	535	1.08	74.8	E	304	0.88	24.2	C
	WB Thru	592	101	0.44	1.8	A	59	0.32	0.2	A	592	58	0.41	1.3	A	52	0.29	0.2	A
	WB Overall				42.9	D			6.4	A				29.8	C			7.7	A
	SB L	502	492	0.72	44.8	D	406	0.92	48.2	D	502	445	0.68	41.8	D	325	0.89	46.3	D
	SB R	502	#526	1.35	217.5	F	109	0.89	52.5	D	502	450	1.21	158.2	F	81	0.74	40.0	D
	SB Overall				**131.6**	**F**			49.9	D				**100.3**	**F**			43.8	D
	Intersection Overall			**1.17**	**77.0**	**E**		**0.90**	**31.2**	**C**			**1.10**	**62.1**	**E**		**0.87**	**27.8**	**C**
#3 NH 28 & I-93 NB On and Off-Ramp (Exit 5) (Signalized) [a]	EB L	592	#729	1.11	67.9	E	#706	1.07	53.5	D	592	#724	1.08	52.6	D	#687	1.03	40.2	D
	EB Thru	592	#789	0.39	0.6	A	316	0.62	6.1	A	592	#693	0.38	0.3	A	301	0.56	3.2	A
	EB Overall				32.0	C			22.5	C				24.9	C			16.1	B
	WB Thru	481	#580	1.05	104.5	F	217	0.91	61.7	E	481	#504	1.01	88.9	F	168	0.78	47.1	D
	WB R	481	171	0.56	1.5	A	-	0.38	0.7	A	481	98	0.57	1.5	A	-	0.39	0.7	A
	WB Overall				48.5	D			29.7	C				40.1	D			21.9	C
	NB L	798	685	1.11	128.2	F	337	0.86	47.1	D	798	592	1.09	118.2	F	432	0.92	**58.7**	**E**
	NB R	798	349	0.23	39.9	D	213	1.08	98.8	F	798	275	0.19	36.9	D	258	1.09	107.7	F
	NB Overall				**101.9**	**F**			**76.0**	**E**				**94.1**	**F**			**85.7**	**F**
	Intersection Overall			**1.10**	**51.7**	**D**		**1.04**	**37.7**	**D**			**1.07**	**44.0**	**D**		**0.99**	**35.1**	**D**

Table 7-17. Comparison between Alternative F and No Build condition intersection capacity and queuing analyses (continued)

		No Build Condition										Alternative F									
		Turning Bay/ Link Length	AM Peak Hour				PM Peak Hour				Turning Bay/ Link Length	AM Peak Hour				PM Peak Hour			
Intersection	Lane Groups	(feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	(feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS
#4 NH 28 & Liberty	EB L	225	79	0.51	42.4	D	50	0.49	30.6	C	225	74	0.49	38.7	D	51	0.47	29.4	C
Dr (Signalized) [a]	EB TR	841	46	0.13	3.9	A	116	0.47	8.8	A	841	32	0.13	4.0	A	106	0.45	8.9	A
	EB Overall				10.7	B			9.9	A				10.2	B			9.9	A
	WB L	250	19	0.29	51.2	D	17	0.22	31.7	C	250	13	0.32	49.5	D	17	0.21	30.5	C
	WB TR	332	178	0.52	8.5	A	88	0.27	8.7	A	332	171	0.55	8.7	A	101	0.28	8.9	A
	WB Overall				8.7	A			9.0	A				8.9	A			9.2	A
	NB L	154	51	0.29	41.6	D	52	0.14	21.4	C	154	25	0.05	36.1	D	44	0.13	20.6	C
	NB Overall				41.6	D			21.4	C				36.1	D			20.6	C
	SB LT	100	29	0.15	40.6	D	38	0.17	21.6	C	100	31	0.15	37.1	D	34	0.16	20.8	C
	SB R	502	96	0.07	39.7	D	97	0.10	21.1	C	502	90	0.07	36.3	D	92	0.10	20.4	C
	SB Overall				39.8	D			21.2	C				36.4	D			20.4	C
	Intersection Overall			**0.50**	**11.3**	**B**		**0.43**	**11.2**	**B**			**0.50**	**10.7**	**B**		**0.41**	**11.1**	**B**

Table 7-17. Comparison between Alternative F and No Build condition intersection capacity and queuing analyses (continued)

		No Build Condition									Alternative F								
		Turning Bay/ Link Length	AM Peak Hour				PM Peak Hour				Turning Bay/ Link Length	AM Peak Hour				PM Peak Hour			
Intersection	Lane Groups	(feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	(feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS
#5 NH 102 &	EB L	275	255	1.00	117.3	F	#345	1.24	193.4	F	275	264	1.02	134.8	F	#329	1.23	187.2	F
Gilcreast Rd	EB RT	852	373	1.10	88.9	F	386	0.81	35.9	D	852	376	1.08	90.2	F	383	0.82	36.3	D
(Signalized) [a]	EB Overall				**91.5**	**F**			**60.6**	**E**				**94.4**	**F**			**59.5**	**E**
	WB L	275	86	0.78	53.7	D	135	0.79	32.0	C	275	95	0.72	57.6	E	122	0.78	32.3	C
	WB Thru	669	150	0.97	33.7	C	266	1.27	134.1	F	669	155	0.92	28.4	C	218	1.26	127.5	F
	WB R	225	40	0.06	24.2	C	117	0.14	0.2	A	225	44	0.06	4.1	A	87	0.13	0.3	A
	WB Overall				34.9	C			**111.7**	**F**				29.4	C			**106.4**	**F**
	NB LT	488	#610	1.16	155.1	F	#567	1.29	200.5	F	488	#569	1.07	134.1	F	#587	1.27	195.3	F
	NB R	488	#598	0.63	47.0	D	#682	0.19	32.8	C	488	#526	0.66	57.4	E	#681	0.20	32.8	C
	NB Overall				**100.5**	**F**			**144.8**	**F**				**95.5**	**F**			**140.6**	**F**
	SB L	356	#442	1.13	142.9	F	314	0.95	114.4	F	356	#440	1.06	129.6	F	354	0.97	118.2	F
	SBT	356	#483	0.53	47.3	D	#433	0.97	116.8	F	356	#485	0.49	56.5	E	#477	0.95	113.1	F
	SB R	225	#291	0.35	45.0	D	#303	0.55	49.0	D	225	#294	0.47	56.4	E	#307	0.54	48.6	D
	SB Overall				**87.6**	**F**			**83.2**	**F**				**87.8**	**F**			**83.2**	**F**
	Intersection Overall			**1.14**	**76.3**	**E**		**1.24**	**94.0**	**F**			**1.08**	**75.7**	**E**		**1.23**	**90.7**	**F**

Table 7-17. Comparison between Alternative F and No Build condition intersection capacity and queuing analyses (continued)

		No Build Condition									Alternative F								
		Turning Bay/ Link Length (feet)	AM Peak Hour				PM Peak Hour				Turning Bay/ Link Length (feet)	AM Peak Hour				PM Peak Hour			
Intersection	Lane Groups		95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS		95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS
#6 NH 102 & Hampton Dr/Garden Ln (Signalized) [a]	EB L	275	179	0.58	61.3	E	242	1.08	125.2	F	275	175	0.62	75.9	E	266	1.07	120.3	F
	EB TR	669	615	1.00	14.9	B	239	0.76	18.9	B	669	480	0.93	10.5	B	258	0.77	18.1	B
	EB Overall				17.6	B			42.7	D				14.3	B			40.4	D
	WB L	275	62	0.47	62.2	E	182	0.61	51.4	D	275	54	0.55	86.4	F	201	0.64	51.8	D
	WB Thru	715	221	0.55	16.9	B	367	0.99	44.7	D	715	226	0.50	20.6	C	388	0.98	47.0	D
	WB R	275	133	0.22	20.4	C	#329	0.81	26.1	C	275	102	0.22	11.6	B	#342	0.80	27.0	C
	WB Overall				19.3	B			39.9	D				21.3	C			41.7	D
	NB LT	630	78	0.28	56.2	E	175	0.77	84.4	F	630	116	0.35	74.8	E	213	0.76	83.6	F
	NB R	100	#110	0.11	47.0	D	#137	0.06	51.5	D	100	#121	0.24	63.1	E	#143	0.06	51.5	D
	NB Overall				49.5	D			**70.1**	**E**				**66.3**	**E**			**69.5**	**E**
	SB L	175	#258	0.91	92.2	F	#242	1.02	104.3	F	175	#237	0.78	79.2	E	#240	1.03	106.0	F
	SB LT	291	#374	0.93	96.9	F	#323	1.00	99.1	F	291	#351	0.79	80.2	F	#322	1.04	108.2	F
	SB R	175	#266	0.10	34.2	C	#210	0.79	59.4	E	175	#252	0.15	42.8	D	#205	0.80	61.2	E
	SB Overall				**77.5**	**E**			**84.5**	**F**				**69.2**	**E**			**88.8**	**F**
	Intersection Overall			**0.92**	**24.9**	**C**		**0.99**	**49.9**	**D**			**0.87**	**23.6**	**C**		**0.98**	**50.9**	**D**

Table 7-17. Comparison between Alternative F and No Build condition intersection capacity and queuing analyses (continued)

		No Build Condition									Alternative F								
		Turning Bay/ Link Length (feet)	AM Peak Hour				PM Peak Hour				Turning Bay/ Link Length (feet)	AM Peak Hour				PM Peak Hour			
Intersection	Lane Groups		95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS		95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS
#7 NH 102 &	EB Thru	895	540	1.06	53.2	D	565	1.12	87.4	F	895	560	1.09	68.1	E	408	1.02	43.0	D
I-93 SB Off-	EB Overall				53.2	D			**87.4**	**F**				**68.1**	**E**			43.0	D
Ramp (Exit 4)	WB Thru	1,057	193	0.58	13.4	B	420	1.26	146.7	F	1,057	154	0.59	17.3	B	288	1.11	52.2	D
(Signalized) [a]	WB Overall				13.4	B			**146.7**	**F**				17.3	B			52.2	D
	SB L	138	#203	1.10	81.8	F	#205	1.20	116.3	F	138	#202	1.10	81.9	F	#201	1.17	117.7	F
	SB R	138	#167	0.84	21.4	C	#192	1.09	72.2	E	138	#159	0.74	19.4	B	#194	0.95	43.0	D
	SB Overall				50.8	D			**91.7**	**F**				51.6	D			**78.1**	**E**
	Intersection Overall			**1.08**	**44.5**	**D**		**1.22**	**106.4**	**F**			**1.09**	**51.0**	**D**		**1.14**	**61.5**	**E**
#8 NH 102 &	EB L	550	529	1.11	85.6	F	475	1.20	127.6	F	550	516	1.07	75.5	E	386	1.18	120.1	F
I-93 NB On	EB Thru	1,057	238	0.37	5.7	A	357	0.69	21.2	C	1,057	274	0.42	5.5	A	274	0.77	20.5	C
and Off-Ramp	EB Overall				50.9	D			**69.9**	**E**				42.4	D			**62.9**	**E**
(Exit 4)	WB Thru	1,462	767	1.07	82.8	F	266	0.77	51.8	D	1,124	722	1.04	81.2	F	277	0.82	54.2	D
(Signalized) [a]	WB R	786	#1006	0.78	3.9	A	230	0.54	1.3	A	786	#879	0.80	4.4	A	287	0.55	1.4	A
	WB Overall				45.6	D			22.0	C				45.0	D			23.5	C
	NB L	1,440	496	1.14	137.6	F	897	1.21	140.7	F	1,440	443	1.09	131.3	F	963	1.20	134.3	F
	NB R	1,440	231	1.08	122.3	F	937	1.26	163.5	F	1,440	279	1.08	131.3	F	996	1.30	181.3	F
	NB Overall				**130.9**	**F**			**151.2**	**F**				**131.3**	**F**			**156.4**	**F**
	Intersection Overall			**1.10**	**61.4**	**E**		**1.12**	**92.8**	**F**			**1.06**	**57.5**	**E**		**1.15**	**91.8**	**F**

Table 7-17. Comparison between Alternative F and No Build condition intersection capacity and queuing analyses (continued)

		No Build Condition									Alternative F								
		Turning Bay/ Link Length (feet)	AM Peak Hour				PM Peak Hour				Turning Bay/ Link Length (feet)	AM Peak Hour				PM Peak Hour			
Intersection	Lane Groups		95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS		95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS
#9 NH 102 & St Charles St/ Londonderry Rd (Signalized) [a]	EB L	350	202	0.85	58.1	E	#422	1.31	176.0	F	360	147	0.67	41.5	D	#410	0.96	58.7	E
	EB TR	1,462	63	0.27	2.7	A	853	0.49	3.5	A	1,462	71	0.31	3.2	A	437	0.61	5.2	A
	EB Overall				17.4	B			**77.9**	**E**				9.7	A			20.9	C
	WB L	100	44	0.31	59.1	E	25	0.31	59.4	E	65	45	0.69	122.6	F	38	0.79	191.4	F
	WB TR	410	320	0.87	19.0	B	324	1.01	59.5	E	410	210	0.78	13.4	B	201	0.85	39.0	D
	WB Overall				19.1	B			**59.5**	**E**				14.1	B			40.4	D
	NB LTR	-	-	-	-	-	-	-	-	-	400	13	0.1	44.2	D	67	0.05	**56.3**	**E**
	NB Overall				0.0	A			0.0	A				44.2	D			56.3	E
	SB LT	780	70	0.23	53.2	D	22	0.21	52.4	D	780	30	0.39	50.9	D	45	0.25	**58.6**	**E**
	SB R	225	194	0.17	7.8	A	141	0.20	22.2	C	180	92	0.08	6.3	A	99	0.11	23.9	C
	SB Overall				8.7	A			22.6	C				9.7	A			26.8	C
	Intersection Overall			**0.85**	**17.7**	**B**		**1.16**	**67.5**	**E**			**0.75**	**12.3**	**B**		**0.87**	**27.9**	**C**

Table 7-17. Comparison between Alternative F and No Build condition intersection capacity and queuing analyses (continued)

		No Build Condition										Alternative F									
		Turning Bay/ Link Length	AM Peak Hour				PM Peak Hour					Turning Bay/ Link Length	AM Peak Hour				PM Peak Hour				
Intersection	Lane Groups	(feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS		(feet)	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	95% queue (ft)	v/c ratio	Average Delay (sec/veh)	LOS	
#10 NH 102 & Fordway/ Madden Hill Rd (Signalized) [a]	EB TR/T	455	332	0.73	17.0	B	#734	1.05	55.2	E		455	384	0.60	13.3	B	#1545	0.98	34.8	C	
	EB R	-	-	-	-	-	-	-	-	-		100	#143	0.16	8.9	B	#155	0.20	5.9	A	
	EB Overall				17.0	B			**55.2**	**E**					12.2	B			29.7	C	
	WB LT	165	#519	0.91	29.2	C	#535	0.71	12.2	B		165	#627	0.92	29.3	C	#725	0.77	14.3	B	
	WB Overall				29.2	C			12.2	B					29.3	C			14.3	B	
	NB LR/L	375	298	0.94	60.4	E	277	1.02	96.3	F		375	311	0.95	64.2	E	#523	0.93	69.3	E	
	NB R	-	-	-	-	-	-	-	-	-		100	100	0.02	21.3	C	#139	0.04	28.0	C	
	NB Overall				**60.4**	**E**			**96.3**	**F**					**60.9**	**E**			**62.7**	**E**	
	SB LTR	120	40	0.05	21.8	C	61	0.16	30.2	C		120	40	0.05	22.6	C	66	0.19	30.3	C	
	SB Overall				21.8	C			30.2	C					22.6	C			30.3	C	
	Intersection Overall			**0.92**	**30.8**	**C**		**1.04**	**47.3**	**D**				**0.93**	**28.7**	**C**		**0.96**	**29.9**	**C**	

Notes:

95th percentile volume exceeds capacity, queue may be longer.

EB = Eastbound, WB = Westbound, NB= Northbound, SB = Southbound

LOS = Level of Service

LTR = left / through / right lanes

V/C = Volume-to-Capacity ratio

Delay is Measured in Seconds Per Vehicle.

Red cells denote intersections or approaches operating at unacceptable conditions or denote approaches and lane groups whose queuing length exceeds capacity

[a] Highway Capacity Manual 2000 results (Signalized intersections)

7.17 2040 Build Alternative F Freeway Operations Analysis

Based on the analysis performed using HCS, one freeway facility would operate above capacity. This includes the I-93 SB off-ramp to NH 102. This facility would fail due to the off-ramp operating over capacity, thus queueing onto the I-93 mainline. The NH 102 on-ramp to I-93 NB would continue to operate above capacity potentially creating a queue into the NH 102 mainline. Table 7-18 contains the Exit 4 Alternative F freeway analysis compared to the No Build condition and Table 7-19 contains the Exit 5 Alternative F freeway analysis compared to the No Build condition. Appendix M contains the Build condition HCS freeway operation reports.

Table 7-18. I-93 Exit 4 2040 Build Alternative F freeway analysis compared to the No Build condition

Freeway Analysis	Facility Type	Time Period	Demand to Capacity Ratio		Density (pc/mi/ln)	Alt F LOS	No Build LOS
			Freeway	Ramp			
I-93 Northbound to NH 102	Diverge	AM	0.37	0.26	0.0	A	A
		PM	0.64	0.62	12.5	B	B
NH 102 to I-93 Northbound	Merge	AM	0.55	1.25[a]	21.9	C	C
		PM	0.58	0.99	23.0	C	C
I-93 Southbound to NH 102	Diverge	AM	0.55	0.85	26.2	C	C
		PM	0.57	1.12	29.6	F	F
NH 102 Westbound to I-93 Southbound	Merge	AM	0.50	0.70	17.5	B	B
		PM	0.39	0.32	11.1	B	B
NH 102 Eastbound to I-93 Southbound	Merge	AM	0.67	0.89	24.2	C	C
		PM	0.47	0.39	14.5	B	B

Notes: LOS = Level of Service; Density = Passenger cars per mile per lane (pc/mi/ln)

Red denotes interstate facilities that would result in failing operations and would produce a queue extending to the I-93 mainline.

[a] The demand of the on-ramp exceeds the capacity; therefore, the ramp would produce a queue extending to NH 102.

Table 7-19. I-93 Exit 5 2040 Build Alternative F freeway analysis compared to the No Build condition

Freeway Analysis	Facility Type	Time Period	Demand to Capacity Ratio		Density (pc/mi/ln)	Alt F LOS	No Build LOS
			Freeway	Ramp			
I-93 Northbound to NH 28	Diverge	AM	0.55	0.36	20.6	C	C
		PM	0.57	0.48	25.3	C	C
NH 28 to I-93 Northbound	Merge	AM	0.67	0.82	24.3	C	C
		PM	0.63	0.62	24.1	C	C
I-93 Southbound to NH 28	Diverge	AM	0.58	0.66	25.1	C	C
		PM	0.64	0.67	27.2	C	D
NH 28 to I-93 Southbound	Merge	AM	0.57	0.45	17.5	B	B
		PM	0.58	0.38	17.0	B	B

Notes: LOS = Level of Service; Density = Passenger cars per mile per lane (pc/mi/ln)

8.0 POLICY ANALYSIS

8.1 Introduction

The need for new access from the Interstate stems from overcrowded traffic conditions through downtown Derry, New Hampshire, as well as traffic diverting to local roads to avoid NH 102 through downtown Derry. These conditions are caused by limited east-west routing options for traffic destined to the NH 28 Bypass and points east along NH 102 from origins along I-93 and points west along NH 102. I-93 Exit 4 along NH 102 provides the straightest path but passes through downtown Derry along an urban-designed roadway with on-street parking, frequent intersections, pedestrian accommodations, and dense development. A new connection from the Interstate would support the study goals to remove the pass-through traffic from downtown Derry, creating a safer and more pedestrian friendly downtown while providing a new direct connection to the Londonderry Turnpike and points east.

The following subsections assess the two FHWA policy requirements. The Project study area is defined in Section 2.3, and the purpose and need is defined in Section 1.2.

8.2 Policy Requirement 1: Operational and Collision Analysis

An operational and safety analysis has concluded that the proposed change in access does not have a significant adverse impact on the safety and operation of the Interstate facility (which includes mainline lanes, existing, new, or modified ramps, and ramp intersections with crossroad) or on the local street network based on both the current and the planned future traffic projections. The analysis should, particularly in urbanized areas, include at least the first adjacent existing or proposed interchange on either side of the proposed change in access (Title 23, Code of Federal Regulations (CFR), paragraphs 625.2(a), 655.603(d) and 771.111(f)). The crossroads and the local street network, to at least the first major intersection on either side of the proposed change in access, should be included in this analysis to the extent necessary to fully evaluate the safety and operational impacts that the proposed change in access and other transportation improvements may have on the local street network (23 CFR 625.2(a) and 655.603(d)). Requests for a proposed change in access should include a description and assessment of the impacts and ability of the proposed changes to safely and efficiently collect, distribute, and accommodate traffic on the Interstate facility, ramps, intersection of ramps with crossroad, and local street network (23 CFR 625.2(a) and 655.603(d)). Each request should also include a conceptual plan of the type and location of the signs proposed to support each design alternative (23 U.S.C. 109(d) and 23 CFR 655.603(d)).

8.2.1 Introduction

The following subsections describe the future traffic and safety conditions based on five alternatives to demonstrate that alternatives that include a new Exit 4A along I-93 would provide equal or more efficient and safe access to the Londonderry/Derry area than the present condition.

8.2.2 Traffic Volume Summary

Traffic volumes were compared between the No Build condition and each alternative at five key locations. These include the following locations:

1. NH 102 eastbound and westbound through movements at Fordway/Madden Hill Road (Intersection #10)
2. NH 28 eastbound through/ northbound right turns and westbound through and right turns at I-93 NB on and off-ramp (Intersection #3)
3. I-93 northbound and southbound between Exit 4 and Exit 4A
4. I-93 northbound and southbound between Exit 5 and Exit 4A
5. Connector Roadway east of I-93 Exit 4A interchange

NH 102 Future Travel Patterns

Based on the comparison of 2040 traffic volume forecasts produced by the SNHPC regional travel demand model, Alternatives A, B, C, and D would reduce traffic along NH 102 and all include a new I-93 Exit 4A interchange. Alternatives A and B would reduce volume by 28 percent along NH 102 when compared to the No Build condition. Alternatives A and B would provide the highest reduction in traffic of the alternatives and would meet the project goal to create a safer pedestrian environment in downtown Derry and reduce diverted traffic off local streets. Alternatives C and D would reduce traffic volume by 24 and 16 percent, respectively, when compared to the No Build condition. These reductions also help reduce traffic along NH 102 through downtown Derry, but not as much as Alternatives A and B. Alternative F would not include a new interchange, but would improvement intersections along NH 102 between I-93 Exit 4 and downtown Derry. These improvements would result in an increase in the vehicle volume by 10 percent which would worsen the traffic levels in downtown Derry.

Table 8-1 presents the NH 102 vehicle volume summary based on the volume of forecasted at location #1.

Table 8-1. NH 102 vehicle volume summary at Location #1

Vehicle Direction	Time Period	No Build	Alt. A	Alt. B	Alt. C	Alt. D	Alt. F
NH 102 Eastbound Volumes	AM	453	370	360	380	420	540
	PM	860	710	680	730	790	1,020
NH 102 Westbound Volumes	AM	790	495	545	525	585	810
	PM	555	345	345	380	420	555
NH 102 Eastbound Average Difference	AM		-18%	-21%	-16%	-7%	19%
	PM		-17%	-21%	-15%	-8%	19%
NH 102 Westbound Average Difference	AM		-37%	-31%	-34%	-26%	3%
	PM		-38%	-38%	-32%	-24%	0%
Overall Average Difference			**-28%**	**-28%**	**-24%**	**-16%**	**10%**

NH 28 Future Travel Patterns

Based on the comparison of 2040 traffic volume forecasts produced by the SNHPC regional travel demand model, Alternatives A, B, C, and D would reduce traffic along NH 28. Alternatives C and D would reduce the volume by more than 44 percent along NH 28 compared to the No Build condition. Of the five alternatives, Alternatives C and D would have the greatest effect on volume, most likely because of the proximity of northern location of the proposed Exit 4A to Exit 5 providing a faster travel time to the same destinations in Londonderry and Derry. Alternatives A and B would reduce traffic volume by 21 and 35 percent, respectively, when compared to the No Build condition. While not as much of a reduction as Alternatives C and D, these reductions would represent a reduction in traffic along NH 28 east of I-93 Exit 5. Alternative F would result in a decrease in the vehicle volume by 3 percent, as a result of improved conditions along NH 102 to access downtown Derry and could represent vehicles shifting to NH 102 rather than remaining on NH 28, which would not achieve the project's goal.

Table 8-2 presents the NH 28 vehicle volume summary forecasted at location #2.

Table 8-2. NH 28 vehicle volume summary at Location #2

Vehicle Direction	Time Period	No Build	Alt. A	Alt. B	Alt. C	Alt. D	Alt. F
NH 28 Eastbound Volumes	AM	890	515	435	360	370	845
	PM	1,525	990	855	750	770	1,445
NH 28 Westbound Volumes	AM	1,425	1,370	1,115	1,050	870	1,415
	PM	1,040	1,000	810	570	620	1,030
NH 28 Eastbound Average Difference	AM		-42%	-51%	-60%	-58%	-5%
	PM		-35%	-44%	-51%	-50%	-5%
NH 28 Westbound Average Difference	AM		-4%	-22%	-26%	-39%	-1%
	PM		-4%	-22%	-45%	-40%	-1%
Overall Average Difference			**-21%**	**-35%**	**-45%**	**-47%**	**-3%**

I-93 between Exit 4 and 5 Future Travel Patterns

Based on the comparison of 2040 traffic volume forecasts produced by the SNHPC regional travel demand model, when compared to the No Build condition, Alternatives A, C, and D would reduce traffic along I-93 between Exit 4 and Exit 4A (southern stretch); however, Alternatives A, B, C, and D would increase traffic along I-93 between Exit 5 and Exit 4A (northern stretch). There would be sufficient capacity along this northern stretch of I-93, resulting in no congestion issue with the completion of the I-93 widening to four travel lanes in each direction. Alternatives C and D would reduce the volume by more than 7 percent along the southern stretch, but increase the volume by 13 percent along the northern stretch. This would represent a shift of vehicles from Exit 4 to Exit 4A from origins from north of Londonderry. Alternatives A and B would result in a similar volume change, a 3 percent decrease and 1 percent increase, respectively for the southern stretch and 10 percent increase for both alternatives along the northern stretch. Alternative A would result in a similar shift from Exit 4 to Exit 4A in vehicle volume from origins from north of Londonderry. Alternative B would create a new travel pattern by shifting north-south vehicle trips from the NH 28 Bypass to I-93, thereby increasing traffic volumes along I-93 from Exit 4A to points south of Londonderry. Both Alternatives A and B would not shift as many vehicle from Exit 5 to Exit 4A because of the more southern interchange location.

Alternatives A through D resulted in the reduction of vehicle trips forecasted between I-93 Exit 4A and Exit 4 during the PM peak hour. This reduction in vehicle volume eliminates the No Build condition failing I-93 southbound diverge facility serving NH 102. Alternative F does not address this failing facility.

Table 8-3 presents the vehicle summary volume for I-93 between Exit 5 and Exit 4A, and Table 8-4 presents the vehicle volume summary for I-93 between Exit 4 and Exit 4A.

Table 8-3. I-93 between Exit 4 and Exit 4A volume summary at Location #3

Vehicle Direction	Time Period	No Build	Alt. A	Alt. B	Alt. C	Alt. D	Alt. F
I-93 Northbound Volumes	AM	4,755	4,290	4,565	4,235	4,150	4,760
	PM	5,045	4,980	5,195	4,790	4,660	5,040
I-93 Southbound Volumes	AM	4,805	4,965	5,065	4,635	4,610	4,845
	PM	4,985	4,775	4,895	4,490	4,465	5,035
I-93 Northbound Average Difference	AM		-10%	-4%	-11%	-13%	0%
	PM		-1%	3%	-5%	-8%	0%
I-93 Southbound Average Difference	AM		3%	5%	-4%	-4%	1%
	PM		-4%	-2%	-10%	-10%	1%
Overall Average Difference			**-3%**	**1%**	**-7%**	**-9%**	**0%**

Table 8-4. I-93 between Exit 5 and Exit 4A volume summary at Location #4

Vehicle Direction	Time Period	No Build	Alt. A	Alt. B	Alt. C	Alt. D	Alt. F
I-93 Northbound Volumes	AM	4,755	4,885	4,905	5,205	5,260	4,760
	PM	5,045	5,510	5,500	5,650	5,650	5,040
I-93 Southbound Volumes	AM	4,805	5,715	5,700	5,750	5,740	4,845
	PM	4,985	5,445	5,460	5,485	5,470	5,035
I-93 Northbound Average Difference	AM		3%	3%	9%	11%	0%
	PM		9%	9%	12%	12%	0%
I-93 Southbound Average Difference	AM		19%	19%	20%	19%	1%
	PM		9%	10%	10%	10%	1%
Overall Average Difference			**10%**	**10%**	**13%**	**13%**	**0%**

I-93 Exit 4A Connector Roadway Future Travel Patterns

Based on the comparison of 2040 traffic volume forecasts produced by the SNHPC regional travel demand model, Alternatives A and B would generate the most volume along the new roadway serving the I-93 Exit 4A interchange. Alternative D would generate the lowest volume of the four alternatives that include the Exit 4A concept. Compared to Alternative D, Alternatives A and B would generate over 46 percent more vehicle trips. The demographic assumptions supporting Alternatives A and B include a full built-out of Woodmont Commons, thus a number of these vehicle trips generated represent Woodmont Commons-destined traffic that would use Exit 4A to access the development through a new planned connection from the Connector Roadway serving Exit 4A.

Table 8-5 contains the I-93 Exit 4A Connector Road vehicle volume summary.

Table 8-5. I-93 Exit 4A Connector Roadway volume summary at Location #5

Vehicle Direction	Time Period	Alt. A	Alt. B	Alt. C	Alt. D
Connector Rd. Eastbound Volumes	AM	2,525	2,635	1,800	1,685
	PM	2,255	2,345	1,635	1,500
Connector Rd. Westbound Volumes	AM	2,370	2,340	1,685	1,665
	PM	2,115	2,085	1,500	1,485
Connector Rd. Eastbound Average Difference	AM	50%	56%	7%	0%
	PM	50%	56%	9%	0%
Connector Rd. Westbound Average Difference	AM	19%	19%	20%	19%
	PM	9%	10%	10%	10%
Overall Average Difference Compared to Alternative D		**46%**	**48%**	**5%**	**0%**

Alternative A Future Traffic Patterns through Downtown Derry

Select link analysis from the travel demand model was conducted along NH 102 east of Griffin Road (a location at the western end of downtown Derry). The intention of the analysis was to determine how many vehicle trips would be shifted from NH 102 to the new proposed interchange and proposed route to bypass downtown Derry (Table 8-6). Based on the model, under Alternative A there would be a 29 percent decrease in the No Build condition forecasted vehicle volume (2,306 vehicles) that would travel through downtown Derry using NH 102. This decrease represents a shift in travel from NH 102 through downtown Derry to the new parallel route serviced by I-93 Exit 4A. At the same time, there would also be a 15 percent increase in the No Build condition forecasted volume (1,205 vehicles) that would travel through downtown Derry using NH 102. This increase represents a shift in travel from another route to NH 102 through downtown Derry because there would be available capacity through downtown Derry. Combining the two changes in travel patterns, there would be a 14 percent decrease in volume (1,100 vehicles) that would travel through downtown Derry if Alternative A was implemented.

Table 8-6. Downtown Derry travel pattern shifted from Alternative A

Alternative	North Derry	East Derry	Chester	Points north of Derry	Other Destinations	Shifted from NH 102	Shifted To NH 102	TOTAL
	Daily Vehicle Trips							
No Build	2,995	2,521	194	115	2,055			7.880
Build Alternative A	878	2,332	392	259	2,918			6,779
	Change in Volume (Percent/Actual)							
Change in Vehicle Trips	-2,117	-189	198	144	863	2,306	1,205	1,101
Percent Change	-71%	-7.5%	102%	125%	42%	29%	15%	-14%

Source: CLD (2017)

8.2.3 Traffic Operational and Queuing Analysis-Base Conditions

The existing traffic operations and queuing conditions are presented in Sections 3.7.4 and 3.7.5. The critical existing areas that experience operation and queueing issues include the following locations (isolated issues would only affect the specific intersections and would not affect adjacent intersections):

- NH 102 at Gilcreast Road (Intersection #5): operational and queueing issues affecting NH 102 through and turning movements
- NH 102 at Hampton Drive/Garden Lane (Intersection #6): operational issues affecting NH 102 through and turning movements
- NH 102 at I-93 SB off-Ramp (Intersection #7): operational issues affecting I-93 SB off-ramp
- NH 102 at I-93 NB On and Off-Ramps (Intersection #8): operational issues affecting conflicting NH 102 movements (westbound through and eastbound left-turn)
- NH 102 at St. Charles Street/Londonderry Road (Intersection #9): isolated queuing issues affecting NH 102 eastbound left
- NH 102 at Fordway/Madden Hill Road (Intersection #10): isolated queuing issues affecting NH 102

In summary, the majority of issues occur along NH 102 at Gilcreast Road (Intersection #5) where queuing affects Intersection #6. The Exit 4 intersections have some minor issues, but overall operate well. The two NH 102 intersections east of Exit 4 have minor and isolated issues. There were no issues regarding the NH 28 intersections surrounding Exit 5.

8.2.4 Freeway Analysis-Base Conditions

The existing freeway facilities all operate at LOS D or better during the AM and PM peak hours; results are presented in Section 3.7.6.

8.2.5 Forecasting Travel Demand for No Build and Build Alternatives

The future forecasted traffic volumes rely on the SNHPC travel demand model. The development of the No Build condition traffic forecasts is presented in Section 5.3, and the Build alternatives are presented in Section 6.0. Both sets of forecasts rely on changes to the model network at 30 locations and reflect roadway improvements and different demographic forecasts. The demographic forecasts used for the No Build condition were also used for Alternative F. Alternatives C and D have similar projections reflecting some growth beyond the No Build level based on a proposed, more northern location of the I-93 Exit 4 interchange. Alternatives A and B also have similar projections reflecting the maximum induced growth potential based on the location of the proposed, more southern location of the I-93 Exit 4A interchange and its relation to the proposed Woodmont Commons PUD. Section 3.1 provides the detailed demographic descriptions assigned to each future alternative and No Build condition.

8.2.6 Traffic Operational and Queuing Analysis - Future Base Conditions for 2040 (Future Year)

The future No Build condition operations and queuing conditions are presented in Sections 5.4 and 5.5. The critical areas that would experience operation and queueing issues include the following locations (isolated issues would only affect the specific intersections and would not affect adjacent intersections):

- NH 28 at Symmes Drive/Vista Ridge Drive (Intersection #1): isolated operational issues affecting NH 28 turning movements
- NH 28 at I-93 SB On and Off-Ramps (Intersection #2): operational and queueing issues affecting NH 28 through and turning movements and I-93 SB off-ramp
- NH 28 at I-93 NB On and Off-Ramps (Intersection #3): operational and queueing issues affecting NH 28 through and turning movements and I-93 NB off-ramp
- NH 102 at Gilcreast Road (Intersection #5): operational and queueing issues affecting NH 102 through and turning movements
- NH 102 at Hampton Drive/Garden Lane (Intersection #6): operational issues affecting NH 102 through movements
- NH 102 at I-93 SB off-Ramp (Intersection #7): operational issues affecting NH 102 through and turning movements and I-93 SB off-ramp
- NH 102 at I-93 NB On and Off-Ramps (Intersection #8): operational issues affecting NH 102 through and turning movements and I-93 NB off-ramp
- NH 102 at St. Charles Street/Londonderry Road (Intersection #9): isolated operational issues affecting NH 102 through and turning movements
- NH 102 at Fordway/Madden Hill Road (Intersection #10): isolated operational and queuing issues affecting NH 102

In summary, the majority of issues would occur along NH 28 at Exit 5 (Intersections #2 and #3) and NH 102 between Gilcreast Road (Intersection #5) and I-93 NB on- and off-ramps

(Intersection #8) affecting the Exit 4 intersections along NH 102. The two NH 102 intersections east of Exit 4 would have minor, isolated issues.

8.2.7 Freeway Analysis - Future Base Conditions for 2040 (Future Year)

The future No Build condition freeway facilities all operate at LOS D or better during the AM and PM peak hours except for the I-93 SB diverge at Exit 4, which operates at LOS F. In addition, the I-93 NB on-ramp from NH 102 at Exit 4 would operate above its capacity. This would create a queue that might extend back into NH 102 at Intersection #8. These results are presented in Section 5.6.

8.2.8 Traffic Operational and Queuing Analysis – 2040 Build Alternatives

Future Build Traffic Operations

The study analyzed 12 intersections under each alternative covering the study area. For each alternative, including the No Build condition, the traffic signal timings were optimized and the offsets were also optimized to process vehicle platoons as best as possible and reduce queuing as much as possible. Based on the analysis when compared to the No Build condition, the following would occur:

- Intersections east and west of Exit 5 along NH 28 (Intersections #1 and #4) would remain the same or improve for all alternatives.
- Intersections serving Exit 5 along NH 28 (Intersections #2 and #3) for the most part improve; however, Intersection #3 worsens operationally under Alternative A and Intersection #2 remains the same under Alternative F.
- Intersections west of Exit 4 along NH 102 (Intersections #5 and #6) would maintain the same LOS or worse because of the projected increase in vehicle volume attracted to the Woodmont Commons development, accessible from Garden Lane and Gilcreast Road.
- Intersections serving Exit 4 along NH 102 (Intersections #7 and #8) would improve for Alternatives B and F, but remain the same or worsen for the other alternatives. The worsening conditions at these locations result from the generation of vehicle trips from Woodmont Commons to access the I-93 NB on-ramp and from the I-93 NB off-ramp to access Woodmont Commons.
- Intersections east of Exit 4 along Exit 102 (Intersections #9 and #10) would improve because the proposed improvements at Intersections #9 for all alternatives and projected decrease in volumes along NH 102 east of Exit 4 for Alternatives A, B, C, and D.
- Intersections serving the I-93 Exit 4A interchange would operate at LOS D or better for all alternatives that include that component (Alternatives A, B, C, and D).

Table 8-7 provides an operational summary. The cells shown in red highlight LOS E or F operation, and cells shown in orange highlight worsening conditions when compared to the No

Build condition. The vehicle delay has been added to the cells in cases where the alternative LOS would remain the same as the No Build condition to highlight where the vehicle delay worsened, but LOS would remain the same. These values were not added to all cells to reduce the clutter on the table.

Table 8-7. Future 2040 intersection operations summary

Intersection		Time Period	No Build	Alt. A	Alt. B	Alt. C	Alt. D	Alt. F
1	NH 28 & Symmes Drive/Vista Ridge Dr.	AM	D	D	C	C	C	D
		PM	C	C	C	C	C	C
2	NH 28 & I-93 SB Off and On-Ramp	AM	E	D	C	C	C	E
		PM	C	C	B	B	B	C
3	NH 28 & I-93 NB Off and On-Ramp	AM	D	E	D	D	D	D
		PM	D	D	C	C	C	D
4	NH 28 & Liberty Drive	AM	B	A	A	A	A	B
		PM	B	B	B	B	B	B
5	NH 102 & Gilcreast Road	AM	E	E	E	F	F	E
		PM	F/94.0	F	E	F/102	F/107	F
6	NH 102 & Hampton Dr./Garden Ln.	AM	C	C	C	C	C	C
		PM	D	F	E	D	E	D
7	NH 102 & I-93 SB Off and On-Ramp	AM	D	C	C	D	D	D
		PM	F	D	D	E	E	E
8	NH 102 & I-93 NB Off and On-Ramp	AM	E/61.4	E/71.2	D	E/62.1	E/67/3	E
		PM	F/92/8	F/115	F	F	F	F
9	NH 102 & St Charles St/Londonderry Rd.	AM	B	B	A	A	A	B
		PM	E	B	B	B	B	C
10	NH 102 & Fordway/ Madden Hill Rd.	AM	C	C	C	C	C	C
		PM	D	D	C	C	C	C
11	Connector Rd. & I-93 SB Off and On-Ramps	AM		D	D	C	B	
		PM		C	C	B	B	
12	Connector Rd. & I-93 NB Off and On-Ramps	AM		C	C	A	A	
		PM		B	B	A	A	

Red denotes overall failing operations (LOS E or F).

Orange denotes cases where the alternative operation would be worse than the No Build condition.

Future Build Traffic and Queuing Assessment

The future Build condition operations and queuing conditions are presented in Sections 7.3 through 7.16. Based on a comparison between the No Build condition and the alternatives, the following can be deduced:

- Alternatives B and C impacted one intersection (Intersection #6 only)
- Alternative D impacted two intersections (Intersections #5 and #6)
- Alternative A impacted two intersections (Intersections #6 and #8)
- Alternative F impacted four intersections (Intersections #2, #3, #7, and #10)
- Alternative A benefited five intersections (Intersections #2, #5, #7, #9, and #10)
- Alternative B benefited seven intersections (Intersections #2, #3, #5, #7, #8, #9, and #10)
- Alternatives C and D benefited six intersections (Intersections #2, #3, #7, #8, #9, and #10)
- Alternative F benefited one intersection (Intersection #9)

Table 8-8 contains a comparison of intersection analysis between Build alternatives.

Based on the Woodmont Commons Memorandum of Understanding, to “unlock” parcels within the PUD Master Plan for the developer to continue construction, the developer must submit a traffic study to the Londonderry Planning Board to ascertain the level of roadway mitigation necessary to handle the new vehicle trips generated (Pillsbury, 2018). The assessment in this study does not include the future mitigation because the future mitigation is not known until the next set of Woodmont Common’s traffic studies are completed. Because it is assumed that Alternatives A and B would induce a fully built out Woodmont Commons PUD, two traffic issues occurred as follows:

- The number of vehicle trips generated through the study area was based on a fully built-out Woodmont Commons PUD.
- The appropriate level of traffic mitigation was not in place to address the forecasted vehicle trips generated by the Woodmont Commons PUD.

The resulting issue was traffic impacts along NH 102 at Exit 4 (Intersections #7 and #8), NH 102 at Garden Lane/Hampton Drive (Intersection #6), and NH 102 at Gilcreast Road (Intersection #5). These traffic issues should be assumed to be addressed by the future traffic studies prepared to “unlock” Woodmont Commons PUD parcels.

Table 8-8. Comparison of intersections analysis between 2040 Build Alternatives

Intersection		Time Period	No Build		Alt. A		Alt. B		Alt. C		Alt. D		Alt. F	
			Oper.	Queue	Oper.	Queue	Oper.	Queue	Oper.	Queue	Oper.	Queue	Oper.	Queue
1	NH 28 & Symmes Drive/Vista Ridge Dr.	AM												
		PM												
2	NH 28 & I-93 SB Off and On-Ramp	AM												
		PM												
3	NH 28 & I-93 NB Off and On-Ramp	AM												
		PM												
4	NH 28 & Liberty Drive	AM												
		PM												
5	NH 102 & Gilcreast Road	AM												
		PM												
6	NH 102 & Hampton Dr./Garden Ln.	AM												
		PM												
7	NH 102 & I-93 SB Off and On-Ramp	AM												
		PM												
8	NH 102 & I-93 NB Off and On-Ramp	AM												
		PM												
9	NH 102 & St Charles St/Londonderry Rd.	AM												
		PM												
10	NH 102 & Fordway/ Madden Hill Rd.	AM												
		PM												

Oper. = Operations

Red under No Build denotes overall failing operations (LOS E or F) or the vehicle queue is projected to extend beyond available storage space.

Red under all other alternatives denotes worse conditions than the No Build Condition.

Green under No Build denotes overall acceptable conditions.

Green under all other alternatives denotes better condition than the No Build Condition.

The proposed new intersections to serve the I-93 Exit 4A interchange ramp termini would both operate at LOS D or better for all alternatives that include the Exit 4A component. Alternatives A, C, and D would result in minor queuing; however, Alternative B would create the longest queues mainly because this alternative would attract the most vehicle trips.

8.2.9 Freeway Analysis – 2040 Build Alternatives

The study analyzed 13 freeway facilities under each alternative covering the study area (Table 8-9). Based on the analysis, the I-93 southbound off-ramp to NH 102 would continue to operate at LOS F under Alternative F. All other freeway facilities under all alternatives would operate at LOS D or better. The future Build condition freeway facilities including the I-93 Exit 4A interchange would operate as follows:

- All facilities would operate at LOS D or better for Alternative A.
- All facilities would operate at LOS D or better for Alternative B; however, the I-93 NB on-ramp would operate above its capacity, thus creating a queue that might extend back into NH 102 at Intersection #8.
- All facilities would operate at LOS D or better for Alternative C.
- All facilities would operate at LOS D or better for Alternative D.
- Under Alternative F, the I-93 SB diverge at Exit 4 would continue to operate at LOS F and the I-93 NB on-ramp would operate above its capacity, thus creating a queue that might extend back into NH 102 at Intersection #8.

These results are presented in Sections 7.5, 7.8, 7.11, 7.14, and 7.17.

Table 8-9. Future 2040 freeway operations summary

Intersection		Time Period	No Build	Alt. A	Alt. B	Alt. C	Alt. D	Alt. F
I-93 Exit 5								
I-93 Northbound to NH 102	Diverge	AM	A	A	A	A	A	A
		PM	B	B	B	B	B	B
NH 102 to I-93 Northbound	Merge	AM	C	B	C	B	B	C
		PM	C	C	C	B	B	C
I-93 Southbound to NH 102	Diverge	AM	C	C	C	C	C	C
		PM	F	C	C	C	C	F
NH 102 Westbound to I-93 Southbound	Merge	AM	B	B	B	B	B	B
		PM	B	A	B	B	B	B
NH 102 Eastbound to I-93 Southbound	Merge	AM	C	C	C	C	C	C
		PM	B	B	B	B	B	B
I-93 Exit 4								
I-93 Northbound to NH 28	Diverge	AM	C	C	C	C	C	C
		PM	C	D	C	C	D	C
NH 28 to I-93 Northbound	Merge	AM	C	C	C	C	C	C
		PM	C	C	C	C	C	C
I-93 Southbound to NH 28	Diverge	AM	C	C	C	C	C	C
		PM	D	C	C	C	C	C
NH 28 to I-93 Southbound	Merge	AM	B	C	B	C	C	B
		PM	B	B	B	B	B	B
I-93 Exit 4A								
I-93 Northbound to Connector Roadway	Diverge	AM		C	C	B	B	
		PM		C	C	B	B	
Connector Roadway to I-93 Northbound	Merge	AM		C	C	C	C	
		PM		C	C	C	C	
I-93 Southbound to Connector Roadway	Diverge	AM		B	B	D	D	
		PM		B	B	D	D	
Connector Roadway to I-93 Southbound	Merge	AM		C	C	B	B	
		PM		C	C	B	B	

Red denotes overall failing operations (LOS E or F).

8.2.10 Collision Analysis – Base Conditions

A crash analysis was performed covering the study area and included the intersections along NH 28 and NH 102 as well as I-93 between Exits 4 and 5 (see Section 3.8). This section discusses the crash types, speculates regarding the reasons for the crashes, and reviews the crash severity.

Types of Collision Occurring

At the intersections, crash types included rear end, angle, side swipes, head-on, fixed objects in the road, fixed object off the road, pedestrian, and other. The rear end collisions represent one vehicle hitting another directly in front. These are usually caused by a vehicle stopping abruptly and the vehicle directly behind unable to stop fast enough to avoid a collision. These can also occur when both vehicles are traveling above the speed limit and trailing vehicle is driving too close, thus reducing the amount of space necessary to avoid the collision. These types of crashes can also be caused by the driver in the trailer vehicle using their mobile phone and not paying attention to the road.

Angle collisions can be caused by one vehicle not yielding to another when entering a lane on a roadway. In most cases, the vehicle already in the lane has the ROW and another vehicle aggressively enters the lane at an intersection.

Side swipe crashes are similar to angle collisions except these crashes occur when one vehicle changes lanes on the same roadway and does not yield to a vehicle already in that lane. These crashes occur often due to blind spots in a vehicle where the drive cannot see if the adjacent lane is clear.

Head-on crashes can occur in a number of instances such as, if a driver enters a roadway headed in the wrong direction and does not realize their mistake until another vehicle appears. They can also occur when a vehicle enters a reversible lane that is closed.

The other crash types are similar in that they can occur at any time based on the weather, not paying attention to the road, speeding, or failure of the vehicle to operate correctly. These crash types do not involve another vehicle.

Based on the crash data provided by NHDOT, the most prevalent crash type along NH 28 and NH 102 were rear end, followed by angle collisions. There were also a number of side swipes. The intersections with the highest crash rates (all exceeded 1.0 MEV) and highest number of injuries were all along NH 102 and included Gilcreast (Intersection #5), Garden Lane/Hampton Drive (Intersection #6), and I-93 NB Ramps (Intersection #8). Tables 3-14 and 3-15 summarize the intersection crash analysis.

Along the freeway, there were slightly different crash types reported. These included fixed object, other motor vehicle, parked vehicle, overturns, jackknife, other object, and other. A fixed object crash involved a vehicle hitting a sign, guard rail, lamp post, tree, or barrier. Other motor vehicle refers to one moving vehicle crashing into another moving vehicle in a sideswipe manner. A parked vehicle refers to a moving vehicle hitting a vehicle parked along the shoulder. Overturns means a vehicle was traveling much faster than the speed limit and flipped over, which would involve some dangerous driving. Jackknife refers to trucks turning beyond the radius designed by the vehicle and the trailer separating from the cab.

Based on the crash data provided by NHDOT, crashes with other motor vehicles were the most common, followed by crashes with fixed objects. There were a number of overturned vehicles mostly along the I-93 mainline between Exits 4 and 5. The freeway location with the highest crash rate and highest number of injuries was I-93 NB between Exits 4 and 5. The area with the second highest crash rates was the I-93 SB merge at Exit 4. Tables 3-16 and 3-17 summarize the freeway crash analysis.

Reasons for Collisions

Crash data helps to point to possible causes for the crashes, but without reviewing each crash report prepared by the state police, the study can only infer what might be causing the crashes.

Based on the intersection data, most of the crashes occurred during the daylight hours, on clear weather days, and in dry pavement conditions. This would point to driver distraction and speeding and to a lesser extent driver error at NH 102 at Gilcreast, NH 102 at Garden Lane/Hampton Drive, and NH 102 at I-93 NB ramps (Intersections #5, #6, and #8) mainly because the roadway is flat, the signing indicates the lane geometry ahead of intersections, there is a clear view of the intersection on approach, and the traffic signal is visible from all lanes. There are also a number of crashes that fell into the “other” category, which does not help to identify the reason for the crash.

Based on the freeway data, most of the crashes occurred during the daylight hours, on clear weather days, and in dry pavement conditions. There were some crashes (approximately 20 percent) that did occur at night and in winter weather conditions This would point to driver distraction, speeding, and to a lesser extent weather conditions along I-93 NB and SB between Exit 4 and 5 mainly because the road is flat, signing warns of upcoming interchange ramps, and the roadway either is straight or has large radius turns (gentle turns). I-93 SB at Exit 4 does have multiple on-ramps from NH 102, which results in a slightly higher crash rate along the stretch of I-93 between the two merges. Both of these facilities still result in low crash rates with 0.24 and 0.20 MEV, respectively. A few crashes along I-93 resulted in overturned vehicles. Based on the data, these crashes primarily occurred during the day in dry conditions, which further supports speeding as the cause of the crashes.

Severity of Collisions

The severity of collisions can be assessed based on the collision type, number of injuries, and number of fatalities. Based on the intersection data, very few crashes were head-on or involved pedestrians. There was one fatality at NH 102 and I-93 NB ramps (Interchange #8). Based on the freeway data, most crashes were not severe, but there were some overturned vehicles and one jackknifed tractor trailer. None of the crashes resulted in a fatality.

8.2.11 Collision Analysis – 2040 Build Alternatives

The future conditions would include roadway improvements beside the construction of the I-93 Exit 4A interchange. These would include the following five improvements:

1. I-93 Mainline would be widening from two to four travel lanes in each direction through the study area **(currently under construction)**.
2. The I-93 Exit 4 ramps and NH 102 alignment would be reconstructed to include more turning lanes at the intersections (Intersections #7 and #8) and more through lanes along NH 102 **(currently under construction)**.

3. The intersection of NH 102 and Gilcreast (Intersection #5) would be reconstructed to include more through lanes along NH 102 **(proposed future Woodmont Commons mitigation)**.
4. The intersection of NH 102 and Garden Lane/Hampton Drive (Intersection #6) would be reconstructed to include more through lanes along NH 102 **(proposed future Woodmont Commons mitigation)**.
5. The intersection of NH 102 and Londonderry Road/St. Charles Street (Intersection #9) would be reconstructed to include more turning lanes along NH 102 **(Proposed future Woodmont Commons mitigation)**.

In addition to these five ongoing and future improvements, NHDOT recently improved the I-93 Exit 5 interchange and adjacent intersections along NH 28 at Symmes Drive/Vista Ridge and Liberty Drive (Intersections #1–#4). Together, these future and ongoing improvements would cover all IJR study area intersections with the exception of NH 102 and Fordway/Madden Hill Road (Intersection #10).

These roadway improvement would be based on the latest designs and would follow all applicable American Association of State Highway Transportation Officials (AASHTO), NHDOT, and FHWA guidelines to ensure they address any safety issues and do not create any new ones. The design of I-93 Exit 4A would also follow the latest AASHTO, NHDOT, and FHWA guidelines to ensure the ramps merges and diverges provide adequate distances, the intersections serving the new connector roadway provide proper lane geometry, and traffic signals serving the new intersections can be seen by approaching vehicles.

Any past safety concerns evident from crash data would be assumed to be addressed through the improvement projects. In terms of driver speeding and distracted driver issues, two counter measures could be implemented. NHDOT could install automated speed enforcement cameras to reduce speeding (FHWA, n.d.a). Prior to investing in enforcement cameras, a speed study should be conducted to confirm that the 85th percentile speed is well over the speed limit. For distracted driving, New Hampshire has published is own Net Zero Plan that includes a number of strategies to address distracted drivers. These strategies include (FHWA, n.d.b):

- Education through action plans and local and national campaigns, and exposing young drivers to presentations on the topic
- Enforcement/adjudication through targeted enforcement times and places as well as asking officers to identify the distraction on the crash reports
- Engineering by installing rumble strips
- Legislative policy/programmatic measures to promote strong laws against distracted driving and developing and implementing action plans to focus drivers

8.2.12 Policy Requirement 1 Conclusion

The proposed five alternatives in tandem with the planned roadway improvements each provide a different level of operation, queueing, and safety impacts and benefits. The overall impacts under Alternatives A and B assume Woodmont Commons follows its memorandum of understanding with the Town of Londonderry and implements traffic improvements along NH 102.

Five alternatives and the No Build condition were analyzed to assess if a new interchange is warranted to address the study goals. The No Build condition and Alternative F represent improvements to NH 102 that do not include a new I-93 Exit 4A interchange; therefore, assessment of these alternatives considers using the existing roadway system to address study goals. Based on the forecasted changes in vehicle trip patterns through downtown Derry (see Table 8-1), Alternative F and the No Build condition would not address the goal of reducing pass-through vehicle volumes.

Alternatives A, B, C, and D would each include a new I-93 Exit 4A interchange and a connector roadway to link the interchange to eastern Derry via either a new alignment or improvements to existing alignments. Alternatives A and B would create a new interchange and would serve adjacent developable lane, thus they also include the assumption that induced and background growth would occur in the area. Alternatives C and D would create a new interchange that does not serve adjacent developable land, thus would only include background growth. Therefore, the SNHPC travel demand model created additional vehicle trips in the study area destined to the specific growth areas depending on the alternative. For Alternatives A and B, these growth areas include Woodmont Commons (full build-out) and other smaller developments in Derry, Londonderry, Auburn, Chester, and Sandown. The Woodmont Commons and other background growth vehicle trips were added to freeway facilities and intersections along NH 102 and NH 28. Alternatives C and D only include growth in Chester and Sandown and maintain Woodmont Commons at the same growth level as the No Build condition.

Based on the analysis, the study area freeway facilities would all operate at acceptable levels for Alternatives A, B, C, and D (see Table 8-9). Each alternative would result in a different number of intersections that would operate at worse conditions (operations not queueing) when compared to No Build condition as follows:

- Under Alternative A, four intersections (one along NH 28 and three along NH 102)
- Under Alternative B, one intersection along NH 102
- Under Alternative C, three intersections along NH 102
- Under Alternative D, four intersections along NH 102
- Under Alternative F, none

The proposed trips generated by Woodmont Commons account for most of these intersection issues under Alternatives A and B because these alternatives include the maximum generation of trips under the full build-out scenario. These trips would be added to NH 102 and NH 28 as well as to Exit 4A and the I-93 mainline.

Alternative A Conclusions

Based on the analysis of trip patterns from the SNHPC travel demand model, Alternative A would provide a more parallel route to bypass downtown Derry and connect I-93 and eastern Derry. Alternative A would result in more east-west regional trips using the new I-93 Exit 4A interchange, which would then disperse between Exits 4 and 5 to reach destinations to the west along NH 102 and NH 28. Alternative A would improve I-93 freeway operations at Exit 4, intersection operations at one location along NH 28 and four locations along NH 102, and queueing issues at two locations along NH 28 and three location along NH 102. Therefore, this alternative would resolve the intersection’s operation, queuing, and freeway operation issues and would not significantly affect the safety and operation of the interstate facility. This alternative would also properly collect, distribute, and accommodate traffic between the freeway and proposed new connector roadway as well as Exits 4 and 5. The results do show adverse impacts to three IJR study area intersections, but these will be addressed by the Woodmont Commons traffic mitigation requirements imposed by Londonderry.

Alternative B Conclusions

Alternative B would create a new direct connection to areas northeast of downtown Derry. Based on the travel patterns reported from the model, this new connection would attract more north-south regional trips by shifting vehicles from the NH 28 Bypass to I-93 because the travel time to access I-93 would drop with the Alternative B alignment. The trips destined to locations south of Derry and Londonderry would use I-93 rather than the NH 28 Bypass starting from the new I-93 Exit 4A interchange. The model also indicates that Alternative B would have more downtown Derry pass-through trips than Alternative A. Alternative B would not improve I-93 freeway operations at Exit 4, but would improve intersection operations at one location along NH 28 and five locations along NH 102, and queueing issues at two locations along NH 28 and three location along NH 102. Therefore, this alternative would resolve the intersection operations and queuing issues along NH 102 and NH 28; however, it would also continue to significantly affect the safety and operation of the I-93 NB on-ramp from NH 102. This would cause safety issues with traffic trying to access the freeway from NH 102. Queuing issues at the ramp termini serving Exit 4A would also occur, but these issues could be addressed through the ramp designs. The freeway mainline would not be significantly affected under Alternative B as long as the off-ramps provide enough space to store the forecasted queuing lengths. The results do show an adverse impact to one IJR study area intersection, but this will be addressed by the Woodmont Commons traffic mitigation requirements imposed by Londonderry.

Alternatives C and D Conclusions

Alternative C and D provide variations to Alternatives A and B in terms of the connection route between I-93 and eastern Derry. These alternatives would include a new proposed interchange in a more northern location; therefore they would not create the best parallel route to downtown Derry. They would create more of a bypass to NH 28 between I-93 Exit 5 and where NH 28 intersects the two alignments, would attract more vehicle trips from NH 28 than NH 102, and would attract far fewer trips to Exit 4A than Alternatives A and B. Alternatives C and D would improve I-93 freeway operations at Exit 4, intersection operations at one location along NH 28 and four locations along NH 102, and queueing issues at two locations along NH 28 and three location along NH 102. Therefore, these alternatives would resolve the intersection's operation, queuing issues along NH 102 and NH 28, and freeway operation issues and would not significantly affect the safety and operation of the interstate facility. These alternatives would also properly collect, distribute, and accommodate traffic between the freeway and proposed new connector roadway as well as Exits 4 and 5.

Alternative F and No Build Conclusions

Alternative F and the No Build would minimally change vehicle trip patterns. Under Alternative F, freeway impacts would continue to occur at the I-93 SB off-ramp to NH 102 and minimal improvement to IJR study area intersection operations and queueing would occur. Therefore, these alternatives would not resolve intersection operation, queuing, and freeway operation issues and would continue to adversely affect the safety and operation of the freeway. Failing freeway facilities would cause queuing onto the I-93 mainline and NH 102 and failing intersections would exist at the ramp termini of Exits 4 and 5.

Overall Conclusions

Based on the goal to reduce through trips traveling through downtown Derry, Alternatives A, B, C, and D would address the policy requirement and Alternatives F would not address the policy requirement. Alternative A would provide the best connection of the five alternatives because it would directly parallel downtown Derry and could handle the design year traffic demands, especially the freeway operations. Some intersections along NH 28 and NH 102 would be affected, but a number of those trips would be directly related to the forecasted trips generated by the Woodmont Commons development. Section 8.2.1 describes the Woodmont Commons PUD process to incrementally perform traffic studies to construct infrastructure improvements, if necessary, to mitigate any future proposed development following the Woodmont Commons PUD Master Plan.

8.2.13 Conceptual Sign Plan

A conceptual sign plan has not been prepared for the proposed alternative designs. It is assumed that once a preferred alternative is identified through the NEPA process and the project moves forward into the design process, a sign plan would be created following the NHDOT and Manual Uniform Traffic Control Devices guidelines to properly alert drivers of the interchange connections, exit locations, entrance locations, ramp speeds, ramp direction (do not enter signs at the end of the ramp), and lane geometry at the ramp termini intersections.

8.3 Policy Requirement 2: Access Connections and Design

The proposed access connects to a public road only and will provide for all traffic movements. Less than “full interchanges” may be considered on a case-by-case basis for applications requiring special access, such as managed lanes (e.g., transit or high occupancy vehicle and high occupancy toll lanes) or park and ride lots. The proposed access will be designed to meet or exceed current standards (23 CFR 625.2(a), 625.4(a)(2), and 655.603(d)). In rare instances where all basic movements are not provided by the proposed design, the report should include a full-interchange option with a comparison of the operational and safety analyses to the partial-interchange option. The report should also include the mitigation proposed to compensate for the missing movements, including wayfinding signage, impacts on local intersections, mitigation of driver expectation leading to wrong-way movements on ramps, etc. The report should describe whether future provision of a full interchange is precluded by the proposed design.

8.3.1 Introduction

The four build alternatives that include a new I-93 Exit 4A interchange have similar designs. The designs follow a standard diamond interchange containing four ramps, two intersections, and a single bridge crossing the Interstate. The spacing for the proposed interchanges places the new interchange over a mile to Exit 4 or Exit 5.

8.3.2 Conceptual Layout

Alternatives A and B include the design of the same interchange approximately 1.25 miles north of Exit 4. The interchange follows a typical diamond interchange design with four ramps, two off-ramps, and two on-ramps, each with adequate space for merging and diverging providing all connections between I-93 and the new connector road. The SB off-ramp would contain two lanes extended to the diverge with I-93 because of the forecasted volume, while the three other ramps would contain one lane. The proposed diamond interchange is the most common interchange configuration and would allow traffic to enter and leave at relatively high speeds (AASHTO, 2011). The ramps would not become new lanes along I-93 but would terminate after providing merging and diverging space. The new connector roadway would contain two intersections, one serving I-93 NB ramps and one serving I-93 SB ramps. A new bridge would be constructed to connect the intersections. The new connector roadway would provide a connection to the Londonderry local roadway network and NH 28 to the east. Figure 8-1 shows the Alternative A and B current interchange design.

Alternatives C and D include a similar diamond interchange design as Alternatives A and B, approximately 1.5 miles south of Exit 5. Figure 8-2 shows the Alternative C and D current interchange design.

These designs both exclude a connection to the west. Alternatives A and B would, therefore, directly connect to the future planned Woodmont Commons PUD development on the eastern side of I-93. Alternatives C and D would not provide a direct connection and instead would connect directly to NH 28. The Woodmont Commons PUD development planned for the western side of I-93 would be accessible from Exit 4A via Ash Street and Pillsbury Road.

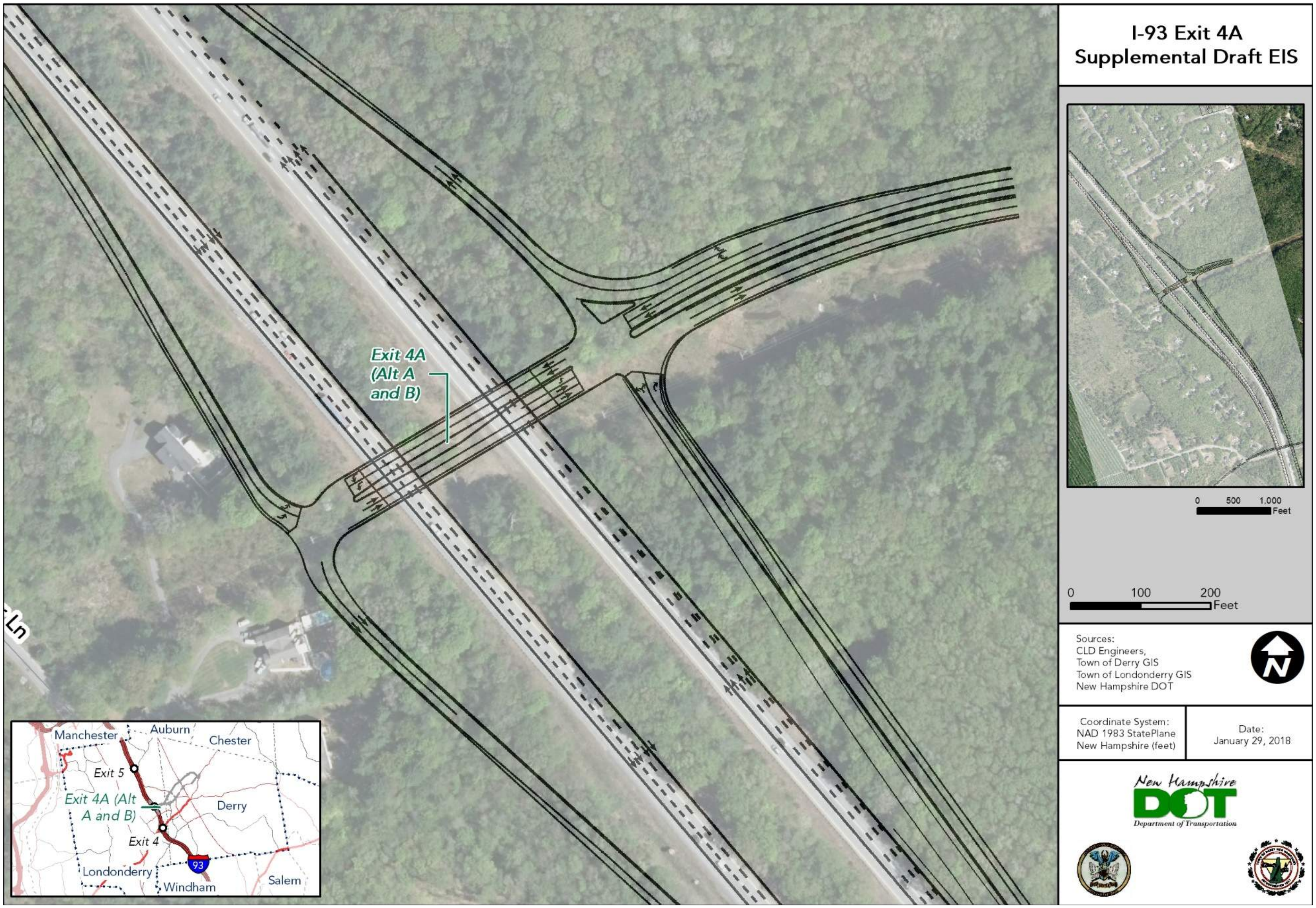


Figure 8-1. Alternatives A and B interchange designs

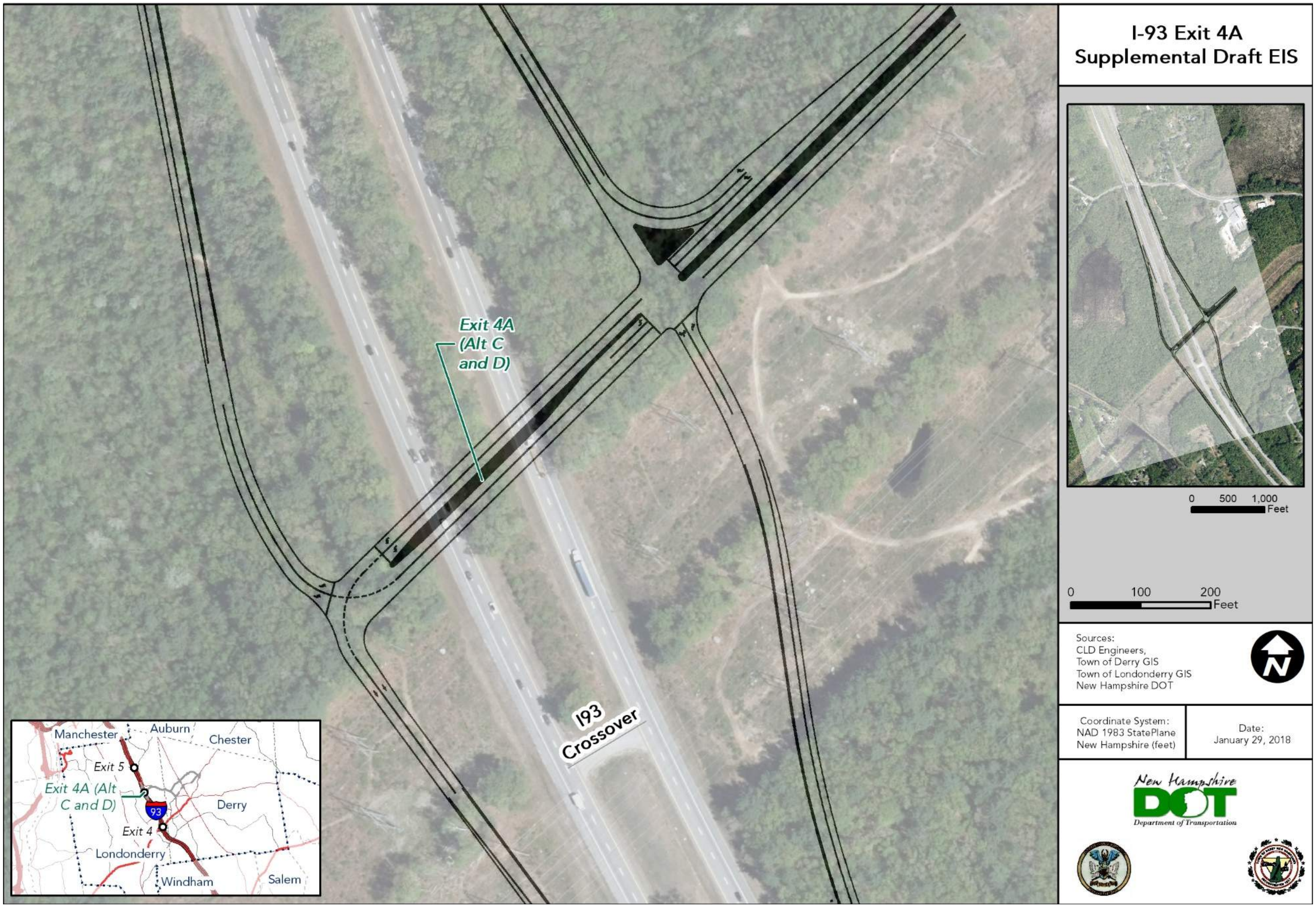


Figure 8-2. Alternatives C and D interchange designs

8.3.3 Present and Future Interchange Spacing

The existing spacing between Exit 4 and Exit 5 is 3.55 miles. Under Alternatives A and B, the proposed interchange spacing between Exit 4 and Exit 4A would be 1.25 miles and between Exit 4A and Exit 5 would be 2.3 miles. Under Alternatives C and D, the proposed interchange spacing between Exit 4 and Exit 4A would be 2.05 miles and between Exit 4A and Exit 5 would be 1.5 miles.

According to the *Policy on Geometric Design of Highways and Streets*, the typical rule of thumb to follow is 1 mile between interchanges in urban areas and 3 miles in rural areas (AASHTO, 2011). In this case, the location is currently suburban in nature and will continue to become more urbanized in the future with additional population and employment growth projected for 2040; therefore, the proposed spacing for either interchange location would exceed the 1-mile minimum threshold.

8.3.4 Policy Requirement 2 Conclusion

The proposed design meets the most common interchange design, and interchange spacing would meet minimum thresholds. The interchange would provide access to parcels to the east of the interchange with connections to NH 28 and points east. Therefore, the proper access would be provided and the interchange design would follow the latest design standards. Before the design is finalized, FHWA would have an opportunity to review.

9.0 SUMMARY

The proposed I-93 Exit 4A interchange would provide an overall benefit to the Londonderry/ Derry area and addresses FHWA's two requirements. Alternative A addresses a number of evaluation factors introduced in Section 4.0, including traffic and accessibility. Table 9-1 summarizes the evaluation criteria presented in Section 4.0 with the preliminary results.

Table 9-1. Preliminary evaluation criteria assessment summary

Criteria	No Build	Alternative A	Alternative B	Alternative C	Alternative D	Alternative F
Traffic	No Change	Improves all freeway and most intersection operations/queuing issues	Improves all freeway and most intersection operations/queuing issues; does not address one on-ramp capacity issue	Improves all freeway and intersection queuing; improves most intersection queuing issues	Improves all freeway and most intersection operations/queuing issues	Minimal Change
Accessibility	No Change	New parallel connection to eastern Derry from I-93 near Exit 4	New connection to northeastern Derry from I-93 near Exit 4	New connection to eastern Derry from I-93 near Exit 5	New connection to northeastern Derry from I-93 near Exit 5	No Change

The IJR study provided an assessment of the existing conditions, future baseline conditions (No Build condition), and future Build based on five alternatives. The future conditions (No Build and Build) were evaluated based on a quantitative traffic operations, queueing, and volume shift assessment as well as a crash data analysis covering the freeway and NH 28/NH 102. The IJR study integrated the various assessments to answer each of the FHWA policy requirements. The following is a summary of the findings for each policy requirement:

1. Operational and Collision Analysis: Alternatives A, B, C and D would not adversely impact the traffic and safety issues along the I-93 freeway as well as NH 102 and NH 28. This includes queuing issues along the ramps serving I-93, the ramp termini intersections at NH 102 and NH 28, and other intersections within the IJR study area. Traffic would also be properly distributed between the different roadway classifications (freeway to ramps to principal arterials to collectors to local roadways).
2. Access Connections and Design: Alternatives A, B, C, and D would all meet minimum interchange spacing thresholds and follow typical interchange design standards established in the AASHTO design manual.

Table 9-2 contains the FHWA policy requirement assessment summary and provides a rating to indicate if the alternative would address the policy requirement. Green indicates the alternative would fully address the policy rating, orange means the alternative would partially address the policy rating, and red means the alternative would minimally address the policy requirements.

Table 9-2. FHWA policy requirement assessment summary

Policy Number		Alternative A	Alternative B	Alternative C	Alternative D	Alternative F
1	Operational and Collision Analysis	Does not adversely impact intersection traffic and safety issues and properly distributes traffic between roadway classes	Does not adversely impact intersection traffic and safety issues and properly distributes traffic between roadway classes	Does not adversely impact intersection traffic and safety issues and properly distributes traffic between roadway classes	Does not adversely impact intersection traffic and safety issues and properly distributes traffic between roadway classes	Adverse impact to traffic operation and safety issues
2	Access Connections and Design	Designs meet minimum thresholds	Designs meet minimum thresholds	Designs meet minimum thresholds	Designs meet minimum thresholds	No Change in freeway network

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Interchange Justification Report
Appendix A
Synchro™ Existing Conditions Intersection Analysis Reports

I-93 Exit 4A

Prepared for:

Town of Derry
Town of Londonderry
New Hampshire Department of Transportation

Prepared by:

CLD and Louis Berger

Version: 2
October 10, 2019

NHDOT Project Number: 13065
Federal Project Number: IM-0931(201)
CLD/Towns Project Number 05-0244

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Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	9	733	9	6	855	39	18	0	35	27	0	18
Future Volume (vph)	9	733	9	6	855	39	18	0	35	27	0	18
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0		6.0	6.0	6.0		6.0	6.0	6.0	6.0	
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00		1.00	1.00	0.95	0.95	
Frt	1.00	1.00		1.00	1.00	0.85		1.00	0.85	1.00	0.87	
Flt Protected	0.95	1.00		0.95	1.00	1.00		0.95	1.00	0.95	0.99	
Satd. Flow (prot)	1583	3161		1687	3374	1509		1770	1583	1681	1529	
Flt Permitted	0.95	1.00		0.95	1.00	1.00		0.95	1.00	0.95	0.99	
Satd. Flow (perm)	1583	3161		1687	3374	1509		1770	1583	1681	1529	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	10	797	10	7	929	42	20	0	38	29	0	20
RTOR Reduction (vph)	0	0	0	0	0	19	0	0	36	0	22	0
Lane Group Flow (vph)	10	807	0	7	929	23	0	20	2	26	1	0
Heavy Vehicles (%)	14%	14%	14%	7%	7%	7%	2%	2%	2%	2%	2%	2%
Turn Type	Prot	NA		Prot	NA	Prot	Split	NA	Prot	Split	NA	
Protected Phases	5	2		1	6	6	3	3	3	4	4	
Permitted Phases												
Actuated Green, G (s)	1.1	38.5		1.0	38.4	38.4		3.8	3.8	3.9	3.9	
Effective Green, g (s)	1.1	38.5		1.0	38.4	38.4		3.8	3.8	3.9	3.9	
Actuated g/C Ratio	0.02	0.54		0.01	0.54	0.54		0.05	0.05	0.05	0.05	
Clearance Time (s)	6.0	6.0		6.0	6.0	6.0		6.0	6.0	6.0	6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0		3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	24	1709		23	1819	813		94	84	92	83	
v/s Ratio Prot	c0.01	0.26		0.00	c0.28	0.02		c0.01	0.00	c0.02	0.00	
v/s Ratio Perm												
v/c Ratio	0.42	0.47		0.30	0.51	0.03		0.21	0.02	0.28	0.02	
Uniform Delay, d1	34.7	10.1		34.8	10.4	7.7		32.3	31.9	32.3	31.8	
Progression Factor	1.00	1.00		1.00	1.00	1.00		1.00	1.00	1.00	1.00	
Incremental Delay, d2	11.3	0.2		7.4	0.2	0.0		1.1	0.1	1.7	0.1	
Delay (s)	46.0	10.3		42.1	10.7	7.7		33.4	32.1	34.0	31.9	
Level of Service	D	B		D	B	A		C	C	C	C	
Approach Delay (s)		10.7			10.8			32.5			33.0	
Approach LOS		B			B			C			C	

Intersection Summary			
HCM 2000 Control Delay	12.0	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.47		
Actuated Cycle Length (s)	71.2	Sum of lost time (s)	24.0
Intersection Capacity Utilization	47.2%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	515	280	235	605	0	0	0	0	465	0	295
Future Volume (vph)	0	515	280	235	605	0	0	0	0	465	0	295
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0	4.0	6.0	6.0					6.0		6.0
Lane Util. Factor		0.95	1.00	1.00	0.95					0.97		1.00
Frt		1.00	0.85	1.00	1.00					1.00		0.85
Flt Protected		1.00	1.00	0.95	1.00					0.95		1.00
Satd. Flow (prot)		3167	1417	1687	3374					3303		1524
Flt Permitted		1.00	1.00	0.95	1.00					0.95		1.00
Satd. Flow (perm)		3167	1417	1687	3374					3303		1524
Peak-hour factor, PHF	0.92	0.92	0.92	0.73	0.73	0.73	0.92	0.92	0.92	0.74	0.74	0.74
Adj. Flow (vph)	0	560	304	322	829	0	0	0	0	628	0	399
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	83
Lane Group Flow (vph)	0	560	304	322	829	0	0	0	0	628	0	316
Heavy Vehicles (%)	14%	14%	14%	7%	7%	7%	2%	2%	2%	6%	6%	6%
Turn Type		NA	Free	Prot	NA					Prot		Prot
Protected Phases		2		1	6					4		4
Permitted Phases			Free									
Actuated Green, G (s)		19.3	80.0	16.8	42.1					25.9		25.9
Effective Green, g (s)		19.3	80.0	16.8	42.1					25.9		25.9
Actuated g/C Ratio		0.24	1.00	0.21	0.53					0.32		0.32
Clearance Time (s)		6.0		6.0	6.0					6.0		6.0
Vehicle Extension (s)		5.0		3.0	5.0					3.0		3.0
Lane Grp Cap (vph)		764	1417	354	1775					1069		493
v/s Ratio Prot		c0.18		c0.19	0.25					0.19		c0.21
v/s Ratio Perm			0.21									
v/c Ratio		0.73	0.21	0.91	0.47					0.59		0.64
Uniform Delay, d1		28.0	0.0	30.9	11.9					22.6		23.1
Progression Factor		1.00	1.00	0.40	0.50					1.00		1.00
Incremental Delay, d2		6.2	0.3	25.3	0.8					0.8		2.8
Delay (s)		34.1	0.3	37.5	6.7					23.4		25.9
Level of Service		C	A	D	A					C		C
Approach Delay (s)		22.2			15.3			0.0			24.4	
Approach LOS		C			B			A			C	

Intersection Summary			
HCM 2000 Control Delay	20.3	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	59.8%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	240	740	0	0	540	740	300	0	110	0	0	0
Future Volume (vph)	240	740	0	0	540	740	300	0	110	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0			6.0	4.0	6.0		6.0			
Lane Util. Factor	1.00	0.95			0.95	1.00	1.00		1.00			
Frt	1.00	1.00			1.00	0.85	1.00		0.85			
Flt Protected	0.95	1.00			1.00	1.00	0.95		1.00			
Satd. Flow (prot)	1641	3282			3438	1538	1656		1482			
Flt Permitted	0.95	1.00			1.00	1.00	0.95		1.00			
Satd. Flow (perm)	1641	3282			3438	1538	1656		1482			
Peak-hour factor, PHF	0.87	0.87	0.87	0.90	0.90	0.90	0.78	0.78	0.78	0.92	0.92	0.92
Adj. Flow (vph)	276	851	0	0	600	822	385	0	141	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	103	0	0	0
Lane Group Flow (vph)	276	851	0	0	600	822	385	0	38	0	0	0
Heavy Vehicles (%)	10%	10%	10%	5%	5%	5%	9%	9%	9%	2%	2%	2%
Turn Type	Prot	NA			NA	Free	Prot		Prot			
Protected Phases	5	2			6		8		8			
Permitted Phases		2			6	Free						
Actuated Green, G (s)	15.9	46.3			24.4	80.0	21.7		21.7			
Effective Green, g (s)	15.9	46.3			24.4	80.0	21.7		21.7			
Actuated g/C Ratio	0.20	0.58			0.30	1.00	0.27		0.27			
Clearance Time (s)	6.0	6.0			6.0		6.0		6.0			
Vehicle Extension (s)	5.0	5.0			5.0		3.0		3.0			
Lane Grp Cap (vph)	326	1899			1048	1538	449		401			
v/s Ratio Prot	c0.17	0.26			0.17		c0.23		0.03			
v/s Ratio Perm						c0.53						
v/c Ratio	0.85	0.45			0.57	0.53	0.86		0.10			
Uniform Delay, d1	30.9	9.6			23.4	0.0	27.7		21.8			
Progression Factor	0.18	0.19			1.00	1.00	1.00		1.00			
Incremental Delay, d2	14.1	0.6			2.3	1.3	14.9		0.1			
Delay (s)	19.8	2.4			25.7	1.3	42.6		21.9			
Level of Service	B	A			C	A	D		C			
Approach Delay (s)		6.7			11.6			37.0			0.0	
Approach LOS		A			B			D			A	

Intersection Summary			
HCM 2000 Control Delay	14.1	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	59.8%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	25	0	0	5	0	39	5	723	24	93	429	0
Future Volume (vph)	25	0	0	5	0	39	5	723	24	93	429	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0				6.0	6.0	6.0	6.0		6.0	6.0	
Lane Util. Factor	1.00				1.00	1.00	1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00				1.00	0.97	1.00	1.00		1.00	1.00	
Flpb, ped/bikes	1.00				1.00	1.00	1.00	1.00		1.00	1.00	
Frt	1.00				1.00	0.85	1.00	1.00		1.00	1.00	
Flt Protected	0.95				0.95	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770				1253	1087	1752	3488		1626	3252	
Flt Permitted	1.00				1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1863				1319	1087	1752	3488		1626	3252	
Peak-hour factor, PHF	0.92	0.92	0.92	0.71	0.71	0.71	0.86	0.86	0.86	0.92	0.92	0.92
Adj. Flow (vph)	27	0	0	7	0	55	6	841	28	101	466	0
RTOR Reduction (vph)	0	0	0	0	0	52	0	2	0	0	0	0
Lane Group Flow (vph)	27	0	0	0	7	3	6	867	0	101	466	0
Confl. Bikes (#/hr)						5						
Heavy Vehicles (%)	2%	2%	2%	44%	44%	44%	3%	3%	3%	11%	11%	11%
Turn Type	Perm			Perm	NA	Perm	Prot	NA		Prot	NA	
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4			8		8						
Actuated Green, G (s)	3.9				3.9	3.9	0.7	36.2		7.7	43.2	
Effective Green, g (s)	3.9				3.9	3.9	0.7	36.2		7.7	43.2	
Actuated g/C Ratio	0.06				0.06	0.06	0.01	0.55		0.12	0.66	
Clearance Time (s)	6.0				6.0	6.0	6.0	6.0		6.0	6.0	
Vehicle Extension (s)	3.0				3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	110				78	64	18	1918		190	2135	
v/s Ratio Prot							0.00	c0.25		c0.06	0.14	
v/s Ratio Perm	c0.01				0.01	0.00						
v/c Ratio	0.25				0.09	0.05	0.33	0.45		0.53	0.22	
Uniform Delay, d1	29.5				29.3	29.2	32.3	8.9		27.4	4.5	
Progression Factor	1.00				1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2	1.2				0.5	0.3	10.6	0.2		2.8	0.1	
Delay (s)	30.7				29.8	29.5	42.9	9.0		30.2	4.6	
Level of Service	C				C	C	D	A		C	A	
Approach Delay (s)		30.7			29.6			9.3			9.1	
Approach LOS		C			C			A			A	

Intersection Summary			
HCM 2000 Control Delay	10.4	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.45		
Actuated Cycle Length (s)	65.8	Sum of lost time (s)	18.0
Intersection Capacity Utilization	49.0%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	8	896	24	16	731	8	8	0	6	28	0	41
Future Volume (vph)	8	896	24	16	731	8	8	0	6	28	0	41
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0		6.0	6.0	6.0		6.0	6.0	6.0	6.0	
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00		1.00	1.00	0.95	0.95	
Frt	1.00	1.00		1.00	1.00	0.85		1.00	0.85	1.00	0.86	
Flt Protected	0.95	1.00		0.95	1.00	1.00		0.95	1.00	0.95	1.00	
Satd. Flow (prot)	1736	3457		1719	3438	1538		1770	1583	1681	1516	
Flt Permitted	0.95	1.00		0.95	1.00	1.00		0.95	1.00	0.95	1.00	
Satd. Flow (perm)	1736	3457		1719	3438	1538		1770	1583	1681	1516	
Peak-hour factor, PHF	0.87	0.87	0.87	0.86	0.86	0.86	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	9	1030	28	19	850	9	9	0	7	30	0	45
RTOR Reduction (vph)	0	1	0	0	0	4	0	0	7	0	44	0
Lane Group Flow (vph)	9	1057	0	19	850	5	0	9	0	27	4	0
Heavy Vehicles (%)	4%	4%	4%	5%	5%	5%	2%	2%	2%	2%	2%	2%
Turn Type	Prot	NA		Prot	NA	Prot	Split	NA	Prot	Split	NA	
Protected Phases	5	2		1	6	6	3	3	3	4	4	
Permitted Phases												
Actuated Green, G (s)	1.2	44.4		2.5	45.7	45.7		2.3	2.3	5.8	5.8	
Effective Green, g (s)	1.2	44.4		2.5	45.7	45.7		2.3	2.3	5.8	5.8	
Actuated g/C Ratio	0.02	0.56		0.03	0.58	0.58		0.03	0.03	0.07	0.07	
Clearance Time (s)	6.0	6.0		6.0	6.0	6.0		6.0	6.0	6.0	6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0		3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	26	1942		54	1988	889		51	46	123	111	
v/s Ratio Prot	0.01	c0.31		c0.01	0.25	0.00		c0.01	0.00	c0.02	0.00	
v/s Ratio Perm												
v/c Ratio	0.35	0.54		0.35	0.43	0.01		0.18	0.00	0.22	0.03	
Uniform Delay, d1	38.5	10.9		37.5	9.3	7.0		37.4	37.2	34.5	34.0	
Progression Factor	1.00	1.00		1.00	1.00	1.00		1.00	1.00	1.00	1.00	
Incremental Delay, d2	7.9	0.3		3.9	0.1	0.0		1.7	0.0	0.9	0.1	
Delay (s)	46.4	11.2		41.4	9.5	7.0		39.1	37.3	35.4	34.1	
Level of Service	D	B		D	A	A		D	D	D	C	
Approach Delay (s)		11.5			10.1			38.3			34.6	
Approach LOS		B			B			D			C	

Intersection Summary			
HCM 2000 Control Delay	12.0	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.49		
Actuated Cycle Length (s)	79.0	Sum of lost time (s)	24.0
Intersection Capacity Utilization	52.2%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	650	280	135	490	0	0	0	0	645	0	265
Future Volume (vph)	0	650	280	135	490	0	0	0	0	645	0	265
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0	4.0	6.0	6.0					6.0		6.0
Lane Util. Factor		0.95	1.00	1.00	0.95					0.97		1.00
Frt		1.00	0.85	1.00	1.00					1.00		0.85
Flt Protected		1.00	1.00	0.95	1.00					0.95		1.00
Satd. Flow (prot)		3471	1553	1719	3438					3367		1553
Flt Permitted		1.00	1.00	0.95	1.00					0.95		1.00
Satd. Flow (perm)		3471	1553	1719	3438					3367		1553
Peak-hour factor, PHF	0.87	0.87	0.87	0.86	0.86	0.86	0.92	0.92	0.92	0.91	0.91	0.91
Adj. Flow (vph)	0	747	322	157	570	0	0	0	0	709	0	291
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	189
Lane Group Flow (vph)	0	747	322	157	570	0	0	0	0	709	0	102
Heavy Vehicles (%)	4%	4%	4%	5%	5%	5%	2%	2%	2%	4%	4%	4%
Turn Type		NA	Free	Prot	NA					Prot		Prot
Protected Phases		2		1	6					4		4
Permitted Phases			Free									
Actuated Green, G (s)		36.5	100.0	14.0	56.5					31.5		31.5
Effective Green, g (s)		36.5	100.0	14.0	56.5					31.5		31.5
Actuated g/C Ratio		0.36	1.00	0.14	0.56					0.32		0.32
Clearance Time (s)		6.0		6.0	6.0					6.0		6.0
Vehicle Extension (s)		5.0		3.0	5.0					3.0		3.0
Lane Grp Cap (vph)		1266	1553	240	1942					1060		489
v/s Ratio Prot		c0.22		c0.09	0.17					c0.21		0.07
v/s Ratio Perm			0.21									
v/c Ratio		0.59	0.21	0.65	0.29					0.67		0.21
Uniform Delay, d1		25.7	0.0	40.7	11.3					29.7		25.1
Progression Factor		1.00	1.00	0.26	0.26					1.00		1.00
Incremental Delay, d2		2.0	0.3	5.9	0.3					1.6		0.2
Delay (s)		27.7	0.3	16.4	3.3					31.3		25.3
Level of Service		C	A	B	A					C		C
Approach Delay (s)		19.5			6.1			0.0			29.6	
Approach LOS		B			A			A			C	

Intersection Summary			
HCM 2000 Control Delay	19.6	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	58.8%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	235	1060	0	0	425	535	220	0	240	0	0	0
Future Volume (vph)	235	1060	0	0	425	535	220	0	240	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0			6.0	4.0	6.0		6.0			
Lane Util. Factor	1.00	0.95			0.95	1.00	1.00		1.00			
Frt	1.00	1.00			1.00	0.85	1.00		0.85			
Flt Protected	0.95	1.00			1.00	1.00	0.95		1.00			
Satd. Flow (prot)	1752	3505			3505	1568	1703		1524			
Flt Permitted	0.95	1.00			1.00	1.00	0.95		1.00			
Satd. Flow (perm)	1752	3505			3505	1568	1703		1524			
Peak-hour factor, PHF	0.92	0.92	0.92	0.91	0.91	0.91	0.67	0.67	0.67	0.92	0.92	0.92
Adj. Flow (vph)	255	1152	0	0	467	588	328	0	358	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	71	0	0	0
Lane Group Flow (vph)	255	1152	0	0	467	588	328	0	287	0	0	0
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	6%	6%	6%	2%	2%	2%
Turn Type	Prot	NA			NA	Free	Prot		Prot			
Protected Phases	5	2			6		8		8			
Permitted Phases		2			6	Free						
Actuated Green, G (s)	21.5	60.9			33.4	100.0	27.1		27.1			
Effective Green, g (s)	21.5	60.9			33.4	100.0	27.1		27.1			
Actuated g/C Ratio	0.22	0.61			0.33	1.00	0.27		0.27			
Clearance Time (s)	6.0	6.0			6.0		6.0		6.0			
Vehicle Extension (s)	5.0	5.0			5.0		3.0		3.0			
Lane Grp Cap (vph)	376	2134			1170	1568	461		413			
v/s Ratio Prot	c0.15	c0.33			0.13		c0.19		0.19			
v/s Ratio Perm						0.38						
v/c Ratio	0.68	0.54			0.40	0.38	0.71		0.69			
Uniform Delay, d1	36.1	11.4			25.6	0.0	32.9		32.7			
Progression Factor	0.30	0.29			1.00	1.00	1.00		1.00			
Incremental Delay, d2	5.1	0.8			1.0	0.7	5.1		5.0			
Delay (s)	16.0	4.1			26.6	0.7	38.1		37.7			
Level of Service	B	A			C	A	D		D			
Approach Delay (s)		6.2			12.2			37.9			0.0	
Approach LOS		A			B			D			A	

Intersection Summary			
HCM 2000 Control Delay	15.1	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	58.8%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	25	0	0	15	0	81	5	382	3	32	630	0
Future Volume (vph)	25	0	0	15	0	81	5	382	3	32	630	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0				6.0	6.0	6.0	6.0		6.0	6.0	
Lane Util. Factor	1.00				1.00	1.00	1.00	0.95		1.00	0.95	
Frt	1.00				1.00	0.85	1.00	1.00		1.00	1.00	
Flt Protected	0.95				0.95	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770				1577	1568	1752	3501		1719	3438	
Flt Permitted	0.74				0.76	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1379				1257	1568	1752	3501		1719	3438	
Peak-hour factor, PHF	0.92	0.92	0.92	0.58	0.58	0.58	0.86	0.86	0.86	0.91	0.91	0.91
Adj. Flow (vph)	27	0	0	26	0	140	6	444	3	35	692	0
RTOR Reduction (vph)	0	0	0	0	0	123	0	1	0	0	0	0
Lane Group Flow (vph)	27	0	0	0	26	17	6	446	0	35	692	0
Heavy Vehicles (%)	2%	2%	2%	3%	3%	3%	3%	3%	3%	5%	5%	5%
Parking (#/hr)					0							
Turn Type	Perm			Perm	NA	Prot	Prot	NA		Prot	NA	
Protected Phases		4			8	8	5	2		1	6	
Permitted Phases	4			8								
Actuated Green, G (s)	6.2				6.2	6.2	0.9	23.2		2.5	24.8	
Effective Green, g (s)	6.2				6.2	6.2	0.9	23.2		2.5	24.8	
Actuated g/C Ratio	0.12				0.12	0.12	0.02	0.46		0.05	0.50	
Clearance Time (s)	6.0				6.0	6.0	6.0	6.0		6.0	6.0	
Vehicle Extension (s)	3.0				3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	171				156	194	31	1627		86	1708	
v/s Ratio Prot						0.01	0.00	0.13		c0.02	c0.20	
v/s Ratio Perm	0.02				c0.02							
v/c Ratio	0.16				0.17	0.09	0.19	0.27		0.41	0.41	
Uniform Delay, d1	19.5				19.5	19.4	24.1	8.2		23.0	7.9	
Progression Factor	1.00				1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.4				0.5	0.2	3.0	0.1		3.1	0.2	
Delay (s)	20.0				20.0	19.6	27.2	8.3		26.1	8.1	
Level of Service	B				C	B	C	A		C	A	
Approach Delay (s)		20.0			19.6			8.5			8.9	
Approach LOS		B			B			A			A	

Intersection Summary			
HCM 2000 Control Delay	10.3	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.38		
Actuated Cycle Length (s)	49.9	Sum of lost time (s)	18.0
Intersection Capacity Utilization	44.6%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SBL	SBR	SBR2	NEL2	NEL	NER
Lane Configurations												
Traffic Volume (vph)	245	89	156	127	49	182	68	760	82	136	1131	44
Future Volume (vph)	245	89	156	127	49	182	68	760	82	136	1131	44
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0	6.0		6.0	6.0	6.0	6.0	6.0	6.0	6.0	
Lane Util. Factor		1.00	1.00		1.00	1.00	0.97	0.88	1.00	1.00	0.97	
Frt		1.00	0.85		1.00	0.85	1.00	0.85	0.85	1.00	0.99	
Flt Protected		0.96	1.00		0.97	1.00	0.95	1.00	1.00	0.95	0.95	
Satd. Flow (prot)		1797	1583		1798	1583	3303	2682	1524	1736	3363	
Flt Permitted		0.96	1.00		0.97	1.00	0.95	1.00	1.00	0.95	0.95	
Satd. Flow (perm)		1797	1583		1798	1583	3303	2682	1524	1736	3363	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.88	0.88	0.88	0.93	0.93	0.93
Adj. Flow (vph)	266	97	170	138	53	198	77	864	93	146	1216	47
RTOR Reduction (vph)	0	0	134	0	0	171	0	0	65	0	110	0
Lane Group Flow (vph)	0	363	36	0	191	27	77	864	28	146	1153	0
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	6%	6%	6%	4%	4%	4%
Turn Type	Split	NA	Prot	Split	NA	Prot	Prot	Prot	Prot	Prot	Prot	
Protected Phases	4	4	4	3	3	3	1	6	6	5	2	
Permitted Phases												
Actuated Green, G (s)		21.2	21.2		13.8	13.8	8.0	30.4	30.4	10.6	33.0	
Effective Green, g (s)		21.2	21.2		13.8	13.8	8.0	30.4	30.4	10.6	33.0	
Actuated g/C Ratio		0.21	0.21		0.14	0.14	0.08	0.30	0.30	0.11	0.33	
Clearance Time (s)		6.0	6.0		6.0	6.0	6.0	6.0	6.0	6.0	6.0	
Vehicle Extension (s)		3.0	3.0		3.0	3.0	3.0	5.0	5.0	3.0	5.0	
Lane Grp Cap (vph)		380	335		248	218	264	815	463	184	1109	
v/s Ratio Prot		c0.20	0.02		c0.11	0.02	0.02	c0.32	0.02	0.08	c0.34	
v/s Ratio Perm												
v/c Ratio		0.96	0.11		0.77	0.13	0.29	1.06	0.06	0.79	1.04	
Uniform Delay, d1		38.9	31.8		41.6	37.8	43.3	34.8	24.7	43.6	33.5	
Progression Factor		1.00	1.00		1.00	1.00	0.57	0.48	7.03	1.00	1.00	
Incremental Delay, d2		34.4	0.1		13.7	0.3	0.5	46.4	0.1	20.5	37.9	
Delay (s)		73.3	31.9		55.3	38.1	25.2	63.1	173.6	64.1	71.4	
Level of Service		E	C		E	D	C	E	F	E	E	
Approach Delay (s)		60.1			46.5		70.2				70.7	
Approach LOS		E			D		E				E	

Intersection Summary			
HCM 2000 Control Delay	66.1	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.02		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	24.0
Intersection Capacity Utilization	82.9%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Volume (vph)	104	10	49	13	10	60	67	1416	68	43	843	174
Future Volume (vph)	104	10	49	13	10	60	67	1416	68	43	843	174
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0	6.0		6.0	6.0	6.0	6.0		6.0	6.0	6.0
Lane Util. Factor	0.95	0.95	1.00		1.00	1.00	0.97	0.95		0.97	0.95	1.00
Frt	1.00	1.00	0.85		1.00	0.85	1.00	0.99		1.00	1.00	0.85
Flt Protected	0.95	0.96	1.00		0.97	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1681	1700	1583		1812	1583	3367	3447		3303	3406	1524
Flt Permitted	0.95	0.96	1.00		0.97	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	1681	1700	1583		1812	1583	3367	3447		3303	3406	1524
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.93	0.93	0.93	0.88	0.88	0.88
Adj. Flow (vph)	113	11	53	14	11	65	72	1523	73	49	958	198
RTOR Reduction (vph)	0	0	48	0	0	57	0	3	0	0	0	105
Lane Group Flow (vph)	62	62	5	0	25	8	72	1593	0	49	958	93
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	4%	4%	4%	6%	6%	6%
Turn Type	Split	NA	Prot	Split	NA	Prot	Prot	NA		Prot	NA	Prot
Protected Phases	4	4	4	3	3	3	5	2		1	6	6
Permitted Phases												
Actuated Green, G (s)	8.7	8.7	8.7		13.0	13.0	7.2	47.7		6.6	47.1	47.1
Effective Green, g (s)	8.7	8.7	8.7		13.0	13.0	7.2	47.7		6.6	47.1	47.1
Actuated g/C Ratio	0.09	0.09	0.09		0.13	0.13	0.07	0.48		0.07	0.47	0.47
Clearance Time (s)	6.0	6.0	6.0		6.0	6.0	6.0	6.0		6.0	6.0	6.0
Vehicle Extension (s)	4.0	4.0	4.0		4.0	4.0	4.0	4.0		4.0	4.0	4.0
Lane Grp Cap (vph)	146	147	137		235	205	242	1644		217	1604	717
v/s Ratio Prot	c0.04	0.04	0.00		c0.01	0.01	c0.02	c0.46		0.01	0.28	0.06
v/s Ratio Perm												
v/c Ratio	0.42	0.42	0.03		0.11	0.04	0.30	0.97		0.23	0.60	0.13
Uniform Delay, d1	43.3	43.3	41.8		38.4	38.0	44.0	25.4		44.3	19.5	14.9
Progression Factor	1.00	1.00	1.00		1.00	1.00	1.27	0.38		0.79	1.28	3.04
Incremental Delay, d2	2.7	2.7	0.1		0.9	0.4	0.3	7.8		0.7	1.6	0.4
Delay (s)	46.0	45.9	41.9		39.3	38.4	56.2	17.5		35.5	26.5	45.7
Level of Service	D	D	D		D	D	E	B		D	C	D
Approach Delay (s)		44.7			38.7			19.2			30.0	
Approach LOS		D			D			B			C	

Intersection Summary			
HCM 2000 Control Delay	25.3	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	24.0
Intersection Capacity Utilization	69.3%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	0	915	565	0	260	495
Future Volume (vph)	0	915	565	0	260	495
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0	6.0		6.0	4.0
Lane Util. Factor		0.95	0.95		1.00	1.00
Frt		1.00	1.00		1.00	0.85
Flt Protected		1.00	1.00		0.95	1.00
Satd. Flow (prot)		3471	3406		1703	1524
Flt Permitted		1.00	1.00		0.95	1.00
Satd. Flow (perm)		3471	3406		1703	1524
Peak-hour factor, PHF	0.93	0.93	0.88	0.88	0.89	0.89
Adj. Flow (vph)	0	984	642	0	292	556
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	0	984	642	0	292	556
Heavy Vehicles (%)	4%	4%	6%	6%	6%	6%
Turn Type		NA	NA		Prot	Free
Protected Phases		2	6		7	
Permitted Phases						Free
Actuated Green, G (s)		65.6	65.6		22.4	100.0
Effective Green, g (s)		65.6	65.6		22.4	100.0
Actuated g/C Ratio		0.66	0.66		0.22	1.00
Clearance Time (s)		6.0	6.0		6.0	
Vehicle Extension (s)		5.0	5.0		4.0	
Lane Grp Cap (vph)		2276	2234		381	1524
v/s Ratio Prot		c0.28	0.19		c0.17	
v/s Ratio Perm						0.36
v/c Ratio		0.43	0.29		0.77	0.36
Uniform Delay, d1		8.3	7.3		36.3	0.0
Progression Factor		0.21	0.31		1.00	1.00
Incremental Delay, d2		0.3	0.2		9.4	0.7
Delay (s)		2.0	2.4		45.8	0.7
Level of Service		A	A		D	A
Approach Delay (s)		2.0	2.4		16.2	
Approach LOS		A	A		B	

Intersection Summary			
HCM 2000 Control Delay	7.0	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.54		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	51.7%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	NBL2	NBL	NBR	SEL	SER	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations											
Traffic Volume (vph)	210	0	200	0	0	585	590	0	0	875	475
Future Volume (vph)	210	0	200	0	0	585	590	0	0	875	475
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0		4.0			6.0	6.0			6.0	4.0
Lane Util. Factor	0.97		1.00			1.00	0.95			0.95	1.00
Frt	1.00		0.85			1.00	1.00			1.00	0.85
Flt Protected	0.95		1.00			0.95	1.00			1.00	1.00
Satd. Flow (prot)	3242		1495			1719	3438			3505	1568
Flt Permitted	0.95		1.00			0.95	1.00			1.00	1.00
Satd. Flow (perm)	3242		1495			1719	3438			3505	1568
Peak-hour factor, PHF	0.88	0.88	0.88	0.92	0.92	0.94	0.94	0.94	0.92	0.92	0.92
Adj. Flow (vph)	239	0	227	0	0	622	628	0	0	951	516
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	239	0	227	0	0	622	628	0	0	951	516
Heavy Vehicles (%)	8%	8%	8%	2%	2%	5%	5%	5%	3%	3%	3%
Turn Type	Prot		Free			Prot	NA			NA	Free
Protected Phases	2					7	4			8	
Permitted Phases			Free								Free
Actuated Green, G (s)	14.5		100.0			39.5	73.5			28.0	100.0
Effective Green, g (s)	14.5		100.0			39.5	73.5			28.0	100.0
Actuated g/C Ratio	0.14		1.00			0.40	0.74			0.28	1.00
Clearance Time (s)	6.0					6.0	6.0			6.0	
Vehicle Extension (s)	5.0					5.0	5.0			5.0	
Lane Grp Cap (vph)	470		1495			679	2526			981	1568
v/s Ratio Prot	c0.07					c0.36	0.18			c0.27	
v/s Ratio Perm			0.15								0.33
v/c Ratio	0.51		0.15			0.92	0.25			0.97	0.33
Uniform Delay, d1	39.5		0.0			28.7	4.3			35.6	0.0
Progression Factor	1.00		1.00			0.76	0.54			1.00	1.00
Incremental Delay, d2	1.8		0.2			16.4	0.2			22.2	0.6
Delay (s)	41.3		0.2			38.2	2.5			57.8	0.6
Level of Service	D		A			D	A			E	A
Approach Delay (s)		21.3		0.0			20.3			37.7	
Approach LOS		C		A			C			D	

Intersection Summary			
HCM 2000 Control Delay	28.4	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.86		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	79.4%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Volume (vph)	5	25	10	345	0	70	0	400	125	15	595	0
Future Volume (vph)	5	25	10	345	0	70	0	400	125	15	595	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0			6.0			6.0			6.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		0.97			0.98			0.97			1.00	
Flt Protected		0.99			0.96			1.00			1.00	
Satd. Flow (prot)		1788			1731			1703			1807	
Flt Permitted		0.94			0.72			1.00			0.98	
Satd. Flow (perm)		1685			1291			1703			1776	
Peak-hour factor, PHF	0.60	0.60	0.60	0.96	0.96	0.96	0.89	0.89	0.89	0.86	0.86	0.86
Adj. Flow (vph)	8	42	17	359	0	73	0	449	140	17	692	0
RTOR Reduction (vph)	0	11	0	0	37	0	0	19	0	0	0	0
Lane Group Flow (vph)	0	56	0	0	395	0	0	570	0	0	709	0
Heavy Vehicles (%)	2%	2%	2%	3%	3%	3%	8%	8%	8%	5%	5%	5%
Turn Type	Perm	NA		Perm	NA			NA		Perm	NA	
Protected Phases		4			4			2			2	
Permitted Phases	4			4						2		
Actuated Green, G (s)		19.1			19.1			27.3			27.3	
Effective Green, g (s)		19.1			19.1			27.3			27.3	
Actuated g/C Ratio		0.33			0.33			0.47			0.47	
Clearance Time (s)		6.0			6.0			6.0			6.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		551			422			796			830	
v/s Ratio Prot								0.33				
v/s Ratio Perm		0.03			c0.31						c0.40	
v/c Ratio		0.10			0.94			0.72			0.85	
Uniform Delay, d1		13.7			19.1			12.4			13.8	
Progression Factor		1.00			1.00			1.00			1.00	
Incremental Delay, d2		0.1			28.1			3.1			8.5	
Delay (s)		13.8			47.1			15.5			22.3	
Level of Service		B			D			B			C	
Approach Delay (s)		13.8			47.1			15.5			22.3	
Approach LOS		B			D			B			C	

Intersection Summary			
HCM 2000 Control Delay	25.7	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.89		
Actuated Cycle Length (s)	58.4	Sum of lost time (s)	12.0
Intersection Capacity Utilization	84.8%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Intersection	
Int Delay, s/veh	3.2

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Vol, veh/h	10	0	105	0	0	1	75	520	5	5	1090	25
Future Vol, veh/h	10	0	105	0	0	1	75	520	5	5	1090	25
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	150	-	-	-	150	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	25	25	25	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	0	0	0	2	2	2	2	2	2
Mvmt Flow	11	0	114	0	0	4	82	565	5	5	1185	27

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	1943	1943	1199	1998	1954	568	1212	0	0	570	0	0
Stage 1	1209	1209	-	732	732	-	-	-	-	-	-	-
Stage 2	734	734	-	1266	1222	-	-	-	-	-	-	-
Critical Hdwy	7.12	6.52	6.22	7.1	6.5	6.2	4.12	-	-	4.12	-	-
Critical Hdwy Stg 1	6.12	5.52	-	6.1	5.5	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.12	5.52	-	6.1	5.5	-	-	-	-	-	-	-
Follow-up Hdwy	3.518	4.018	3.318	3.5	4	3.3	2.218	-	-	2.218	-	-
Pot Cap-1 Maneuver	49	65	226	45	65	526	576	-	-	1002	-	-
Stage 1	223	256	-	416	430	-	-	-	-	-	-	-
Stage 2	412	426	-	209	254	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	43	55	226	20	55	526	576	-	-	1002	-	-
Mov Cap-2 Maneuver	43	55	-	20	55	-	-	-	-	-	-	-
Stage 1	191	252	-	357	369	-	-	-	-	-	-	-
Stage 2	351	366	-	102	250	-	-	-	-	-	-	-

Approach	SE	NW	NE	SW
HCM Control Delay, s	43	11.9	1.5	0
HCM LOS	E	B		

Minor Lane/Major Mvmt	NEL	NET	NER	NWLn1	SELn1	SELn2	SWL	SWT	SWR
Capacity (veh/h)	576	-	-	526	43	226	1002	-	-
HCM Lane V/C Ratio	0.142	-	-	0.008	0.253	0.505	0.005	-	-
HCM Control Delay (s)	12.3	-	-	11.9	115	36.1	8.6	0	-
HCM Lane LOS	B	-	-	B	F	E	A	A	-
HCM 95th %tile Q(veh)	0.5	-	-	0	0.8	2.6	0	-	-

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SBL	SBR	SBR2	NEL2	NEL	NER
Lane Configurations												
Traffic Volume (vph)	112	80	157	120	94	124	151	993	146	174	890	61
Future Volume (vph)	112	80	157	120	94	124	151	993	146	174	890	61
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0	6.0		6.0	6.0	6.0	6.0	6.0	6.0	6.0	
Lane Util. Factor		1.00	1.00		1.00	1.00	0.97	0.88	1.00	1.00	0.97	
Frt		1.00	0.85		1.00	0.85	1.00	0.85	0.85	1.00	0.99	
Flt Protected		0.97	1.00		0.97	1.00	0.95	1.00	1.00	0.95	0.96	
Satd. Flow (prot)		1828	1599		1830	1599	3467	2814	1599	1787	3453	
Flt Permitted		0.97	1.00		0.97	1.00	0.95	1.00	1.00	0.95	0.96	
Satd. Flow (perm)		1828	1599		1830	1599	3467	2814	1599	1787	3453	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.89	0.89	0.89	0.92	0.92	0.92
Adj. Flow (vph)	122	87	171	130	102	135	170	1116	164	189	967	66
RTOR Reduction (vph)	0	0	147	0	0	114	0	0	103	0	89	0
Lane Group Flow (vph)	0	209	24	0	232	21	170	1116	61	189	944	0
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Split	NA	Prot	Split	NA	Prot	Prot	Prot	Perm	Prot	Prot	
Protected Phases	4	4	4	3	3	3	1	6		5	2	
Permitted Phases									6			
Actuated Green, G (s)		16.8	16.8		18.8	18.8	19.0	44.6	44.6	15.8	41.4	
Effective Green, g (s)		16.8	16.8		18.8	18.8	19.0	44.6	44.6	15.8	41.4	
Actuated g/C Ratio		0.14	0.14		0.16	0.16	0.16	0.37	0.37	0.13	0.34	
Clearance Time (s)		6.0	6.0		6.0	6.0	6.0	6.0	6.0	6.0	6.0	
Vehicle Extension (s)		3.0	3.0		3.0	3.0	3.0	5.0	5.0	3.0	5.0	
Lane Grp Cap (vph)		255	223		286	250	548	1045	594	235	1191	
v/s Ratio Prot		c0.11	0.01		c0.13	0.01	0.05	c0.40		0.11	c0.27	
v/s Ratio Perm									0.04			
v/c Ratio		0.82	0.11		0.81	0.08	0.31	1.07	0.10	0.80	0.79	
Uniform Delay, d1		50.1	45.1		48.9	43.2	44.7	37.7	24.6	50.6	35.4	
Progression Factor		1.00	1.00		1.00	1.00	0.56	0.48	0.16	1.00	1.00	
Incremental Delay, d2		18.2	0.2		15.9	0.1	0.2	44.8	0.1	17.8	5.5	
Delay (s)		68.4	45.3		64.7	43.4	25.2	62.9	4.1	68.4	40.9	
Level of Service		E	D		E	D	C	E	A	E	D	
Approach Delay (s)		58.0			56.9		51.8				45.1	
Approach LOS		E			E		D				D	

Intersection Summary			
HCM 2000 Control Delay	50.7	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.96		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	24.0
Intersection Capacity Utilization	74.0%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Volume (vph)	260	35	180	39	24	57	162	917	35	119	1058	319
Future Volume (vph)	260	35	180	39	24	57	162	917	35	119	1058	319
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0	6.0		6.0	6.0	6.0	6.0		6.0	6.0	6.0
Lane Util. Factor	0.95	0.95	1.00		1.00	1.00	0.97	0.95		0.97	0.95	1.00
Frt	1.00	1.00	0.85		1.00	0.85	1.00	0.99		1.00	1.00	0.85
Flt Protected	0.95	0.96	1.00		0.97	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1698	1721	1599		1825	1599	3467	3555		3467	3574	1599
Flt Permitted	0.95	0.96	1.00		0.97	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	1698	1721	1599		1825	1599	3467	3555		3467	3574	1599
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.89	0.89	0.89
Adj. Flow (vph)	283	38	196	42	26	62	176	997	38	134	1189	358
RTOR Reduction (vph)	0	0	167	0	0	57	0	2	0	0	0	150
Lane Group Flow (vph)	158	163	29	0	68	5	176	1033	0	134	1189	208
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Split	NA	Prot	Split	NA	Prot	Prot	NA		Prot	NA	Prot
Protected Phases	4	4	4	3	3	3	5	2		1	6	6
Permitted Phases												
Actuated Green, G (s)	17.8	17.8	17.8		9.4	9.4	12.4	57.9		10.9	56.4	56.4
Effective Green, g (s)	17.8	17.8	17.8		9.4	9.4	12.4	57.9		10.9	56.4	56.4
Actuated g/C Ratio	0.15	0.15	0.15		0.08	0.08	0.10	0.48		0.09	0.47	0.47
Clearance Time (s)	6.0	6.0	6.0		6.0	6.0	6.0	6.0		6.0	6.0	6.0
Vehicle Extension (s)	4.0	4.0	4.0		4.0	4.0	4.0	4.0		4.0	4.0	4.0
Lane Grp Cap (vph)	251	255	237		142	125	358	1715		314	1679	751
v/s Ratio Prot	0.09	c0.09	0.02		c0.04	0.00	c0.05	0.29		0.04	c0.33	0.13
v/s Ratio Perm												
v/c Ratio	0.63	0.64	0.12		0.48	0.04	0.49	0.60		0.43	0.71	0.28
Uniform Delay, d1	48.0	48.1	44.3		53.0	51.1	50.8	22.7		51.6	25.3	19.4
Progression Factor	1.00	1.00	1.00		1.00	1.00	1.32	0.33		1.17	0.75	0.59
Incremental Delay, d2	5.5	5.8	0.3		3.4	0.2	0.9	1.0		1.2	2.4	0.9
Delay (s)	53.5	53.9	44.6		56.4	51.3	68.1	8.5		61.4	21.4	12.3
Level of Service	D	D	D		E	D	E	A		E	C	B
Approach Delay (s)		50.3			54.0			17.2			22.6	
Approach LOS		D			D			B			C	

Intersection Summary			
HCM 2000 Control Delay	26.0	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.64		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	24.0
Intersection Capacity Utilization	68.4%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	0	935	850	0	280	645
Future Volume (vph)	0	935	850	0	280	645
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0	6.0		6.0	4.0
Lane Util. Factor		0.95	0.95		1.00	1.00
Frt		1.00	1.00		1.00	0.85
Flt Protected		1.00	1.00		0.95	1.00
Satd. Flow (prot)		3574	3574		1752	1568
Flt Permitted		1.00	1.00		0.95	1.00
Satd. Flow (perm)		3574	3574		1752	1568
Peak-hour factor, PHF	0.92	0.92	0.89	0.89	0.92	0.92
Adj. Flow (vph)	0	1016	955	0	304	701
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	0	1016	955	0	304	701
Heavy Vehicles (%)	1%	1%	1%	1%	3%	3%
Turn Type		NA	NA		Prot	Free
Protected Phases		2	6		7	
Permitted Phases						Free
Actuated Green, G (s)		81.7	81.7		26.3	120.0
Effective Green, g (s)		81.7	81.7		26.3	120.0
Actuated g/C Ratio		0.68	0.68		0.22	1.00
Clearance Time (s)		6.0	6.0		6.0	
Vehicle Extension (s)		5.0	5.0		4.0	
Lane Grp Cap (vph)		2433	2433		383	1568
v/s Ratio Prot		0.28	0.27		c0.17	
v/s Ratio Perm						c0.45
v/c Ratio		0.42	0.39		0.79	0.45
Uniform Delay, d1		8.5	8.3		44.3	0.0
Progression Factor		1.64	1.60		1.00	1.00
Incremental Delay, d2		0.4	0.4		11.4	0.9
Delay (s)		14.4	13.7		55.7	0.9
Level of Service		B	B		E	A
Approach Delay (s)		14.4	13.7		17.5	
Approach LOS		B	B		B	

Intersection Summary			
HCM 2000 Control Delay	15.2	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.57		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	53.4%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	NBL2	NBL	NBR	SEL	SER	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations											
Traffic Volume (vph)	580	0	605	0	0	475	740	0	0	485	315
Future Volume (vph)	580	0	605	0	0	475	740	0	0	485	315
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0		4.0			6.0	6.0			6.0	4.0
Lane Util. Factor	0.97		1.00			1.00	0.95			0.95	1.00
Frt	1.00		0.85			1.00	1.00			1.00	0.85
Flt Protected	0.95		1.00			0.95	1.00			1.00	1.00
Satd. Flow (prot)	3467		1599			1770	3539			3539	1583
Flt Permitted	0.95		1.00			0.95	1.00			1.00	1.00
Satd. Flow (perm)	3467		1599			1770	3539			3539	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.96	0.96	0.96	0.87	0.87	0.87
Adj. Flow (vph)	630	0	658	0	0	495	771	0	0	557	362
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	630	0	658	0	0	495	771	0	0	557	362
Heavy Vehicles (%)	1%	1%	1%	2%	2%	2%	2%	2%	2%	2%	2%
Turn Type	Prot		Free			Prot	NA			NA	Free
Protected Phases	2					7	4			8	
Permitted Phases			Free								Free
Actuated Green, G (s)	29.0		120.0			37.7	79.0			35.3	120.0
Effective Green, g (s)	29.0		120.0			37.7	79.0			35.3	120.0
Actuated g/C Ratio	0.24		1.00			0.31	0.66			0.29	1.00
Clearance Time (s)	6.0					6.0	6.0			6.0	
Vehicle Extension (s)	5.0					5.0	5.0			5.0	
Lane Grp Cap (vph)	837		1599			556	2329			1041	1583
v/s Ratio Prot	c0.18					c0.28	0.22			c0.16	
v/s Ratio Perm			0.41								0.23
v/c Ratio	0.75		0.41			0.89	0.33			0.54	0.23
Uniform Delay, d1	42.2		0.0			39.2	9.0			35.5	0.0
Progression Factor	1.00		1.00			1.14	0.98			1.00	1.00
Incremental Delay, d2	4.6		0.8			15.8	0.3			2.0	0.3
Delay (s)	46.8		0.8			60.5	9.1			37.4	0.3
Level of Service	D		A			E	A			D	A
Approach Delay (s)		23.3		0.0			29.2			22.8	
Approach LOS		C		A			C			C	

Intersection Summary			
HCM 2000 Control Delay	25.3	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.73		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	83.9%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Volume (vph)	15	50	5	230	0	100	0	760	150	15	415	0
Future Volume (vph)	15	50	5	230	0	100	0	760	150	15	415	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0			6.0			6.0			6.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		0.99			0.96			0.98			1.00	
Flt Protected		0.99			0.97			1.00			1.00	
Satd. Flow (prot)		1843			1744			1821			1841	
Flt Permitted		0.90			0.74			1.00			0.63	
Satd. Flow (perm)		1681			1335			1821			1164	
Peak-hour factor, PHF	0.83	0.83	0.83	0.98	0.98	0.98	0.95	0.95	0.95	0.89	0.89	0.89
Adj. Flow (vph)	18	60	6	235	0	102	0	800	158	17	466	0
RTOR Reduction (vph)	0	4	0	0	40	0	0	11	0	0	0	0
Lane Group Flow (vph)	0	80	0	0	297	0	0	947	0	0	483	0
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	2%	2%	2%	3%	3%	3%
Turn Type	Perm	NA		Perm	NA			NA		Perm	NA	
Protected Phases		4			4			2			2	
Permitted Phases	4			4						2		
Actuated Green, G (s)		15.9			15.9			30.6			30.6	
Effective Green, g (s)		15.9			15.9			30.6			30.6	
Actuated g/C Ratio		0.27			0.27			0.52			0.52	
Clearance Time (s)		6.0			6.0			6.0			6.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		456			362			952			608	
v/s Ratio Prot								c0.52				
v/s Ratio Perm		0.05			c0.22						0.41	
v/c Ratio		0.17			0.82			0.99			0.79	
Uniform Delay, d1		16.3			20.0			13.9			11.4	
Progression Factor		1.00			1.00			1.00			1.00	
Incremental Delay, d2		0.2			13.8			27.6			7.1	
Delay (s)		16.5			33.8			41.5			18.5	
Level of Service		B			C			D			B	
Approach Delay (s)		16.5			33.8			41.5			18.5	
Approach LOS		B			C			D			B	

Intersection Summary			
HCM 2000 Control Delay	33.0	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.93		
Actuated Cycle Length (s)	58.5	Sum of lost time (s)	12.0
Intersection Capacity Utilization	88.0%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Intersection	
Int Delay, s/veh	12.3

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Vol, veh/h	10	5	130	5	0	5	285	950	120	5	720	35
Future Vol, veh/h	10	5	130	5	0	5	285	950	120	5	720	35
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	150	-	-	-	150	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	83	83	83	58	58	58	97	97	97	95	95	95
Heavy Vehicles, %	2	2	2	0	0	0	1	1	1	2	2	2
Mvmt Flow	12	6	157	9	0	9	294	979	124	5	758	37

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	2421	2478	777	2497	2434	1041	795	0	0	1103	0	0
Stage 1	787	787	-	1629	1629	-	-	-	-	-	-	-
Stage 2	1634	1691	-	868	805	-	-	-	-	-	-	-
Critical Hdwy	7.12	6.52	6.22	7.1	6.5	6.2	4.11	-	-	4.12	-	-
Critical Hdwy Stg 1	6.12	5.52	-	6.1	5.5	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.12	5.52	-	6.1	5.5	-	-	-	-	-	-	-
Follow-up Hdwy	3.518	4.018	3.318	3.5	4	3.3	2.209	-	-	2.218	-	-
Pot Cap-1 Maneuver	22	30	397	20	32	282	831	-	-	633	-	-
Stage 1	385	403	-	130	162	-	-	-	-	-	-	-
Stage 2	127	149	-	350	398	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	15	19	397	~ 7	20	282	831	-	-	633	-	-
Mov Cap-2 Maneuver	15	19	-	~ 7	20	-	-	-	-	-	-	-
Stage 1	249	397	-	84	105	-	-	-	-	-	-	-
Stage 2	80	96	-	206	392	-	-	-	-	-	-	-

Approach	SE	NW	NE	SW
HCM Control Delay, s	79.8	$ 695.3	2.5	0.1
HCM LOS	F	F		

Minor Lane/Major Mvmt	NEL	NET	NER	NWLn1	SELn1	SELn2	SWL	SWT	SWR
Capacity (veh/h)	831	-	-	14	16	397	633	-	-
HCM Lane V/C Ratio	0.354	-	-	1.232	1.13	0.395	0.008	-	-
HCM Control Delay (s)	11.7	-	-	$ 695.3	$ 598.6	19.9	10.7	0	-
HCM Lane LOS	B	-	-	F	F	C	B	A	-
HCM 95th %tile Q(veh)	1.6	-	-	2.8	2.7	1.8	0	-	-

Notes

~: Volume exceeds capacity $: Delay exceeds 300s +: Computation Not Defined *: All major volume in platoon

Interchange Justification Report
Appendix B
Synchro™ Existing Conditions Intersection Queuing Reports

I-93 Exit 4A

Prepared for:

Town of Derry
Town of Londonderry
New Hampshire Department of Transportation

Prepared by:

CLD and Louis Berger

Version: 2
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NHDOT Project Number: 13065
Federal Project Number: IM-0931(201)
CLD/Towns Project Number 05-0244

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Queuing and Blocking Report
Existing 2015 AM Peak 11/06/2017

Intersection: 1: Vista Ridge/Symmes Drive & NH 28

Movement	EB	EB	EB	WB	WB	WB	WB	NB	NB	SB	SB
Directions Served	L	T	TR	L	T	T	R	LT	R	L	LTR
Maximum Queue (ft)	26	171	190	23	385	333	32	52	75	42	62
Average Queue (ft)	6	65	75	4	170	107	4	14	28	9	19
95th Queue (ft)	24	136	153	18	320	262	16	40	61	33	48
Link Distance (ft)	402	402	402		755	755		131		368	368
Upstream Blk Time (%)											
Queuing Penalty (veh)											
Storage Bay Dist (ft)				450			500		10		
Storage Blk Time (%)					0			10	16		
Queuing Penalty (veh)					0			4	3		

Intersection: 2: Exit 5 SB On/Exit 5 SB Off & NH 28

Movement	EB	EB	EB	WB	WB	WB	SB	SB	SB
Directions Served	T	T	R	L	T	T	L	L	R
Maximum Queue (ft)	258	274	75	312	189	167	229	214	109
Average Queue (ft)	120	134	3	117	73	62	131	87	4
95th Queue (ft)	210	232	55	263	147	136	204	167	57
Link Distance (ft)	782	782		592	592	592	502	502	502
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)			350						
Storage Blk Time (%)		0	0						
Queuing Penalty (veh)		0	0						

Intersection: 3: Exit 5 NB Off & NH 28

Movement	EB	EB	EB	WB	WB	NB
Directions Served	L	T	T	T	T	L
Maximum Queue (ft)	334	139	88	184	166	336
Average Queue (ft)	115	40	17	66	70	171

95th Queue (ft)	255	99	59	140	144	302
Link Distance (ft)	592	592	592	481	481	798
Upstream Blk Time (%)						
Queuing Penalty (veh)						
Storage Bay Dist (ft)						
Storage Blk Time (%)						
Queuing Penalty (veh)						

Intersection: 4: NH 28 & Liberty Drive

Movement	EB	WB	WB	NB	NB	NB	SB	SB	SB
Directions Served	L	LT	R	L	T	TR	L	T	TR
Maximum Queue (ft)	64	43	94	26	182	200	99	88	108
Average Queue (ft)	18	4	33	5	61	89	44	18	23
95th Queue (ft)	50	24	78	21	129	161	90	55	72
Link Distance (ft)	154		502		332	332		841	841
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)		100		250			225		
Storage Blk Time (%)			0						
Queuing Penalty (veh)			0						

Intersection: 5: NH 102 & Gilcrest Road

Movement	EB	EB	WB	WB	SB	SB	SB	SB	SB	NE	NE	NE
Directions Served	LT	R	LT	R	L	L	R	R	>	<	L	LR
Maximum Queue (ft)	316	294	202	275	58	193	332	335	146	300	1203	1189
Average Queue (ft)	224	110	115	136	10	36	141	150	21	216	847	837
95th Queue (ft)	339	220	185	226	37	102	276	286	85	394	1395	1375
Link Distance (ft)	303	303	499	499			666	666			1170	1170
Upstream Blk Time (%)	8	1									24	21
Queuing Penalty (veh)	0	0									0	0
Storage Bay Dist (ft)					250	250			375	275		
Storage Blk Time (%)							2	0		0	55	
Queuing Penalty (veh)							1	0		0	75	

Intersection: 6: NH 102 & Hampton Drive/Garden Lane

Movement	SE	SE	SE	NW	NW	NE	NE	NE	NE	SW	SW	SW	SW	SW
Directions Served	L	LT	R	LT	R	L	L	T	TR	L	L	T	T	R
Maximum Queue (ft)	110	91	68	64	79	56	275	664	663	47	70	288	301	202
Average Queue (ft)	39	34	22	20	38	14	64	356	379	7	30	183	194	77
95th Queue (ft)	85	73	57	50	74	42	193	606	617	29	61	277	279	153
Link Distance (ft)	303	303	303	265				666	666			364	364	364
Upstream Blk Time (%)								0	0					
Queuing Penalty (veh)								1	1					
Storage Bay Dist (ft)					100	250	250			300	300			
Storage Blk Time (%)					0		0	25				0		
Queuing Penalty (veh)					0		0	17				0		

Intersection: 7: NH 102 & Exit 4 SB Off

Movement	EB	EB	WB	WB	SB	SB
Directions Served	T	T	T	T	L	R
Maximum Queue (ft)	165	129	101	105	262	268
Average Queue (ft)	62	32	29	29	155	25
95th Queue (ft)	132	86	83	82	244	138
Link Distance (ft)	605	605	217	217	294	294
Upstream Blk Time (%)					0	0
Queuing Penalty (veh)					0	0
Storage Bay Dist (ft)						
Storage Blk Time (%)						
Queuing Penalty (veh)						

Intersection: 8: NH 102 & Exit 4 NB Off

Movement	NB	NB	NE	NE	NE	SW	SW	SW
Directions Served	<	<	L	T	T	T	T	R

Maximum Queue (ft)	157	176	665	678	552	562	612	387
Average Queue (ft)	68	81	357	149	74	312	376	51
95th Queue (ft)	130	152	629	479	342	567	616	294
Link Distance (ft)	513	513		816	816	758	758	758
Upstream Blk Time (%)				0	0		0	
Queuing Penalty (veh)				2	0		0	
Storage Bay Dist (ft)			700					
Storage Blk Time (%)			2	0				
Queuing Penalty (veh)			5	0				

Intersection: 9: NH 102 & St. Charles Street/Londonderry Road

Movement	SE	SE	NW	NE	SW
Directions Served	LT	R	LTR	L	LTR
Maximum Queue (ft)	45	117	23	95	73
Average Queue (ft)	11	56	1	34	6
95th Queue (ft)	35	100	10	72	35
Link Distance (ft)	554		412		516
Upstream Blk Time (%)					
Queuing Penalty (veh)					
Storage Bay Dist (ft)		150		150	
Storage Blk Time (%)		0			
Queuing Penalty (veh)		0			

Intersection: 10: NH 102 & Fordway/Madden Hill Road

Movement	SE	NW	NE	SW
Directions Served	LTR	LTR	TR	LT
Maximum Queue (ft)	50	304	363	528
Average Queue (ft)	18	152	144	208
95th Queue (ft)	46	248	277	413
Link Distance (ft)	323	459	1062	560
Upstream Blk Time (%)				1
Queuing Penalty (veh)				0
Storage Bay Dist (ft)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

Queuing and Blocking Report
Existing 2015 PM Peak 11/06/2017

Intersection: 1: NH 28 & Symmes Drive

Movement	EB	EB	EB	WB	WB	WB	WB	NB	NB	SB	SB
Directions Served	L	T	TR	L	T	T	R	LT	R	L	LTR
Maximum Queue (ft)	30	155	192	48	300	244	10	44	30	49	70
Average Queue (ft)	6	65	82	9	107	46	1	8	6	9	22
95th Queue (ft)	24	130	153	35	223	154	7	30	26	34	55
Link Distance (ft)	402	402	402		755	755		131		368	368
Upstream Blk Time (%)											
Queuing Penalty (veh)											
Storage Bay Dist (ft)				450			500		10		
Storage Blk Time (%)								5	4		
Queuing Penalty (veh)								0	0		

Intersection: 2: Exit 5 SB On/Exit 5 SB Off & NH 28

Movement	EB	EB	EB	WB	WB	WB	SB	SB
Directions Served	T	T	R	L	T	T	L	L
Maximum Queue (ft)	312	338	75	196	157	172	316	273
Average Queue (ft)	145	174	3	67	53	49	186	136
95th Queue (ft)	258	281	55	147	122	120	271	236
Link Distance (ft)	782	782		592	592	592	502	502
Upstream Blk Time (%)								
Queuing Penalty (veh)								
Storage Bay Dist (ft)			350					
Storage Blk Time (%)		0	0					
Queuing Penalty (veh)		0	0					

Intersection: 3: Exit 5 NB Off & NH 28

Movement	EB	EB	EB	WB	WB	NB	NB
Directions Served	L	T	T	T	T	L	R
Maximum Queue (ft)	310	246	168	137	154	298	206
Average Queue (ft)	114	80	32	37	54	142	13

95th Queue (ft)	252	187	108	98	126	253	98
Link Distance (ft)	592	592	592	481	481	798	798
Upstream Blk Time (%)							
Queuing Penalty (veh)							
Storage Bay Dist (ft)							
Storage Blk Time (%)							
Queuing Penalty (veh)							

Intersection: 4: NH 28 & Liberty Drive

Movement	EB	WB	WB	NB	NB	NB	SB	SB	SB
Directions Served	L	LT	R	L	T	TR	L	T	TR
Maximum Queue (ft)	62	42	104	30	103	123	52	125	127
Average Queue (ft)	18	10	46	4	32	43	17	39	49
95th Queue (ft)	48	35	90	19	75	94	43	93	103
Link Distance (ft)	154		502		332	332		841	841
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)		100		250			225		
Storage Blk Time (%)			1						
Queuing Penalty (veh)			0						

Intersection: 5: NH 102 & Gilcrest Rd

Movement	EB	EB	WB	WB	SB	SB	SB	SB	SB	NE	NE	NE
Directions Served	LT	R	LT	R	L	L	R	R	>	<	L	LR
Maximum Queue (ft)	266	220	263	185	94	275	671	678	400	300	423	402
Average Queue (ft)	151	114	150	91	30	142	418	435	206	149	257	245
95th Queue (ft)	247	194	240	158	69	326	758	779	513	279	385	363
Link Distance (ft)	303	303	499	499			666	666			1170	1170
Upstream Blk Time (%)	0						1	2				
Queuing Penalty (veh)	0						6	10				
Storage Bay Dist (ft)					250	250			375	275		
Storage Blk Time (%)						0	36	21	0	0	7	
Queuing Penalty (veh)						0	54	30	1	1	12	

Intersection: 6: NH 102 & Hampton Drive/Garden Ln

Movement	SE	SE	SE	NW	NW	NE	NE	NE	NE	SW	SW	SW	SW	SW
Directions Served	L	LT	R	LT	R	L	L	T	TR	L	L	T	T	R
Maximum Queue (ft)	209	178	235	134	118	102	191	288	280	78	325	381	388	283
Average Queue (ft)	118	82	106	46	53	56	82	119	127	32	110	280	290	154
95th Queue (ft)	191	161	192	100	106	94	141	222	226	73	285	411	408	253
Link Distance (ft)	303	303	303	265				666	666			364	364	364
Upstream Blk Time (%)			0									6	6	
Queuing Penalty (veh)			0									28	31	
Storage Bay Dist (ft)					100	250	250			300	300			
Storage Blk Time (%)				1	2			1			0	12		
Queuing Penalty (veh)				0	1			1			0	14		

Intersection: 7: NH 102 & Exit 4 SB Off

Movement	EB	EB	WB	WB	SB	SB
Directions Served	T	T	T	T	L	R
Maximum Queue (ft)	366	326	238	241	307	308
Average Queue (ft)	190	158	136	133	199	128
95th Queue (ft)	330	293	238	239	301	335
Link Distance (ft)	605	605	217	217	294	294
Upstream Blk Time (%)			1	1	3	3
Queuing Penalty (veh)			6	5	14	12
Storage Bay Dist (ft)						
Storage Blk Time (%)						
Queuing Penalty (veh)						

Intersection: 8: NH 102 & Exit 4 NB Off

Movement	NB	NB	NB	NE	NE	NE	SW	SW
Directions Served	<	<	R	L	T	T	T	T

Maximum Queue (ft)	340	345	172	526	401	283	237	292
Average Queue (ft)	181	179	22	331	157	96	129	159
95th Queue (ft)	277	287	182	494	300	231	218	265
Link Distance (ft)	513	513	513		816	816	753	753
Upstream Blk Time (%)	0	0	2					
Queuing Penalty (veh)	0	0	0					
Storage Bay Dist (ft)				700				
Storage Blk Time (%)								
Queuing Penalty (veh)								

Intersection: 9: NH 102 & St. Charles Street/Londonderry Road

Movement	SE	SE	NW	NE	NE	B17	B17	SW	B20
Directions Served	LT	R	LTR	L	TR	T		LTR	T
Maximum Queue (ft)	135	154	85	174	744	758	858	504	148
Average Queue (ft)	42	56	25	96	129	261	197	53	8
95th Queue (ft)	109	114	88	180	545	800	752	276	79
Link Distance (ft)	554		412		677	757	757	516	1062
Upstream Blk Time (%)					4	2	6	1	
Queuing Penalty (veh)					48	14	42	9	
Storage Bay Dist (ft)		150		150					
Storage Blk Time (%)	0	1		6	3				
Queuing Penalty (veh)	0	0		65	8				

Intersection: 10: NH 102 & Fordway/Madden Hill Road

Movement	SE	NW	NE	B20	SW
Directions Served	LTR	LTR	TR	T	LT
Maximum Queue (ft)	77	244	1117	339	600
Average Queue (ft)	30	121	798	114	331
95th Queue (ft)	63	196	1315	439	693
Link Distance (ft)	323	459	1062	516	560
Upstream Blk Time (%)			25	0	28
Queuing Penalty (veh)			242	1	0
Storage Bay Dist (ft)					
Storage Blk Time (%)					
Queuing Penalty (veh)					

Interchange Justification Report
Appendix C
HCS Existing Conditions Freeway Operation Reports

I-93 Exit 4A

Prepared for:

Town of Derry
Town of Londonderry
New Hampshire Department of Transportation

Prepared by:

CLD and Louis Berger

Version: 2
October 10, 2019

NHDOT Project Number: 13065
Federal Project Number: IM-0931(201)
CLD/Towns Project Number 05-0244

HCS 2010 Facilities Report

Project Information

Analyst	PK/LCG	Agency	CLD
Jurisdiction		Time Period Analyzed	AM Peak - NB
Analysis Year	2015 Base - AM	Date	6/8/2017
Project Description	I-93 NB - from S. of Exit 4 to N of Exit 5		

Facility Global Input

Jam Density, pc/mi/ln	190.0	Density at Capacity, pc/mi/ln	45.0
Queue Discharge Capacity Drop, %	7	Total Segments	9
Total Time Periods	1	Time Period Duration, min	15

Segment Geometric Data

No.	Coded	Analyzed	Name	Length, ft	Lanes
1	Basic	Basic	a->b	5280	2
2	Diverge	Diverge	b.->c	1500	2
3	Basic	Basic	c->d	3275	2
4	Merge	Merge	d->e	1500	2
5	Basic	Basic	e->f	13025	2
6	Diverge	Diverge	f->g	1500	2
7	Basic	Basic	g->h	4100	2
8	Merge	Merge	h->i	1500	2
9	Basic	Basic	i->j	5280	2

Facility Segment Data

Segment 1: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.979	2152	4800	0.45	70.0	15.4	B

Segment 2: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.77	0.979	0.964	2152	552	4800	2100	0.45	0.26	62.1	62.1	17.3	15.4	B

Segment 3: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.979	1706	4800	0.36	70.0	12.2	B

Segment 4: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	

1	0.94	0.90	0.979	0.983	2904	1198	4800	2100	0.60	0.57	62.9	62.9	23.1	18.8	B

Segment 5: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.964	2902	4800	0.60	69.3	20.9	C

Segment 6: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.75	0.964	0.956	2902	572	4800	2100	0.60	0.27	62.0	62.0	23.4	24.9	C

Segment 7: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.964	2450	4800	0.51	70.0	17.5	B

Segment 8: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.83	0.964	0.972	3665	1215	4800	2100	0.76	0.58	58.9	58.9	31.1	28.8	D

Segment 9: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.964	3531	4800	0.74	66.3	26.6	D

Facility Time Period Results

T	Speed, mi/h	Density, pc/mi/ln	Density, veh/mi/ln	Travel Time, min	LOS
1	67.5	20.2	19.6	6.2	C

Facility Overall Results

Space Mean Speed, mi/h	67.5	Density, veh/mi/ln	19.6
Average Travel Time, min	6.2		

HCS 2010 Facilities Report

Project Information

Analyst	PK/LCG	Agency	
Jurisdiction		Time Period Analyzed	AM Peak - SB
Analysis Year	2015 - Base AM	Date	6/8/2017
Project Description	I-93 SB - from N of Exit 5 to S of Exit 4		

Facility Global Input

Jam Density, pc/mi/ln	190.0	Density at Capacity, pc/mi/ln	45.0
Queue Discharge Capacity Drop, %	7	Total Segments	11
Total Time Periods	1	Time Period Duration, min	15

Segment Geometric Data

No.	Coded	Analyzed	Name	Length, ft	Lanes
1	Basic	Basic	a->b	5280	2
2	Diverge	Diverge	b->c	1500	2
3	Basic	Basic	c->d	3920	2
4	Merge	Merge	d->e	1500	2
5	Basic	Basic	e->f	11730	2
6	Diverge	Diverge	f->g	1500	2
7	Basic	Basic	g->h	2550	2
8	Merge	Merge	h->i	1500	2
9	Basic	Basic	i->j	600	2
10	Merge	Merge	j->k	1500	2
11	Basic	Basic	l->m	5280	2

Facility Segment Data

Segment 1: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.970	3570	4800	0.74	66.0	27.0	D

Segment 2: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.74	0.970	0.972	3570	1057	4800	2100	0.74	0.50	60.8	60.8	29.4	30.3	D

Segment 3: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.970	2736	4800	0.57	69.7	19.6	C

Segment 4: Merge

Time	PHF	fHV	Flow Rate	Capacity	d/c	Speed	Density	LOS

Period					(pc/h)		(pc/h)		Ratio		(mi/h)		(pc/mi/ln)		
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.84	0.970	0.953	3379	643	4800	2100	0.70	0.31	60.3	60.3	28.0	26.0	C

Segment 5: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.970	3301	4800	0.69	67.7	24.4	C

Segment 6: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.95	0.970	0.975	3301	815	4800	2100	0.69	0.39	61.4	61.4	26.9	26.0	C

Segment 7: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	2448	4800	0.51	70.0	17.5	B

Segment 8: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.82	0.980	0.970	3102	654	4800	1900	0.65	0.34	61.1	61.1	25.4	20.0	B

Segment 9: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	3012	4800	0.63	68.9	21.9	C

Segment 10: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.82	0.980	0.970	3848	836	4800	2100	0.80	0.40	59.8	59.8	32.2	26.3	C

Segment 11: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	3734	4800	0.78	64.9	28.8	D

Facility Time Period Results

T	Speed, mi/h	Density, pc/mi/ln	Density, veh/mi/ln	Travel Time, min	LOS
1	65.8	25.2	24.5	6.4	C

Facility Overall Results

Space Mean Speed, mi/h	65.8	Density, veh/mi/ln	24.5
Average Travel Time, min	6.4		

HCS 2010 Facilities Report

Project Information

Analyst	PK/LCG	Agency	CLD
Jurisdiction		Time Period Analyzed	2015 PM Peak - NB
Analysis Year	2015- Base PM	Date	6/8/2017
Project Description	I-93 NB - from S. of Exit 4 to N of Exit 5		

Facility Global Input

Jam Density, pc/mi/ln	190.0	Density at Capacity, pc/mi/ln	45.0
Queue Discharge Capacity Drop, %	7	Total Segments	9
Total Time Periods	1	Time Period Duration, min	15

Segment Geometric Data

No.	Coded	Analyzed	Name	Length, ft	Lanes
1	Basic	Basic	a->b	5280	2
2	Diverge	Diverge	b.->c	1500	2
3	Basic	Basic	c->d	3275	2
4	Merge	Merge	d->e	1500	2
5	Basic	Basic	e->f	13025	2
6	Diverge	Diverge	f->g	1500	2
7	Basic	Basic	g->h	4100	2
8	Merge	Merge	h->i	1500	2
9	Basic	Basic	i->j	5280	2

Facility Segment Data

Segment 1: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.979	3705	4800	0.77	65.1	28.4	D

Segment 2: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.92	0.979	0.991	3705	1300	4800	2100	0.77	0.62	60.2	60.2	30.8	28.8	D

Segment 3: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.979	2418	4800	0.50	70.0	17.3	B

Segment 4: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	

1	0.94	0.87	0.979	0.988	3337	919	4800	2100	0.70	0.44	61.9	61.9	27.0	22.3	C

Segment 5: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.985	3256	4800	0.68	67.9	24.0	C

Segment 6: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.67	0.985	0.964	3256	712	4800	2100	0.68	0.34	61.7	61.7	26.4	27.9	C

Segment 7: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.985	2759	4800	0.57	69.6	19.8	C

Segment 8: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.89	0.985	0.988	3635	876	4800	2100	0.76	0.42	59.0	59.0	30.8	28.7	D

Segment 9: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.985	3591	4800	0.75	65.9	27.3	D

Facility Time Period Results

T	Speed, mi/h	Density, pc/mi/ln	Density, veh/mi/ln	Travel Time, min	LOS
1	66.2	24.8	24.4	6.3	C

Facility Overall Results

Space Mean Speed, mi/h	66.2	Density, veh/mi/ln	24.4
Average Travel Time, min	6.3		

HCS 2010 Facilities Report

Project Information

Analyst	PK/LCG	Agency	
Jurisdiction		Time Period Analyzed	2015 PM Peak - SB
Analysis Year	2015 Base - PM	Date	6/10/2017
Project Description	I93 SB - from N of Exit 5 to S of Exit 4		

Facility Global Input

Jam Density, pc/mi/ln	190.0	Density at Capacity, pc/mi/ln	45.0
Queue Discharge Capacity Drop, %	7	Total Segments	11
Total Time Periods	1	Time Period Duration, min	15

Segment Geometric Data

No.	Coded	Analyzed	Name	Length, ft	Lanes
1	Basic	Basic	a->b	5280	2
2	Diverge	Diverge	b->c	1500	2
3	Basic	Basic	c->d	3920	2
4	Merge	Merge	d->e	1500	2
5	Basic	Basic	e->f	11730	2
6	Diverge	Diverge	f->g	1500	2
7	Basic	Basic	g->h	2550	2
8	Merge	Merge	h->i	1500	2
9	Basic	Basic	i->j	600	2
10	Merge	Merge	j->k	1500	2
11	Basic	Basic	l->m	5280	2

Facility Segment Data

Segment 1: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.982	3645	4800	0.76	65.5	27.8	D

Segment 2: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.89	0.982	0.979	3645	1044	4800	2100	0.76	0.50	60.8	60.8	30.0	30.9	D

Segment 3: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.982	2660	4800	0.55	69.8	19.1	C

Segment 4: Merge

Time	PHF	fHV	Flow Rate	Capacity	d/c	Speed	Density	LOS

Period					(pc/h)		(pc/h)		Ratio		(mi/h)		(pc/mi/ln)		
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.81	0.982	0.978	3184	524	4800	2100	0.66	0.25	60.8	60.8	26.2	24.6	C

Segment 5: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.982	3109	4800	0.65	68.5	22.7	C

Segment 6: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.92	0.982	0.986	3109	1020	4800	2100	0.65	0.49	60.9	60.9	25.5	24.3	C

Segment 7: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	2111	4800	0.44	70.0	15.1	B

Segment 8: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.82	0.980	0.980	2379	268	4800	1900	0.50	0.14	62.4	62.4	19.1	14.5	B

Segment 9: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	2345	4764	0.49	68.2	17.2	B

Segment 10: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.82	0.980	0.980	2718	373	4800	2100	0.57	0.18	63.3	63.3	21.5	17.7	B

Segment 11: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	2670	4800	0.56	69.8	19.1	C

Facility Time Period Results

T	Speed, mi/h	Density, pc/mi/ln	Density, veh/mi/ln	Travel Time, min	LOS
1	66.9	22.3	21.9	6.3	C

Facility Overall Results

Space Mean Speed, mi/h	66.9	Density, veh/mi/ln	21.9
Average Travel Time, min	6.3		

Interchange Justification Report
Appendix D
Synchro™ No Build Condition Intersection Analysis Reports

I-93 Exit 4A

Prepared for:

Town of Derry
Town of Londonderry
New Hampshire Department of Transportation

Prepared by:

CLD and Louis Berger

Version: 2
October 10, 2019

NHDOT Project Number: 13065
Federal Project Number: IM-0931(201)
CLD/Towns Project Number 05-0244

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Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	286	866	18	16	1077	112	64	0	111	193	0	18
Future Volume (vph)	286	866	18	16	1077	112	64	0	111	193	0	18
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0		6.0	6.0	6.0		6.0	6.0	6.0	6.0	
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00		1.00	1.00	0.95	0.95	
Frt	1.00	1.00		1.00	1.00	0.85		1.00	0.85	1.00	0.97	
Flt Protected	0.95	1.00		0.95	1.00	1.00		0.95	1.00	0.95	0.96	
Satd. Flow (prot)	1583	3157		1687	3374	1509		1770	1583	1681	1655	
Flt Permitted	0.95	1.00		0.95	1.00	1.00		0.95	1.00	0.95	0.96	
Satd. Flow (perm)	1583	3157		1687	3374	1509		1770	1583	1681	1655	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	311	941	20	17	1171	122	70	0	121	210	0	20
RTOR Reduction (vph)	0	1	0	0	0	72	0	0	110	0	107	0
Lane Group Flow (vph)	311	960	0	17	1171	50	0	70	11	115	8	0
Heavy Vehicles (%)	14%	14%	14%	7%	7%	7%	2%	2%	2%	2%	2%	2%
Turn Type	Prot	NA		Prot	NA	Prot	Split	NA	Prot	Split	NA	
Protected Phases	5	2		1	6	6	3	3	3	4	4	
Permitted Phases												
Actuated Green, G (s)	22.0	64.7		2.0	44.7	44.7		10.0	10.0	8.0	8.0	
Effective Green, g (s)	22.0	64.7		2.0	44.7	44.7		10.0	10.0	8.0	8.0	
Actuated g/C Ratio	0.20	0.60		0.02	0.41	0.41		0.09	0.09	0.07	0.07	
Clearance Time (s)	6.0	6.0		6.0	6.0	6.0		6.0	6.0	6.0	6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0		3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	320	1879		31	1387	620		162	145	123	121	
v/s Ratio Prot	c0.20	0.30		0.01	c0.35	0.03		c0.04	0.01	c0.07	0.01	
v/s Ratio Perm												
v/c Ratio	0.97	0.51		0.55	0.84	0.08		0.43	0.08	0.93	0.07	
Uniform Delay, d1	43.0	12.8		52.9	28.9	19.5		46.7	45.1	50.1	46.9	
Progression Factor	1.00	1.00		1.00	1.00	1.00		1.00	1.00	1.00	1.00	
Incremental Delay, d2	42.5	0.2		18.4	4.9	0.1		1.8	0.2	60.7	0.2	
Delay (s)	85.5	13.0		71.3	33.8	19.5		48.5	45.4	110.8	47.1	
Level of Service	F	B		E	C	B		D	D	F	D	
Approach Delay (s)		30.8			32.9			46.5			79.0	
Approach LOS		C			C			D			E	

Intersection Summary			
HCM 2000 Control Delay	36.4	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.84		
Actuated Cycle Length (s)	108.7	Sum of lost time (s)	24.0
Intersection Capacity Utilization	73.2%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	810	360	390	650	0	0	0	0	550	0	555
Future Volume (vph)	0	810	360	390	650	0	0	0	0	550	0	555
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0	4.0	6.0	6.0					6.0		6.0
Lane Util. Factor		0.95	1.00	1.00	0.95					0.97		1.00
Frt		1.00	0.85	1.00	1.00					1.00		0.85
Flt Protected		1.00	1.00	0.95	1.00					0.95		1.00
Satd. Flow (prot)		3167	1417	1687	3374					3303		1524
Flt Permitted		1.00	1.00	0.95	1.00					0.95		1.00
Satd. Flow (perm)		3167	1417	1687	3374					3303		1524
Peak-hour factor, PHF	0.92	0.92	0.92	0.73	0.73	0.73	0.92	0.92	0.92	0.74	0.74	0.74
Adj. Flow (vph)	0	880	391	534	890	0	0	0	0	743	0	750
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	106
Lane Group Flow (vph)	0	880	391	534	890	0	0	0	0	743	0	644
Heavy Vehicles (%)	14%	14%	14%	7%	7%	7%	2%	2%	2%	6%	6%	6%
Turn Type		NA	Free	Prot	NA					Prot		Prot
Protected Phases		2		1	6					4		4
Permitted Phases			Free									
Actuated Green, G (s)		40.0	140.0	38.0	84.0					44.0		44.0
Effective Green, g (s)		40.0	140.0	38.0	84.0					44.0		44.0
Actuated g/C Ratio		0.29	1.00	0.27	0.60					0.31		0.31
Clearance Time (s)		6.0		6.0	6.0					6.0		6.0
Vehicle Extension (s)		5.0		3.0	5.0					3.0		3.0
Lane Grp Cap (vph)		904	1417	457	2024					1038		478
v/s Ratio Prot		c0.28		c0.32	0.26					0.22		c0.42
v/s Ratio Perm			0.28									
v/c Ratio		0.97	0.28	1.17	0.44					0.72		1.35
Uniform Delay, d1		49.5	0.0	51.0	15.2					42.5		48.0
Progression Factor		1.00	1.00	0.36	0.10					1.00		1.00
Incremental Delay, d2		24.2	0.5	92.9	0.3					2.4		169.5
Delay (s)		73.6	0.5	111.5	1.8					44.8		217.5
Level of Service		E	A	F	A					D		F
Approach Delay (s)		51.1			42.9			0.0			131.6	
Approach LOS		D			D			A			F	

Intersection Summary			
HCM 2000 Control Delay	77.0	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.17		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	89.8%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	635	725	0	0	650	775	390	0	165	0	0	0
Future Volume (vph)	635	725	0	0	650	775	390	0	165	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0			6.0	4.0	6.0		6.0			
Lane Util. Factor	1.00	0.95			0.95	1.00	1.00		1.00			
Frt	1.00	1.00			1.00	0.85	1.00		0.85			
Flt Protected	0.95	1.00			1.00	1.00	0.95		1.00			
Satd. Flow (prot)	1641	3282			3438	1538	1656		1482			
Flt Permitted	0.95	1.00			1.00	1.00	0.95		1.00			
Satd. Flow (perm)	1641	3282			3438	1538	1656		1482			
Peak-hour factor, PHF	0.87	0.87	0.87	0.90	0.90	0.90	0.78	0.78	0.78	0.92	0.92	0.92
Adj. Flow (vph)	730	833	0	0	722	861	500	0	212	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	120	0	0	0
Lane Group Flow (vph)	730	833	0	0	722	861	500	0	92	0	0	0
Heavy Vehicles (%)	10%	10%	10%	5%	5%	5%	9%	9%	9%	2%	2%	2%
Turn Type	Prot	NA			NA	Free	Prot		Prot			
Protected Phases	5	2			6		8		8			
Permitted Phases		2			6	Free						
Actuated Green, G (s)	56.0	90.0			28.0	140.0	38.0		38.0			
Effective Green, g (s)	56.0	90.0			28.0	140.0	38.0		38.0			
Actuated g/C Ratio	0.40	0.64			0.20	1.00	0.27		0.27			
Clearance Time (s)	6.0	6.0			6.0		6.0		6.0			
Vehicle Extension (s)	5.0	5.0			5.0		3.0		3.0			
Lane Grp Cap (vph)	656	2109			687	1538	449		402			
v/s Ratio Prot	c0.44	0.25			c0.21		c0.30		0.06			
v/s Ratio Perm						0.56						
v/c Ratio	1.11	0.39			1.05	0.56	1.11		0.23			
Uniform Delay, d1	42.0	12.0			56.0	0.0	51.0		39.6			
Progression Factor	0.22	0.02			1.00	1.00	1.00		1.00			
Incremental Delay, d2	58.7	0.3			48.5	1.5	77.2		0.3			
Delay (s)	67.9	0.6			104.5	1.5	128.2		39.9			
Level of Service	E	A			F	A	F		D			
Approach Delay (s)		32.0			48.5			101.9			0.0	
Approach LOS		C			D			F			A	

Intersection Summary			
HCM 2000 Control Delay	51.7	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	1.10		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	89.8%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	25	0	0	7	0	54	5	990	33	63	291	0
Future Volume (vph)	25	0	0	7	0	54	5	990	33	63	291	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0				6.0	6.0	6.0	6.0		6.0	6.0	
Lane Util. Factor	1.00				1.00	1.00	1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00				1.00	0.97	1.00	1.00		1.00	1.00	
Flpb, ped/bikes	1.00				1.00	1.00	1.00	1.00		1.00	1.00	
Frt	1.00				1.00	0.85	1.00	1.00		1.00	1.00	
Flt Protected	0.95				0.95	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770				1253	1089	1752	3488		1626	3252	
Flt Permitted	0.75				0.76	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1399				999	1089	1752	3488		1626	3252	
Peak-hour factor, PHF	0.92	0.92	0.92	0.71	0.71	0.71	0.86	0.86	0.86	0.92	0.92	0.92
Adj. Flow (vph)	27	0	0	10	0	76	6	1151	38	68	316	0
RTOR Reduction (vph)	0	0	0	0	0	71	0	2	0	0	0	0
Lane Group Flow (vph)	27	0	0	0	10	5	6	1187	0	68	316	0
Confl. Bikes (#/hr)						5						
Heavy Vehicles (%)	2%	2%	2%	44%	44%	44%	3%	3%	3%	11%	11%	11%
Turn Type	Perm			Perm	NA	Perm	Prot	NA		Prot	NA	
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4			8		8						
Actuated Green, G (s)	5.9				5.9	5.9	1.1	58.3		7.4	64.6	
Effective Green, g (s)	5.9				5.9	5.9	1.1	58.3		7.4	64.6	
Actuated g/C Ratio	0.07				0.07	0.07	0.01	0.65		0.08	0.72	
Clearance Time (s)	6.0				6.0	6.0	6.0	6.0		6.0	6.0	
Vehicle Extension (s)	3.0				3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	92				65	71	21	2269		134	2344	
v/s Ratio Prot							0.00	c0.34		c0.04	0.10	
v/s Ratio Perm	c0.02				0.01	0.00						
v/c Ratio	0.29				0.15	0.07	0.29	0.52		0.51	0.13	
Uniform Delay, d1	39.9				39.5	39.3	43.9	8.3		39.4	3.9	
Progression Factor	1.00				1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2	1.8				1.1	0.4	7.4	0.2		3.0	0.0	
Delay (s)	41.6				40.6	39.7	51.2	8.5		42.4	3.9	
Level of Service	D				D	D	D	A		D	A	
Approach Delay (s)		41.6			39.8			8.7			10.7	
Approach LOS		D			D			A			B	

Intersection Summary			
HCM 2000 Control Delay	11.3	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.50		
Actuated Cycle Length (s)	89.6	Sum of lost time (s)	18.0
Intersection Capacity Utilization	55.6%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	28	1030	28	123	915	47	57	9	33	262	9	245
Future Volume (vph)	28	1030	28	123	915	47	57	9	33	262	9	245
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0		6.0	6.0	6.0		6.0	6.0	6.0	6.0	
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00		1.00	1.00	0.95	0.95	
Frt	1.00	1.00		1.00	1.00	0.85		1.00	0.85	1.00	0.87	
Flt Protected	0.95	1.00		0.95	1.00	1.00		0.96	1.00	0.95	1.00	
Satd. Flow (prot)	1736	3457		1719	3438	1538		1786	1583	1681	1531	
Flt Permitted	0.95	1.00		0.95	1.00	1.00		0.96	1.00	0.95	1.00	
Satd. Flow (perm)	1736	3457		1719	3438	1538		1786	1583	1681	1531	
Peak-hour factor, PHF	0.87	0.87	0.87	0.86	0.86	0.86	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	32	1184	32	143	1064	55	62	10	36	285	10	266
RTOR Reduction (vph)	0	2	0	0	0	27	0	0	33	0	197	0
Lane Group Flow (vph)	32	1214	0	143	1064	28	0	72	3	256	108	0
Heavy Vehicles (%)	4%	4%	4%	5%	5%	5%	2%	2%	2%	2%	2%	2%
Turn Type	Prot	NA		Prot	NA	Prot	Split	NA	Prot	Split	NA	
Protected Phases	5	2		1	6	6	3	3	3	4	4	
Permitted Phases												
Actuated Green, G (s)	2.8	49.1		11.7	58.0	58.0		8.4	8.4	20.6	20.6	
Effective Green, g (s)	2.8	49.1		11.7	58.0	58.0		8.4	8.4	20.6	20.6	
Actuated g/C Ratio	0.02	0.43		0.10	0.51	0.51		0.07	0.07	0.18	0.18	
Clearance Time (s)	6.0	6.0		6.0	6.0	6.0		6.0	6.0	6.0	6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0		3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	42	1491		176	1752	783		131	116	304	277	
v/s Ratio Prot	0.02	c0.35		c0.08	0.31	0.02		c0.04	0.00	c0.15	0.07	
v/s Ratio Perm												
v/c Ratio	0.76	0.81		0.81	0.61	0.04		0.55	0.02	0.84	0.39	
Uniform Delay, d1	55.2	28.4		50.0	19.8	13.9		50.9	48.9	45.0	41.1	
Progression Factor	1.00	1.00		1.00	1.00	1.00		1.00	1.00	1.00	1.00	
Incremental Delay, d2	56.2	3.5		24.0	0.6	0.0		4.7	0.1	18.6	0.9	
Delay (s)	111.3	31.9		74.0	20.4	14.0		55.5	49.0	63.6	42.0	
Level of Service	F	C		E	C	B		E	D	E	D	
Approach Delay (s)		33.9			26.2			53.3			51.9	
Approach LOS		C			C			D			D	

Intersection Summary			
HCM 2000 Control Delay	34.7	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	113.8	Sum of lost time (s)	24.0
Intersection Capacity Utilization	77.0%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
2: Exit 5 SB On/Exit 5 SB Off & NH 28

01/19/2018

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	935	390	240	550	0	0	0	0	820	0	535
Future Volume (vph)	0	935	390	240	550	0	0	0	0	820	0	535
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0	4.0	6.0	6.0					6.0		6.0
Lane Util. Factor		0.95	1.00	1.00	0.95					0.97		1.00
Frt		1.00	0.85	1.00	1.00					1.00		0.85
Flt Protected		1.00	1.00	0.95	1.00					0.95		1.00
Satd. Flow (prot)		3471	1553	1719	3438					3367		1553
Flt Permitted		1.00	1.00	0.95	1.00					0.95		1.00
Satd. Flow (perm)		3471	1553	1719	3438					3367		1553
Peak-hour factor, PHF	0.87	0.87	0.87	0.86	0.86	0.86	0.92	0.92	0.92	0.91	0.91	0.91
Adj. Flow (vph)	0	1075	448	279	640	0	0	0	0	901	0	588
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	189
Lane Group Flow (vph)	0	1075	448	279	640	0	0	0	0	901	0	399
Heavy Vehicles (%)	4%	4%	4%	5%	5%	5%	2%	2%	2%	4%	4%	4%
Turn Type		NA	Free	Prot	NA					Prot		Prot
Protected Phases		2		1	6					4		4
Permitted Phases			Free									
Actuated Green, G (s)		35.3	100.0	17.7	59.0					29.0		29.0
Effective Green, g (s)		35.3	100.0	17.7	59.0					29.0		29.0
Actuated g/C Ratio		0.35	1.00	0.18	0.59					0.29		0.29
Clearance Time (s)		6.0		6.0	6.0					6.0		6.0
Vehicle Extension (s)		5.0		3.0	5.0					3.0		3.0
Lane Grp Cap (vph)		1225	1553	304	2028					976		450
v/s Ratio Prot		c0.31		c0.16	0.19					c0.27		0.26
v/s Ratio Perm			0.29									
v/c Ratio		0.88	0.29	0.92	0.32					0.92		0.89
Uniform Delay, d1		30.3	0.0	40.4	10.3					34.4		33.9
Progression Factor		1.00	1.00	0.12	0.00					1.00		1.00
Incremental Delay, d2		9.0	0.5	16.0	0.2					13.8		18.6
Delay (s)		39.4	0.5	20.7	0.2					48.2		52.5
Level of Service		D	A	C	A					D		D
Approach Delay (s)		27.9			6.4			0.0			49.9	
Approach LOS		C			A			A			D	

Intersection Summary			
HCM 2000 Control Delay	31.2	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.90		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	78.5%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	605	1150	0	0	495	545	295	0	375	0	0	0
Future Volume (vph)	605	1150	0	0	495	545	295	0	375	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0			6.0	4.0	6.0		6.0			
Lane Util. Factor	1.00	0.95			0.95	1.00	1.00		1.00			
Frt	1.00	1.00			1.00	0.85	1.00		0.85			
Flt Protected	0.95	1.00			1.00	1.00	0.95		1.00			
Satd. Flow (prot)	1752	3505			3505	1568	1703		1524			
Flt Permitted	0.95	1.00			1.00	1.00	0.95		1.00			
Satd. Flow (perm)	1752	3505			3505	1568	1703		1524			
Peak-hour factor, PHF	0.92	0.92	0.92	0.91	0.91	0.91	0.67	0.67	0.67	0.92	0.92	0.92
Adj. Flow (vph)	658	1250	0	0	544	599	440	0	560	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	69	0	0	0
Lane Group Flow (vph)	658	1250	0	0	544	599	440	0	491	0	0	0
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	6%	6%	6%	2%	2%	2%
Turn Type	Prot	NA			NA	Free	Prot		Prot			
Protected Phases	5	2			6		8		8			
Permitted Phases		2			6	Free						
Actuated Green, G (s)	35.0	58.0			17.0	100.0	30.0		30.0			
Effective Green, g (s)	35.0	58.0			17.0	100.0	30.0		30.0			
Actuated g/C Ratio	0.35	0.58			0.17	1.00	0.30		0.30			
Clearance Time (s)	6.0	6.0			6.0		6.0		6.0			
Vehicle Extension (s)	5.0	5.0			5.0		3.0		3.0			
Lane Grp Cap (vph)	613	2032			595	1568	510		457			
v/s Ratio Prot	c0.38	0.36			c0.16		0.26		c0.32			
v/s Ratio Perm						0.38						
v/c Ratio	1.07	0.62			0.91	0.38	0.86		1.08			
Uniform Delay, d1	32.5	13.7			40.8	0.0	33.1		35.0			
Progression Factor	0.20	0.41			1.00	1.00	1.00		1.00			
Incremental Delay, d2	46.9	0.6			20.9	0.7	14.0		63.8			
Delay (s)	53.5	6.1			61.7	0.7	47.1		98.8			
Level of Service	D	A			E	A	D		F			
Approach Delay (s)		22.5			29.7			76.0			0.0	
Approach LOS		C			C			E			A	

Intersection Summary			
HCM 2000 Control Delay	37.7	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	1.04		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	78.5%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	25	0	0	18	0	88	5	392	4	39	761	0
Future Volume (vph)	25	0	0	18	0	88	5	392	4	39	761	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0				6.0	6.0	6.0	6.0		6.0	6.0	
Lane Util. Factor	1.00				1.00	1.00	1.00	0.95		1.00	0.95	
Frt	1.00				1.00	0.85	1.00	1.00		1.00	1.00	
Flt Protected	0.95				0.95	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770				1577	1568	1752	3499		1719	3438	
Flt Permitted	0.74				0.76	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1373				1257	1568	1752	3499		1719	3438	
Peak-hour factor, PHF	0.92	0.92	0.92	0.58	0.58	0.58	0.86	0.86	0.86	0.91	0.91	0.91
Adj. Flow (vph)	27	0	0	31	0	152	6	456	5	43	836	0
RTOR Reduction (vph)	0	0	0	0	0	130	0	1	0	0	0	0
Lane Group Flow (vph)	27	0	0	0	31	22	6	460	0	43	836	0
Heavy Vehicles (%)	2%	2%	2%	3%	3%	3%	3%	3%	3%	5%	5%	5%
Parking (#/hr)					0							
Turn Type	Perm			Perm	NA	Prot	Prot	NA		Prot	NA	
Protected Phases		4			8	8	5	2		1	6	
Permitted Phases	4			8								
Actuated Green, G (s)	8.3				8.3	8.3	0.9	27.5		2.9	29.5	
Effective Green, g (s)	8.3				8.3	8.3	0.9	27.5		2.9	29.5	
Actuated g/C Ratio	0.15				0.15	0.15	0.02	0.49		0.05	0.52	
Clearance Time (s)	6.0				6.0	6.0	6.0	6.0		6.0	6.0	
Vehicle Extension (s)	3.0				3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	200				184	229	27	1697		87	1788	
v/s Ratio Prot						0.01	0.00	0.13		c0.03	c0.24	
v/s Ratio Perm	0.02				c0.02							
v/c Ratio	0.14				0.17	0.10	0.22	0.27		0.49	0.47	
Uniform Delay, d1	21.1				21.2	21.0	27.6	8.7		26.2	8.6	
Progression Factor	1.00				1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.3				0.4	0.2	4.1	0.1		4.4	0.2	
Delay (s)	21.4				21.6	21.1	31.7	8.7		30.6	8.8	
Level of Service	C				C	C	C	A		C	A	
Approach Delay (s)		21.4			21.2			9.0			9.9	
Approach LOS		C			C			A			A	

Intersection Summary			
HCM 2000 Control Delay	11.2	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.43		
Actuated Cycle Length (s)	56.7	Sum of lost time (s)	18.0
Intersection Capacity Utilization	48.3%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SBL	SBR	SBR2	NEL2	NEL	NER
Lane Configurations												
Traffic Volume (vph)	307	150	258	223	81	309	113	1117	82	209	1971	74
Future Volume (vph)	307	150	258	223	81	309	113	1117	82	209	1971	74
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	7.0	7.0	7.0		7.0	7.0	7.0	7.0	7.0	7.0	7.0	
Lane Util. Factor	1.00	1.00	1.00		1.00	1.00	0.97	0.76	1.00	0.97	0.94	
Frt	1.00	1.00	0.85		1.00	0.85	1.00	0.85	0.85	1.00	0.99	
Flt Protected	0.95	1.00	1.00		0.96	1.00	0.95	1.00	1.00	0.95	0.95	
Satd. Flow (prot)	1770	1863	1583		1797	1583	3303	3474	1524	3367	4888	
Flt Permitted	0.95	1.00	1.00		0.96	1.00	0.95	1.00	1.00	0.95	0.95	
Satd. Flow (perm)	1770	1863	1583		1797	1583	3303	3474	1524	3367	4888	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.88	0.88	0.88	0.93	0.93	0.93
Adj. Flow (vph)	334	163	280	242	88	336	128	1269	93	225	2119	80
RTOR Reduction (vph)	0	0	189	0	0	130	0	0	58	0	100	0
Lane Group Flow (vph)	334	163	91	0	330	206	128	1269	35	225	2099	0
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	6%	6%	6%	4%	4%	4%
Turn Type	Split	NA	Prot	Split	NA	pt+ov	Prot	Prot	Prot	Prot	Prot	
Protected Phases	4	4	4	8	8	1 8	1	6	6	5	2	
Permitted Phases												
Actuated Green, G (s)	20.0	20.0	20.0		19.0	25.0	6.0	45.0	45.0	8.0	47.0	
Effective Green, g (s)	20.0	20.0	20.0		19.0	25.0	6.0	45.0	45.0	8.0	47.0	
Actuated g/C Ratio	0.17	0.17	0.17		0.16	0.21	0.05	0.38	0.38	0.07	0.39	
Clearance Time (s)	7.0	7.0	7.0		7.0		7.0	7.0	7.0	7.0	7.0	
Vehicle Extension (s)	3.0	3.0	3.0		3.0		3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	295	310	263		284	329	165	1302	571	224	1914	
v/s Ratio Prot	c0.19	0.09	0.06		c0.18	0.13	0.04	c0.37	0.02	0.07	c0.43	
v/s Ratio Perm												
v/c Ratio	1.13	0.53	0.35		1.16	0.63	0.78	0.97	0.06	1.00	1.10	
Uniform Delay, d1	50.0	45.7	44.2		50.5	43.3	56.3	36.9	24.0	56.0	36.5	
Progression Factor	1.00	1.00	1.00		1.00	1.00	0.64	0.43	1.00	1.00	1.00	
Incremental Delay, d2	92.9	1.6	0.8		104.6	3.7	17.8	17.9	0.2	61.3	52.4	
Delay (s)	142.9	47.3	45.0		155.1	47.0	53.7	33.7	24.2	117.3	88.9	
Level of Service	F	D	D		F	D	D	C	C	F	F	
Approach Delay (s)		87.6			100.5		34.9				91.5	
Approach LOS		F			F		C				F	

Intersection Summary			
HCM 2000 Control Delay	76.3	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.14		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	28.0
Intersection Capacity Utilization	105.6%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Volume (vph)	316	17	131	22	17	101	148	2318	114	56	1154	295
Future Volume (vph)	316	17	131	22	17	101	148	2318	114	56	1154	295
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	7.0	7.0	7.0		7.0	7.0	7.0	7.0		7.0	7.0	7.0
Lane Util. Factor	0.95	0.95	1.00		1.00	1.00	0.97	0.91		0.97	0.91	1.00
Frt	1.00	1.00	0.85		1.00	0.85	1.00	0.99		1.00	1.00	0.85
Flt Protected	0.95	0.96	1.00		0.97	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1681	1693	1583		1811	1583	3367	4952		3303	4893	1524
Flt Permitted	0.95	0.96	1.00		0.97	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	1681	1693	1583		1811	1583	3367	4952		3303	4893	1524
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.93	0.93	0.93	0.88	0.88	0.88
Adj. Flow (vph)	343	18	142	24	18	110	159	2492	123	64	1311	335
RTOR Reduction (vph)	0	0	100	0	0	88	0	4	0	0	0	133
Lane Group Flow (vph)	178	183	42	0	42	23	159	2611	0	64	1311	202
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	4%	4%	4%	6%	6%	6%
Turn Type	Split	NA	pt+ov	Split	NA	pt+ov	Prot	NA		Prot	NA	pt+ov
Protected Phases	4	4	4 5	8	8	1 8	5	2		1	6	4 6
Permitted Phases												
Actuated Green, G (s)	14.0	14.0	30.8		10.0	15.0	9.8	63.0		5.0	58.2	72.2
Effective Green, g (s)	14.0	14.0	30.8		10.0	15.0	9.8	63.0		5.0	58.2	72.2
Actuated g/C Ratio	0.12	0.12	0.26		0.08	0.12	0.08	0.52		0.04	0.49	0.60
Clearance Time (s)	7.0	7.0			7.0		7.0	7.0		7.0	7.0	
Vehicle Extension (s)	4.0	4.0			4.0		4.0	4.0		4.0	4.0	
Lane Grp Cap (vph)	196	197	406		150	197	274	2599		137	2373	916
v/s Ratio Prot	0.11	c0.11	0.03		c0.02	0.01	c0.05	c0.53		0.02	0.27	0.13
v/s Ratio Perm												
v/c Ratio	0.91	0.93	0.10		0.28	0.11	0.58	1.00		0.47	0.55	0.22
Uniform Delay, d1	52.4	52.5	34.1		51.6	46.6	53.1	28.5		56.2	21.7	11.0
Progression Factor	1.00	1.00	1.00		1.00	1.00	1.15	0.30		1.06	0.75	1.85
Incremental Delay, d2	39.8	44.4	0.2		4.6	0.4	0.3	6.4		2.4	0.7	0.1
Delay (s)	92.2	96.9	34.2		56.2	47.0	61.3	14.9		62.2	16.9	20.4
Level of Service	F	F	C		E	D	E	B		E	B	C
Approach Delay (s)		77.5			49.5			17.6			19.3	
Approach LOS		E			D			B			B	

Intersection Summary			
HCM 2000 Control Delay	24.9	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.92		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	28.0
Intersection Capacity Utilization	84.6%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↑↑	↑↑		↰	↱↱
Traffic Volume (vph)	0	1315	670	0	790	835
Future Volume (vph)	0	1315	670	0	790	835
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	12	16	12
Total Lost time (s)		6.0	6.0		6.0	6.0
Lane Util. Factor		0.95	0.95		1.00	0.88
Frt		1.00	1.00		1.00	0.85
Flt Protected		1.00	1.00		0.95	1.00
Satd. Flow (prot)		3471	3406		1930	2682
Flt Permitted		1.00	1.00		0.95	1.00
Satd. Flow (perm)		3471	3406		1930	2682
Peak-hour factor, PHF	0.93	0.93	0.88	0.88	0.89	0.89
Adj. Flow (vph)	0	1414	761	0	888	938
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	0	1414	761	0	888	938
Heavy Vehicles (%)	4%	4%	6%	6%	6%	6%
Turn Type		NA	NA		Prot	Prot
Protected Phases		2	6		4	4
Permitted Phases						
Actuated Green, G (s)		23.0	23.0		25.0	25.0
Effective Green, g (s)		23.0	23.0		25.0	25.0
Actuated g/C Ratio		0.38	0.38		0.42	0.42
Clearance Time (s)		6.0	6.0		6.0	6.0
Vehicle Extension (s)		3.0	3.0		3.0	3.0
Lane Grp Cap (vph)		1330	1305		804	1117
v/s Ratio Prot		c0.41	0.22		c0.46	0.35
v/s Ratio Perm						
v/c Ratio		1.06	0.58		1.10	0.84
Uniform Delay, d1		18.5	14.7		17.5	15.7
Progression Factor		1.03	0.90		1.00	1.00
Incremental Delay, d2		34.1	0.2		64.3	5.7
Delay (s)		53.2	13.4		81.8	21.4
Level of Service		D	B		F	C
Approach Delay (s)		53.2	13.4		50.8	
Approach LOS		D	B		D	

Intersection Summary			
HCM 2000 Control Delay	44.5	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	1.08		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	92.1%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Movement	NBL2	NBL	NBR	SEL	SER	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations											
Traffic Volume (vph)	460	0	355	0	0	1190	915	0	0	1260	1125
Future Volume (vph)	460	0	355	0	0	1190	915	0	0	1260	1125
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0		6.0			6.0	6.0			6.0	4.0
Lane Util. Factor	0.97		0.88			0.97	0.95			0.95	1.00
Frt	1.00		0.85			1.00	1.00			1.00	0.85
Flt Protected	0.95		1.00			0.95	1.00			1.00	1.00
Satd. Flow (prot)	3242		2632			3335	3438			3505	1568
Flt Permitted	0.95		1.00			0.95	1.00			1.00	1.00
Satd. Flow (perm)	3242		2632			3335	3438			3505	1568
Peak-hour factor, PHF	0.88	0.88	0.88	0.92	0.92	0.94	0.94	0.94	0.92	0.92	0.92
Adj. Flow (vph)	523	0	403	0	0	1266	973	0	0	1370	1223
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	523	0	403	0	0	1266	973	0	0	1370	1223
Heavy Vehicles (%)	8%	8%	8%	2%	2%	5%	5%	5%	3%	3%	3%
Turn Type	Prot		Prot			Prot	NA			NA	Free
Protected Phases	8		8			5	2			6	
Permitted Phases											Free
Actuated Green, G (s)	17.0		17.0			41.0	91.0			44.0	120.0
Effective Green, g (s)	17.0		17.0			41.0	91.0			44.0	120.0
Actuated g/C Ratio	0.14		0.14			0.34	0.76			0.37	1.00
Clearance Time (s)	6.0		6.0			6.0	6.0			6.0	
Vehicle Extension (s)	3.0		3.0			3.0	3.0			3.0	
Lane Grp Cap (vph)	459		372			1139	2607			1285	1568
v/s Ratio Prot	c0.16		0.15			c0.38	0.28			c0.39	
v/s Ratio Perm											0.78
v/c Ratio	1.14		1.08			1.11	0.37			1.07	0.78
Uniform Delay, d1	51.5		51.5			39.5	4.9			38.0	0.0
Progression Factor	1.00		1.00			0.86	1.15			1.00	1.00
Incremental Delay, d2	86.1		70.8			51.6	0.0			44.8	3.9
Delay (s)	137.6		122.3			85.6	5.7			82.8	3.9
Level of Service	F		F			F	A			F	A
Approach Delay (s)		130.9		0.0			50.9			45.6	
Approach LOS		F		A			D			D	

Intersection Summary			
HCM 2000 Control Delay	61.4	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.10		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	97.9%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Volume (vph)	5	0	240	0	0	0	250	690	5	5	1755	5
Future Volume (vph)	5	0	240	0	0	0	250	690	5	5	1755	5
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0	6.0				6.0	6.0		6.0	6.0	
Lane Util. Factor		1.00	1.00				1.00	0.95		1.00	0.95	
Frt		1.00	0.85				1.00	1.00		1.00	1.00	
Flt Protected		0.95	1.00				0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1770	1583				1770	3536		1770	3538	
Flt Permitted		1.00	1.00				0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1863	1583				1770	3536		1770	3538	
Peak-hour factor, PHF	0.92	0.92	0.92	0.25	0.25	0.25	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	5	0	261	0	0	0	272	750	5	5	1908	5
RTOR Reduction (vph)	0	0	98	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	5	163	0	0	0	272	755	0	5	1913	0
Heavy Vehicles (%)	2%	2%	2%	0%	0%	0%	2%	2%	2%	2%	2%	2%
Turn Type	Perm	NA	custom				Prot	NA		Prot	NA	
Protected Phases		8			4		5	2		1	6	
Permitted Phases	8		6	4								
Actuated Green, G (s)		1.2	61.1				17.7	77.9		0.9	61.1	
Effective Green, g (s)		1.2	61.1				17.7	77.9		0.9	61.1	
Actuated g/C Ratio		0.01	0.62				0.18	0.79		0.01	0.62	
Clearance Time (s)		6.0	6.0				6.0	6.0		6.0	6.0	
Vehicle Extension (s)		3.0	3.0				3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		22	986				319	2810		16	2205	
v/s Ratio Prot							c0.15	0.21		0.00	c0.54	
v/s Ratio Perm		c0.00	0.10									
v/c Ratio		0.23	0.17				0.85	0.27		0.31	0.87	
Uniform Delay, d1		47.9	7.7				38.9	2.6		48.2	15.1	
Progression Factor		1.00	1.00				1.00	1.00		1.00	1.00	
Incremental Delay, d2		5.2	0.1				19.2	0.1		10.9	3.9	
Delay (s)		53.2	7.8				58.1	2.7		59.1	19.0	
Level of Service		D	A				E	A		E	B	
Approach Delay (s)		8.7			0.0			17.4			19.1	
Approach LOS		A			A			B			B	

Intersection Summary			
HCM 2000 Control Delay	17.7	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.85		
Actuated Cycle Length (s)	98.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	85.5%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Volume (vph)	0	15	5	345	0	35	0	453	180	5	790	0
Future Volume (vph)	0	15	5	345	0	35	0	453	180	5	790	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0			6.0			6.0			6.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		0.97			0.99			0.96			1.00	
Flt Protected		1.00			0.96			1.00			1.00	
Satd. Flow (prot)		1802			1743			1692			1809	
Flt Permitted		1.00			0.72			1.00			1.00	
Satd. Flow (perm)		1802			1315			1692			1802	
Peak-hour factor, PHF	0.60	0.60	0.60	0.96	0.96	0.96	0.89	0.89	0.89	0.86	0.86	0.86
Adj. Flow (vph)	0	25	8	359	0	36	0	509	202	6	919	0
RTOR Reduction (vph)	0	6	0	0	25	0	0	16	0	0	0	0
Lane Group Flow (vph)	0	27	0	0	370	0	0	695	0	0	925	0
Heavy Vehicles (%)	2%	2%	2%	3%	3%	3%	8%	8%	8%	5%	5%	5%
Turn Type		NA		Perm	NA			NA		Perm	NA	
Protected Phases		4			4			2			2	
Permitted Phases	4			4						2		
Actuated Green, G (s)		26.1			26.1			49.1			49.1	
Effective Green, g (s)		26.1			26.1			49.1			49.1	
Actuated g/C Ratio		0.30			0.30			0.56			0.56	
Clearance Time (s)		6.0			6.0			6.0			6.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		539			393			952			1014	
v/s Ratio Prot		0.02						0.41				
v/s Ratio Perm					c0.28						c0.51	
v/c Ratio		0.05			0.94			0.73			0.91	
Uniform Delay, d1		21.7			29.8			14.1			17.1	
Progression Factor		1.00			1.00			1.00			1.00	
Incremental Delay, d2		0.0			30.6			2.8			12.1	
Delay (s)		21.8			60.4			17.0			29.2	
Level of Service		C			E			B			C	
Approach Delay (s)		21.8			60.4			17.0			29.2	
Approach LOS		C			E			B			C	

Intersection Summary			
HCM 2000 Control Delay	30.8	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.92		
Actuated Cycle Length (s)	87.2	Sum of lost time (s)	12.0
Intersection Capacity Utilization	86.1%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SBL	SBR	SBR2	NEL2	NEL	NER
Lane Configurations												
Traffic Volume (vph)	129	138	253	212	164	187	249	1685	161	291	1457	108
Future Volume (vph)	129	138	253	212	164	187	249	1685	161	291	1457	108
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	7.0	7.0	7.0		7.0	7.0	7.0	7.0	7.0	7.0	7.0	
Lane Util. Factor	1.00	1.00	1.00		1.00	1.00	0.97	0.76	1.00	0.97	0.94	
Frt	1.00	1.00	0.85		1.00	0.85	1.00	0.85	0.85	1.00	0.99	
Flt Protected	0.95	1.00	1.00		0.97	1.00	0.95	1.00	1.00	0.95	0.96	
Satd. Flow (prot)	1770	1863	1583		1812	1583	3303	3474	1524	3367	4872	
Flt Permitted	0.95	1.00	1.00		0.97	1.00	0.95	1.00	1.00	0.95	0.96	
Satd. Flow (perm)	1770	1863	1583		1812	1583	3303	3474	1524	3367	4872	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.88	0.88	0.88	0.93	0.93	0.93
Adj. Flow (vph)	140	150	275	230	178	203	283	1915	183	313	1567	116
RTOR Reduction (vph)	0	0	138	0	0	118	0	0	93	0	98	0
Lane Group Flow (vph)	140	150	137	0	408	85	283	1915	90	313	1585	0
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	6%	6%	6%	4%	4%	4%
Turn Type	Split	NA	pt+ov	Split	NA	pt+ov	Prot	Prot	Prot	Prot	Prot	
Protected Phases	4	4	4 5	8	8	1 8	1	6	6	5	2	
Permitted Phases												
Actuated Green, G (s)	10.0	10.0	19.0		21.0	34.0	13.0	52.0	52.0	9.0	48.0	
Effective Green, g (s)	10.0	10.0	19.0		21.0	34.0	13.0	52.0	52.0	9.0	48.0	
Actuated g/C Ratio	0.08	0.08	0.16		0.18	0.28	0.11	0.43	0.43	0.08	0.40	
Clearance Time (s)	7.0	7.0			7.0		7.0	7.0	7.0	7.0	7.0	
Vehicle Extension (s)	3.0	3.0			3.0		3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	147	155	250		317	448	357	1505	660	252	1948	
v/s Ratio Prot	0.08	c0.08	0.09		c0.23	0.05	0.09	c0.55	0.06	c0.09	0.33	
v/s Ratio Perm												
v/c Ratio	0.95	0.97	0.55		1.29	0.19	0.79	1.27	0.14	1.24	0.81	
Uniform Delay, d1	54.8	54.8	46.5		49.5	32.6	52.2	34.0	20.5	55.5	32.0	
Progression Factor	1.00	1.00	1.00		1.00	1.00	0.54	0.28	0.00	1.00	1.00	
Incremental Delay, d2	59.6	61.9	2.4		151.0	0.2	4.1	124.4	0.1	137.9	3.9	
Delay (s)	114.4	116.8	49.0		200.5	32.8	32.0	134.1	0.2	193.4	35.9	
Level of Service	F	F	D		F	C	C	F	A	F	D	
Approach Delay (s)		83.2			144.8		111.7				60.6	
Approach LOS		F			F		F				E	

Intersection Summary			
HCM 2000 Control Delay	94.0	HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio	1.24		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	28.0
Intersection Capacity Utilization	96.3%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Volume (vph)	541	63	414	66	40	81	394	1308	59	181	1602	712
Future Volume (vph)	541	63	414	66	40	81	394	1308	59	181	1602	712
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	7.0	7.0	7.0		7.0	7.0	7.0	7.0		7.0	7.0	7.0
Lane Util. Factor	0.95	0.95	1.00		1.00	1.00	0.97	0.91		0.97	0.91	1.00
Frt	1.00	1.00	0.85		1.00	0.85	1.00	0.99		1.00	1.00	0.85
Flt Protected	0.95	0.96	1.00		0.97	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1681	1702	1583		1806	1583	3367	4955		3303	4893	1524
Flt Permitted	0.95	0.96	1.00		0.97	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	1681	1702	1583		1806	1583	3367	4955		3303	4893	1524
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.93	0.93	0.93	0.88	0.88	0.88
Adj. Flow (vph)	588	68	450	72	43	88	424	1406	63	206	1820	809
RTOR Reduction (vph)	0	0	212	0	0	81	0	4	0	0	0	107
Lane Group Flow (vph)	329	327	238	0	115	7	424	1465	0	206	1820	702
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	4%	4%	4%	6%	6%	6%
Turn Type	Split	NA	Prot	Split	NA	Prot	Prot	NA		Prot	NA	pt+ov
Protected Phases	4	4	4	8	8	8	5	2		1	6	4 6
Permitted Phases												
Actuated Green, G (s)	23.0	23.0	23.0		10.0	10.0	14.0	46.7		12.3	45.0	68.0
Effective Green, g (s)	23.0	23.0	23.0		10.0	10.0	14.0	46.7		12.3	45.0	68.0
Actuated g/C Ratio	0.19	0.19	0.19		0.08	0.08	0.12	0.39		0.10	0.38	0.57
Clearance Time (s)	7.0	7.0	7.0		7.0	7.0	7.0	7.0		7.0	7.0	
Vehicle Extension (s)	4.0	4.0	4.0		4.0	4.0	4.0	4.0		4.0	4.0	
Lane Grp Cap (vph)	322	326	303		150	131	392	1928		338	1834	863
v/s Ratio Prot	c0.20	0.19	0.15		c0.06	0.00	c0.13	0.30		0.06	c0.37	0.46
v/s Ratio Perm												
v/c Ratio	1.02	1.00	0.79		0.77	0.06	1.08	0.76		0.61	0.99	0.81
Uniform Delay, d1	48.5	48.5	46.2		53.9	50.7	53.0	31.8		51.6	37.3	20.9
Progression Factor	1.00	1.00	1.00		1.00	1.00	1.24	0.54		0.99	1.07	1.22
Incremental Delay, d2	55.8	50.6	13.3		30.5	0.8	59.3	1.7		0.3	4.8	0.6
Delay (s)	104.3	99.1	59.4		84.4	51.5	125.2	18.9		51.4	44.7	26.1
Level of Service	F	F	E		F	D	F	B		D	D	C
Approach Delay (s)		84.5			70.1			42.7			39.9	
Approach LOS		F			E			D			D	

Intersection Summary			
HCM 2000 Control Delay	49.9	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.99		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	28.0
Intersection Capacity Utilization	87.8%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	0	1260	1320	0	925	1175
Future Volume (vph)	0	1260	1320	0	925	1175
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	12	16	12
Total Lost time (s)		6.0	6.0		6.0	6.0
Lane Util. Factor		0.95	0.95		1.00	0.88
Frt		1.00	1.00		1.00	0.85
Flt Protected		1.00	1.00		0.95	1.00
Satd. Flow (prot)		3471	3406		1930	2682
Flt Permitted		1.00	1.00		0.95	1.00
Satd. Flow (perm)		3471	3406		1930	2682
Peak-hour factor, PHF	0.93	0.93	0.88	0.88	0.89	0.89
Adj. Flow (vph)	0	1355	1500	0	1039	1320
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	0	1355	1500	0	1039	1320
Heavy Vehicles (%)	4%	4%	6%	6%	6%	6%
Turn Type		NA	NA		Prot	Prot
Protected Phases		2	6		4	4
Permitted Phases						
Actuated Green, G (s)		21.0	21.0		27.0	27.0
Effective Green, g (s)		21.0	21.0		27.0	27.0
Actuated g/C Ratio		0.35	0.35		0.45	0.45
Clearance Time (s)		6.0	6.0		6.0	6.0
Vehicle Extension (s)		3.0	3.0		3.0	3.0
Lane Grp Cap (vph)		1214	1192		868	1206
v/s Ratio Prot		0.39	c0.44		c0.54	0.49
v/s Ratio Perm						
v/c Ratio		1.12	1.26		1.20	1.09
Uniform Delay, d1		19.5	19.5		16.5	16.5
Progression Factor		1.44	1.52		1.00	1.00
Incremental Delay, d2		59.3	116.9		99.8	55.7
Delay (s)		87.4	146.7		116.3	72.2
Level of Service		F	F		F	E
Approach Delay (s)		87.4	146.7		91.7	
Approach LOS		F	F		F	

Intersection Summary			
HCM 2000 Control Delay	106.4	HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio	1.22		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	99.7%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Movement	NBL2	NBL	NBR	SEL	SER	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations											
Traffic Volume (vph)	1265	0	1070	0	0	1000	1185	0	0	540	780
Future Volume (vph)	1265	0	1070	0	0	1000	1185	0	0	540	780
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0		6.0			6.0	6.0			6.0	4.0
Lane Util. Factor	0.97		0.88			0.97	0.95			0.95	1.00
Frt	1.00		0.85			1.00	1.00			1.00	0.85
Flt Protected	0.95		1.00			0.95	1.00			1.00	1.00
Satd. Flow (prot)	3242		2632			3335	3438			3505	1568
Flt Permitted	0.95		1.00			0.95	1.00			1.00	1.00
Satd. Flow (perm)	3242		2632			3335	3438			3505	1568
Peak-hour factor, PHF	0.88	0.88	0.88	0.92	0.92	0.94	0.94	0.94	0.92	0.92	0.92
Adj. Flow (vph)	1438	0	1216	0	0	1064	1261	0	0	587	848
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	1438	0	1216	0	0	1064	1261	0	0	587	848
Heavy Vehicles (%)	8%	8%	8%	2%	2%	5%	5%	5%	3%	3%	3%
Turn Type	Prot		Prot			Prot	NA			NA	Free
Protected Phases	8		8			5	2			6	
Permitted Phases											Free
Actuated Green, G (s)	44.0		44.0			32.0	64.0			26.0	120.0
Effective Green, g (s)	44.0		44.0			32.0	64.0			26.0	120.0
Actuated g/C Ratio	0.37		0.37			0.27	0.53			0.22	1.00
Clearance Time (s)	6.0		6.0			6.0	6.0			6.0	
Vehicle Extension (s)	3.0		3.0			3.0	3.0			3.0	
Lane Grp Cap (vph)	1188		965			889	1833			759	1568
v/s Ratio Prot	0.44		c0.46			c0.32	0.37			c0.17	
v/s Ratio Perm											0.54
v/c Ratio	1.21		1.26			1.20	0.69			0.77	0.54
Uniform Delay, d1	38.0		38.0			44.0	20.6			44.2	0.0
Progression Factor	1.00		1.00			0.86	1.02			1.00	1.00
Incremental Delay, d2	102.7		125.5			89.7	0.2			7.5	1.3
Delay (s)	140.7		163.5			127.6	21.2			51.8	1.3
Level of Service	F		F			F	C			D	A
Approach Delay (s)		151.2		0.0			69.9			22.0	
Approach LOS		F		A			E			C	

Intersection Summary			
HCM 2000 Control Delay	92.8	HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio	1.12		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	95.5%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Volume (vph)	5	0	295	0	0	0	955	1260	0	5	1160	10
Future Volume (vph)	5	0	295	0	0	0	955	1260	0	5	1160	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0	6.0				6.0	6.0		6.0	6.0	
Lane Util. Factor		1.00	1.00				1.00	0.95		1.00	0.95	
Frt		1.00	0.85				1.00	1.00		1.00	1.00	
Flt Protected		0.95	1.00				0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1770	1583				1770	3539		1770	3535	
Flt Permitted		1.00	1.00				0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1863	1583				1770	3539		1770	3535	
Peak-hour factor, PHF	0.92	0.92	0.92	0.25	0.25	0.25	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	5	0	321	0	0	0	1038	1370	0	5	1261	11
RTOR Reduction (vph)	0	0	207	0	0	0	0	0	0	0	1	0
Lane Group Flow (vph)	0	5	114	0	0	0	1038	1370	0	5	1271	0
Heavy Vehicles (%)	2%	2%	2%	0%	0%	0%	2%	2%	2%	2%	2%	2%
Turn Type	Perm	NA	custom				Prot	NA		Prot	NA	
Protected Phases		8			4		5	2		1	6	
Permitted Phases	8		6	4								
Actuated Green, G (s)		1.3	35.1				44.1	78.3		0.9	35.1	
Effective Green, g (s)		1.3	35.1				44.1	78.3		0.9	35.1	
Actuated g/C Ratio		0.01	0.36				0.45	0.79		0.01	0.36	
Clearance Time (s)		6.0	6.0				6.0	6.0		6.0	6.0	
Vehicle Extension (s)		3.0	3.0				3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		24	564				792	2813		16	1259	
v/s Ratio Prot							c0.59	0.39		0.00	c0.36	
v/s Ratio Perm		c0.00	0.07									
v/c Ratio		0.21	0.20				1.31	0.49		0.31	1.01	
Uniform Delay, d1		48.1	22.0				27.2	3.4		48.5	31.7	
Progression Factor		1.00	1.00				1.00	1.00		1.00	1.00	
Incremental Delay, d2		4.3	0.2				148.8	0.1		10.9	27.8	
Delay (s)		52.4	22.2				176.0	3.5		59.4	59.5	
Level of Service		D	C				F	A		E	E	
Approach Delay (s)		22.6			0.0			77.9			59.5	
Approach LOS		C			A			E			E	

Intersection Summary			
HCM 2000 Control Delay	67.5	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.16		
Actuated Cycle Length (s)	98.5	Sum of lost time (s)	18.0
Intersection Capacity Utilization	108.3%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Volume (vph)	5	30	0	230	0	50	0	860	215	5	555	0
Future Volume (vph)	5	30	0	230	0	50	0	860	215	5	555	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0			6.0			6.0			6.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		1.00			0.98			0.97			1.00	
Flt Protected		0.99			0.96			1.00			1.00	
Satd. Flow (prot)		1850			1729			1712			1809	
Flt Permitted		0.96			0.72			1.00			0.75	
Satd. Flow (perm)		1782			1304			1712			1364	
Peak-hour factor, PHF	0.60	0.60	0.60	0.96	0.96	0.96	0.89	0.89	0.89	0.86	0.86	0.86
Adj. Flow (vph)	8	50	0	240	0	52	0	966	242	6	645	0
RTOR Reduction (vph)	0	0	0	0	29	0	0	10	0	0	0	0
Lane Group Flow (vph)	0	58	0	0	263	0	0	1198	0	0	651	0
Heavy Vehicles (%)	2%	2%	2%	3%	3%	3%	8%	8%	8%	5%	5%	5%
Turn Type	Perm	NA		Perm	NA			NA		Perm	NA	
Protected Phases		4			4			2			2	
Permitted Phases	4			4						2		
Actuated Green, G (s)		18.0			18.0			60.4			60.4	
Effective Green, g (s)		18.0			18.0			60.4			60.4	
Actuated g/C Ratio		0.20			0.20			0.67			0.67	
Clearance Time (s)		6.0			6.0			6.0			6.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		354			259			1143			911	
v/s Ratio Prot								c0.70				
v/s Ratio Perm		0.03			c0.20						0.48	
v/c Ratio		0.16			1.02			1.05			0.71	
Uniform Delay, d1		30.0			36.2			15.0			9.5	
Progression Factor		1.00			1.00			1.00			1.00	
Incremental Delay, d2		0.2			60.1			40.2			2.7	
Delay (s)		30.2			96.3			55.2			12.2	
Level of Service		C			F			E			B	
Approach Delay (s)		30.2			96.3			55.2			12.2	
Approach LOS		C			F			E			B	

Intersection Summary			
HCM 2000 Control Delay	47.3	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	1.04		
Actuated Cycle Length (s)	90.4	Sum of lost time (s)	12.0
Intersection Capacity Utilization	94.1%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Interchange Justification Report
Appendix E
Synchro™ No Build Condition Intersection Queuing Reports

I-93 Exit 4A

Prepared for:

Town of Derry
Town of Londonderry
New Hampshire Department of Transportation

Prepared by:

CLD and Louis Berger

Version: 2
October 10, 2019

NHDOT Project Number: 13065
Federal Project Number: IM-0931(201)
CLD/Towns Project Number 05-0244

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Queuing and Blocking Report
No Build 2040 AM Peak 11/06/2017

Intersection: 1: Vista Ridge/Symmes Drive & NH 28

Movement	EB	EB	EB	WB	WB	WB	WB	NB	NB	B12	SB	SB
Directions Served	L	T	TR	L	T	T	R	LT	R	T	L	LTR
Maximum Queue (ft)	365	364	372	52	453	432	203	206	85	110	208	214
Average Queue (ft)	218	207	211	14	271	278	53	120	69	20	104	103
95th Queue (ft)	353	412	416	40	410	408	137	230	101	100	181	191
Link Distance (ft)	414	414	414		755	755		131		155	368	368
Upstream Blk Time (%)		6	6					21		7		
Queuing Penalty (veh)		23	22					0		0		
Storage Bay Dist (ft)				450			500		10			
Storage Blk Time (%)					0	0	0	37	67			
Queuing Penalty (veh)					0	0	0	41	43			

Intersection: 2: Exit 5 SB On/Exit 5 SB Off & NH 28

Movement	EB	EB	EB	B19	B19	WB	WB	WB	SB	SB	SB
Directions Served	T	T	R	T	T	L	T	T	L	L	R
Maximum Queue (ft)	892	894	375	677	713	606	160	151	479	468	501
Average Queue (ft)	698	693	267	294	300	271	19	15	299	255	187
95th Queue (ft)	1027	1043	546	865	873	632	104	97	505	478	526
Link Distance (ft)	782	782		755	755	592	592	592	502	502	502
Upstream Blk Time (%)	41	39		10	12	2			6	2	2
Queuing Penalty (veh)	238	228		59	71	6			22	6	6
Storage Bay Dist (ft)			350								
Storage Blk Time (%)		42	0								
Queuing Penalty (veh)		151	2								

Intersection: 3: Exit 5 NB Off & NH 28

Movement	EB	EB	EB	WB	WB	WB	NB	NB
Directions Served	L	T	T	T	T	R	L	R
Maximum Queue (ft)	629	613	623	506	498	300	724	369
Average Queue (ft)	445	448	374	416	325	18	378	47
95th Queue (ft)	729	775	803	582	577	171	685	349

Link Distance (ft)	592	592	592	481	481	481	798	798
Upstream Blk Time (%)	2	11	9	17	4	0	3	2
Queuing Penalty (veh)	9	50	43	80	19	2	0	0
Storage Bay Dist (ft)								
Storage Blk Time (%)								
Queuing Penalty (veh)								

Intersection: 4: NH 28 & Liberty Drive

Movement	EB	WB	WB	NB	NB	NB	SB	SB	SB
Directions Served	L	LT	R	L	T	TR	L	T	TR
Maximum Queue (ft)	70	48	116	30	195	223	95	62	76
Average Queue (ft)	19	6	43	4	80	104	38	8	17
95th Queue (ft)	51	29	96	19	165	190	79	37	54
Link Distance (ft)	154		502		332	332		841	841
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)		100		250			225		
Storage Blk Time (%)			1						
Queuing Penalty (veh)			0						

Intersection: 5: NH 102 & Gilcrest Road

Movement	EB	EB	EB	WB	WB	SB	SB	SB	SB	SB	SB	NE	NE	NE	NE	NE
Directions Served	L	T	R	LT	R	L	L	R	R	R	>	<	<	L	L	LR
Maximum Queue (ft)	375	402	250	526	511	104	118	150	182	191	70	151	300	422	426	300
Average Queue (ft)	331	330	227	413	341	28	53	81	100	107	11	67	211	394	395	299
95th Queue (ft)	442	483	291	610	598	72	100	131	151	167	40	123	386	406	409	303
Link Distance (ft)	356	356		488	488			672	672	672				340	340	
Upstream Blk Time (%)	36	41		37	15									46	45	

Queuing Penalty (veh)	0	0		0	0									523	512	
Storage Bay Dist (ft)			225			275	275				225	275	275		275	
Storage Blk Time (%)		2	50							0			0	48	44	31
Queuing Penalty (veh)		4	76							0			0	99	320	201

Intersection: 6: NH 102 & Hampton Drive/Garden Lane

Movement	SE	SE	SE	NW	NW	NE	NE	NE	NE	NE	SW	SW	SW	SW	SW	SW
Directions Served	L	LT	R	LT	R	L	L	T	T	TR	L	L	T	T	T	R
Maximum Queue (ft)	200	326	200	105	118	125	300	654	676	635	72	106	258	252	234	157
Average Queue (ft)	160	258	143	40	60	46	112	357	399	413	14	36	171	166	139	76
95th Queue (ft)	258	374	266	78	110	95	262	589	640	617	46	78	234	227	201	133
Link Distance (ft)		291		256				672	672	672			352	352	352	
Upstream Blk Time (%)		33						0	0	0						
Queuing Penalty (veh)		0						1	1	1						
Storage Bay Dist (ft)	175		175		100	275	275				275	275			275	
Storage Blk Time (%)	4	48	1	0	3		0	14					0	0		
Queuing Penalty (veh)	13	139	3	0	1		0	21					0	0		

Intersection: 7: NH 102 & Exit 4 SB Off

Movement	EB	EB	WB	WB	SB	SB	SB
Directions Served	T	T	T	T	L	R	R

Maximum Queue (ft)	641	537	196	217	223	207	107
Average Queue (ft)	361	298	119	159	189	110	9
95th Queue (ft)	574	505	177	208	203	262	71
Link Distance (ft)	540	540	335	335	138	138	138
Upstream Blk Time (%)	3	1			50	11	1
Queuing Penalty (veh)	18	4			272	62	3
Storage Bay Dist (ft)							
Storage Blk Time (%)							
Queuing Penalty (veh)							

Intersection: 8: NH 102 & Exit 4 NB Off

Movement	NB	NB	NB	NB	NE	NE	NE	NE	SW	SW	SW	B24	B24
Directions Served	<	<	R	R	L	L	T	T	T	T	R	T	T
Maximum Queue (ft)	464	425	261	202	530	548	453	175	704	686	864	300	369
Average Queue (ft)	295	271	159	100	381	390	107	84	498	525	712	16	44
95th Queue (ft)	508	483	241	220	525	533	332	143	766	767	1006	139	207
Link Distance (ft)	799	799	799	799			722	722	786	786	786	676	676
Upstream Blk Time (%)							0		0		11		
Queuing Penalty (veh)							1		1		74		
Storage Bay Dist (ft)					550	550							
Storage Blk Time (%)					0	1	0						
Queuing Penalty (veh)					1	5	0						

Intersection: 9: NH 102 & St. Charles Street/Londonderry Road

Movement	SE	SE	NE	NE	NE	SW	SW	SW
Directions Served	LT	R	L	T	TR	L	T	TR
Maximum Queue (ft)	88	221	238	92	109	76	314	309
Average Queue (ft)	9	116	123	12	18	8	207	256
95th Queue (ft)	70	194	202	55	71	44	318	322
Link Distance (ft)	542			676	676		288	288
Upstream Blk Time (%)							1	3
Queuing Penalty (veh)							10	22
Storage Bay Dist (ft)		225	350			100		
Storage Blk Time (%)		1					16	
Queuing Penalty (veh)		0					1	

Intersection: 10: NH 102 & Fordway/Madden Hill Road

Movement	SE	NW	NE	SW
Directions Served	LTR	LTR	TR	LT
Maximum Queue (ft)	55	312	436	561
Average Queue (ft)	13	190	176	289
95th Queue (ft)	40	298	332	519
Link Distance (ft)	323	459	1062	560
Upstream Blk Time (%)				4
Queuing Penalty (veh)				0
Storage Bay Dist (ft)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

Queuing and Blocking Report
No Build 2040 PM Peak 11/06/2017

Intersection: 1: NH 28 & Symmes Drive

Movement	EB	EB	EB	B13	WB	WB	WB	WB	NB	NB	SB	SB	B14
Directions Served	L	T	TR	T	L	T	T	R	LT	R	L	LTR	T
Maximum Queue (ft)	56	435	442	136	184	307	314	48	147	85	327	410	74
Average Queue (ft)	19	257	276	15	86	196	179	9	58	35	139	230	3
95th Queue (ft)	50	394	415	106	154	301	295	31	120	79	267	368	34
Link Distance (ft)	402	402	402	215		755	755		131		368	368	226
Upstream Blk Time (%)		1	2	1					1		0	3	
Queuing Penalty (veh)		0	0	0					0		0	0	
Storage Bay Dist (ft)					450			500		10			
Storage Blk Time (%)									45	29			
Queuing Penalty (veh)									15	19			

Intersection: 2: Exit 5 SB On/Exit 5 SB Off & NH 28

Movement	EB	EB	EB	B19	B19	WB	WB	WB	SB	SB	SB
Directions Served	T	T	R	T	T	L	T	T	L	L	R
Maximum Queue (ft)	790	824	375	179	212	326	118	82	442	422	158
Average Queue (ft)	440	431	158	66	74	137	14	9	285	245	11

95th Queue (ft)	859	889	463	355	383	280	69	49	417	395	109
Link Distance (ft)	782	782		755	755	592	592	592	502	502	502
Upstream Blk Time (%)	12	13		0	0				0	0	
Queuing Penalty (veh)	79	86		1	2				1	0	
Storage Bay Dist (ft)			350								
Storage Blk Time (%)		17	0								
Queuing Penalty (veh)		69	1								

Intersection: 3: Exit 5 NB Off & NH 28

Movement	EB	EB	EB	WB	WB	NB	NB
Directions Served	L	T	T	T	T	L	R
Maximum Queue (ft)	625	597	297	255	246	383	312
Average Queue (ft)	333	192	88	112	113	183	46
95th Queue (ft)	706	427	204	216	218	337	213
Link Distance (ft)	592	592	592	481	481	798	798
Upstream Blk Time (%)	3	0					
Queuing Penalty (veh)	17	2					
Storage Bay Dist (ft)							
Storage Blk Time (%)							
Queuing Penalty (veh)							

Intersection: 4: NH 28 & Liberty Drive

Movement	EB	WB	WB	NB	NB	NB	SB	SB	SB
Directions Served	L	LT	R	L	T	TR	L	T	TR
Maximum Queue (ft)	64	61	134	26	98	105	68	124	143
Average Queue (ft)	20	10	44	3	38	48	19	50	65
95th Queue (ft)	52	38	97	17	81	94	50	108	124
Link Distance (ft)	154		502		332	332		841	841
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)		100		250			225		
Storage Blk Time (%)			1						
Queuing Penalty (veh)									

Intersection: 5: NH 102 & Gilcrest Road

Movement	EB	EB	EB	WB	WB	SB	SB	SB	SB	SB	SB	NE	NE	NE	NE	NE
Directions Served	L	T	R	LT	R	L	L	R	R	R	>	<	<	L	L	LR
Maximum Queue (ft)	363	381	250	529	510	141	198	378	361	292	111	285	300	381	383	300
Average Queue (ft)	157	240	193	490	415	55	80	131	153	155	30	195	270	342	300	250
95th Queue (ft)	314	433	303	567	682	116	153	272	273	252	117	325	364	410	406	341
Link Distance (ft)	356	356		487	487			666	666	666				340	340	
Upstream Blk Time (%)	2	25		75	32			0	0					24	5	
Queuing Penalty (veh)	0	0		0	0			0	0					227	45	
Storage Bay Dist (ft)			225			275	275				225	275	275		275	
Storage Blk Time (%)		12	28					0		4	0	6	22	20	8	6
Queuing Penalty (veh)		31	39					1		6	0	29	106	58	50	27

Intersection: 6: NH 102 & Hampton Drive/Garden Lane

Movement	SE	SE	SE	NW	NW	NE	NE	NE	NE	NE	SW	SW	SW	SW	SW	SW
Directions Served	L	LT	R	LT	R	L	L	T	T	TR	L	L	T	T	T	R
Maximum Queue (ft)	200	335	200	210	125	258	273	259	250	262	116	299	421	367	381	300
Average Queue (ft)	141	309	198	96	73	158	176	163	156	173	51	115	290	276	251	211
95th Queue (ft)	242	323	210	175	137	238	246	225	235	257	103	260	382	362	357	329
Link Distance (ft)		291		253				666	666	666			358	358	358	

Upstream Blk Time (%)		65											1	0	1
Queuing Penalty (veh)		0											9	3	5
Storage Bay Dist (ft)	175		175		100	275	275				275	275			275
Storage Blk Time (%)	2	25	53	13	6	0	0	0				0	8	2	1
Queuing Penalty (veh)	17	168	321	10	6	0	0	1				0	15	18	7

Intersection: 7: NH 102 & Exit 4 SB Off

Movement	EB	EB	WB	WB	SB	SB	SB
Directions Served	T	T	T	T	L	R	R
Maximum Queue (ft)	592	560	406	400	207	191	191
Average Queue (ft)	389	330	341	364	187	100	28
95th Queue (ft)	595	534	422	417	205	249	134
Link Distance (ft)	540	540	335	335	138	138	138
Upstream Blk Time (%)	6	2	21	31	35	10	1
Queuing Penalty (veh)	35	14	142	205	246	68	8
Storage Bay Dist (ft)							
Storage Blk Time (%)							
Queuing Penalty (veh)							

Intersection: 8: NH 102 & Exit 4 NB Off

Movement	NB	NB	NB	NB	NE	NE	NE	NE	SW	SW	SW
Directions Served	<	<	R	R	L	L	T	T	T	T	R
Maximum Queue (ft)	855	851	851	835	477	484	452	350	280	304	365
Average Queue (ft)	809	809	794	685	325	331	238	205	171	201	46
95th Queue (ft)	890	903	947	927	471	479	411	302	250	281	230
Link Distance (ft)	799	799	799	799			722	722	786	786	786
Upstream Blk Time (%)	42	63	48	5			0				
Queuing Penalty (veh)	0	0	0	0			3				
Storage Bay Dist (ft)					550	550					
Storage Blk Time (%)					0	1	0				
Queuing Penalty (veh)					0	3	3				

Intersection: 9: NH 102 & St. Charles Street/Londonderry Road

Movement	SE	SE	NE	NE	NE	B24	B24	SW	SW	SW
Directions Served	LT	R	L	T	TR	T	T	L	T	TR
Maximum Queue (ft)	37	173	375	775	687	653	625	43	331	331
Average Queue (ft)	4	85	365	608	214	273	236	4	287	298
95th Queue (ft)	22	141	422	1020	685	815	762	25	327	321
Link Distance (ft)	542			676	676	786	786		288	288
Upstream Blk Time (%)				33	0	4	1		16	33
Queuing Penalty (veh)				370	4	47	15		94	195
Storage Bay Dist (ft)		225	350					100		
Storage Blk Time (%)		0	45	0					50	
Queuing Penalty (veh)		0	287	3					2	

Intersection: 10: NH 102 & Fordway/Madden Hill Road

Movement	SE	NW	NE	B19	SW
Directions Served	LTR	LTR	TR	T	LT
Maximum Queue (ft)	69	321	828	12	575
Average Queue (ft)	27	169	397	0	229
95th Queue (ft)	61	277	734	9	535
Link Distance (ft)	323	459	1062	197	560
Upstream Blk Time (%)			0		9
Queuing Penalty (veh)			2		0
Storage Bay Dist (ft)					
Storage Blk Time (%)					
Queuing Penalty (veh)					

Interchange Justification Report
Appendix F
HCS No Build Condition Freeway Operation Reports

I-93 Exit 4A

Prepared for:

Town of Derry
Town of Londonderry
New Hampshire Department of Transportation

Prepared by:

CLD and Louis Berger

Version: 2
October 10, 2019

NHDOT Project Number: 13065
Federal Project Number: IM-0931(201)
CLD/Towns Project Number 05-0244

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HCS 2010 Facilities Report

Project Information

Analyst	PK/LCG	Agency	Fuss and O'Neill
Jurisdiction		Time Period Analyzed	AM Peak - NB
Analysis Year	2040 No Build - AM	Date	3/8/2019
Project Description	I-93 NB - from S. of Exit 4 to N of Exit 5		

Facility Global Input

Jam Density, pc/mi/ln	190.0	Density at Capacity, pc/mi/ln	45.0
Queue Discharge Capacity Drop, %	7	Total Segments	9
Total Time Periods	1	Time Period Duration, min	15

Segment Geometric Data

No.	Coded	Analyzed	Name	Length, ft	Lanes
1	Basic	Basic	a->b	5280	4
2	Diverge	Diverge	b.->c	1500	4
3	Basic	Basic	c->d	4525	4
4	Merge	Merge	d->e	1500	4
5	Basic	Basic	e->f	11825	4
6	Diverge	Diverge	f->g	1500	4
7	Basic	Basic	g->h	4100	4
8	Merge	Merge	h->i	1500	4
9	Basic	Basic	i->j	5280	4

Facility Segment Data

Segment 1: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.979	3537	9600	0.37	70.0	12.6	B

Segment 2: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.77	0.979	0.964	3537	1098	9600	4200	0.37	0.26	68.0	60.7	13.0	0.0	A

Segment 3: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.979	2439	9600	0.28	70.0	8.7	A

Segment 4: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	

1	0.94	0.90	0.979	0.983	4539	2617	9600	2100	0.55	1.25	53.3	61.7	45.0	21.9	C

Segment 5: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.964	4539	9600	0.55	70.0	16.2	B

Segment 6: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.75	0.964	0.956	4539	774	9600	2100	0.55	0.37	67.7	61.5	16.8	20.7	C

Segment 7: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.964	3765	9600	0.48	70.0	13.4	B

Segment 8: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.83	0.964	0.972	5513	1748	9600	2100	0.66	0.83	63.4	60.7	21.7	24.4	C

Segment 9: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.964	5513	9600	0.64	69.6	19.8	C

Facility Time Period Results

T	Speed, mi/h	Density, pc/mi/ln	Density, veh/mi/ln	Travel Time, min	LOS
1	68.4	16.3	15.8	6.1	B

Facility Overall Results

Space Mean Speed, mi/h	68.4	Density, veh/mi/ln	15.8
Average Travel Time, min	6.1		

HCS 2010 Facilities Report

Project Information

Analyst	PK/LCG	Agency	Fuss and O'Neill
Jurisdiction		Time Period Analyzed	AM Peak - SB
Analysis Year	2040 - No Build -SB AM	Date	3/8/2019
Project Description	I-93 SB - from N of Exit 5 to S of Exit 4		

Facility Global Input

Jam Density, pc/mi/ln	190.0	Density at Capacity, pc/mi/ln	45.0
Queue Discharge Capacity Drop, %	7	Total Segments	11
Total Time Periods	1	Time Period Duration, min	15

Segment Geometric Data

No.	Coded	Analyzed	Name	Length, ft	Lanes
1	Basic	Basic	a->b	5280	4
2	Diverge	Diverge	b->c	1500	4
3	Basic	Basic	c->d	3920	4
4	Merge	Merge	d->e	1500	4
5	Basic	Basic	e->f	11730	4
6	Diverge	Diverge	f->g	1500	4
7	Basic	Basic	g->h	2550	4
8	Merge	Merge	h->i	1500	4
9	Basic	Basic	i->j	600	4
10	Merge	Merge	j->k	1500	4
11	Basic	Basic	l->m	5280	4

Facility Segment Data

Segment 1: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.970	5659	9600	0.59	69.5	20.4	C

Segment 2: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.74	0.970	0.972	5659	1536	9600	2100	0.59	0.73	65.5	59.6	21.6	26.2	C

Segment 3: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.970	4447	9600	0.46	70.0	15.9	B

Segment 4: Merge

Time	PHF	fHV	Flow Rate	Capacity	d/c	Speed	Density	LOS

Period					(pc/h)		(pc/h)		Ratio		(mi/h)		(pc/mi/ln)		
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.84	0.970	0.953	5384	937	9600	2100	0.56	0.45	65.1	63.3	20.7	17.3	B

Segment 5: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.970	5270	9600	0.55	69.8	18.9	C

Segment 6: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.95	0.970	0.975	5270	1754	9600	2100	0.55	0.84	64.7	59.1	20.4	25.9	C

Segment 7: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	3452	9600	0.36	70.0	12.3	B

Segment 8: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.82	0.980	0.970	4772	1320	9600	1900	0.50	0.69	64.3	61.7	18.6	17.3	B

Segment 9: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	4592	9600	0.48	70.0	16.4	B

Segment 10: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.82	0.980	0.970	6377	1785	9600	2100	0.66	0.85	63.3	60.8	25.2	24.2	C

Segment 11: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	6133	9600	0.64	68.7	22.3	C

Facility Time Period Results

T	Speed, mi/h	Density, pc/mi/ln	Density, veh/mi/ln	Travel Time, min	LOS
1	68.5	19.3	18.8	6.1	C

Facility Overall Results

Space Mean Speed, mi/h	68.5	Density, veh/mi/ln	18.8
Average Travel Time, min	6.1		

HCS 2010 Facilities Report

Project Information

Analyst	PK/LCG	Agency	Fuss and O'Neill
Jurisdiction		Time Period Analyzed	PM Peak - NB
Analysis Year	2040 No Build PM - NB	Date	3/8/2019
Project Description	I-93 NB - from S. of Exit 4 to N of Exit 5		

Facility Global Input

Jam Density, pc/mi/ln	190.0	Density at Capacity, pc/mi/ln	45.0
Queue Discharge Capacity Drop, %	7	Total Segments	9
Total Time Periods	1	Time Period Duration, min	15

Segment Geometric Data

No.	Coded	Analyzed	Name	Length, ft	Lanes
1	Basic	Basic	a->b	5280	4
2	Diverge	Diverge	b.->c	1500	4
3	Basic	Basic	c->d	4525	4
4	Merge	Merge	d->e	1500	4
5	Basic	Basic	e->f	11825	4
6	Diverge	Diverge	f->g	1500	4
7	Basic	Basic	g->h	4100	4
8	Merge	Merge	h->i	1500	4
9	Basic	Basic	i->j	5280	4

Facility Segment Data

Segment 1: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.979	6085	9600	0.63	68.8	22.1	C

Segment 2: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.92	0.979	0.991	6085	2561	9600	4200	0.63	0.61	63.7	57.0	23.9	12.3	B

Segment 3: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.979	3548	9600	0.37	70.0	12.7	B

Segment 4: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	

1	0.94	0.87	0.979	0.988	5619	2071	9600	2100	0.59	0.99	63.7	61.3	22.1	23.0	C

Segment 5: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.985	5449	9600	0.57	69.7	19.5	C

Segment 6: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.67	0.985	0.964	5449	1037	9600	2100	0.57	0.49	66.9	60.9	20.4	25.4	C

Segment 7: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.985	4725	9600	0.49	70.0	16.9	B

Segment 8: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.89	0.985	0.988	6033	1308	9600	2100	0.63	0.62	63.5	60.9	23.8	24.2	C

Segment 9: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.985	5967	9600	0.62	69.0	21.6	C

Facility Time Period Results

T	Speed, mi/h	Density, pc/mi/ln	Density, veh/mi/ln	Travel Time, min	LOS
1	68.6	19.6	19.2	6.1	C

Facility Overall Results

Space Mean Speed, mi/h	68.6	Density, veh/mi/ln	19.2
Average Travel Time, min	6.1		

HCS 2010 Facilities Report

Project Information

Analyst	PK/LCG	Agency	Fuss and O'Neill
Jurisdiction		Time Period Analyzed	PM Peak - SB
Analysis Year	2040 No Build - SB PM	Date	3/8/2019
Project Description	I-93 SB - from N of Exit 5 to S of Exit 4		

Facility Global Input

Jam Density, pc/mi/ln	190.0	Density at Capacity, pc/mi/ln	45.0
Queue Discharge Capacity Drop, %	7	Total Segments	11
Total Time Periods	1	Time Period Duration, min	15

Segment Geometric Data

No.	Coded	Analyzed	Name	Length, ft	Lanes
1	Basic	Basic	a->b	5280	4
2	Diverge	Diverge	b->c	1500	4
3	Basic	Basic	c->d	3920	4
4	Merge	Merge	d->e	1500	4
5	Basic	Basic	e->f	11730	4
6	Diverge	Diverge	f->g	1500	4
7	Basic	Basic	g->h	2550	4
8	Merge	Merge	h->i	1500	4
9	Basic	Basic	i->j	600	4
10	Merge	Merge	j->k	1500	4
11	Basic	Basic	l->m	5280	4

Facility Segment Data

Segment 1: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.982	6186	9600	0.64	68.6	22.5	C

Segment 2: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.89	0.982	0.979	6186	1555	9600	2100	0.64	0.74	65.4	59.6	23.6	28.2	D

Segment 3: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.982	4631	9600	0.49	70.0	16.5	B

Segment 4: Merge

Time	PHF	fHV	Flow Rate	Capacity	d/c	Speed	Density	LOS

Period					(pc/h)		(pc/h)		Ratio		(mi/h)		(pc/mi/ln)		
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.81	0.982	0.978	5426	795	9600	2100	0.57	0.38	65.1	63.4	20.8	16.9	B

Segment 5: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.982	5426	9600	0.56	69.7	19.5	C

Segment 6: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.92	0.982	0.986	5426	2315	9600	2100	0.56	1.10	53.3	57.7	45.0	29.2	D

Segment 7: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	3111	9600	0.33	70.0	11.1	B

Segment 8: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.82	0.980	0.980	3715	604	9600	1900	0.39	0.32	65.4	62.6	14.2	11.0	B

Segment 9: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	3715	9600	0.38	70.0	13.3	B

Segment 10: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.82	0.980	0.980	4549	834	9600	2100	0.47	0.40	65.7	63.8	17.3	14.5	B

Segment 11: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	4549	9600	0.46	70.0	16.2	B

Facility Time Period Results

T	Speed, mi/h	Density, pc/mi/ln	Density, veh/mi/ln	Travel Time, min	LOS
1	68.4	19.4	19.1	6.1	C

Facility Overall Results

Space Mean Speed, mi/h	68.4	Density, veh/mi/ln	19.1
Average Travel Time, min	6.1		

Interchange Justification Report
Appendix G
Synchro™ Build Condition NH 102 Intersection Analysis Reports

I-93 Exit 4A

Prepared for:

Town of Derry
Town of Londonderry
New Hampshire Department of Transportation

Prepared by:

CLD and Louis Berger

Version: 2
October 10, 2019

NHDOT Project Number: 13065
Federal Project Number: IM-0931(201)
CLD/Towns Project Number 05-0244

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Movement	EBL	EBT	EBR	WBL	WBT	WBR	SBL	SBR	SBR2	NEL2	NEL	NER
Lane Configurations												
Traffic Volume (vph)	311	130	284	172	88	288	107	1119	69	278	2150	56
Future Volume (vph)	311	130	284	172	88	288	107	1119	69	278	2150	56
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	7.0	7.0	7.0		7.0	7.0	7.0	7.0	7.0	7.0	7.0	
Lane Util. Factor	1.00	1.00	1.00		1.00	1.00	0.97	0.76	1.00	0.97	0.94	
Frt	1.00	1.00	0.85		1.00	0.85	1.00	0.85	0.85	1.00	1.00	
Flt Protected	0.95	1.00	1.00		0.97	1.00	0.95	1.00	1.00	0.95	0.95	
Satd. Flow (prot)	1770	1863	1583		1803	1583	3303	3474	1524	3367	4894	
Flt Permitted	0.95	1.00	1.00		0.97	1.00	0.95	1.00	1.00	0.95	0.95	
Satd. Flow (perm)	1770	1863	1583		1803	1583	3303	3474	1524	3367	4894	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.88	0.88	0.88	0.93	0.93	0.93
Adj. Flow (vph)	338	141	309	187	96	313	122	1272	78	299	2312	60
RTOR Reduction (vph)	0	0	191	0	0	106	0	0	47	0	72	0
Lane Group Flow (vph)	338	141	118	0	283	207	122	1272	31	299	2300	0
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	6%	6%	6%	4%	4%	4%
Turn Type	Split	NA	Prot	Split	NA	pt+ov	Prot	Prot	Prot	Prot	Prot	
Protected Phases	4	4	4	8	8	1 8	1	6	6	5	2	
Permitted Phases												
Actuated Green, G (s)	26.0	26.0	26.0		22.0	29.0	7.0	60.0	60.0	14.0	67.0	
Effective Green, g (s)	26.0	26.0	26.0		22.0	29.0	7.0	60.0	60.0	14.0	67.0	
Actuated g/C Ratio	0.17	0.17	0.17		0.15	0.19	0.05	0.40	0.40	0.09	0.45	
Clearance Time (s)	7.0	7.0	7.0		7.0		7.0	7.0	7.0	7.0	7.0	
Vehicle Extension (s)	3.0	3.0	3.0		3.0		3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	306	322	274		264	306	154	1389	609	314	2185	
v/s Ratio Prot	c0.19	0.08	0.07		c0.16	0.13	0.04	c0.37	0.02	0.09	c0.47	
v/s Ratio Perm												
v/c Ratio	1.10	0.44	0.43		1.07	0.68	0.79	0.92	0.05	0.95	1.05	
Uniform Delay, d1	62.0	55.5	55.4		64.0	56.2	70.8	42.6	27.6	67.7	41.5	
Progression Factor	1.00	1.00	1.00		1.00	1.00	0.78	0.65	1.06	1.00	1.00	
Incremental Delay, d2	82.5	1.0	1.1		75.8	5.8	20.9	9.7	0.1	38.0	34.8	
Delay (s)	144.5	56.4	56.5		139.8	62.0	76.5	37.6	29.5	105.7	76.3	
Level of Service	F	E	E		F	E	E	D	C	F	E	
Approach Delay (s)		94.2			98.9		40.4				79.6	
Approach LOS		F			F		D				E	

Intersection Summary			
HCM 2000 Control Delay	73.3	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.08		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	28.0
Intersection Capacity Utilization	106.4%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Volume (vph)	488	16	224	18	16	88	323	2324	95	47	1048	580
Future Volume (vph)	488	16	224	18	16	88	323	2324	95	47	1048	580
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	7.0	7.0	7.0		7.0	7.0	7.0	7.0		7.0	7.0	7.0
Lane Util. Factor	0.95	0.95	1.00		1.00	1.00	0.97	0.91		0.97	0.91	1.00
Frt	1.00	1.00	0.85		1.00	0.85	1.00	0.99		1.00	1.00	0.85
Flt Protected	0.95	0.96	1.00		0.97	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1681	1690	1583		1814	1583	3367	4958		3303	4893	1524
Flt Permitted	0.95	0.96	1.00		0.97	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	1681	1690	1583		1814	1583	3367	4958		3303	4893	1524
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.93	0.93	0.93	0.88	0.88	0.88
Adj. Flow (vph)	530	17	243	20	17	96	347	2499	102	53	1191	659
RTOR Reduction (vph)	0	0	78	0	0	86	0	3	0	0	0	137
Lane Group Flow (vph)	276	271	165	0	37	10	347	2598	0	53	1191	523
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	4%	4%	4%	6%	6%	6%
Turn Type	Split	NA	pt+ov	Split	NA	pt+ov	Prot	NA		Prot	NA	pt+ov
Protected Phases	4	4	4 5	8	8	1 8	5	2		1	6	4 6
Permitted Phases												
Actuated Green, G (s)	27.0	27.0	54.5		10.0	15.0	20.5	80.0		5.0	64.5	91.5
Effective Green, g (s)	27.0	27.0	54.5		10.0	15.0	20.5	80.0		5.0	64.5	91.5
Actuated g/C Ratio	0.18	0.18	0.36		0.07	0.10	0.14	0.53		0.03	0.43	0.61
Clearance Time (s)	7.0	7.0			7.0		7.0	7.0		7.0	7.0	
Vehicle Extension (s)	4.0	4.0			4.0		4.0	4.0		4.0	4.0	
Lane Grp Cap (vph)	302	304	575		120	158	460	2644		110	2103	929
v/s Ratio Prot	c0.16	0.16	0.10		c0.02	0.01	c0.10	c0.52		0.02	0.24	0.34
v/s Ratio Perm												
v/c Ratio	0.91	0.89	0.29		0.31	0.06	0.75	0.98		0.48	0.57	0.56
Uniform Delay, d1	60.4	60.1	33.9		66.7	61.1	62.3	34.3		71.2	32.2	17.4
Progression Factor	1.00	1.00	1.00		1.00	1.00	1.34	0.32		1.04	0.83	0.58
Incremental Delay, d2	30.8	26.6	0.4		6.5	0.2	0.7	2.6		3.0	0.7	0.6
Delay (s)	91.2	86.7	34.3		73.3	61.3	84.4	13.5		77.0	27.5	10.8
Level of Service	F	F	C		E	E	F	B		E	C	B
Approach Delay (s)		72.1			64.7			21.8			23.1	
Approach LOS		E			E			C			C	

Intersection Summary			
HCM 2000 Control Delay	30.1	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.93		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	28.0
Intersection Capacity Utilization	95.0%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	0	1340	825	0	375	850
Future Volume (vph)	0	1340	825	0	375	850
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	12	16	12
Total Lost time (s)		6.0	6.0		6.0	6.0
Lane Util. Factor		0.95	0.95		1.00	0.88
Frt		1.00	1.00		1.00	0.85
Flt Protected		1.00	1.00		0.95	1.00
Satd. Flow (prot)		3471	3406		1930	2682
Flt Permitted		1.00	1.00		0.95	1.00
Satd. Flow (perm)		3471	3406		1930	2682
Peak-hour factor, PHF	0.93	0.93	0.88	0.88	0.89	0.89
Adj. Flow (vph)	0	1441	938	0	421	955
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	0	1441	938	0	421	955
Heavy Vehicles (%)	4%	4%	6%	6%	6%	6%
Turn Type		NA	NA		Prot	Prot
Protected Phases		2	6		4	4
Permitted Phases						
Actuated Green, G (s)		34.0	34.0		29.0	29.0
Effective Green, g (s)		34.0	34.0		29.0	29.0
Actuated g/C Ratio		0.45	0.45		0.39	0.39
Clearance Time (s)		6.0	6.0		6.0	6.0
Vehicle Extension (s)		3.0	3.0		3.0	3.0
Lane Grp Cap (vph)		1573	1544		746	1037
v/s Ratio Prot		c0.42	0.28		0.22	c0.36
v/s Ratio Perm						
v/c Ratio		0.92	0.61		0.56	0.92
Uniform Delay, d1		19.2	15.5		18.0	21.9
Progression Factor		1.07	1.41		1.00	1.00
Incremental Delay, d2		3.9	0.2		1.0	12.9
Delay (s)		24.4	22.0		19.0	34.8
Level of Service		C	C		B	C
Approach Delay (s)		24.4	22.0		30.0	
Approach LOS		C	C		C	

Intersection Summary			
HCM 2000 Control Delay	25.9	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.92		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	69.8%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	NBL2	NBL	NBR	SEL	SER	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations											
Traffic Volume (vph)	490	0	235	0	0	1470	245	0	0	885	175
Future Volume (vph)	490	0	235	0	0	1470	245	0	0	885	175
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0		6.0			6.0	6.0			6.0	4.0
Lane Util. Factor	0.97		0.88			0.97	0.95			0.95	1.00
Frt	1.00		0.85			1.00	1.00			1.00	0.85
Flt Protected	0.95		1.00			0.95	1.00			1.00	1.00
Satd. Flow (prot)	3242		2632			3335	3438			3505	1568
Flt Permitted	0.95		1.00			0.95	1.00			1.00	1.00
Satd. Flow (perm)	3242		2632			3335	3438			3505	1568
Peak-hour factor, PHF	0.88	0.88	0.88	0.92	0.92	0.94	0.94	0.94	0.92	0.92	0.92
Adj. Flow (vph)	557	0	267	0	0	1564	261	0	0	962	190
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	557	0	267	0	0	1564	261	0	0	962	190
Heavy Vehicles (%)	8%	8%	8%	2%	2%	5%	5%	5%	3%	3%	3%
Turn Type	Prot		Prot			Prot	NA			NA	Free
Protected Phases	8		8			5	2			6	
Permitted Phases											Free
Actuated Green, G (s)	25.0		25.0			67.0	113.0			40.0	150.0
Effective Green, g (s)	25.0		25.0			67.0	113.0			40.0	150.0
Actuated g/C Ratio	0.17		0.17			0.45	0.75			0.27	1.00
Clearance Time (s)	6.0		6.0			6.0	6.0			6.0	
Vehicle Extension (s)	3.0		3.0			3.0	3.0			3.0	
Lane Grp Cap (vph)	540		438			1489	2589			934	1568
v/s Ratio Prot	c0.17		0.10			c0.47	0.08			c0.27	
v/s Ratio Perm											0.12
v/c Ratio	1.03		0.61			1.05	0.10			1.03	0.12
Uniform Delay, d1	62.5		58.0			41.5	4.9			55.0	0.0
Progression Factor	1.00		1.00			0.80	1.82			1.00	1.00
Incremental Delay, d2	47.1		2.4			32.0	0.0			37.4	0.2
Delay (s)	109.6		60.4			65.4	9.0			92.4	0.2
Level of Service	F		E			E	A			F	A
Approach Delay (s)		93.6		0.0			57.3			77.2	
Approach LOS		F		A			E			E	

Intersection Summary			
HCM 2000 Control Delay	71.2	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.04		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	96.4%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Volume (vph)	80	0	25	0	1	0	60	430	0	5	930	20
Future Volume (vph)	80	0	25	0	1	0	60	430	0	5	930	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0	6.0		6.0		6.0	6.0		6.0	6.0	
Lane Util. Factor		1.00	1.00		1.00		1.00	0.95		1.00	0.95	
Frt		1.00	0.85		1.00		1.00	1.00		1.00	1.00	
Flt Protected		0.95	1.00		1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1770	1583		1900		1770	3539		1770	3528	
Flt Permitted		0.76	1.00		1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1407	1583		1900		1770	3539		1770	3528	
Peak-hour factor, PHF	0.92	0.92	0.92	0.25	0.25	0.25	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	87	0	27	0	4	0	65	467	0	5	1011	22
RTOR Reduction (vph)	0	0	12	0	0	0	0	0	0	0	1	0
Lane Group Flow (vph)	0	87	15	0	4	0	65	467	0	5	1032	0
Heavy Vehicles (%)	2%	2%	2%	0%	0%	0%	2%	2%	2%	2%	2%	2%
Turn Type	Perm	NA	custom		NA		Prot	NA		Prot	NA	
Protected Phases		8			4		5	2		1	6	
Permitted Phases	8		6	4								
Actuated Green, G (s)		7.9	40.1		7.9		6.4	45.7		0.8	40.1	
Effective Green, g (s)		7.9	40.1		7.9		6.4	45.7		0.8	40.1	
Actuated g/C Ratio		0.11	0.55		0.11		0.09	0.63		0.01	0.55	
Clearance Time (s)		6.0	6.0		6.0		6.0	6.0		6.0	6.0	
Vehicle Extension (s)		3.0	3.0		3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		153	876		207		156	2233		19	1954	
v/s Ratio Prot					0.00		c0.04	c0.13		0.00	c0.29	
v/s Ratio Perm		c0.06	0.01									
v/c Ratio		0.57	0.02		0.02		0.42	0.21		0.26	0.53	
Uniform Delay, d1		30.6	7.3		28.8		31.2	5.7		35.5	10.2	
Progression Factor		1.00	1.00		1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		4.8	0.0		0.0		1.8	0.0		7.3	0.3	
Delay (s)		35.4	7.3		28.8		33.0	5.7		42.8	10.4	
Level of Service		D	A		C		C	A		D	B	
Approach Delay (s)		28.8			28.8			9.1			10.6	
Approach LOS		C			C			A			B	

Intersection Summary			
HCM 2000 Control Delay	11.4	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.52		
Actuated Cycle Length (s)	72.4	Sum of lost time (s)	18.0
Intersection Capacity Utilization	61.8%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Volume (vph)	10	70	10	370	0	50	0	370	110	15	495	0
Future Volume (vph)	10	70	10	370	0	50	0	370	110	15	495	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0			6.0			6.0			6.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		0.98			0.98			0.97			1.00	
Flt Protected		0.99			0.96			1.00			1.00	
Satd. Flow (prot)		1824			1738			1705			1807	
Flt Permitted		0.94			0.68			1.00			0.98	
Satd. Flow (perm)		1716			1243			1705			1772	
Peak-hour factor, PHF	0.60	0.60	0.60	0.96	0.96	0.96	0.89	0.89	0.89	0.86	0.86	0.86
Adj. Flow (vph)	17	117	17	385	0	52	0	416	124	17	576	0
RTOR Reduction (vph)	0	5	0	0	22	0	0	12	0	0	0	0
Lane Group Flow (vph)	0	146	0	0	415	0	0	528	0	0	593	0
Heavy Vehicles (%)	2%	2%	2%	3%	3%	3%	8%	8%	8%	5%	5%	5%
Turn Type	Perm	NA		Perm	NA			NA		Perm	NA	
Protected Phases		4			4			2			2	
Permitted Phases	4			4						2		
Actuated Green, G (s)		30.7			30.7			33.9			33.9	
Effective Green, g (s)		30.7			30.7			33.9			33.9	
Actuated g/C Ratio		0.40			0.40			0.44			0.44	
Clearance Time (s)		6.0			6.0			6.0			6.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		687			498			754			784	
v/s Ratio Prot								0.31				
v/s Ratio Perm		0.08			c0.33						c0.33	
v/c Ratio		0.21			0.83			0.70			0.76	
Uniform Delay, d1		15.0			20.7			17.2			17.9	
Progression Factor		1.00			1.00			1.00			1.00	
Incremental Delay, d2		0.2			11.5			2.9			4.2	
Delay (s)		15.2			32.1			20.1			22.1	
Level of Service		B			C			C			C	
Approach Delay (s)		15.2			32.1			20.1			22.1	
Approach LOS		B			C			C			C	

Intersection Summary			
HCM 2000 Control Delay	23.4	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	76.6	Sum of lost time (s)	12.0
Intersection Capacity Utilization	79.7%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SBL	SBR	SBR2	NEL2	NEL	NER
Lane Configurations												
Traffic Volume (vph)	112	127	329	154	147	167	225	1741	159	327	1412	72
Future Volume (vph)	112	127	329	154	147	167	225	1741	159	327	1412	72
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	7.0	7.0	7.0		7.0	7.0	7.0	7.0	7.0	7.0	7.0	
Lane Util. Factor	1.00	1.00	1.00		1.00	1.00	0.97	0.76	1.00	0.97	0.94	
Frt	1.00	1.00	0.85		1.00	0.85	1.00	0.85	0.85	1.00	0.99	
Flt Protected	0.95	1.00	1.00		0.98	1.00	0.95	1.00	1.00	0.95	0.95	
Satd. Flow (prot)	1770	1863	1583		1816	1583	3303	3474	1524	3367	4882	
Flt Permitted	0.95	1.00	1.00		0.98	1.00	0.95	1.00	1.00	0.95	0.95	
Satd. Flow (perm)	1770	1863	1583		1816	1583	3303	3474	1524	3367	4882	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.88	0.88	0.88	0.93	0.93	0.93
Adj. Flow (vph)	122	138	358	167	160	182	256	1978	181	352	1518	77
RTOR Reduction (vph)	0	0	127	0	0	110	0	0	79	0	85	0
Lane Group Flow (vph)	122	138	231	0	327	72	256	1978	102	352	1510	0
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	6%	6%	6%	4%	4%	4%
Turn Type	Split	NA	pt+ov	Split	NA	pt+ov	Prot	Prot	Prot	Prot	Prot	
Protected Phases	4	4	4 5	8	8	1 8	1	6	6	5	2	
Permitted Phases												
Actuated Green, G (s)	10.0	10.0	21.0		19.0	35.0	16.0	62.0	62.0	11.0	57.0	
Effective Green, g (s)	10.0	10.0	21.0		19.0	35.0	16.0	62.0	62.0	11.0	57.0	
Actuated g/C Ratio	0.08	0.08	0.16		0.15	0.27	0.12	0.48	0.48	0.08	0.44	
Clearance Time (s)	7.0	7.0			7.0		7.0	7.0	7.0	7.0	7.0	
Vehicle Extension (s)	3.0	3.0			3.0		3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	136	143	255		265	426	406	1656	726	284	2140	
v/s Ratio Prot	0.07	c0.07	0.15		c0.18	0.05	0.08	c0.57	0.07	c0.10	0.31	
v/s Ratio Perm												
v/c Ratio	0.90	0.97	0.91		1.23	0.17	0.63	1.19	0.14	1.24	0.71	
Uniform Delay, d1	59.5	59.8	53.5		55.5	36.4	54.2	34.0	19.1	59.5	29.7	
Progression Factor	1.00	1.00	1.00		1.00	1.00	0.58	0.35	0.03	1.00	1.00	
Incremental Delay, d2	47.1	64.1	32.6		133.5	0.2	0.3	88.1	0.0	134.1	2.0	
Delay (s)	106.6	123.9	86.1		189.0	36.5	31.9	99.9	0.7	193.6	31.7	
Level of Service	F	F	F		F	D	C	F	A	F	C	
Approach Delay (s)		98.6			134.5		85.2				60.9	
Approach LOS		F			F		F				E	

Intersection Summary			
HCM 2000 Control Delay	82.7	HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio	1.18		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	28.0
Intersection Capacity Utilization	98.2%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Volume (vph)	749	50	522	49	35	67	487	1149	43	132	1541	997
Future Volume (vph)	749	50	522	49	35	67	487	1149	43	132	1541	997
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	7.0	7.0	7.0		7.0	7.0	7.0	7.0		7.0	7.0	7.0
Lane Util. Factor	0.95	0.95	1.00		1.00	1.00	0.97	0.91		0.97	0.91	1.00
Frt	1.00	1.00	0.85		1.00	0.85	1.00	0.99		1.00	1.00	0.85
Flt Protected	0.95	0.96	1.00		0.97	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1681	1695	1583		1810	1583	3367	4961		3303	4893	1524
Flt Permitted	0.95	0.96	1.00		0.97	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	1681	1695	1583		1810	1583	3367	4961		3303	4893	1524
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.93	0.93	0.93	0.88	0.88	0.88
Adj. Flow (vph)	814	54	567	53	38	73	524	1235	46	150	1751	1133
RTOR Reduction (vph)	0	0	183	0	0	67	0	3	0	0	0	121
Lane Group Flow (vph)	431	437	384	0	91	6	524	1278	0	150	1751	1012
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	4%	4%	4%	6%	6%	6%
Turn Type	Split	NA	Prot	Split	NA	Prot	Prot	NA		Prot	NA	pt+ov
Protected Phases	4	4	4	8	8	8	5	2		1	6	4 6
Permitted Phases												
Actuated Green, G (s)	33.0	33.0	33.0		10.0	10.0	16.0	49.2		9.8	43.0	76.0
Effective Green, g (s)	33.0	33.0	33.0		10.0	10.0	16.0	49.2		9.8	43.0	76.0
Actuated g/C Ratio	0.25	0.25	0.25		0.08	0.08	0.12	0.38		0.08	0.33	0.58
Clearance Time (s)	7.0	7.0	7.0		7.0	7.0	7.0	7.0		7.0	7.0	
Vehicle Extension (s)	4.0	4.0	4.0		4.0	4.0	4.0	4.0		4.0	4.0	
Lane Grp Cap (vph)	426	430	401		139	121	414	1877		248	1618	890
v/s Ratio Prot	0.26	0.26	0.24		c0.05	0.00	c0.16	c0.26		0.05	0.36	c0.66
v/s Ratio Perm												
v/c Ratio	1.01	1.02	0.96		0.65	0.05	1.27	0.68		0.60	1.08	1.14
Uniform Delay, d1	48.5	48.5	47.8		58.3	55.6	57.0	33.8		58.2	43.5	27.0
Progression Factor	1.00	1.00	1.00		1.00	1.00	1.40	0.45		1.00	1.06	1.25
Incremental Delay, d2	46.6	47.6	34.0		21.6	0.7	132.8	1.4		0.4	38.3	63.2
Delay (s)	95.1	96.1	81.8		79.9	56.3	212.8	16.7		58.6	84.3	97.0
Level of Service	F	F	F		E	E	F	B		E	F	F
Approach Delay (s)		90.2			69.4			73.6			87.8	
Approach LOS		F			E			E			F	

Intersection Summary			
HCM 2000 Control Delay	83.9	HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio	1.11		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	28.0
Intersection Capacity Utilization	106.6%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	0	1230	1475	0	385	1195
Future Volume (vph)	0	1230	1475	0	385	1195
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	12	16	12
Total Lost time (s)		6.0	6.0		6.0	6.0
Lane Util. Factor		0.95	0.95		1.00	0.88
Frt		1.00	1.00		1.00	0.85
Flt Protected		1.00	1.00		0.95	1.00
Satd. Flow (prot)		3471	3406		1930	2682
Flt Permitted		1.00	1.00		0.95	1.00
Satd. Flow (perm)		3471	3406		1930	2682
Peak-hour factor, PHF	0.93	0.93	0.88	0.88	0.89	0.89
Adj. Flow (vph)	0	1323	1676	0	433	1343
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	0	1323	1676	0	433	1343
Heavy Vehicles (%)	4%	4%	6%	6%	6%	6%
Turn Type		NA	NA		Prot	Prot
Protected Phases		2	6		4	4
Permitted Phases						
Actuated Green, G (s)		59.0	59.0		59.0	59.0
Effective Green, g (s)		59.0	59.0		59.0	59.0
Actuated g/C Ratio		0.45	0.45		0.45	0.45
Clearance Time (s)		6.0	6.0		6.0	6.0
Vehicle Extension (s)		3.0	3.0		3.0	3.0
Lane Grp Cap (vph)		1575	1545		875	1217
v/s Ratio Prot		0.38	c0.49		0.22	c0.50
v/s Ratio Perm						
v/c Ratio		0.84	1.08		0.49	1.10
Uniform Delay, d1		31.3	35.5		25.0	35.5
Progression Factor		0.66	0.12		1.00	1.00
Incremental Delay, d2		3.4	39.5		0.4	59.0
Delay (s)		23.9	43.9		25.4	94.5
Level of Service		C	D		C	F
Approach Delay (s)		23.9	43.9		77.7	
Approach LOS		C	D		E	

Intersection Summary			
HCM 2000 Control Delay	50.9	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	1.09		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	94.6%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Movement	NBL2	NBL	NBR	SEL	SER	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations											
Traffic Volume (vph)	1360	0	725	0	0	1155	460	0	0	370	110
Future Volume (vph)	1360	0	725	0	0	1155	460	0	0	370	110
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0		6.0			6.0	6.0			6.0	4.0
Lane Util. Factor	0.97		0.88			0.97	0.95			0.95	1.00
Frt	1.00		0.85			1.00	1.00			1.00	0.85
Flt Protected	0.95		1.00			0.95	1.00			1.00	1.00
Satd. Flow (prot)	3242		2632			3335	3438			3505	1568
Flt Permitted	0.95		1.00			0.95	1.00			1.00	1.00
Satd. Flow (perm)	3242		2632			3335	3438			3505	1568
Peak-hour factor, PHF	0.88	0.88	0.88	0.92	0.92	0.94	0.94	0.94	0.92	0.92	0.92
Adj. Flow (vph)	1545	0	824	0	0	1229	489	0	0	402	120
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	1545	0	824	0	0	1229	489	0	0	402	120
Heavy Vehicles (%)	8%	8%	8%	2%	2%	5%	5%	5%	3%	3%	3%
Turn Type	Prot		Prot			Prot	NA			NA	Free
Protected Phases	8		8			5	2			6	
Permitted Phases											Free
Actuated Green, G (s)	48.0		48.0			38.0	70.0			26.0	130.0
Effective Green, g (s)	48.0		48.0			38.0	70.0			26.0	130.0
Actuated g/C Ratio	0.37		0.37			0.29	0.54			0.20	1.00
Clearance Time (s)	6.0		6.0			6.0	6.0			6.0	
Vehicle Extension (s)	3.0		3.0			3.0	3.0			3.0	
Lane Grp Cap (vph)	1197		971			974	1851			701	1568
v/s Ratio Prot	c0.48		0.31			c0.37	0.14			c0.11	
v/s Ratio Perm											0.08
v/c Ratio	1.29		0.85			1.26	0.26			0.57	0.08
Uniform Delay, d1	41.0		37.7			46.0	16.1			47.0	0.0
Progression Factor	1.00		1.00			0.76	0.46			1.00	1.00
Incremental Delay, d2	137.2		7.0			123.2	0.2			3.4	0.1
Delay (s)	178.2		44.7			158.2	7.7			50.4	0.1
Level of Service	F		D			F	A			D	A
Approach Delay (s)		131.8		0.0			115.3			38.8	
Approach LOS		F		A			F			D	

Intersection Summary			
HCM 2000 Control Delay	115.1	HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio	1.11		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	98.0%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Volume (vph)	100	5	90	10	0	10	210	880	120	5	520	140
Future Volume (vph)	100	5	90	10	0	10	210	880	120	5	520	140
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0	6.0		6.0		6.0	6.0		6.0	6.0	
Lane Util. Factor		1.00	1.00		1.00		1.00	0.95		1.00	0.95	
Frt		1.00	0.85		0.93		1.00	0.98		1.00	0.97	
Flt Protected		0.95	1.00		0.98		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1778	1583		1729		1770	3476		1770	3427	
Flt Permitted		0.78	1.00		0.78		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1461	1583		1388		1770	3476		1770	3427	
Peak-hour factor, PHF	0.92	0.92	0.92	0.25	0.25	0.25	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	109	5	98	40	0	40	228	957	130	5	565	152
RTOR Reduction (vph)	0	0	57	0	70	0	0	10	0	0	24	0
Lane Group Flow (vph)	0	114	41	0	10	0	228	1077	0	5	693	0
Heavy Vehicles (%)	2%	2%	2%	0%	0%	0%	2%	2%	2%	2%	2%	2%
Turn Type	Perm	NA	custom	Perm	NA		Prot	NA		Prot	NA	
Protected Phases		8			4		5	2		1	6	
Permitted Phases	8		6	4								
Actuated Green, G (s)		9.3	30.8		9.3		14.7	44.7		0.8	30.8	
Effective Green, g (s)		9.3	30.8		9.3		14.7	44.7		0.8	30.8	
Actuated g/C Ratio		0.13	0.42		0.13		0.20	0.61		0.01	0.42	
Clearance Time (s)		6.0	6.0		6.0		6.0	6.0		6.0	6.0	
Vehicle Extension (s)		3.0	3.0		3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		186	669		177		357	2134		19	1449	
v/s Ratio Prot							c0.13	c0.31		0.00	0.20	
v/s Ratio Perm		c0.08	0.03		0.01							
v/c Ratio		0.61	0.06		0.06		0.64	0.50		0.26	0.48	
Uniform Delay, d1		30.0	12.4		27.9		26.6	7.9		35.7	15.2	
Progression Factor		1.00	1.00		1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		5.9	0.0		0.1		3.7	0.2		7.3	0.3	
Delay (s)		35.9	12.5		28.0		30.3	8.0		43.0	15.4	
Level of Service		D	B		C		C	A		D	B	
Approach Delay (s)		25.1			28.0			11.9			15.6	
Approach LOS		C			C			B			B	

Intersection Summary			
HCM 2000 Control Delay	14.8	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.58		
Actuated Cycle Length (s)	72.8	Sum of lost time (s)	18.0
Intersection Capacity Utilization	60.9%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Volume (vph)	20	110	5	270	0	70	0	710	130	15	345	0
Future Volume (vph)	20	110	5	270	0	70	0	710	130	15	345	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0			6.0			6.0			6.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		1.00			0.97			0.98			1.00	
Flt Protected		0.99			0.96			1.00			1.00	
Satd. Flow (prot)		1840			1725			1723			1806	
Flt Permitted		0.92			0.58			1.00			0.70	
Satd. Flow (perm)		1706			1046			1723			1268	
Peak-hour factor, PHF	0.60	0.60	0.60	0.96	0.96	0.96	0.89	0.89	0.89	0.86	0.86	0.86
Adj. Flow (vph)	33	183	8	281	0	73	0	798	146	17	401	0
RTOR Reduction (vph)	0	1	0	0	25	0	0	7	0	0	0	0
Lane Group Flow (vph)	0	223	0	0	329	0	0	937	0	0	418	0
Heavy Vehicles (%)	2%	2%	2%	3%	3%	3%	8%	8%	8%	5%	5%	5%
Turn Type	Perm	NA		Perm	NA			NA		Perm	NA	
Protected Phases		4			4			2			2	
Permitted Phases	4			4						2		
Actuated Green, G (s)		28.0			28.0			50.0			50.0	
Effective Green, g (s)		28.0			28.0			50.0			50.0	
Actuated g/C Ratio		0.31			0.31			0.56			0.56	
Clearance Time (s)		6.0			6.0			6.0			6.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		530			325			957			704	
v/s Ratio Prot								c0.54				
v/s Ratio Perm		0.13			c0.31						0.33	
v/c Ratio		0.42			1.01			0.98			0.59	
Uniform Delay, d1		24.6			31.0			19.5			13.3	
Progression Factor		1.00			1.00			1.00			1.00	
Incremental Delay, d2		0.5			53.2			23.8			1.4	
Delay (s)		25.1			84.2			43.2			14.6	
Level of Service		C			F			D			B	
Approach Delay (s)		25.1			84.2			43.2			14.6	
Approach LOS		C			F			D			B	

Intersection Summary			
HCM 2000 Control Delay	42.5	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.99		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	84.5%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SBL	SBR	SBR2	NEL2	NEL	NER
Lane Configurations												
Traffic Volume (vph)	302	126	275	167	86	280	105	1096	68	270	2087	55
Future Volume (vph)	302	126	275	167	86	280	105	1096	68	270	2087	55
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	7.0	7.0	7.0		7.0	7.0	7.0	7.0	7.0	7.0	7.0	
Lane Util. Factor	1.00	1.00	1.00		1.00	1.00	0.97	0.76	1.00	0.97	0.94	
Frt	1.00	1.00	0.85		1.00	0.85	1.00	0.85	0.85	1.00	1.00	
Flt Protected	0.95	1.00	1.00		0.97	1.00	0.95	1.00	1.00	0.95	0.95	
Satd. Flow (prot)	1770	1863	1583		1803	1583	3303	3474	1524	3367	4894	
Flt Permitted	0.95	1.00	1.00		0.97	1.00	0.95	1.00	1.00	0.95	0.95	
Satd. Flow (perm)	1770	1863	1583		1803	1583	3303	3474	1524	3367	4894	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.88	0.88	0.88	0.93	0.93	0.93
Adj. Flow (vph)	328	137	299	182	93	304	119	1245	77	290	2244	59
RTOR Reduction (vph)	0	0	189	0	0	105	0	0	46	0	73	0
Lane Group Flow (vph)	328	137	110	0	275	199	119	1245	31	290	2230	0
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	6%	6%	6%	4%	4%	4%
Turn Type	Split	NA	Prot	Split	NA	pt+ov	Prot	Prot	Prot	Prot	Prot	
Protected Phases	4	4	4	8	8	1 8	1	6	6	5	2	
Permitted Phases												
Actuated Green, G (s)	26.0	26.0	26.0		21.0	30.0	9.0	61.0	61.0	14.0	66.0	
Effective Green, g (s)	26.0	26.0	26.0		21.0	30.0	9.0	61.0	61.0	14.0	66.0	
Actuated g/C Ratio	0.17	0.17	0.17		0.14	0.20	0.06	0.41	0.41	0.09	0.44	
Clearance Time (s)	7.0	7.0	7.0		7.0		7.0	7.0	7.0	7.0	7.0	
Vehicle Extension (s)	3.0	3.0	3.0		3.0		3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	306	322	274		252	316	198	1412	619	314	2153	
v/s Ratio Prot	c0.19	0.07	0.07		c0.15	0.13	0.04	c0.36	0.02	0.09	c0.46	
v/s Ratio Perm												
v/c Ratio	1.07	0.43	0.40		1.09	0.63	0.60	0.88	0.05	0.92	1.04	
Uniform Delay, d1	62.0	55.3	55.1		64.5	54.9	68.7	41.2	27.0	67.5	42.0	
Progression Factor	1.00	1.00	1.00		1.00	1.00	0.53	0.34	0.23	1.00	1.00	
Incremental Delay, d2	71.8	0.9	1.0		83.2	4.1	4.4	7.2	0.1	31.5	29.3	
Delay (s)	133.8	56.2	56.0		147.7	59.0	40.9	21.4	6.4	99.0	71.3	
Level of Service	F	E	E		F	E	D	C	A	F	E	
Approach Delay (s)		89.5			101.1		22.2				74.4	
Approach LOS		F			F		C				E	

Intersection Summary			
HCM 2000 Control Delay	65.4	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.06		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	28.0
Intersection Capacity Utilization	104.3%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Volume (vph)	474	16	217	17	16	85	314	2256	92	46	1030	569
Future Volume (vph)	474	16	217	17	16	85	314	2256	92	46	1030	569
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	7.0	7.0	7.0		7.0	7.0	7.0	7.0		7.0	7.0	7.0
Lane Util. Factor	0.95	0.95	1.00		1.00	1.00	0.97	0.91		0.97	0.91	1.00
Frt	1.00	1.00	0.85		1.00	0.85	1.00	0.99		1.00	1.00	0.85
Flt Protected	0.95	0.96	1.00		0.97	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1681	1691	1583		1816	1583	3367	4958		3303	4893	1524
Flt Permitted	0.95	0.96	1.00		0.97	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	1681	1691	1583		1816	1583	3367	4958		3303	4893	1524
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.93	0.93	0.93	0.88	0.88	0.88
Adj. Flow (vph)	515	17	236	18	17	92	338	2426	99	52	1170	647
RTOR Reduction (vph)	0	0	80	0	0	83	0	3	0	0	0	137
Lane Group Flow (vph)	268	264	156	0	35	9	338	2522	0	52	1170	510
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	4%	4%	4%	6%	6%	6%
Turn Type	Split	NA	pt+ov	Split	NA	pt+ov	Prot	NA		Prot	NA	pt+ov
Protected Phases	4	4	4 5	8	8	1 8	5	2		1	6	4 6
Permitted Phases												
Actuated Green, G (s)	28.0	28.0	55.4		10.0	15.0	20.4	79.0		5.0	63.6	91.6
Effective Green, g (s)	28.0	28.0	55.4		10.0	15.0	20.4	79.0		5.0	63.6	91.6
Actuated g/C Ratio	0.19	0.19	0.37		0.07	0.10	0.14	0.53		0.03	0.42	0.61
Clearance Time (s)	7.0	7.0			7.0		7.0	7.0		7.0	7.0	
Vehicle Extension (s)	4.0	4.0			4.0		4.0	4.0		4.0	4.0	
Lane Grp Cap (vph)	313	315	584		121	158	457	2611		110	2074	930
v/s Ratio Prot	c0.16	0.16	0.10		c0.02	0.01	c0.10	c0.51		0.02	0.24	0.33
v/s Ratio Perm												
v/c Ratio	0.86	0.84	0.27		0.29	0.06	0.74	0.97		0.47	0.56	0.55
Uniform Delay, d1	59.1	58.8	33.1		66.6	61.1	62.2	34.2		71.2	32.7	17.1
Progression Factor	1.00	1.00	1.00		1.00	1.00	1.35	0.31		1.07	1.07	1.82
Incremental Delay, d2	20.5	18.1	0.3		5.9	0.2	0.6	1.6		2.8	0.7	0.5
Delay (s)	79.6	76.9	33.4		72.6	61.3	84.8	12.3		78.8	35.9	31.6
Level of Service	E	E	C		E	E	F	B		E	D	C
Approach Delay (s)		64.5			64.4			20.9			35.6	
Approach LOS		E			E			C			D	

Intersection Summary			
HCM 2000 Control Delay	32.7	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.90		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	28.0
Intersection Capacity Utilization	93.2%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	0	1280	720	0	385	925
Future Volume (vph)	0	1280	720	0	385	925
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	12	16	12
Total Lost time (s)		6.0	6.0		6.0	6.0
Lane Util. Factor		0.95	0.95		1.00	0.88
Frt		1.00	1.00		1.00	0.85
Flt Protected		1.00	1.00		0.95	1.00
Satd. Flow (prot)		3471	3406		1930	2682
Flt Permitted		1.00	1.00		0.95	1.00
Satd. Flow (perm)		3471	3406		1930	2682
Peak-hour factor, PHF	0.93	0.93	0.88	0.88	0.89	0.89
Adj. Flow (vph)	0	1376	818	0	433	1039
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	0	1376	818	0	433	1039
Heavy Vehicles (%)	4%	4%	6%	6%	6%	6%
Turn Type		NA	NA		Prot	Prot
Protected Phases		2	6		4	4
Permitted Phases						
Actuated Green, G (s)		32.0	32.0		31.0	31.0
Effective Green, g (s)		32.0	32.0		31.0	31.0
Actuated g/C Ratio		0.43	0.43		0.41	0.41
Clearance Time (s)		6.0	6.0		6.0	6.0
Vehicle Extension (s)		3.0	3.0		3.0	3.0
Lane Grp Cap (vph)		1480	1453		797	1108
v/s Ratio Prot		c0.40	0.24		0.22	c0.39
v/s Ratio Perm						
v/c Ratio		0.93	0.56		0.54	0.94
Uniform Delay, d1		20.4	16.2		16.6	21.1
Progression Factor		1.01	1.36		1.00	1.00
Incremental Delay, d2		5.3	0.4		0.8	14.4
Delay (s)		25.8	22.5		17.4	35.4
Level of Service		C	C		B	D
Approach Delay (s)		25.8	22.5		30.1	
Approach LOS		C	C		C	

Intersection Summary			
HCM 2000 Control Delay	26.8	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.93		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	68.7%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	NBL2	NBL	NBR	SEL	SER	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations											
Traffic Volume (vph)	485	0	245	0	0	1415	250	0	0	820	500
Future Volume (vph)	485	0	245	0	0	1415	250	0	0	820	500
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0		6.0			6.0	6.0			6.0	4.0
Lane Util. Factor	0.97		0.88			0.97	0.95			0.95	1.00
Frt	1.00		0.85			1.00	1.00			1.00	0.85
Flt Protected	0.95		1.00			0.95	1.00			1.00	1.00
Satd. Flow (prot)	3242		2632			3335	3438			3505	1568
Flt Permitted	0.95		1.00			0.95	1.00			1.00	1.00
Satd. Flow (perm)	3242		2632			3335	3438			3505	1568
Peak-hour factor, PHF	0.88	0.88	0.88	0.92	0.92	0.94	0.94	0.94	0.92	0.92	0.92
Adj. Flow (vph)	551	0	278	0	0	1505	266	0	0	891	543
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	551	0	278	0	0	1505	266	0	0	891	543
Heavy Vehicles (%)	8%	8%	8%	2%	2%	5%	5%	5%	3%	3%	3%
Turn Type	Prot		Prot			Prot	NA			NA	Free
Protected Phases	8		8			5	2			6	
Permitted Phases											Free
Actuated Green, G (s)	25.0		25.0			67.0	113.0			40.0	150.0
Effective Green, g (s)	25.0		25.0			67.0	113.0			40.0	150.0
Actuated g/C Ratio	0.17		0.17			0.45	0.75			0.27	1.00
Clearance Time (s)	6.0		6.0			6.0	6.0			6.0	
Vehicle Extension (s)	3.0		3.0			3.0	3.0			3.0	
Lane Grp Cap (vph)	540		438			1489	2589			934	1568
v/s Ratio Prot	c0.17		0.11			c0.45	0.08			c0.25	
v/s Ratio Perm											0.35
v/c Ratio	1.02		0.63			1.01	0.10			0.95	0.35
Uniform Delay, d1	62.5		58.2			41.5	4.9			54.1	0.0
Progression Factor	1.00		1.00			0.75	1.80			1.00	1.00
Incremental Delay, d2	44.0		3.0			19.5	0.0			20.2	0.6
Delay (s)	106.5		61.2			50.8	8.9			74.3	0.6
Level of Service	F		E			D	A			E	A
Approach Delay (s)		91.3		0.0			44.5			46.4	
Approach LOS		F		A			D			D	

Intersection Summary			
HCM 2000 Control Delay	54.8	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.99		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	92.9%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Volume (vph)	10	0	150	0	1	0	60	410	0	5	1030	20
Future Volume (vph)	10	0	150	0	1	0	60	410	0	5	1030	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0	6.0		6.0		6.0	6.0		6.0	6.0	
Lane Util. Factor		1.00	1.00		1.00		1.00	0.95		1.00	0.95	
Frt		1.00	0.85		1.00		1.00	1.00		1.00	1.00	
Flt Protected		0.95	1.00		1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1770	1583		1900		1770	3539		1770	3529	
Flt Permitted		1.00	1.00		1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1863	1583		1900		1770	3539		1770	3529	
Peak-hour factor, PHF	0.92	0.92	0.92	0.25	0.25	0.25	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	11	0	163	0	4	0	65	446	0	5	1120	22
RTOR Reduction (vph)	0	0	59	0	0	0	0	0	0	0	1	0
Lane Group Flow (vph)	0	11	104	0	4	0	65	446	0	5	1141	0
Heavy Vehicles (%)	2%	2%	2%	0%	0%	0%	2%	2%	2%	2%	2%	2%
Turn Type	Perm	NA	custom		NA		Prot	NA		Prot	NA	
Protected Phases		8			4		5	2		1	6	
Permitted Phases	8		6	4								
Actuated Green, G (s)		1.3	45.3		1.3		6.3	50.8		0.8	45.3	
Effective Green, g (s)		1.3	45.3		1.3		6.3	50.8		0.8	45.3	
Actuated g/C Ratio		0.02	0.64		0.02		0.09	0.72		0.01	0.64	
Clearance Time (s)		6.0	6.0		6.0		6.0	6.0		6.0	6.0	
Vehicle Extension (s)		3.0	3.0		3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		34	1011		34		157	2535		19	2254	
v/s Ratio Prot					0.00		c0.04	c0.13		0.00	c0.32	
v/s Ratio Perm		c0.01	0.07									
v/c Ratio		0.32	0.10		0.12		0.41	0.18		0.26	0.51	
Uniform Delay, d1		34.4	4.9		34.2		30.6	3.3		34.8	6.8	
Progression Factor		1.00	1.00		1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		5.5	0.0		1.5		1.8	0.0		7.3	0.2	
Delay (s)		39.8	5.0		35.8		32.3	3.3		42.0	7.0	
Level of Service		D	A		D		C	A		D	A	
Approach Delay (s)		7.2			35.8			7.0			7.2	
Approach LOS		A			D			A			A	

Intersection Summary			
HCM 2000 Control Delay	7.2	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.48		
Actuated Cycle Length (s)	70.9	Sum of lost time (s)	18.0
Intersection Capacity Utilization	61.4%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Volume (vph)	10	50	0	350	0	40	0	360	110	15	545	0
Future Volume (vph)	10	50	0	350	0	40	0	360	110	15	545	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0			6.0			6.0			6.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		1.00			0.99			0.97			1.00	
Flt Protected		0.99			0.96			1.00			1.00	
Satd. Flow (prot)		1847			1741			1703			1807	
Flt Permitted		0.91			0.68			1.00			0.98	
Satd. Flow (perm)		1694			1233			1703			1776	
Peak-hour factor, PHF	0.60	0.60	0.60	0.96	0.96	0.96	0.89	0.89	0.89	0.86	0.86	0.86
Adj. Flow (vph)	17	83	0	365	0	42	0	404	124	17	634	0
RTOR Reduction (vph)	0	0	0	0	23	0	0	13	0	0	0	0
Lane Group Flow (vph)	0	100	0	0	384	0	0	515	0	0	651	0
Heavy Vehicles (%)	2%	2%	2%	3%	3%	3%	8%	8%	8%	5%	5%	5%
Turn Type	Perm	NA		Perm	NA			NA		Perm	NA	
Protected Phases		4			4			2			2	
Permitted Phases	4			4						2		
Actuated Green, G (s)		28.5			28.5			36.1			36.1	
Effective Green, g (s)		28.5			28.5			36.1			36.1	
Actuated g/C Ratio		0.37			0.37			0.47			0.47	
Clearance Time (s)		6.0			6.0			6.0			6.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		630			458			802			836	
v/s Ratio Prot								0.30				
v/s Ratio Perm		0.06			c0.31						c0.37	
v/c Ratio		0.16			0.84			0.64			0.78	
Uniform Delay, d1		16.0			22.0			15.4			16.9	
Progression Factor		1.00			1.00			1.00			1.00	
Incremental Delay, d2		0.1			12.7			1.8			4.6	
Delay (s)		16.2			34.7			17.1			21.5	
Level of Service		B			C			B			C	
Approach Delay (s)		16.2			34.7			17.1			21.5	
Approach LOS		B			C			B			C	

Intersection Summary			
HCM 2000 Control Delay	23.0	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.80		
Actuated Cycle Length (s)	76.6	Sum of lost time (s)	12.0
Intersection Capacity Utilization	80.6%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SBL	SBR	SBR2	NEL2	NEL	NER
Lane Configurations												
Traffic Volume (vph)	109	128	330	155	148	164	227	1750	160	328	1386	73
Future Volume (vph)	109	128	330	155	148	164	227	1750	160	328	1386	73
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	7.0	7.0	7.0		7.0	7.0	7.0	7.0	7.0	7.0	7.0	
Lane Util. Factor	1.00	1.00	1.00		1.00	1.00	0.97	0.76	1.00	0.97	0.94	
Frt	1.00	1.00	0.85		1.00	0.85	1.00	0.85	0.85	1.00	0.99	
Flt Protected	0.95	1.00	1.00		0.98	1.00	0.95	1.00	1.00	0.95	0.95	
Satd. Flow (prot)	1770	1863	1583		1816	1583	3303	3474	1524	3367	4882	
Flt Permitted	0.95	1.00	1.00		0.98	1.00	0.95	1.00	1.00	0.95	0.95	
Satd. Flow (perm)	1770	1863	1583		1816	1583	3303	3474	1524	3367	4882	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.88	0.88	0.88	0.93	0.93	0.93
Adj. Flow (vph)	118	139	359	168	161	178	258	1989	182	353	1490	78
RTOR Reduction (vph)	0	0	111	0	0	95	0	0	65	0	69	0
Lane Group Flow (vph)	118	139	248	0	329	83	258	1989	117	353	1499	0
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	6%	6%	6%	4%	4%	4%
Turn Type	Split	NA	pt+ov	Split	NA	pt+ov	Prot	Prot	Prot	Prot	Prot	
Protected Phases	4	4	4 5	8	8	1 8	1	6	6	5	2	
Permitted Phases												
Actuated Green, G (s)	10.0	10.0	23.0		23.0	41.0	18.0	76.0	76.0	13.0	71.0	
Effective Green, g (s)	10.0	10.0	23.0		23.0	41.0	18.0	76.0	76.0	13.0	71.0	
Actuated g/C Ratio	0.07	0.07	0.15		0.15	0.27	0.12	0.51	0.51	0.09	0.47	
Clearance Time (s)	7.0	7.0			7.0		7.0	7.0	7.0	7.0	7.0	
Vehicle Extension (s)	3.0	3.0			3.0		3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	118	124	242		278	432	396	1760	772	291	2310	
v/s Ratio Prot	0.07	c0.07	0.16		c0.18	0.05	0.08	c0.57	0.08	c0.10	0.31	
v/s Ratio Perm												
v/c Ratio	1.00	1.12	1.03		1.18	0.19	0.65	1.13	0.15	1.21	0.65	
Uniform Delay, d1	70.0	70.0	63.5		63.5	41.8	63.0	37.0	19.8	68.5	30.0	
Progression Factor	1.00	1.00	1.00		1.00	1.00	0.63	0.38	0.05	1.00	1.00	
Incremental Delay, d2	82.9	117.0	64.5		113.1	0.2	0.4	59.3	0.0	123.3	1.4	
Delay (s)	152.9	187.0	128.0		176.6	42.0	39.8	73.4	1.0	191.8	31.5	
Level of Service	F	F	F		F	D	D	E	A	F	C	
Approach Delay (s)		146.1			129.3		64.4				60.9	
Approach LOS		F			F		E				E	

Intersection Summary			
HCM 2000 Control Delay	78.4	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.15		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	28.0
Intersection Capacity Utilization	98.6%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Volume (vph)	726	50	525	49	35	65	490	1114	43	133	1550	1002
Future Volume (vph)	726	50	525	49	35	65	490	1114	43	133	1550	1002
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	7.0	7.0	7.0		7.0	7.0	7.0	7.0		7.0	7.0	7.0
Lane Util. Factor	0.95	0.95	1.00		1.00	1.00	0.97	0.91		0.97	0.91	1.00
Frt	1.00	1.00	0.85		1.00	0.85	1.00	0.99		1.00	1.00	0.85
Flt Protected	0.95	0.96	1.00		0.97	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1681	1696	1583		1810	1583	3367	4960		3303	4893	1524
Flt Permitted	0.95	0.96	1.00		0.97	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	1681	1696	1583		1810	1583	3367	4960		3303	4893	1524
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.93	0.93	0.93	0.88	0.88	0.88
Adj. Flow (vph)	789	54	571	53	38	71	527	1198	46	151	1761	1139
RTOR Reduction (vph)	0	0	179	0	0	66	0	2	0	0	0	89
Lane Group Flow (vph)	418	425	392	0	91	5	527	1242	0	151	1761	1050
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	4%	4%	4%	6%	6%	6%
Turn Type	Split	NA	Prot	Split	NA	Prot	Prot	NA		Prot	NA	pt+ov
Protected Phases	4	4	4	8	8	8	5	2		1	6	4 6
Permitted Phases												
Actuated Green, G (s)	42.0	42.0	42.0		10.0	10.0	20.0	58.5		11.5	50.0	92.0
Effective Green, g (s)	42.0	42.0	42.0		10.0	10.0	20.0	58.5		11.5	50.0	92.0
Actuated g/C Ratio	0.28	0.28	0.28		0.07	0.07	0.13	0.39		0.08	0.33	0.61
Clearance Time (s)	7.0	7.0	7.0		7.0	7.0	7.0	7.0		7.0	7.0	
Vehicle Extension (s)	4.0	4.0	4.0		4.0	4.0	4.0	4.0		4.0	4.0	
Lane Grp Cap (vph)	470	474	443		120	105	448	1934		253	1631	934
v/s Ratio Prot	0.25	0.25	0.25		c0.05	0.00	c0.16	0.25		0.05	0.36	c0.69
v/s Ratio Perm												
v/c Ratio	0.89	0.90	0.89		0.76	0.05	1.18	0.64		0.60	1.08	1.12
Uniform Delay, d1	51.8	51.9	51.7		68.8	65.5	65.0	37.2		67.0	50.0	29.0
Progression Factor	1.00	1.00	1.00		1.00	1.00	1.48	0.47		1.00	0.99	0.99
Incremental Delay, d2	18.6	19.6	19.1		35.5	0.8	96.1	1.3		0.4	37.2	57.4
Delay (s)	70.4	71.5	70.8		104.3	66.3	192.5	18.7		67.7	86.6	86.0
Level of Service	E	E	E		F	E	F	B		E	F	F
Approach Delay (s)		70.9			87.7			70.4			85.4	
Approach LOS		E			F			E			F	

Intersection Summary			
HCM 2000 Control Delay	78.1	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.10		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	28.0
Intersection Capacity Utilization	107.0%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	0	1180	1385	0	390	1300
Future Volume (vph)	0	1180	1385	0	390	1300
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	12	16	12
Total Lost time (s)		6.0	6.0		6.0	6.0
Lane Util. Factor		0.95	0.95		1.00	0.88
Frt		1.00	1.00		1.00	0.85
Flt Protected		1.00	1.00		0.95	1.00
Satd. Flow (prot)		3471	3406		1930	2682
Flt Permitted		1.00	1.00		0.95	1.00
Satd. Flow (perm)		3471	3406		1930	2682
Peak-hour factor, PHF	0.93	0.93	0.88	0.88	0.89	0.89
Adj. Flow (vph)	0	1269	1574	0	438	1461
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	0	1269	1574	0	438	1461
Heavy Vehicles (%)	4%	4%	6%	6%	6%	6%
Turn Type		NA	NA		Prot	Prot
Protected Phases		2	6		4	4
Permitted Phases						
Actuated Green, G (s)		64.0	64.0		74.0	74.0
Effective Green, g (s)		64.0	64.0		74.0	74.0
Actuated g/C Ratio		0.43	0.43		0.49	0.49
Clearance Time (s)		6.0	6.0		6.0	6.0
Vehicle Extension (s)		3.0	3.0		3.0	3.0
Lane Grp Cap (vph)		1480	1453		952	1323
v/s Ratio Prot		0.37	c0.46		0.23	c0.54
v/s Ratio Perm						
v/c Ratio		0.86	1.08		0.46	1.10
Uniform Delay, d1		38.9	43.0		24.9	38.0
Progression Factor		0.68	0.04		1.00	1.00
Incremental Delay, d2		4.6	38.9		0.4	58.5
Delay (s)		31.0	40.7		25.3	96.5
Level of Service		C	D		C	F
Approach Delay (s)		31.0	40.7		80.1	
Approach LOS		C	D		F	

Intersection Summary			
HCM 2000 Control Delay	53.9	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	1.09		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	95.8%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Movement	NBL2	NBL	NBR	SEL	SER	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations											
Traffic Volume (vph)	1345	0	750	0	0	1140	430	0	0	310	330
Future Volume (vph)	1345	0	750	0	0	1140	430	0	0	310	330
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0		6.0			6.0	6.0			6.0	4.0
Lane Util. Factor	0.97		0.88			0.97	0.95			0.95	1.00
Frt	1.00		0.85			1.00	1.00			1.00	0.85
Flt Protected	0.95		1.00			0.95	1.00			1.00	1.00
Satd. Flow (prot)	3242		2632			3335	3438			3505	1568
Flt Permitted	0.95		1.00			0.95	1.00			1.00	1.00
Satd. Flow (perm)	3242		2632			3335	3438			3505	1568
Peak-hour factor, PHF	0.88	0.88	0.88	0.92	0.92	0.94	0.94	0.94	0.92	0.92	0.92
Adj. Flow (vph)	1528	0	852	0	0	1213	457	0	0	337	359
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	1528	0	852	0	0	1213	457	0	0	337	359
Heavy Vehicles (%)	8%	8%	8%	2%	2%	5%	5%	5%	3%	3%	3%
Turn Type	Prot		Prot			Prot	NA			NA	Free
Protected Phases	8		8			5	2			6	
Permitted Phases											Free
Actuated Green, G (s)	60.0		60.0			46.0	78.0			26.0	150.0
Effective Green, g (s)	60.0		60.0			46.0	78.0			26.0	150.0
Actuated g/C Ratio	0.40		0.40			0.31	0.52			0.17	1.00
Clearance Time (s)	6.0		6.0			6.0	6.0			6.0	
Vehicle Extension (s)	3.0		3.0			3.0	3.0			3.0	
Lane Grp Cap (vph)	1296		1052			1022	1787			607	1568
v/s Ratio Prot	c0.47		0.32			c0.36	0.13			c0.10	
v/s Ratio Perm											0.23
v/c Ratio	1.18		0.81			1.19	0.26			0.56	0.23
Uniform Delay, d1	45.0		39.9			52.0	19.9			56.7	0.0
Progression Factor	1.00		1.00			0.65	0.40			1.00	1.00
Incremental Delay, d2	88.8		4.7			90.7	0.2			3.6	0.3
Delay (s)	133.8		44.6			124.3	8.1			60.3	0.3
Level of Service	F		D			F	A			E	A
Approach Delay (s)		101.9		0.0			92.5			29.4	
Approach LOS		F		A			F			C	

Intersection Summary			
HCM 2000 Control Delay	88.0	HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio	1.06		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	95.5%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Volume (vph)	80	5	120	10	0	10	210	830	120	5	610	100
Future Volume (vph)	80	5	120	10	0	10	210	830	120	5	610	100
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0	6.0		6.0		6.0	6.0		6.0	6.0	
Lane Util. Factor		1.00	1.00		1.00		1.00	0.95		1.00	0.95	
Frt		1.00	0.85		0.93		1.00	0.98		1.00	0.98	
Flt Protected		0.95	1.00		0.98		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1779	1583		1729		1770	3472		1770	3464	
Flt Permitted		0.81	1.00		0.79		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1505	1583		1408		1770	3472		1770	3464	
Peak-hour factor, PHF	0.92	0.92	0.92	0.25	0.25	0.25	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	87	5	130	40	0	40	228	902	130	5	663	109
RTOR Reduction (vph)	0	0	72	0	71	0	0	10	0	0	13	0
Lane Group Flow (vph)	0	92	58	0	9	0	228	1022	0	5	759	0
Heavy Vehicles (%)	2%	2%	2%	0%	0%	0%	2%	2%	2%	2%	2%	2%
Turn Type	Perm	NA	custom	Perm	NA		Prot	NA		Prot	NA	
Protected Phases		8			4		5	2		1	6	
Permitted Phases	8		6	4								
Actuated Green, G (s)		8.3	33.1		8.3		14.8	47.1		0.8	33.1	
Effective Green, g (s)		8.3	33.1		8.3		14.8	47.1		0.8	33.1	
Actuated g/C Ratio		0.11	0.45		0.11		0.20	0.63		0.01	0.45	
Clearance Time (s)		6.0	6.0		6.0		6.0	6.0		6.0	6.0	
Vehicle Extension (s)		3.0	3.0		3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		168	706		157		353	2203		19	1545	
v/s Ratio Prot							c0.13	c0.29		0.00	0.22	
v/s Ratio Perm		c0.06	0.04		0.01							
v/c Ratio		0.55	0.08		0.06		0.65	0.46		0.26	0.49	
Uniform Delay, d1		31.2	11.8		29.5		27.3	7.0		36.4	14.6	
Progression Factor		1.00	1.00		1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		3.6	0.1		0.2		4.0	0.2		7.3	0.2	
Delay (s)		34.8	11.9		29.6		31.3	7.2		43.7	14.8	
Level of Service		C	B		C		C	A		D	B	
Approach Delay (s)		21.4			29.6			11.5			15.0	
Approach LOS		C			C			B			B	

Intersection Summary			
HCM 2000 Control Delay	14.2	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.54		
Actuated Cycle Length (s)	74.2	Sum of lost time (s)	18.0
Intersection Capacity Utilization	58.4%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Volume (vph)	20	80	5	250	0	60	0	680	130	15	345	0
Future Volume (vph)	20	80	5	250	0	60	0	680	130	15	345	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0			6.0			6.0			6.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		0.99			0.97			0.98			1.00	
Flt Protected		0.99			0.96			1.00			1.00	
Satd. Flow (prot)		1834			1727			1721			1806	
Flt Permitted		0.91			0.64			1.00			0.82	
Satd. Flow (perm)		1677			1157			1721			1481	
Peak-hour factor, PHF	0.60	0.60	0.60	0.96	0.96	0.96	0.89	0.89	0.89	0.86	0.86	0.86
Adj. Flow (vph)	33	133	8	260	0	62	0	764	146	17	401	0
RTOR Reduction (vph)	0	2	0	0	26	0	0	8	0	0	0	0
Lane Group Flow (vph)	0	172	0	0	297	0	0	902	0	0	418	0
Heavy Vehicles (%)	2%	2%	2%	3%	3%	3%	8%	8%	8%	5%	5%	5%
Turn Type	Perm	NA		Perm	NA			NA		Perm	NA	
Protected Phases		4			4			2			2	
Permitted Phases	4			4						2		
Actuated Green, G (s)		24.5			24.5			48.8			48.8	
Effective Green, g (s)		24.5			24.5			48.8			48.8	
Actuated g/C Ratio		0.29			0.29			0.57			0.57	
Clearance Time (s)		6.0			6.0			6.0			6.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		481			332			984			847	
v/s Ratio Prot								c0.52				
v/s Ratio Perm		0.10			c0.26						0.28	
v/c Ratio		0.36			0.90			0.92			0.49	
Uniform Delay, d1		24.1			29.2			16.4			10.9	
Progression Factor		1.00			1.00			1.00			1.00	
Incremental Delay, d2		0.5			25.0			12.9			0.5	
Delay (s)		24.6			54.2			29.3			11.3	
Level of Service		C			D			C			B	
Approach Delay (s)		24.6			54.2			29.3			11.3	
Approach LOS		C			D			C			B	

Intersection Summary			
HCM 2000 Control Delay	29.1	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.91		
Actuated Cycle Length (s)	85.3	Sum of lost time (s)	12.0
Intersection Capacity Utilization	81.2%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SBL	SBR	SBR2	NEL2	NEL	NER
Lane Configurations												
Traffic Volume (vph)	312	152	262	226	82	313	127	1261	93	212	2000	75
Future Volume (vph)	312	152	262	226	82	313	127	1261	93	212	2000	75
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	7.0	7.0	7.0		7.0	7.0	7.0	7.0	7.0	7.0	7.0	
Lane Util. Factor	1.00	1.00	1.00		1.00	1.00	0.97	0.76	1.00	0.97	0.94	
Frt	1.00	1.00	0.85		1.00	0.85	1.00	0.85	0.85	1.00	0.99	
Flt Protected	0.95	1.00	1.00		0.96	1.00	0.95	1.00	1.00	0.95	0.95	
Satd. Flow (prot)	1770	1863	1583		1797	1583	3303	3474	1524	3367	4888	
Flt Permitted	0.95	1.00	1.00		0.96	1.00	0.95	1.00	1.00	0.95	0.95	
Satd. Flow (perm)	1770	1863	1583		1797	1583	3303	3474	1524	3367	4888	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.88	0.88	0.88	0.93	0.93	0.93
Adj. Flow (vph)	339	165	285	246	89	340	144	1433	106	228	2151	81
RTOR Reduction (vph)	0	0	149	0	0	101	0	0	64	0	78	0
Lane Group Flow (vph)	339	165	136	0	335	239	144	1433	42	228	2154	0
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	6%	6%	6%	4%	4%	4%
Turn Type	Split	NA	Prot	Split	NA	pt+ov	Prot	Prot	Prot	Prot	Prot	
Protected Phases	4	4	4	8	8	1 8	1	6	6	5	2	
Permitted Phases												
Actuated Green, G (s)	27.0	27.0	27.0		26.0	34.0	8.0	59.0	59.0	10.0	61.0	
Effective Green, g (s)	27.0	27.0	27.0		26.0	34.0	8.0	59.0	59.0	10.0	61.0	
Actuated g/C Ratio	0.18	0.18	0.18		0.17	0.23	0.05	0.39	0.39	0.07	0.41	
Clearance Time (s)	7.0	7.0	7.0		7.0		7.0	7.0	7.0	7.0	7.0	
Vehicle Extension (s)	3.0	3.0	3.0		3.0		3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	318	335	284		311	358	176	1366	599	224	1987	
v/s Ratio Prot	c0.19	0.09	0.09		c0.19	0.15	0.04	c0.41	0.03	0.07	c0.44	
v/s Ratio Perm												
v/c Ratio	1.07	0.49	0.48		1.08	0.67	0.82	1.05	0.07	1.02	1.08	
Uniform Delay, d1	61.5	55.3	55.2		62.0	52.8	70.3	45.5	28.4	70.0	44.5	
Progression Factor	1.00	1.00	1.00		1.00	1.00	0.58	0.33	0.03	1.00	1.00	
Incremental Delay, d2	69.0	1.1	1.3		73.1	4.6	21.5	36.5	0.2	64.8	47.2	
Delay (s)	130.5	56.5	56.4		135.1	57.5	62.3	51.7	1.0	134.8	91.7	
Level of Service	F	E	E		F	E	E	D	A	F	F	
Approach Delay (s)		88.3			96.0		49.4				95.7	
Approach LOS		F			F		D				F	

Intersection Summary			
HCM 2000 Control Delay	80.8	HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio	1.10		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	28.0
Intersection Capacity Utilization	106.7%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Volume (vph)	321	17	133	22	17	102	150	2352	116	65	1321	339
Future Volume (vph)	321	17	133	22	17	102	150	2352	116	65	1321	339
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	7.0	7.0	7.0		7.0	7.0	7.0	7.0		7.0	7.0	7.0
Lane Util. Factor	0.95	0.95	1.00		1.00	1.00	0.97	0.91		0.97	0.91	1.00
Frt	1.00	1.00	0.85		1.00	0.85	1.00	0.99		1.00	1.00	0.85
Flt Protected	0.95	0.96	1.00		0.97	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1681	1693	1583		1811	1583	3367	4952		3303	4893	1524
Flt Permitted	0.95	0.96	1.00		0.97	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	1681	1693	1583		1811	1583	3367	4952		3303	4893	1524
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.93	0.93	0.93	0.88	0.88	0.88
Adj. Flow (vph)	349	18	145	24	18	111	161	2529	125	74	1501	385
RTOR Reduction (vph)	0	0	71	0	0	72	0	3	0	0	0	127
Lane Group Flow (vph)	181	186	74	0	42	39	161	2651	0	74	1501	258
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	4%	4%	4%	6%	6%	6%
Turn Type	Split	NA	pt+ov	Split	NA	pt+ov	Prot	NA		Prot	NA	pt+ov
Protected Phases	4	4	4 5	8	8	1 8	5	2		1	6	4 6
Permitted Phases												
Actuated Green, G (s)	20.9	20.9	39.5		10.0	15.1	11.6	86.0		5.1	79.5	100.4
Effective Green, g (s)	20.9	20.9	39.5		10.0	15.1	11.6	86.0		5.1	79.5	100.4
Actuated g/C Ratio	0.14	0.14	0.26		0.07	0.10	0.08	0.57		0.03	0.53	0.67
Clearance Time (s)	7.0	7.0			7.0		7.0	7.0		7.0	7.0	
Vehicle Extension (s)	4.0	4.0			4.0		4.0	4.0		4.0	4.0	
Lane Grp Cap (vph)	234	235	416		120	159	260	2839		112	2593	1020
v/s Ratio Prot	0.11	c0.11	0.05		c0.02	0.02	c0.05	c0.54		0.02	0.31	0.17
v/s Ratio Perm												
v/c Ratio	0.77	0.79	0.18		0.35	0.25	0.62	0.93		0.66	0.58	0.25
Uniform Delay, d1	62.3	62.4	42.7		66.9	62.2	67.1	29.4		71.6	23.9	9.9
Progression Factor	1.00	1.00	1.00		1.00	1.00	1.13	0.34		1.12	1.02	1.81
Incremental Delay, d2	15.5	17.3	0.3		7.9	1.1	0.5	0.8		9.0	0.6	0.1
Delay (s)	77.7	79.8	43.0		74.8	63.3	76.0	10.7		89.3	24.9	18.0
Level of Service	E	E	D		E	E	E	B		F	C	B
Approach Delay (s)		68.6			66.4			14.4			26.0	
Approach LOS		E			E			B			C	

Intersection Summary			
HCM 2000 Control Delay	25.1	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.87		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	28.0
Intersection Capacity Utilization	85.3%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	0	1345	715	0	115	1010
Future Volume (vph)	0	1345	715	0	115	1010
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	12	16	12
Total Lost time (s)		6.0	6.0		6.0	6.0
Lane Util. Factor		0.95	0.95		1.00	0.88
Frt		1.00	1.00		1.00	0.85
Flt Protected		1.00	1.00		0.95	1.00
Satd. Flow (prot)		3471	3406		1930	2682
Flt Permitted		1.00	1.00		0.95	1.00
Satd. Flow (perm)		3471	3406		1930	2682
Peak-hour factor, PHF	0.93	0.93	0.88	0.88	0.89	0.89
Adj. Flow (vph)	0	1446	812	0	129	1135
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	0	1446	813	0	129	1135
Heavy Vehicles (%)	4%	4%	6%	6%	6%	6%
Turn Type		NA	NA		Prot	Prot
Protected Phases		2	6		4	4
Permitted Phases						
Actuated Green, G (s)		32.0	32.0		31.0	31.0
Effective Green, g (s)		32.0	32.0		31.0	31.0
Actuated g/C Ratio		0.43	0.43		0.41	0.41
Clearance Time (s)		6.0	6.0		6.0	6.0
Vehicle Extension (s)		3.0	3.0		3.0	3.0
Lane Grp Cap (vph)		1480	1453		797	1108
v/s Ratio Prot		c0.42	0.24		0.07	c0.42
v/s Ratio Perm						
v/c Ratio		0.98	0.56		0.16	1.02
Uniform Delay, d1		21.1	16.2		13.8	22.0
Progression Factor		1.00	1.23		1.00	1.00
Incremental Delay, d2		10.9	0.1		0.1	33.4
Delay (s)		32.0	20.0		13.9	55.4
Level of Service		C	B		B	E
Approach Delay (s)		32.0	20.0		51.2	
Approach LOS		C	B		D	

Intersection Summary			
HCM 2000 Control Delay	36.1	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	1.00		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	67.1%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	NBL2	NBL	NBR	SEL	SER	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations											
Traffic Volume (vph)	455	0	300	0	0	1350	110	0	0	990	375
Future Volume (vph)	455	0	300	0	0	1350	110	0	0	990	375
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0		6.0			6.0	6.0			6.0	4.0
Lane Util. Factor	0.97		0.88			0.97	0.95			0.95	1.00
Frt	1.00		0.85			1.00	1.00			1.00	0.85
Flt Protected	0.95		1.00			0.95	1.00			1.00	1.00
Satd. Flow (prot)	3242		2632			3335	3438			3505	1568
Flt Permitted	0.95		1.00			0.95	1.00			1.00	1.00
Satd. Flow (perm)	3242		2632			3335	3438			3505	1568
Peak-hour factor, PHF	0.88	0.88	0.88	0.92	0.92	0.94	0.94	0.94	0.92	0.92	0.92
Adj. Flow (vph)	517	0	341	0	0	1436	117	0	0	1076	408
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	517	0	341	0	0	1436	117	0	0	1076	408
Heavy Vehicles (%)	8%	8%	8%	2%	2%	5%	5%	5%	3%	3%	3%
Turn Type	Prot		Prot			Prot	NA			NA	Free
Protected Phases	8		8			5	2			6	
Permitted Phases											Free
Actuated Green, G (s)	23.0		23.0			63.0	115.0			46.0	150.0
Effective Green, g (s)	23.0		23.0			63.0	115.0			46.0	150.0
Actuated g/C Ratio	0.15		0.15			0.42	0.77			0.31	1.00
Clearance Time (s)	6.0		6.0			6.0	6.0			6.0	
Vehicle Extension (s)	3.0		3.0			3.0	3.0			3.0	
Lane Grp Cap (vph)	497		403			1400	2635			1074	1568
v/s Ratio Prot	c0.16		0.13			c0.43	0.03			c0.31	
v/s Ratio Perm											0.26
v/c Ratio	1.04		0.85			1.03	0.04			1.00	0.26
Uniform Delay, d1	63.5		61.8			43.5	4.2			52.0	0.0
Progression Factor	1.00		1.00			0.59	1.90			1.00	1.00
Incremental Delay, d2	51.2		15.0			22.4	0.0			27.9	0.4
Delay (s)	114.7		76.8			48.2	8.0			79.9	0.4
Level of Service	F		E			D	A			E	A
Approach Delay (s)		99.6		0.0			45.2			58.1	
Approach LOS		F		A			D			E	

Intersection Summary			
HCM 2000 Control Delay	62.1	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.02		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	94.9%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Volume (vph)	10	0	170	0	0	0	100	450	5	5	1010	40
Future Volume (vph)	10	0	170	0	0	0	100	450	5	5	1010	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0	6.0				6.0	6.0		6.0	6.0	
Lane Util. Factor		1.00	1.00				1.00	0.95		1.00	0.95	
Frt		1.00	0.85				1.00	1.00		1.00	0.99	
Flt Protected		0.95	1.00				0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1770	1583				1770	3534		1770	3519	
Flt Permitted		1.00	1.00				0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1863	1583				1770	3534		1770	3519	
Peak-hour factor, PHF	0.92	0.92	0.92	0.25	0.25	0.25	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	11	0	185	0	0	0	109	489	5	5	1098	43
RTOR Reduction (vph)	0	0	70	0	0	0	0	1	0	0	2	0
Lane Group Flow (vph)	0	11	115	0	0	0	109	493	0	5	1139	0
Heavy Vehicles (%)	2%	2%	2%	0%	0%	0%	2%	2%	2%	2%	2%	2%
Turn Type	Perm	NA	custom				Prot	NA		Prot	NA	
Protected Phases		8			4		5	2		1	6	
Permitted Phases	8		6	4								
Actuated Green, G (s)		1.2	43.9				7.6	50.7		0.8	43.9	
Effective Green, g (s)		1.2	43.9				7.6	50.7		0.8	43.9	
Actuated g/C Ratio		0.02	0.62				0.11	0.72		0.01	0.62	
Clearance Time (s)		6.0	6.0				6.0	6.0		6.0	6.0	
Vehicle Extension (s)		3.0	3.0				3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		31	982				190	2534		20	2185	
v/s Ratio Prot							c0.06	0.14		0.00	c0.32	
v/s Ratio Perm		c0.01	0.07									
v/c Ratio		0.35	0.12				0.57	0.19		0.25	0.52	
Uniform Delay, d1		34.4	5.5				30.0	3.3		34.7	7.5	
Progression Factor		1.00	1.00				1.00	1.00		1.00	1.00	
Incremental Delay, d2		6.9	0.1				4.1	0.0		6.5	0.2	
Delay (s)		41.2	5.5				34.2	3.3		41.1	7.7	
Level of Service		D	A				C	A		D	A	
Approach Delay (s)		7.5			0.0			8.9			7.9	
Approach LOS		A			A			A			A	

Intersection Summary			
HCM 2000 Control Delay	8.2	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.52		
Actuated Cycle Length (s)	70.7	Sum of lost time (s)	18.0
Intersection Capacity Utilization	57.7%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Volume (vph)	10	10	10	360	0	40	0	380	110	15	525	0
Future Volume (vph)	10	10	10	360	0	40	0	380	110	15	525	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0			6.0			6.0			6.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		0.95			0.99			0.97			1.00	
Flt Protected		0.98			0.96			1.00			1.00	
Satd. Flow (prot)		1750			1741			1706			1807	
Flt Permitted		0.84			0.71			1.00			0.98	
Satd. Flow (perm)		1501			1293			1706			1774	
Peak-hour factor, PHF	0.60	0.60	0.60	0.96	0.96	0.96	0.89	0.89	0.89	0.86	0.86	0.86
Adj. Flow (vph)	17	17	17	375	0	42	0	427	124	17	610	0
RTOR Reduction (vph)	0	11	0	0	23	0	0	12	0	0	0	0
Lane Group Flow (vph)	0	40	0	0	394	0	0	539	0	0	627	0
Heavy Vehicles (%)	2%	2%	2%	3%	3%	3%	8%	8%	8%	5%	5%	5%
Turn Type	Perm	NA		Perm	NA			NA		Perm	NA	
Protected Phases		4			4			2			2	
Permitted Phases	4			4						2		
Actuated Green, G (s)		27.9			27.9			34.8			34.8	
Effective Green, g (s)		27.9			27.9			34.8			34.8	
Actuated g/C Ratio		0.37			0.37			0.47			0.47	
Clearance Time (s)		6.0			6.0			6.0			6.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		560			482			794			826	
v/s Ratio Prot								0.32				
v/s Ratio Perm		0.03			c0.30						c0.35	
v/c Ratio		0.07			0.82			0.68			0.76	
Uniform Delay, d1		15.1			21.1			15.6			16.5	
Progression Factor		1.00			1.00			1.00			1.00	
Incremental Delay, d2		0.1			10.4			2.3			4.0	
Delay (s)		15.1			31.5			17.9			20.5	
Level of Service		B			C			B			C	
Approach Delay (s)		15.1			31.5			17.9			20.5	
Approach LOS		B			C			B			C	

Intersection Summary			
HCM 2000 Control Delay	22.3	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	74.7	Sum of lost time (s)	12.0
Intersection Capacity Utilization	80.1%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SBL	SBR	SBR2	NEL2	NEL	NER
Lane Configurations												
Traffic Volume (vph)	131	147	269	226	174	190	265	1792	171	309	1481	115
Future Volume (vph)	131	147	269	226	174	190	265	1792	171	309	1481	115
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	7.0	7.0	7.0		7.0	7.0	7.0	7.0	7.0	7.0	7.0	
Lane Util. Factor	1.00	1.00	1.00		1.00	1.00	0.97	0.76	1.00	0.97	0.94	
Frt	1.00	1.00	0.85		1.00	0.85	1.00	0.85	0.85	1.00	0.99	
Flt Protected	0.95	1.00	1.00		0.97	1.00	0.95	1.00	1.00	0.95	0.96	
Satd. Flow (prot)	1770	1863	1583		1812	1583	3303	3474	1524	3367	4870	
Flt Permitted	0.95	1.00	1.00		0.97	1.00	0.95	1.00	1.00	0.95	0.96	
Satd. Flow (perm)	1770	1863	1583		1812	1583	3303	3474	1524	3367	4870	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.88	0.88	0.88	0.93	0.93	0.93
Adj. Flow (vph)	142	160	292	246	189	207	301	2036	194	332	1592	124
RTOR Reduction (vph)	0	0	119	0	0	98	0	0	75	0	80	0
Lane Group Flow (vph)	142	160	173	0	435	109	301	2036	119	332	1636	0
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	6%	6%	6%	4%	4%	4%
Turn Type	Split	NA	pt+ov	Split	NA	pt+ov	Prot	Prot	Prot	Prot	Prot	
Protected Phases	4	4	4 5	8	8	1 8	1	6	6	5	2	
Permitted Phases												
Actuated Green, G (s)	10.0	10.0	21.0		26.0	42.0	16.0	65.0	65.0	11.0	60.0	
Effective Green, g (s)	10.0	10.0	21.0		26.0	42.0	16.0	65.0	65.0	11.0	60.0	
Actuated g/C Ratio	0.07	0.07	0.15		0.19	0.30	0.11	0.46	0.46	0.08	0.43	
Clearance Time (s)	7.0	7.0			7.0		7.0	7.0	7.0	7.0	7.0	
Vehicle Extension (s)	3.0	3.0			3.0		3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	126	133	237		336	474	377	1612	707	264	2087	
v/s Ratio Prot	0.08	c0.09	0.11		c0.24	0.07	0.09	c0.59	0.08	c0.10	0.34	
v/s Ratio Perm												
v/c Ratio	1.13	1.20	0.73		1.29	0.23	0.80	1.26	0.17	1.26	0.78	
Uniform Delay, d1	65.0	65.0	56.8		57.0	36.8	60.4	37.5	21.8	64.5	34.4	
Progression Factor	1.00	1.00	1.00		1.00	1.00	0.57	0.31	0.02	1.00	1.00	
Incremental Delay, d2	118.4	142.7	10.7		153.0	0.2	3.6	119.9	0.2	142.9	3.0	
Delay (s)	183.4	207.7	67.5		210.0	37.1	38.2	131.6	0.6	207.4	37.5	
Level of Service	F	F	E		F	D	D	F	A	F	D	
Approach Delay (s)		133.0			154.2		110.4				65.0	
Approach LOS		F			F		F				E	

Intersection Summary			
HCM 2000 Control Delay	101.6	HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio	1.26		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	28.0
Intersection Capacity Utilization	101.1%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Volume (vph)	541	67	441	70	43	81	419	1308	63	193	1704	758
Future Volume (vph)	541	67	441	70	43	81	419	1308	63	193	1704	758
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	7.0	7.0	7.0		7.0	7.0	7.0	7.0		7.0	7.0	7.0
Lane Util. Factor	0.95	0.95	1.00		1.00	1.00	0.97	0.91		0.97	0.91	1.00
Frt	1.00	1.00	0.85		1.00	0.85	1.00	0.99		1.00	1.00	0.85
Flt Protected	0.95	0.96	1.00		0.97	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1681	1703	1583		1807	1583	3367	4953		3303	4893	1524
Flt Permitted	0.95	0.96	1.00		0.97	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	1681	1703	1583		1807	1583	3367	4953		3303	4893	1524
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.93	0.93	0.93	0.88	0.88	0.88
Adj. Flow (vph)	588	73	479	76	47	88	451	1406	68	219	1936	861
RTOR Reduction (vph)	0	0	190	0	0	82	0	3	0	0	0	77
Lane Group Flow (vph)	329	332	289	0	123	6	451	1471	0	219	1936	784
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	4%	4%	4%	6%	6%	6%
Turn Type	Split	NA	Prot	Split	NA	Prot	Prot	NA		Prot	NA	pt+ov
Protected Phases	4	4	4	8	8	8	5	2		1	6	4 6
Permitted Phases												
Actuated Green, G (s)	28.0	28.0	28.0		10.0	10.0	18.0	59.9		14.1	56.0	84.0
Effective Green, g (s)	28.0	28.0	28.0		10.0	10.0	18.0	59.9		14.1	56.0	84.0
Actuated g/C Ratio	0.20	0.20	0.20		0.07	0.07	0.13	0.43		0.10	0.40	0.60
Clearance Time (s)	7.0	7.0	7.0		7.0	7.0	7.0	7.0		7.0	7.0	
Vehicle Extension (s)	4.0	4.0	4.0		4.0	4.0	4.0	4.0		4.0	4.0	
Lane Grp Cap (vph)	336	340	316		129	113	432	2119		332	1957	914
v/s Ratio Prot	c0.20	0.19	0.18		c0.07	0.00	c0.13	c0.30		0.07	c0.40	0.51
v/s Ratio Perm												
v/c Ratio	0.98	0.98	0.92		0.95	0.06	1.04	0.69		0.66	0.99	0.86
Uniform Delay, d1	55.7	55.7	54.8		64.8	60.6	61.0	32.6		60.6	41.7	23.1
Progression Factor	1.00	1.00	1.00		1.00	1.00	1.34	0.40		1.00	1.03	1.12
Incremental Delay, d2	43.1	42.2	30.2		67.6	0.9	46.0	1.2		0.5	4.1	0.8
Delay (s)	98.8	97.9	85.0		132.4	61.5	127.9	14.1		61.2	47.0	26.7
Level of Service	F	F	F		F	E	F	B		E	D	C
Approach Delay (s)		92.7			102.8			40.7			42.3	
Approach LOS		F			F			D			D	

Intersection Summary			
HCM 2000 Control Delay	53.0	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	1.00		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	28.0
Intersection Capacity Utilization	91.2%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
7: NH 102 & Exit 4 SB Off

12/27/2017

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	0	1255	1330	0	125	1325
Future Volume (vph)	0	1255	1330	0	125	1325
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	12	16	12
Total Lost time (s)		6.0	6.0		6.0	6.0
Lane Util. Factor		0.95	0.95		1.00	0.88
Frt		1.00	1.00		1.00	0.85
Flt Protected		1.00	1.00		0.95	1.00
Satd. Flow (prot)		3471	3406		1930	2682
Flt Permitted		1.00	1.00		0.95	1.00
Satd. Flow (perm)		3471	3406		1930	2682
Peak-hour factor, PHF	0.93	0.93	0.88	0.88	0.89	0.89
Adj. Flow (vph)	0	1349	1511	0	140	1489
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	0	1349	1511	0	140	1489
Heavy Vehicles (%)	4%	4%	6%	6%	6%	6%
Turn Type		NA	NA		Prot	Prot
Protected Phases		2	6		4	4
Permitted Phases						
Actuated Green, G (s)		57.0	57.0		71.0	71.0
Effective Green, g (s)		57.0	57.0		71.0	71.0
Actuated g/C Ratio		0.41	0.41		0.51	0.51
Clearance Time (s)		6.0	6.0		6.0	6.0
Vehicle Extension (s)		3.0	3.0		3.0	3.0
Lane Grp Cap (vph)		1413	1386		978	1360
v/s Ratio Prot		0.39	c0.44		0.07	c0.56
v/s Ratio Perm						
v/c Ratio		0.95	1.09		0.14	1.09
Uniform Delay, d1		40.2	41.5		18.3	34.5
Progression Factor		0.71	0.07		1.00	1.00
Incremental Delay, d2		11.0	42.0		0.1	54.6
Delay (s)		39.6	45.0		18.4	89.1
Level of Service		D	D		B	F
Approach Delay (s)		39.6	45.0		83.0	
Approach LOS		D	D		F	

Intersection Summary			
HCM 2000 Control Delay	57.2	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.09		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	95.1%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Movement	NBL2	NBL	NBR	SEL	SER	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations											
Traffic Volume (vph)	1250	0	910	0	0	1085	295	0	0	420	240
Future Volume (vph)	1250	0	910	0	0	1085	295	0	0	420	240
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0		6.0			6.0	6.0			6.0	4.0
Lane Util. Factor	0.97		0.88			0.97	0.95			0.95	1.00
Frt	1.00		0.85			1.00	1.00			1.00	0.85
Flt Protected	0.95		1.00			0.95	1.00			1.00	1.00
Satd. Flow (prot)	3242		2632			3335	3438			3505	1568
Flt Permitted	0.95		1.00			0.95	1.00			1.00	1.00
Satd. Flow (perm)	3242		2632			3335	3438			3505	1568
Peak-hour factor, PHF	0.88	0.88	0.88	0.92	0.92	0.94	0.94	0.94	0.92	0.92	0.92
Adj. Flow (vph)	1420	0	1034	0	0	1154	314	0	0	457	261
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	1420	0	1034	0	0	1154	314	0	0	457	261
Heavy Vehicles (%)	8%	8%	8%	2%	2%	5%	5%	5%	3%	3%	3%
Turn Type	Prot		Prot			Prot	NA			NA	Free
Protected Phases	8		8			5	2			6	
Permitted Phases											Free
Actuated Green, G (s)	54.0		54.0			42.0	74.0			26.0	140.0
Effective Green, g (s)	54.0		54.0			42.0	74.0			26.0	140.0
Actuated g/C Ratio	0.39		0.39			0.30	0.53			0.19	1.00
Clearance Time (s)	6.0		6.0			6.0	6.0			6.0	
Vehicle Extension (s)	3.0		3.0			3.0	3.0			3.0	
Lane Grp Cap (vph)	1250		1015			1000	1817			650	1568
v/s Ratio Prot	c0.44		0.39			c0.35	0.09			c0.13	
v/s Ratio Perm											0.17
v/c Ratio	1.14		1.02			1.15	0.17			0.70	0.17
Uniform Delay, d1	43.0		43.0			49.0	17.1			53.4	0.0
Progression Factor	1.00		1.00			0.44	0.15			1.00	1.00
Incremental Delay, d2	71.5		33.0			75.1	0.1			6.3	0.2
Delay (s)	114.5		76.0			96.4	2.7			59.6	0.2
Level of Service	F		E			F	A			E	A
Approach Delay (s)		98.3		0.0			76.4			38.0	
Approach LOS		F		A			E			D	

Intersection Summary			
HCM 2000 Control Delay	82.0	HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio	1.05		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	94.2%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Volume (vph)	10	5	210	10	0	10	270	820	120	5	590	130
Future Volume (vph)	10	5	210	10	0	10	270	820	120	5	590	130
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0	6.0		6.0		6.0	6.0		6.0	6.0	
Lane Util. Factor		1.00	1.00		1.00		1.00	0.95		1.00	0.95	
Frt		1.00	0.85		0.93		1.00	0.98		1.00	0.97	
Flt Protected		0.97	1.00		0.98		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1801	1583		1729		1770	3472		1770	3443	
Flt Permitted		0.87	1.00		0.83		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1622	1583		1477		1770	3472		1770	3443	
Peak-hour factor, PHF	0.92	0.92	0.92	0.25	0.25	0.25	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	11	5	228	40	0	40	293	891	130	5	641	141
RTOR Reduction (vph)	0	0	125	0	75	0	0	9	0	0	17	0
Lane Group Flow (vph)	0	16	103	0	5	0	293	1012	0	5	765	0
Heavy Vehicles (%)	2%	2%	2%	0%	0%	0%	2%	2%	2%	2%	2%	2%
Turn Type	Perm	NA	custom	Perm	NA		Prot	NA		Prot	NA	
Protected Phases		8			4		5	2		1	6	
Permitted Phases	8		6	4								
Actuated Green, G (s)		4.8	32.6		4.8		16.9	48.7		0.8	32.6	
Effective Green, g (s)		4.8	32.6		4.8		16.9	48.7		0.8	32.6	
Actuated g/C Ratio		0.07	0.45		0.07		0.23	0.67		0.01	0.45	
Clearance Time (s)		6.0	6.0		6.0		6.0	6.0		6.0	6.0	
Vehicle Extension (s)		3.0	3.0		3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		107	713		98		413	2338		19	1552	
v/s Ratio Prot							c0.17	0.29		0.00	c0.22	
v/s Ratio Perm		c0.01	0.06		0.00							
v/c Ratio		0.15	0.14		0.05		0.71	0.43		0.26	0.49	
Uniform Delay, d1		31.8	11.7		31.6		25.4	5.4		35.5	14.0	
Progression Factor		1.00	1.00		1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.6	0.1		0.2		5.5	0.1		7.3	0.2	
Delay (s)		32.5	11.8		31.9		31.0	5.6		42.7	14.3	
Level of Service		C	B		C		C	A		D	B	
Approach Delay (s)		13.1			31.9			11.2			14.4	
Approach LOS		B			C			B			B	

Intersection Summary			
HCM 2000 Control Delay	13.1	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.53		
Actuated Cycle Length (s)	72.3	Sum of lost time (s)	18.0
Intersection Capacity Utilization	62.0%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Volume (vph)	20	20	5	270	0	50	0	730	130	10	380	0
Future Volume (vph)	20	20	5	270	0	50	0	730	130	10	380	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0			6.0			6.0			6.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		0.99			0.98			0.98			1.00	
Flt Protected		0.98			0.96			1.00			1.00	
Satd. Flow (prot)		1796			1733			1723			1807	
Flt Permitted		0.83			0.71			1.00			0.89	
Satd. Flow (perm)		1530			1279			1723			1610	
Peak-hour factor, PHF	0.60	0.60	0.60	0.96	0.96	0.96	0.89	0.89	0.89	0.86	0.86	0.86
Adj. Flow (vph)	33	33	8	281	0	52	0	820	146	12	442	0
RTOR Reduction (vph)	0	5	0	0	27	0	0	7	0	0	0	0
Lane Group Flow (vph)	0	69	0	0	306	0	0	959	0	0	454	0
Heavy Vehicles (%)	2%	2%	2%	3%	3%	3%	8%	8%	8%	5%	5%	5%
Turn Type	Perm	NA		Perm	NA			NA		Perm	NA	
Protected Phases		4			4			2			2	
Permitted Phases	4			4						2		
Actuated Green, G (s)		22.3			22.3			52.1			52.1	
Effective Green, g (s)		22.3			22.3			52.1			52.1	
Actuated g/C Ratio		0.26			0.26			0.60			0.60	
Clearance Time (s)		6.0			6.0			6.0			6.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		394			330			1038			970	
v/s Ratio Prot								c0.56				
v/s Ratio Perm		0.04			c0.24						0.28	
v/c Ratio		0.17			0.93			0.92			0.47	
Uniform Delay, d1		24.9			31.3			15.4			9.5	
Progression Factor		1.00			1.00			1.00			1.00	
Incremental Delay, d2		0.2			31.2			13.2			0.4	
Delay (s)		25.1			62.5			28.6			9.8	
Level of Service		C			E			C			A	
Approach Delay (s)		25.1			62.5			28.6			9.8	
Approach LOS		C			E			C			A	

Intersection Summary			
HCM 2000 Control Delay	30.0	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.92		
Actuated Cycle Length (s)	86.4	Sum of lost time (s)	12.0
Intersection Capacity Utilization	84.3%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SBL	SBR	SBR2	NEL2	NEL	NER
Lane Configurations												
Traffic Volume (vph)	314	154	264	228	83	316	132	1305	96	214	2019	76
Future Volume (vph)	314	154	264	228	83	316	132	1305	96	214	2019	76
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	7.0	7.0	7.0		7.0	7.0	7.0	7.0	7.0	7.0	7.0	
Lane Util. Factor	1.00	1.00	1.00		1.00	1.00	0.97	0.76	1.00	0.97	0.94	
Frt	1.00	1.00	0.85		1.00	0.85	1.00	0.85	0.85	1.00	0.99	
Flt Protected	0.95	1.00	1.00		0.96	1.00	0.95	1.00	1.00	0.95	0.95	
Satd. Flow (prot)	1770	1863	1583		1797	1583	3303	3474	1524	3367	4888	
Flt Permitted	0.95	1.00	1.00		0.96	1.00	0.95	1.00	1.00	0.95	0.95	
Satd. Flow (perm)	1770	1863	1583		1797	1583	3303	3474	1524	3367	4888	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.88	0.88	0.88	0.93	0.93	0.93
Adj. Flow (vph)	341	167	287	248	90	343	150	1483	109	230	2171	82
RTOR Reduction (vph)	0	0	149	0	0	101	0	0	66	0	78	0
Lane Group Flow (vph)	341	167	138	0	338	242	150	1483	43	230	2175	0
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	6%	6%	6%	4%	4%	4%
Turn Type	Split	NA	Prot	Split	NA	pt+ov	Prot	Prot	Prot	Prot	Prot	
Protected Phases	4	4	4	8	8	1 8	1	6	6	5	2	
Permitted Phases												
Actuated Green, G (s)	27.0	27.0	27.0		26.0	34.0	8.0	59.0	59.0	10.0	61.0	
Effective Green, g (s)	27.0	27.0	27.0		26.0	34.0	8.0	59.0	59.0	10.0	61.0	
Actuated g/C Ratio	0.18	0.18	0.18		0.17	0.23	0.05	0.39	0.39	0.07	0.41	
Clearance Time (s)	7.0	7.0	7.0		7.0		7.0	7.0	7.0	7.0	7.0	
Vehicle Extension (s)	3.0	3.0	3.0		3.0		3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	318	335	284		311	358	176	1366	599	224	1987	
v/s Ratio Prot	c0.19	0.09	0.09		c0.19	0.15	0.05	c0.43	0.03	0.07	c0.44	
v/s Ratio Perm												
v/c Ratio	1.07	0.50	0.49		1.09	0.68	0.85	1.09	0.07	1.03	1.09	
Uniform Delay, d1	61.5	55.4	55.3		62.0	53.0	70.4	45.5	28.4	70.0	44.5	
Progression Factor	1.00	1.00	1.00		1.00	1.00	0.60	0.36	0.06	1.00	1.00	
Incremental Delay, d2	71.0	1.2	1.3		76.2	5.0	26.6	49.4	0.2	67.3	51.3	
Delay (s)	132.5	56.6	56.6		138.2	57.9	68.7	65.7	1.9	137.3	95.8	
Level of Service	F	E	E		F	E	E	E	A	F	F	
Approach Delay (s)		89.1			97.8		62.0				99.7	
Approach LOS		F			F		E				F	

Intersection Summary			
HCM 2000 Control Delay	86.5	HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio	1.12		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	28.0
Intersection Capacity Utilization	107.4%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Volume (vph)	324	17	134	22	17	103	152	2373	117	67	1372	351
Future Volume (vph)	324	17	134	22	17	103	152	2373	117	67	1372	351
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	7.0	7.0	7.0		7.0	7.0	7.0	7.0		7.0	7.0	7.0
Lane Util. Factor	0.95	0.95	1.00		1.00	1.00	0.97	0.91		0.97	0.91	1.00
Frt	1.00	1.00	0.85		1.00	0.85	1.00	0.99		1.00	1.00	0.85
Flt Protected	0.95	0.96	1.00		0.97	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1681	1693	1583		1811	1583	3367	4952		3303	4893	1524
Flt Permitted	0.95	0.96	1.00		0.97	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	1681	1693	1583		1811	1583	3367	4952		3303	4893	1524
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.93	0.93	0.93	0.88	0.88	0.88
Adj. Flow (vph)	352	18	146	24	18	112	163	2552	126	76	1559	399
RTOR Reduction (vph)	0	0	69	0	0	72	0	3	0	0	0	132
Lane Group Flow (vph)	183	187	77	0	42	40	163	2675	0	76	1559	267
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	4%	4%	4%	6%	6%	6%
Turn Type	Split	NA	pt+ov	Split	NA	pt+ov	Prot	NA		Prot	NA	pt+ov
Protected Phases	4	4	4 5	8	8	1 8	5	2		1	6	4 6
Permitted Phases												
Actuated Green, G (s)	21.0	21.0	39.6		10.0	15.0	11.6	86.0		5.0	79.4	100.4
Effective Green, g (s)	21.0	21.0	39.6		10.0	15.0	11.6	86.0		5.0	79.4	100.4
Actuated g/C Ratio	0.14	0.14	0.26		0.07	0.10	0.08	0.57		0.03	0.53	0.67
Clearance Time (s)	7.0	7.0			7.0		7.0	7.0		7.0	7.0	
Vehicle Extension (s)	4.0	4.0			4.0		4.0	4.0		4.0	4.0	
Lane Grp Cap (vph)	235	237	417		120	158	260	2839		110	2590	1020
v/s Ratio Prot	0.11	c0.11	0.05		c0.02	0.03	c0.05	c0.54		0.02	0.32	0.18
v/s Ratio Perm												
v/c Ratio	0.78	0.79	0.18		0.35	0.25	0.63	0.94		0.69	0.60	0.26
Uniform Delay, d1	62.3	62.4	42.7		66.9	62.3	67.1	29.7		71.7	24.4	9.9
Progression Factor	1.00	1.00	1.00		1.00	1.00	1.13	0.34		1.13	0.99	1.47
Incremental Delay, d2	15.8	16.7	0.3		7.9	1.2	0.5	0.9		11.1	0.6	0.1
Delay (s)	78.0	79.1	43.0		74.8	63.5	76.2	10.9		92.1	24.8	14.7
Level of Service	E	E	D		E	E	E	B		F	C	B
Approach Delay (s)		68.5			66.6			14.7			25.3	
Approach LOS		E			E			B			C	

Intersection Summary			
HCM 2000 Control Delay	25.0	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.88		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	28.0
Intersection Capacity Utilization	85.8%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	0	1365	805	0	115	985
Future Volume (vph)	0	1365	805	0	115	985
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	12	16	12
Total Lost time (s)		6.0	6.0		6.0	6.0
Lane Util. Factor		0.95	0.95		1.00	0.88
Frt		1.00	1.00		1.00	0.85
Flt Protected		1.00	1.00		0.95	1.00
Satd. Flow (prot)		3471	3406		1930	2682
Flt Permitted		1.00	1.00		0.95	1.00
Satd. Flow (perm)		3471	3406		1930	2682
Peak-hour factor, PHF	0.93	0.93	0.88	0.88	0.89	0.89
Adj. Flow (vph)	0	1468	915	0	129	1107
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	0	1468	915	0	129	1107
Heavy Vehicles (%)	4%	4%	6%	6%	6%	6%
Turn Type		NA	NA		Prot	Prot
Protected Phases		2	6		4	4
Permitted Phases						
Actuated Green, G (s)		32.0	32.0		31.0	31.0
Effective Green, g (s)		32.0	32.0		31.0	31.0
Actuated g/C Ratio		0.43	0.43		0.41	0.41
Clearance Time (s)		6.0	6.0		6.0	6.0
Vehicle Extension (s)		3.0	3.0		3.0	3.0
Lane Grp Cap (vph)		1480	1453		797	1108
v/s Ratio Prot		c0.42	0.27		0.07	c0.41
v/s Ratio Perm						
v/c Ratio		0.99	0.63		0.16	1.00
Uniform Delay, d1		21.4	16.9		13.8	22.0
Progression Factor		0.99	1.32		1.00	1.00
Incremental Delay, d2		13.3	0.2		0.1	26.6
Delay (s)		34.6	22.4		13.9	48.6
Level of Service		C	C		B	D
Approach Delay (s)		34.6	22.4		45.0	
Approach LOS		C	C		D	

Intersection Summary			
HCM 2000 Control Delay	35.1	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.99		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	68.7%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	NBL2	NBL	NBR	SEL	SER	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations											
Traffic Volume (vph)	455	0	330	0	0	1310	170	0	0	1080	360
Future Volume (vph)	455	0	330	0	0	1310	170	0	0	1080	360
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0		6.0			6.0	6.0			6.0	4.0
Lane Util. Factor	0.97		0.88			0.97	0.95			0.95	1.00
Frt	1.00		0.85			1.00	1.00			1.00	0.85
Flt Protected	0.95		1.00			0.95	1.00			1.00	1.00
Satd. Flow (prot)	3242		2632			3335	3438			3505	1568
Flt Permitted	0.95		1.00			0.95	1.00			1.00	1.00
Satd. Flow (perm)	3242		2632			3335	3438			3505	1568
Peak-hour factor, PHF	0.88	0.88	0.88	0.92	0.92	0.94	0.94	0.94	0.92	0.92	0.92
Adj. Flow (vph)	517	0	375	0	0	1394	181	0	0	1174	391
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	517	0	375	0	0	1394	181	0	0	1174	391
Heavy Vehicles (%)	8%	8%	8%	2%	2%	5%	5%	5%	3%	3%	3%
Turn Type	Prot		Prot			Prot	NA			NA	Free
Protected Phases	8		8			5	2			6	
Permitted Phases											Free
Actuated Green, G (s)	23.0		23.0			60.0	115.0			49.0	150.0
Effective Green, g (s)	23.0		23.0			60.0	115.0			49.0	150.0
Actuated g/C Ratio	0.15		0.15			0.40	0.77			0.33	1.00
Clearance Time (s)	6.0		6.0			6.0	6.0			6.0	
Vehicle Extension (s)	3.0		3.0			3.0	3.0			3.0	
Lane Grp Cap (vph)	497		403			1334	2635			1144	1568
v/s Ratio Prot	c0.16		0.14			c0.42	0.05			c0.33	
v/s Ratio Perm											0.25
v/c Ratio	1.04		0.93			1.04	0.07			1.03	0.25
Uniform Delay, d1	63.5		62.7			45.0	4.3			50.5	0.0
Progression Factor	1.00		1.00			0.61	1.73			1.00	1.00
Incremental Delay, d2	51.2		28.0			28.7	0.0			33.5	0.4
Delay (s)	114.7		90.7			56.0	7.5			84.0	0.4
Level of Service	F		F			E	A			F	A
Approach Delay (s)		104.6		0.0			50.5			63.1	
Approach LOS		F		A			D			E	

Intersection Summary			
HCM 2000 Control Delay	67.3	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.04		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	96.2%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Volume (vph)	10	0	160	0	0	1	100	500	5	5	1110	30
Future Volume (vph)	10	0	160	0	0	1	100	500	5	5	1110	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0	6.0		6.0		6.0	6.0		6.0	6.0	
Lane Util. Factor		1.00	1.00		1.00		1.00	0.95		1.00	0.95	
Frt		1.00	0.85		0.86		1.00	1.00		1.00	1.00	
Flt Protected		0.95	1.00		1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1770	1583		1644		1770	3534		1770	3525	
Flt Permitted		1.00	1.00		1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1863	1583		1644		1770	3534		1770	3525	
Peak-hour factor, PHF	0.92	0.92	0.92	0.25	0.25	0.25	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	11	0	174	0	0	4	109	543	5	5	1207	33
RTOR Reduction (vph)	0	0	65	0	4	0	0	1	0	0	2	0
Lane Group Flow (vph)	0	11	109	0	0	0	109	547	0	5	1238	0
Heavy Vehicles (%)	2%	2%	2%	0%	0%	0%	2%	2%	2%	2%	2%	2%
Turn Type	Perm	NA	custom		NA		Prot	NA		Prot	NA	
Protected Phases		8			4		5	2		1	6	
Permitted Phases	8		6	4								
Actuated Green, G (s)		1.2	44.8		1.2		7.8	51.8		0.8	44.8	
Effective Green, g (s)		1.2	44.8		1.2		7.8	51.8		0.8	44.8	
Actuated g/C Ratio		0.02	0.62		0.02		0.11	0.72		0.01	0.62	
Clearance Time (s)		6.0	6.0		6.0		6.0	6.0		6.0	6.0	
Vehicle Extension (s)		3.0	3.0		3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		31	987		27		192	2549		19	2199	
v/s Ratio Prot					0.00		c0.06	0.15		0.00	c0.35	
v/s Ratio Perm		c0.01	0.07									
v/c Ratio		0.35	0.11		0.00		0.57	0.21		0.26	0.56	
Uniform Delay, d1		34.9	5.5		34.7		30.4	3.3		35.2	7.8	
Progression Factor		1.00	1.00		1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		6.9	0.0		0.0		3.8	0.0		7.3	0.3	
Delay (s)		41.8	5.5		34.7		34.2	3.3		42.5	8.2	
Level of Service		D	A		C		C	A		D	A	
Approach Delay (s)		7.7			34.7			8.5			8.3	
Approach LOS		A			C			A			A	

Intersection Summary			
HCM 2000 Control Delay	8.3	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.56		
Actuated Cycle Length (s)	71.8	Sum of lost time (s)	18.0
Intersection Capacity Utilization	64.5%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Volume (vph)	10	20	10	350	0	30	0	420	110	15	585	0
Future Volume (vph)	10	20	10	350	0	30	0	420	110	15	585	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0			6.0			6.0			6.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		0.97			0.99			0.97			1.00	
Flt Protected		0.99			0.96			1.00			1.00	
Satd. Flow (prot)		1776			1745			1710			1807	
Flt Permitted		0.87			0.69			1.00			0.98	
Satd. Flow (perm)		1573			1268			1710			1776	
Peak-hour factor, PHF	0.60	0.60	0.60	0.96	0.96	0.96	0.89	0.89	0.89	0.86	0.86	0.86
Adj. Flow (vph)	17	33	17	365	0	31	0	472	124	17	680	0
RTOR Reduction (vph)	0	11	0	0	23	0	0	11	0	0	0	0
Lane Group Flow (vph)	0	56	0	0	373	0	0	585	0	0	697	0
Heavy Vehicles (%)	2%	2%	2%	3%	3%	3%	8%	8%	8%	5%	5%	5%
Turn Type	Perm	NA		Perm	NA			NA		Perm	NA	
Protected Phases		4			4			2			2	
Permitted Phases	4			4						2		
Actuated Green, G (s)		27.3			27.3			38.4			38.4	
Effective Green, g (s)		27.3			27.3			38.4			38.4	
Actuated g/C Ratio		0.35			0.35			0.49			0.49	
Clearance Time (s)		6.0			6.0			6.0			6.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		552			445			845			877	
v/s Ratio Prot								0.34				
v/s Ratio Perm		0.04			c0.29						c0.39	
v/c Ratio		0.10			0.84			0.69			0.79	
Uniform Delay, d1		16.9			23.2			15.1			16.4	
Progression Factor		1.00			1.00			1.00			1.00	
Incremental Delay, d2		0.1			12.9			2.5			5.0	
Delay (s)		17.0			36.1			17.6			21.4	
Level of Service		B			D			B			C	
Approach Delay (s)		17.0			36.1			17.6			21.4	
Approach LOS		B			D			B			C	

Intersection Summary			
HCM 2000 Control Delay	23.2	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.81		
Actuated Cycle Length (s)	77.7	Sum of lost time (s)	12.0
Intersection Capacity Utilization	82.1%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SBL	SBR	SBR2	NEL2	NEL	NER
Lane Configurations												
Traffic Volume (vph)	133	149	274	230	177	193	268	1823	174	315	1504	117
Future Volume (vph)	133	149	274	230	177	193	268	1823	174	315	1504	117
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	7.0	7.0	7.0		7.0	7.0	7.0	7.0	7.0	7.0	7.0	
Lane Util. Factor	1.00	1.00	1.00		1.00	1.00	0.97	0.76	1.00	0.97	0.94	
Frpb, ped/bikes	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Frt	1.00	1.00	0.85		1.00	0.85	1.00	0.85	0.85	1.00	0.99	
Flt Protected	0.95	1.00	1.00		0.97	1.00	0.95	1.00	1.00	0.95	0.96	
Satd. Flow (prot)	1770	1863	1583		1812	1583	3303	3474	1524	3367	4870	
Flt Permitted	0.95	1.00	1.00		0.97	1.00	0.95	1.00	1.00	0.95	0.96	
Satd. Flow (perm)	1770	1863	1583		1812	1583	3303	3474	1524	3367	4870	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.88	0.88	0.88	0.93	0.93	0.93
Adj. Flow (vph)	145	162	298	250	192	210	305	2072	198	339	1617	126
RTOR Reduction (vph)	0	0	119	0	0	98	0	0	75	0	80	0
Lane Group Flow (vph)	145	162	179	0	442	112	305	2072	123	339	1663	0
Confl. Peds. (#/hr)				3								
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	6%	6%	6%	4%	4%	4%
Turn Type	Split	NA	pt+ov	Split	NA	pt+ov	Prot	Prot	Prot	Prot	Prot	
Protected Phases	4	4	4 5	8	8	1 8	1	6	6	5	2	
Permitted Phases												
Actuated Green, G (s)	10.0	10.0	21.0		26.0	42.0	16.0	65.0	65.0	11.0	60.0	
Effective Green, g (s)	10.0	10.0	21.0		26.0	42.0	16.0	65.0	65.0	11.0	60.0	
Actuated g/C Ratio	0.07	0.07	0.15		0.19	0.30	0.11	0.46	0.46	0.08	0.43	
Clearance Time (s)	7.0	7.0			7.0		7.0	7.0	7.0	7.0	7.0	
Vehicle Extension (s)	3.0	3.0			3.0		3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	126	133	237		336	474	377	1612	707	264	2087	
v/s Ratio Prot	0.08	c0.09	0.11		c0.24	0.07	0.09	c0.60	0.08	c0.10	0.34	
v/s Ratio Perm												
v/c Ratio	1.15	1.22	0.76		1.32	0.24	0.81	1.29	0.17	1.28	0.80	
Uniform Delay, d1	65.0	65.0	57.0		57.0	36.9	60.5	37.5	21.9	64.5	34.7	
Progression Factor	1.00	1.00	1.00		1.00	1.00	0.58	0.32	0.03	1.00	1.00	
Incremental Delay, d2	126.4	148.2	12.8		161.6	0.3	3.7	129.8	0.2	153.5	3.3	
Delay (s)	191.4	213.2	69.8		218.6	37.2	38.9	141.9	0.7	218.0	38.0	
Level of Service	F	F	E		F	D	D	F	A	F	D	
Approach Delay (s)		137.4			160.2		118.8				67.3	
Approach LOS		F			F		F				E	

Intersection Summary			
HCM 2000 Control Delay	107.1	HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio	1.28		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	28.0
Intersection Capacity Utilization	102.5%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Volume (vph)	550	68	448	71	44	82	426	1328	64	196	1733	771
Future Volume (vph)	550	68	448	71	44	82	426	1328	64	196	1733	771
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	7.0	7.0	7.0		7.0	7.0	7.0	7.0		7.0	7.0	7.0
Lane Util. Factor	0.95	0.95	1.00		1.00	1.00	0.97	0.91		0.97	0.91	1.00
Frt	1.00	1.00	0.85		1.00	0.85	1.00	0.99		1.00	1.00	0.85
Flt Protected	0.95	0.96	1.00		0.97	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1681	1703	1583		1807	1583	3367	4953		3303	4893	1524
Flt Permitted	0.95	0.96	1.00		0.97	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	1681	1703	1583		1807	1583	3367	4953		3303	4893	1524
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.93	0.93	0.93	0.88	0.88	0.88
Adj. Flow (vph)	598	74	487	77	48	89	458	1428	69	223	1969	876
RTOR Reduction (vph)	0	0	188	0	0	83	0	3	0	0	0	75
Lane Group Flow (vph)	335	337	299	0	125	6	458	1494	0	223	1969	801
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	4%	4%	4%	6%	6%	6%
Turn Type	Split	NA	Prot	Split	NA	Prot	Prot	NA		Prot	NA	pt+ov
Protected Phases	4	4	4	8	8	8	5	2		1	6	4 6
Permitted Phases												
Actuated Green, G (s)	27.0	27.0	27.0		10.0	10.0	18.0	60.8		14.2	57.0	84.0
Effective Green, g (s)	27.0	27.0	27.0		10.0	10.0	18.0	60.8		14.2	57.0	84.0
Actuated g/C Ratio	0.19	0.19	0.19		0.07	0.07	0.13	0.43		0.10	0.41	0.60
Clearance Time (s)	7.0	7.0	7.0		7.0	7.0	7.0	7.0		7.0	7.0	
Vehicle Extension (s)	4.0	4.0	4.0		4.0	4.0	4.0	4.0		4.0	4.0	
Lane Grp Cap (vph)	324	328	305		129	113	432	2151		335	1992	914
v/s Ratio Prot	c0.20	0.20	0.19		c0.07	0.00	c0.14	c0.30		0.07	c0.40	0.53
v/s Ratio Perm												
v/c Ratio	1.03	1.03	0.98		0.97	0.06	1.06	0.69		0.67	0.99	0.88
Uniform Delay, d1	56.5	56.5	56.2		64.8	60.6	61.0	32.1		60.6	41.2	23.6
Progression Factor	1.00	1.00	1.00		1.00	1.00	1.33	0.40		1.00	1.01	1.08
Incremental Delay, d2	59.1	56.9	46.0		71.3	0.9	50.6	1.1		0.5	4.0	1.0
Delay (s)	115.6	113.4	102.3		136.2	61.5	131.4	14.0		61.2	45.6	26.4
Level of Service	F	F	F		F	E	F	B		E	D	C
Approach Delay (s)		109.3			105.1			41.5			41.3	
Approach LOS		F			F			D			D	

Intersection Summary			
HCM 2000 Control Delay	55.8	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.02		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	28.0
Intersection Capacity Utilization	92.2%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	0	1285	1405	0	125	1295
Future Volume (vph)	0	1285	1405	0	125	1295
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	12	16	12
Total Lost time (s)		6.0	6.0		6.0	6.0
Lane Util. Factor		0.95	0.95		1.00	0.88
Frt		1.00	1.00		1.00	0.85
Flt Protected		1.00	1.00		0.95	1.00
Satd. Flow (prot)		3471	3406		1930	2682
Flt Permitted		1.00	1.00		0.95	1.00
Satd. Flow (perm)		3471	3406		1930	2682
Peak-hour factor, PHF	0.93	0.93	0.88	0.88	0.89	0.89
Adj. Flow (vph)	0	1382	1597	0	140	1455
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	0	1382	1597	0	140	1455
Heavy Vehicles (%)	4%	4%	6%	6%	6%	6%
Turn Type		NA	NA		Prot	Prot
Protected Phases		2	6		4	4
Permitted Phases						
Actuated Green, G (s)		60.0	60.0		68.0	68.0
Effective Green, g (s)		60.0	60.0		68.0	68.0
Actuated g/C Ratio		0.43	0.43		0.49	0.49
Clearance Time (s)		6.0	6.0		6.0	6.0
Vehicle Extension (s)		3.0	3.0		3.0	3.0
Lane Grp Cap (vph)		1487	1459		937	1302
v/s Ratio Prot		0.40	c0.47		0.07	c0.54
v/s Ratio Perm						
v/c Ratio		0.93	1.09		0.15	1.12
Uniform Delay, d1		38.0	40.0		20.0	36.0
Progression Factor		0.74	0.08		1.00	1.00
Incremental Delay, d2		7.9	43.8		0.1	63.8
Delay (s)		35.8	47.1		20.0	99.8
Level of Service		D	D		C	F
Approach Delay (s)		35.8	47.1		92.8	
Approach LOS		D	D		F	

Intersection Summary			
HCM 2000 Control Delay	59.6	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.11		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	96.1%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Movement	NBL2	NBL	NBR	SEL	SER	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations											
Traffic Volume (vph)	1245	0	1005	0	0	1050	360	0	0	500	235
Future Volume (vph)	1245	0	1005	0	0	1050	360	0	0	500	235
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0		6.0			6.0	6.0			6.0	4.0
Lane Util. Factor	0.97		0.88			0.97	0.95			0.95	1.00
Frt	1.00		0.85			1.00	1.00			1.00	0.85
Flt Protected	0.95		1.00			0.95	1.00			1.00	1.00
Satd. Flow (prot)	3242		2632			3335	3438			3505	1568
Flt Permitted	0.95		1.00			0.95	1.00			1.00	1.00
Satd. Flow (perm)	3242		2632			3335	3438			3505	1568
Peak-hour factor, PHF	0.88	0.88	0.88	0.92	0.92	0.94	0.94	0.94	0.92	0.92	0.92
Adj. Flow (vph)	1415	0	1142	0	0	1117	383	0	0	543	255
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	1415	0	1142	0	0	1117	383	0	0	543	255
Heavy Vehicles (%)	8%	8%	8%	2%	2%	5%	5%	5%	3%	3%	3%
Turn Type	Prot		Prot			Prot	NA			NA	Free
Protected Phases	8		8			5	2			6	
Permitted Phases											Free
Actuated Green, G (s)	55.0		55.0			42.0	73.0			25.0	140.0
Effective Green, g (s)	55.0		55.0			42.0	73.0			25.0	140.0
Actuated g/C Ratio	0.39		0.39			0.30	0.52			0.18	1.00
Clearance Time (s)	6.0		6.0			6.0	6.0			6.0	
Vehicle Extension (s)	3.0		3.0			3.0	3.0			3.0	
Lane Grp Cap (vph)	1273		1034			1000	1792			625	1568
v/s Ratio Prot	c0.44		0.43			c0.33	0.11			c0.15	
v/s Ratio Perm											0.16
v/c Ratio	1.11		1.10			1.12	0.21			0.87	0.16
Uniform Delay, d1	42.5		42.5			49.0	18.0			55.9	0.0
Progression Factor	1.00		1.00			0.44	0.21			1.00	1.00
Incremental Delay, d2	61.7		61.2			60.1	0.1			15.2	0.2
Delay (s)	104.2		103.7			81.8	3.9			71.1	0.2
Level of Service	F		F			F	A			E	A
Approach Delay (s)		103.9		0.0			61.9			48.4	
Approach LOS		F		A			E			D	

Intersection Summary			
HCM 2000 Control Delay	81.8	HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio	1.06		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	95.3%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Volume (vph)	10	5	210	10	0	10	410	910	120	5	650	120
Future Volume (vph)	10	5	210	10	0	10	410	910	120	5	650	120
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0	6.0		6.0		6.0	6.0		6.0	6.0	
Lane Util. Factor		1.00	1.00		1.00		1.00	0.95		1.00	0.95	
Frt		1.00	0.85		0.93		1.00	0.98		1.00	0.98	
Flt Protected		0.97	1.00		0.98		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1801	1583		1729		1770	3478		1770	3457	
Flt Permitted		0.88	1.00		0.83		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1636	1583		1477		1770	3478		1770	3457	
Peak-hour factor, PHF	0.92	0.92	0.92	0.25	0.25	0.25	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	11	5	228	40	0	40	446	989	130	5	707	130
RTOR Reduction (vph)	0	0	138	0	75	0	0	8	0	0	14	0
Lane Group Flow (vph)	0	16	90	0	5	0	446	1111	0	5	823	0
Heavy Vehicles (%)	2%	2%	2%	0%	0%	0%	2%	2%	2%	2%	2%	2%
Turn Type	Perm	NA	custom	Perm	NA		Prot	NA		Prot	NA	
Protected Phases		8			4		5	2		1	6	
Permitted Phases	8		6	4								
Actuated Green, G (s)		4.9	30.5		4.9		23.6	53.2		0.9	30.5	
Effective Green, g (s)		4.9	30.5		4.9		23.6	53.2		0.9	30.5	
Actuated g/C Ratio		0.06	0.40		0.06		0.31	0.69		0.01	0.40	
Clearance Time (s)		6.0	6.0		6.0		6.0	6.0		6.0	6.0	
Vehicle Extension (s)		3.0	3.0		3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		104	627		93		542	2402		20	1369	
v/s Ratio Prot							c0.25	0.32		0.00	c0.24	
v/s Ratio Perm		c0.01	0.06		0.00							
v/c Ratio		0.15	0.14		0.05		0.82	0.46		0.25	0.60	
Uniform Delay, d1		34.1	14.9		33.9		24.8	5.4		37.7	18.4	
Progression Factor		1.00	1.00		1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.7	0.1		0.2		9.8	0.1		6.5	0.7	
Delay (s)		34.8	15.0		34.1		34.5	5.5		44.2	19.2	
Level of Service		C	B		C		C	A		D	B	
Approach Delay (s)		16.3			34.1			13.8			19.3	
Approach LOS		B			C			B			B	

Intersection Summary			
HCM 2000 Control Delay	16.3	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	77.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	71.1%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Volume (vph)	20	30	5	260	0	40	0	790	130	15	420	0
Future Volume (vph)	20	30	5	260	0	40	0	790	130	15	420	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0			6.0			6.0			6.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		0.99			0.98			0.98			1.00	
Flt Protected		0.98			0.96			1.00			1.00	
Satd. Flow (prot)		1808			1736			1726			1806	
Flt Permitted		0.87			0.74			1.00			0.80	
Satd. Flow (perm)		1610			1338			1726			1455	
Peak-hour factor, PHF	0.60	0.60	0.60	0.96	0.96	0.96	0.89	0.89	0.89	0.86	0.86	0.86
Adj. Flow (vph)	33	50	8	271	0	42	0	888	146	17	488	0
RTOR Reduction (vph)	0	4	0	0	28	0	0	7	0	0	0	0
Lane Group Flow (vph)	0	87	0	0	285	0	0	1027	0	0	505	0
Heavy Vehicles (%)	2%	2%	2%	3%	3%	3%	8%	8%	8%	5%	5%	5%
Turn Type	Perm	NA		Perm	NA			NA		Perm	NA	
Protected Phases		4			4			2			2	
Permitted Phases	4			4						2		
Actuated Green, G (s)		20.1			20.1			55.8			55.8	
Effective Green, g (s)		20.1			20.1			55.8			55.8	
Actuated g/C Ratio		0.23			0.23			0.63			0.63	
Clearance Time (s)		6.0			6.0			6.0			6.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		368			305			1095			923	
v/s Ratio Prot								c0.60				
v/s Ratio Perm		0.05			c0.21						0.35	
v/c Ratio		0.24			0.94			0.94			0.55	
Uniform Delay, d1		27.6			33.3			14.5			9.0	
Progression Factor		1.00			1.00			1.00			1.00	
Incremental Delay, d2		0.3			34.6			14.6			0.7	
Delay (s)		28.0			67.9			29.1			9.6	
Level of Service		C			E			C			A	
Approach Delay (s)		28.0			67.9			29.1			9.6	
Approach LOS		C			E			C			A	

Intersection Summary			
HCM 2000 Control Delay	30.2	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.94		
Actuated Cycle Length (s)	87.9	Sum of lost time (s)	12.0
Intersection Capacity Utilization	86.3%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SBL	SBR	SBR2	NEL2	NEL	NER
Lane Configurations												
Traffic Volume (vph)	311	152	261	225	82	312	112	1109	81	212	1993	75
Future Volume (vph)	311	152	261	225	82	312	112	1109	81	212	1993	75
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	7.0	7.0	7.0		7.0	7.0	7.0	7.0	7.0	7.0	7.0	
Lane Util. Factor	1.00	1.00	1.00		1.00	1.00	0.97	0.76	1.00	0.97	0.94	
Frt	1.00	1.00	0.85		1.00	0.85	1.00	0.85	0.85	1.00	0.99	
Flt Protected	0.95	1.00	1.00		0.96	1.00	0.95	1.00	1.00	0.95	0.95	
Satd. Flow (prot)	1770	1863	1583		1797	1583	3303	3474	1524	3367	4888	
Flt Permitted	0.95	1.00	1.00		0.96	1.00	0.95	1.00	1.00	0.95	0.95	
Satd. Flow (perm)	1770	1863	1583		1797	1583	3303	3474	1524	3367	4888	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.88	0.88	0.88	0.93	0.93	0.93
Adj. Flow (vph)	338	165	284	245	89	339	127	1260	92	228	2143	81
RTOR Reduction (vph)	0	0	149	0	0	101	0	0	56	0	78	0
Lane Group Flow (vph)	338	165	135	0	334	238	127	1260	36	228	2146	0
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	6%	6%	6%	4%	4%	4%
Turn Type	Split	NA	Prot	Split	NA	pt+ov	Prot	Prot	Prot	Prot	Prot	
Protected Phases	4	4	4	8	8	1 8	1	6	6	5	2	
Permitted Phases												
Actuated Green, G (s)	27.0	27.0	27.0		26.0	34.0	8.0	59.0	59.0	10.0	61.0	
Effective Green, g (s)	27.0	27.0	27.0		26.0	34.0	8.0	59.0	59.0	10.0	61.0	
Actuated g/C Ratio	0.18	0.18	0.18		0.17	0.23	0.05	0.39	0.39	0.07	0.41	
Clearance Time (s)	7.0	7.0	7.0		7.0		7.0	7.0	7.0	7.0	7.0	
Vehicle Extension (s)	3.0	3.0	3.0		3.0		3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	318	335	284		311	358	176	1366	599	224	1987	
v/s Ratio Prot	c0.19	0.09	0.09		c0.19	0.15	0.04	c0.36	0.02	0.07	c0.44	
v/s Ratio Perm												
v/c Ratio	1.06	0.49	0.47		1.07	0.66	0.72	0.92	0.06	1.02	1.08	
Uniform Delay, d1	61.5	55.3	55.1		62.0	52.8	69.9	43.3	28.3	70.0	44.5	
Progression Factor	1.00	1.00	1.00		1.00	1.00	0.65	0.41	0.14	1.00	1.00	
Incremental Delay, d2	68.1	1.1	1.3		72.1	4.6	12.3	10.7	0.2	64.8	45.7	
Delay (s)	129.6	56.5	56.4		134.1	57.4	57.6	28.4	4.1	134.8	90.2	
Level of Service	F	E	E		F	E	E	C	A	F	F	
Approach Delay (s)		87.8			95.5		29.4				94.4	
Approach LOS		F			F		C				F	

Intersection Summary			
HCM 2000 Control Delay	75.7	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.08		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	28.0
Intersection Capacity Utilization	106.5%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Volume (vph)	320	17	133	22	17	102	150	2343	116	56	1142	292
Future Volume (vph)	320	17	133	22	17	102	150	2343	116	56	1142	292
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	7.0	7.0	7.0		7.0	7.0	7.0	7.0		7.0	7.0	7.0
Lane Util. Factor	0.95	0.95	1.00		1.00	1.00	0.97	0.91		0.97	0.91	1.00
Frt	1.00	1.00	0.85		1.00	0.85	1.00	0.99		1.00	1.00	0.85
Flt Protected	0.95	0.96	1.00		0.97	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1681	1693	1583		1811	1583	3367	4952		3303	4893	1524
Flt Permitted	0.95	0.96	1.00		0.97	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	1681	1693	1583		1811	1583	3367	4952		3303	4893	1524
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.93	0.93	0.93	0.88	0.88	0.88
Adj. Flow (vph)	348	18	145	24	18	111	161	2519	125	64	1298	332
RTOR Reduction (vph)	0	0	83	0	0	72	0	3	0	0	0	110
Lane Group Flow (vph)	181	185	62	0	42	39	161	2641	0	64	1298	222
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	4%	4%	4%	6%	6%	6%
Turn Type	Split	NA	pt+ov	Split	NA	pt+ov	Prot	NA		Prot	NA	pt+ov
Protected Phases	4	4	4 5	8	8	1 8	5	2		1	6	4 6
Permitted Phases												
Actuated Green, G (s)	20.7	20.7	39.3		10.0	15.3	11.6	86.0		5.3	79.7	100.4
Effective Green, g (s)	20.7	20.7	39.3		10.0	15.3	11.6	86.0		5.3	79.7	100.4
Actuated g/C Ratio	0.14	0.14	0.26		0.07	0.10	0.08	0.57		0.04	0.53	0.67
Clearance Time (s)	7.0	7.0			7.0		7.0	7.0		7.0	7.0	
Vehicle Extension (s)	4.0	4.0			4.0		4.0	4.0		4.0	4.0	
Lane Grp Cap (vph)	231	233	414		120	161	260	2839		116	2599	1020
v/s Ratio Prot	0.11	c0.11	0.04		c0.02	0.02	c0.05	c0.53		0.02	0.27	0.15
v/s Ratio Perm												
v/c Ratio	0.78	0.79	0.15		0.35	0.24	0.62	0.93		0.55	0.50	0.22
Uniform Delay, d1	62.5	62.6	42.5		66.9	62.0	67.1	29.3		71.2	22.4	9.6
Progression Factor	1.00	1.00	1.00		1.00	1.00	1.13	0.34		1.14	0.90	1.19
Incremental Delay, d2	16.7	17.7	0.2		7.9	1.1	0.5	0.7		5.2	0.5	0.1
Delay (s)	79.2	80.2	42.8		74.8	63.1	75.9	10.5		86.4	20.6	11.6
Level of Service	E	F	D		E	E	E	B		F	C	B
Approach Delay (s)		69.2			66.3			14.3			21.3	
Approach LOS		E			E			B			C	

Intersection Summary			
HCM 2000 Control Delay	23.6	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.87		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	28.0
Intersection Capacity Utilization	85.2%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	0	1355	685	0	855	805
Future Volume (vph)	0	1355	685	0	855	805
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	12	16	12
Total Lost time (s)		6.0	6.0		6.0	6.0
Lane Util. Factor		0.95	0.95		1.00	0.88
Frt		1.00	1.00		1.00	0.85
Flt Protected		1.00	1.00		0.95	1.00
Satd. Flow (prot)		3471	3406		1930	2682
Flt Permitted		1.00	1.00		0.95	1.00
Satd. Flow (perm)		3471	3406		1930	2682
Peak-hour factor, PHF	0.93	0.93	0.88	0.88	0.89	0.89
Adj. Flow (vph)	0	1457	778	0	961	904
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	0	1457	778	0	961	904
Heavy Vehicles (%)	4%	4%	6%	6%	6%	6%
Turn Type		NA	NA		Prot	Prot
Protected Phases		2	6		4	4
Permitted Phases						
Actuated Green, G (s)		29.0	29.0		34.0	34.0
Effective Green, g (s)		29.0	29.0		34.0	34.0
Actuated g/C Ratio		0.39	0.39		0.45	0.45
Clearance Time (s)		6.0	6.0		6.0	6.0
Vehicle Extension (s)		3.0	3.0		3.0	3.0
Lane Grp Cap (vph)		1342	1316		874	1215
v/s Ratio Prot		c0.42	0.23		c0.50	0.34
v/s Ratio Perm						
v/c Ratio		1.09	0.59		1.10	0.74
Uniform Delay, d1		23.0	18.3		20.5	16.9
Progression Factor		1.01	0.94		1.00	1.00
Incremental Delay, d2		44.9	0.2		61.4	2.5
Delay (s)		68.1	17.3		81.9	19.4
Level of Service		E	B		F	B
Approach Delay (s)		68.1	17.3		51.6	
Approach LOS		E	B		D	

Intersection Summary			
HCM 2000 Control Delay	51.0	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	1.09		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	96.8%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Movement	NBL2	NBL	NBR	SEL	SER	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations											
Traffic Volume (vph)	455	0	365	0	0	1165	1045	0	0	1295	1155
Future Volume (vph)	455	0	365	0	0	1165	1045	0	0	1295	1155
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0		6.0			6.0	6.0			6.0	4.0
Lane Util. Factor	0.97		0.88			0.97	0.95			0.95	1.00
Frt	1.00		0.85			1.00	1.00			1.00	0.85
Flt Protected	0.95		1.00			0.95	1.00			1.00	1.00
Satd. Flow (prot)	3242		2632			3335	3438			3505	1568
Flt Permitted	0.95		1.00			0.95	1.00			1.00	1.00
Satd. Flow (perm)	3242		2632			3335	3438			3505	1568
Peak-hour factor, PHF	0.88	0.88	0.88	0.92	0.92	0.94	0.94	0.94	0.92	0.92	0.92
Adj. Flow (vph)	517	0	415	0	0	1239	1112	0	0	1408	1255
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	517	0	415	0	0	1239	1112	0	0	1408	1255
Heavy Vehicles (%)	8%	8%	8%	2%	2%	5%	5%	5%	3%	3%	3%
Turn Type	Prot		Prot			Prot	NA			NA	Free
Protected Phases	8		8			5	2			6	
Permitted Phases											Free
Actuated Green, G (s)	22.0		22.0			52.0	116.0			58.0	150.0
Effective Green, g (s)	22.0		22.0			52.0	116.0			58.0	150.0
Actuated g/C Ratio	0.15		0.15			0.35	0.77			0.39	1.00
Clearance Time (s)	6.0		6.0			6.0	6.0			6.0	
Vehicle Extension (s)	3.0		3.0			3.0	3.0			3.0	
Lane Grp Cap (vph)	475		386			1156	2658			1355	1568
v/s Ratio Prot	c0.16		0.16			c0.37	0.32			c0.40	
v/s Ratio Perm											0.80
v/c Ratio	1.09		1.08			1.07	0.42			1.04	0.80
Uniform Delay, d1	64.0		64.0			49.0	5.7			46.0	0.0
Progression Factor	1.00		1.00			0.84	0.96			1.00	1.00
Incremental Delay, d2	67.3		67.3			34.3	0.0			35.2	4.4
Delay (s)	131.3		131.3			75.5	5.5			81.2	4.4
Level of Service	F		F			E	A			F	A
Approach Delay (s)		131.3		0.0			42.4			45.0	
Approach LOS		F		A			D			D	

Intersection Summary			
HCM 2000 Control Delay	57.5	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.06		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	98.0%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Volume (vph)	10	0	120	0	1	0	160	780	5	10	1550	40
Future Volume (vph)	10	0	120	0	1	0	160	780	5	10	1550	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0	6.0		6.0		6.0	6.0		6.0	6.0	
Lane Util. Factor		1.00	1.00		1.00		1.00	0.95		1.00	0.95	
Frt		1.00	0.85		1.00		1.00	1.00		1.00	1.00	
Flt Protected		0.95	1.00		1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1770	1583		1900		1770	3536		1770	3526	
Flt Permitted		1.00	1.00		1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1863	1583		1900		1770	3536		1770	3526	
Peak-hour factor, PHF	0.92	0.92	0.92	0.25	0.25	0.25	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	11	0	130	0	4	0	174	848	5	11	1685	43
RTOR Reduction (vph)	0	0	48	0	0	0	0	0	0	0	1	0
Lane Group Flow (vph)	0	11	82	0	4	0	174	853	0	11	1727	0
Heavy Vehicles (%)	2%	2%	2%	0%	0%	0%	2%	2%	2%	2%	2%	2%
Turn Type	Perm	NA	custom		NA		Prot	NA		Prot	NA	
Protected Phases		8			4		5	2		1	6	
Permitted Phases	8		6	4								
Actuated Green, G (s)		1.3	54.2		1.3		12.6	66.0		0.8	54.2	
Effective Green, g (s)		1.3	54.2		1.3		12.6	66.0		0.8	54.2	
Actuated g/C Ratio		0.02	0.63		0.02		0.15	0.77		0.01	0.63	
Clearance Time (s)		6.0	6.0		6.0		6.0	6.0		6.0	6.0	
Vehicle Extension (s)		3.0	3.0		3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		28	996		28		259	2710		16	2219	
v/s Ratio Prot					0.00		c0.10	0.24		0.01	c0.49	
v/s Ratio Perm		c0.01	0.05									
v/c Ratio		0.39	0.08		0.14		0.67	0.31		0.69	0.78	
Uniform Delay, d1		42.0	6.2		41.9		34.8	3.1		42.5	11.6	
Progression Factor		1.00	1.00		1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		8.9	0.0		2.3		6.7	0.1		80.1	1.8	
Delay (s)		50.9	6.3		44.2		41.5	3.2		122.6	13.4	
Level of Service		D	A		D		D	A		F	B	
Approach Delay (s)		9.7			44.2			9.7			14.1	
Approach LOS		A			D			A			B	

Intersection Summary			
HCM 2000 Control Delay	12.3	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	86.1	Sum of lost time (s)	18.0
Intersection Capacity Utilization	77.9%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Volume (vph)	5	10	5	360	0	30	0	540	180	5	810	0
Future Volume (vph)	5	10	5	360	0	30	0	540	180	5	810	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0		6.0		4.5		6.0	6.0		6.0	
Lane Util. Factor		1.00		1.00		1.00		1.00	1.00		1.00	
Frt		0.97		1.00		0.85		1.00	0.85		1.00	
Flt Protected		0.99		0.95		1.00		1.00	1.00		1.00	
Satd. Flow (prot)		1780		1752		1568		1759	1495		1809	
Flt Permitted		0.99		0.74		1.00		1.00	1.00		1.00	
Satd. Flow (perm)		1780		1357		1568		1759	1495		1803	
Peak-hour factor, PHF	0.60	0.60	0.60	0.96	0.96	0.96	0.89	0.89	0.89	0.86	0.86	0.86
Adj. Flow (vph)	8	17	8	375	0	31	0	607	202	6	942	0
RTOR Reduction (vph)	0	6	0	0	0	21	0	0	67	0	0	0
Lane Group Flow (vph)	0	27	0	375	0	10	0	607	135	0	948	0
Heavy Vehicles (%)	2%	2%	2%	3%	3%	3%	8%	8%	8%	5%	5%	5%
Turn Type	Perm	NA		D.Pm		Perm		NA	Perm	Perm	NA	
Protected Phases		4						2			2	
Permitted Phases	4			4		8			2	2		
Actuated Green, G (s)		25.6		25.6		27.1		50.6	50.6		50.6	
Effective Green, g (s)		25.6		25.6		27.1		50.6	50.6		50.6	
Actuated g/C Ratio		0.29		0.29		0.31		0.57	0.57		0.57	
Clearance Time (s)		6.0		6.0		4.5		6.0	6.0		6.0	
Vehicle Extension (s)		3.0		3.0		3.0		3.0	3.0		3.0	
Lane Grp Cap (vph)		516		393		481		1009	857		1034	
v/s Ratio Prot								0.35				
v/s Ratio Perm		0.02		c0.28		0.01			0.09		c0.53	
v/c Ratio		0.05		0.95		0.02		0.60	0.16		0.92	
Uniform Delay, d1		22.6		30.7		21.3		12.2	8.8		16.9	
Progression Factor		1.00		1.00		1.00		1.00	1.00		1.00	
Incremental Delay, d2		0.0		33.5		0.0		1.0	0.1		12.4	
Delay (s)		22.6		64.2		21.3		13.3	8.9		29.3	
Level of Service		C		E		C		B	A		C	
Approach Delay (s)		22.6			60.9			12.2			29.3	
Approach LOS		C			E			B			C	

Intersection Summary			
HCM 2000 Control Delay	28.7	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.93		
Actuated Cycle Length (s)	88.2	Sum of lost time (s)	12.0
Intersection Capacity Utilization	83.9%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SBL	SBR	SBR2	NEL2	NEL	NER
Lane Configurations												
Traffic Volume (vph)	131	136	250	210	162	189	246	1664	159	287	1478	107
Future Volume (vph)	131	136	250	210	162	189	246	1664	159	287	1478	107
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	7.0	7.0	7.0		7.0	7.0	7.0	7.0	7.0	7.0	7.0	
Lane Util. Factor	1.00	1.00	1.00		1.00	1.00	0.97	0.76	1.00	0.97	0.94	
Frpb, ped/bikes	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Frt	1.00	1.00	0.85		1.00	0.85	1.00	0.85	0.85	1.00	0.99	
Flt Protected	0.95	1.00	1.00		0.97	1.00	0.95	1.00	1.00	0.95	0.96	
Satd. Flow (prot)	1770	1863	1583		1812	1583	3303	3474	1524	3367	4873	
Flt Permitted	0.95	1.00	1.00		0.97	1.00	0.95	1.00	1.00	0.95	0.96	
Satd. Flow (perm)	1770	1863	1583		1812	1583	3303	3474	1524	3367	4873	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.88	0.88	0.88	0.93	0.93	0.93
Adj. Flow (vph)	142	148	272	228	176	205	280	1891	181	309	1589	115
RTOR Reduction (vph)	0	0	138	0	0	118	0	0	93	0	98	0
Lane Group Flow (vph)	142	148	134	0	404	87	280	1891	88	309	1606	0
Confl. Peds. (#/hr)				3								
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	6%	6%	6%	4%	4%	4%
Turn Type	Split	NA	pt+ov	Split	NA	pt+ov	Prot	Prot	Prot	Prot	Prot	
Protected Phases	4	4	4 5	8	8	1 8	1	6	6	5	2	
Permitted Phases												
Actuated Green, G (s)	10.0	10.0	19.0		21.0	34.0	13.0	52.0	52.0	9.0	48.0	
Effective Green, g (s)	10.0	10.0	19.0		21.0	34.0	13.0	52.0	52.0	9.0	48.0	
Actuated g/C Ratio	0.08	0.08	0.16		0.18	0.28	0.11	0.43	0.43	0.08	0.40	
Clearance Time (s)	7.0	7.0			7.0		7.0	7.0	7.0	7.0	7.0	
Vehicle Extension (s)	3.0	3.0			3.0		3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	147	155	250		317	448	357	1505	660	252	1949	
v/s Ratio Prot	c0.08	0.08	0.08		c0.22	0.06	0.08	c0.54	0.06	0.09	c0.33	
v/s Ratio Perm												
v/c Ratio	0.97	0.95	0.54		1.27	0.20	0.78	1.26	0.13	1.23	0.82	
Uniform Delay, d1	54.8	54.8	46.4		49.5	32.6	52.1	34.0	20.4	55.5	32.2	
Progression Factor	1.00	1.00	1.00		1.00	1.00	0.54	0.30	0.01	1.00	1.00	
Incremental Delay, d2	63.3	58.4	2.2		145.8	0.2	4.0	117.4	0.1	131.7	4.1	
Delay (s)	118.2	113.1	48.6		195.3	32.8	32.3	127.5	0.3	187.2	36.3	
Level of Service	F	F	D		F	C	C	F	A	F	D	
Approach Delay (s)		83.2			140.6		106.4				59.5	
Approach LOS		F			F		F				E	

Intersection Summary			
HCM 2000 Control Delay	90.7	HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio	1.23		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	28.0
Intersection Capacity Utilization	95.5%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Volume (vph)	554	62	409	65	40	82	389	1339	58	179	1582	704
Future Volume (vph)	554	62	409	65	40	82	389	1339	58	179	1582	704
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	7.0	7.0	7.0		7.0	7.0	7.0	7.0		7.0	7.0	7.0
Lane Util. Factor	0.95	0.95	1.00		1.00	1.00	0.97	0.91		0.97	0.91	1.00
Frt	1.00	1.00	0.85		1.00	0.85	1.00	0.99		1.00	1.00	0.85
Flt Protected	0.95	0.96	1.00		0.97	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1681	1701	1583		1806	1583	3367	4957		3303	4893	1524
Flt Permitted	0.95	0.96	1.00		0.97	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	1681	1701	1583		1806	1583	3367	4957		3303	4893	1524
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.93	0.93	0.93	0.88	0.88	0.88
Adj. Flow (vph)	602	67	445	71	43	89	418	1440	62	203	1798	800
RTOR Reduction (vph)	0	0	202	0	0	82	0	4	0	0	0	112
Lane Group Flow (vph)	331	338	243	0	114	7	418	1498	0	203	1798	688
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	4%	4%	4%	6%	6%	6%
Turn Type	Split	NA	Prot	Split	NA	Prot	Prot	NA		Prot	NA	pt+ov
Protected Phases	4	4	4	8	8	8	5	2		1	6	4 6
Permitted Phases												
Actuated Green, G (s)	23.0	23.0	23.0		10.0	10.0	14.0	47.4		11.6	45.0	68.0
Effective Green, g (s)	23.0	23.0	23.0		10.0	10.0	14.0	47.4		11.6	45.0	68.0
Actuated g/C Ratio	0.19	0.19	0.19		0.08	0.08	0.12	0.39		0.10	0.38	0.57
Clearance Time (s)	7.0	7.0	7.0		7.0	7.0	7.0	7.0		7.0	7.0	
Vehicle Extension (s)	4.0	4.0	4.0		4.0	4.0	4.0	4.0		4.0	4.0	
Lane Grp Cap (vph)	322	326	303		150	131	392	1958		319	1834	863
v/s Ratio Prot	0.20	c0.20	0.15		c0.06	0.00	c0.12	0.30		0.06	c0.37	0.45
v/s Ratio Perm												
v/c Ratio	1.03	1.04	0.80		0.76	0.06	1.07	0.77		0.64	0.98	0.80
Uniform Delay, d1	48.5	48.5	46.3		53.8	50.7	53.0	31.5		52.2	37.1	20.5
Progression Factor	1.00	1.00	1.00		1.00	1.00	1.26	0.52		0.97	1.09	1.25
Incremental Delay, d2	57.5	59.7	14.8		29.8	0.8	53.8	1.7		1.1	6.7	1.4
Delay (s)	106.0	108.2	61.2		83.6	51.5	120.3	18.1		51.8	47.0	27.0
Level of Service	F	F	E		F	D	F	B		D	D	C
Approach Delay (s)		88.8			69.5			40.4			41.7	
Approach LOS		F			E			D			D	

Intersection Summary			
HCM 2000 Control Delay	50.9	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.98		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	28.0
Intersection Capacity Utilization	87.6%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	0	1310	1330	0	1005	1135
Future Volume (vph)	0	1310	1330	0	1005	1135
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	12	16	12
Total Lost time (s)		6.0	6.0		6.0	6.0
Lane Util. Factor		0.95	0.95		1.00	0.88
Frt		1.00	1.00		1.00	0.85
Flt Protected		1.00	1.00		0.95	1.00
Satd. Flow (prot)		3471	3406		1930	2682
Flt Permitted		1.00	1.00		0.95	1.00
Satd. Flow (perm)		3471	3406		1930	2682
Peak-hour factor, PHF	0.93	0.93	0.88	0.88	0.89	0.89
Adj. Flow (vph)	0	1409	1511	0	1129	1275
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	0	1409	1511	0	1129	1275
Heavy Vehicles (%)	4%	4%	6%	6%	6%	6%
Turn Type		NA	NA		Prot	Prot
Protected Phases		2	6		4	4
Permitted Phases						
Actuated Green, G (s)		48.0	48.0		60.0	60.0
Effective Green, g (s)		48.0	48.0		60.0	60.0
Actuated g/C Ratio		0.40	0.40		0.50	0.50
Clearance Time (s)		6.0	6.0		6.0	6.0
Vehicle Extension (s)		3.0	3.0		3.0	3.0
Lane Grp Cap (vph)		1388	1362		965	1341
v/s Ratio Prot		0.41	c0.44		c0.59	0.48
v/s Ratio Perm						
v/c Ratio		1.02	1.11		1.17	0.95
Uniform Delay, d1		36.0	36.0		30.0	28.6
Progression Factor		0.59	0.05		1.00	1.00
Incremental Delay, d2		21.8	50.4		87.7	14.4
Delay (s)		43.0	52.2		117.7	43.0
Level of Service		D	D		F	D
Approach Delay (s)		43.0	52.2		78.1	
Approach LOS		D	D		E	

Intersection Summary			
HCM 2000 Control Delay	61.5	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.14		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	104.4%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

Movement	NBL2	NBL	NBR	SEL	SER	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations											
Traffic Volume (vph)	1250	0	1105	0	0	985	1330	0	0	570	795
Future Volume (vph)	1250	0	1105	0	0	985	1330	0	0	570	795
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0		6.0			6.0	6.0			6.0	4.0
Lane Util. Factor	0.97		0.88			0.97	0.95			0.95	1.00
Frt	1.00		0.85			1.00	1.00			1.00	0.85
Flt Protected	0.95		1.00			0.95	1.00			1.00	1.00
Satd. Flow (prot)	3242		2632			3335	3438			3505	1568
Flt Permitted	0.95		1.00			0.95	1.00			1.00	1.00
Satd. Flow (perm)	3242		2632			3335	3438			3505	1568
Peak-hour factor, PHF	0.88	0.88	0.88	0.92	0.92	0.94	0.94	0.94	0.92	0.92	0.92
Adj. Flow (vph)	1420	0	1256	0	0	1048	1415	0	0	620	864
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	1420	0	1256	0	0	1048	1415	0	0	620	864
Heavy Vehicles (%)	8%	8%	8%	2%	2%	5%	5%	5%	3%	3%	3%
Turn Type	Prot		Prot			Prot	NA			NA	Free
Protected Phases	8		8			5	2			6	
Permitted Phases											Free
Actuated Green, G (s)	44.0		44.0			32.0	64.0			26.0	120.0
Effective Green, g (s)	44.0		44.0			32.0	64.0			26.0	120.0
Actuated g/C Ratio	0.37		0.37			0.27	0.53			0.22	1.00
Clearance Time (s)	6.0		6.0			6.0	6.0			6.0	
Vehicle Extension (s)	3.0		3.0			3.0	3.0			3.0	
Lane Grp Cap (vph)	1188		965			889	1833			759	1568
v/s Ratio Prot	0.44		c0.48			c0.31	c0.41			0.18	
v/s Ratio Perm											0.55
v/c Ratio	1.20		1.30			1.18	0.77			0.82	0.55
Uniform Delay, d1	38.0		38.0			44.0	22.2			44.7	0.0
Progression Factor	1.00		1.00			0.87	0.91			1.00	1.00
Incremental Delay, d2	96.3		143.3			81.7	0.3			9.5	1.4
Delay (s)	134.3		181.3			120.1	20.5			54.2	1.4
Level of Service	F		F			F	C			D	A
Approach Delay (s)		156.4		0.0			62.9			23.5	
Approach LOS		F		A			E			C	

Intersection Summary			
HCM 2000 Control Delay	91.8	HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio	1.15		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	95.5%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Volume (vph)	10	5	160	10	0	10	650	1440	120	10	1020	50
Future Volume (vph)	10	5	160	10	0	10	650	1440	120	10	1020	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0	6.0		6.0		6.0	6.0		6.0	6.0	
Lane Util. Factor		1.00	1.00		1.00		1.00	0.95		1.00	0.95	
Frt		1.00	0.85		0.93		1.00	0.99		1.00	0.99	
Flt Protected		0.97	1.00		0.98		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1801	1583		1729		1770	3498		1770	3515	
Flt Permitted		0.74	1.00		0.83		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1378	1583		1477		1770	3498		1770	3515	
Peak-hour factor, PHF	0.92	0.92	0.92	0.25	0.25	0.25	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	11	5	174	40	0	40	707	1565	130	11	1109	54
RTOR Reduction (vph)	0	0	106	0	76	0	0	3	0	0	2	0
Lane Group Flow (vph)	0	16	68	0	4	0	707	1692	0	11	1161	0
Heavy Vehicles (%)	2%	2%	2%	0%	0%	0%	2%	2%	2%	2%	2%	2%
Turn Type	Perm	NA	custom	Perm	NA		Prot	NA		Prot	NA	
Protected Phases		8			4		5	2		1	6	
Permitted Phases	8		6	4								
Actuated Green, G (s)		5.7	48.0		5.7		51.1	98.1		1.0	48.0	
Effective Green, g (s)		5.7	48.0		5.7		51.1	98.1		1.0	48.0	
Actuated g/C Ratio		0.05	0.39		0.05		0.42	0.80		0.01	0.39	
Clearance Time (s)		6.0	6.0		6.0		6.0	6.0		6.0	6.0	
Vehicle Extension (s)		3.0	3.0		3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		63	618		68		736	2794		14	1373	
v/s Ratio Prot							c0.40	0.48		0.01	c0.33	
v/s Ratio Perm		c0.01	0.04		0.00							
v/c Ratio		0.25	0.11		0.05		0.96	0.61		0.79	0.85	
Uniform Delay, d1		56.5	23.8		56.0		34.9	4.8		60.8	34.0	
Progression Factor		1.00	1.00		1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		2.1	0.1		0.3		23.8	0.4		130.6	5.0	
Delay (s)		58.6	23.9		56.3		58.7	5.2		191.4	39.0	
Level of Service		E	C		E		E	A		F	D	
Approach Delay (s)		26.8			56.3			20.9			40.4	
Approach LOS		C			E			C			D	

Intersection Summary			
HCM 2000 Control Delay	27.9	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.87		
Actuated Cycle Length (s)	122.8	Sum of lost time (s)	18.0
Intersection Capacity Utilization	92.4%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Volume (vph)	10	30	5	260	0	50	0	1020	220	15	555	0
Future Volume (vph)	10	30	5	260	0	50	0	1020	220	15	555	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0		6.0		4.5		6.0	6.0		6.0	
Lane Util. Factor		1.00		1.00		1.00		1.00	1.00		1.00	
Frt		0.99		1.00		0.85		1.00	0.85		1.00	
Flt Protected		0.99		0.95		1.00		1.00	1.00		1.00	
Satd. Flow (prot)		1815		1752		1568		1759	1495		1807	
Flt Permitted		0.99		0.80		1.00		1.00	1.00		0.72	
Satd. Flow (perm)		1815		1469		1568		1759	1495		1295	
Peak-hour factor, PHF	0.60	0.60	0.60	0.96	0.96	0.96	0.89	0.89	0.89	0.86	0.86	0.86
Adj. Flow (vph)	17	50	8	271	0	52	0	1146	247	17	645	0
RTOR Reduction (vph)	0	5	0	0	0	38	0	0	43	0	0	0
Lane Group Flow (vph)	0	70	0	271	0	14	0	1146	204	0	662	0
Heavy Vehicles (%)	2%	2%	2%	3%	3%	3%	8%	8%	8%	5%	5%	5%
Turn Type	Perm	NA		D.Pm		Perm		NA	Perm	Perm	NA	
Protected Phases		4						2			2	
Permitted Phases	4			4		8			2	2		
Actuated Green, G (s)		17.9		17.9		19.4		60.1	60.1		60.1	
Effective Green, g (s)		17.9		17.9		19.4		60.1	60.1		60.1	
Actuated g/C Ratio		0.20		0.20		0.22		0.67	0.67		0.67	
Clearance Time (s)		6.0		6.0		4.5		6.0	6.0		6.0	
Vehicle Extension (s)		3.0		3.0		3.0		3.0	3.0		3.0	
Lane Grp Cap (vph)		360		292		337		1174	998		864	
v/s Ratio Prot								c0.65				
v/s Ratio Perm		0.04		c0.18		0.01			0.14		0.51	
v/c Ratio		0.19		0.93		0.04		0.98	0.20		0.77	
Uniform Delay, d1		30.0		35.4		27.9		14.3	5.8		10.2	
Progression Factor		1.00		1.00		1.00		1.00	1.00		1.00	
Incremental Delay, d2		0.3		33.9		0.0		20.5	0.1		4.1	
Delay (s)		30.3		69.3		28.0		34.8	5.9		14.3	
Level of Service		C		E		C		C	A		B	
Approach Delay (s)		30.3			62.7			29.7			14.3	
Approach LOS		C			E			C			B	

Intersection Summary			
HCM 2000 Control Delay	29.9	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.96		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	86.1%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Interchange Justification Report
Appendix H
Synchro™ Build Condition NH 28 Intersection Analysis Reports

I-93 Exit 4A

Prepared for:

Town of Derry
Town of Londonderry
New Hampshire Department of Transportation

Prepared by:

CLD and Louis Berger

Version: 2
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NHDOT Project Number: 13065
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CLD/Towns Project Number 05-0244

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Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	272	826	18	16	1104	115	61	0	105	184	0	18
Future Volume (vph)	272	826	18	16	1104	115	61	0	105	184	0	18
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0		6.0	6.0	6.0		6.0	6.0	6.0	6.0	
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00		1.00	1.00	0.95	0.95	
Frt	1.00	1.00		1.00	1.00	0.85		1.00	0.85	1.00	0.97	
Flt Protected	0.95	1.00		0.95	1.00	1.00		0.95	1.00	0.95	0.96	
Satd. Flow (prot)	1583	3156		1687	3374	1509		1770	1583	1681	1653	
Flt Permitted	0.95	1.00		0.95	1.00	1.00		0.95	1.00	0.95	0.96	
Satd. Flow (perm)	1583	3156		1687	3374	1509		1770	1583	1681	1653	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	296	898	20	17	1200	125	66	0	114	200	0	20
RTOR Reduction (vph)	0	1	0	0	0	77	0	0	104	0	99	0
Lane Group Flow (vph)	296	917	0	17	1200	48	0	66	10	112	9	0
Heavy Vehicles (%)	14%	14%	14%	7%	7%	7%	2%	2%	2%	2%	2%	2%
Turn Type	Prot	NA		Prot	NA	Prot	Split	NA	Prot	Split	NA	
Protected Phases	5	2		1	6	6	3	3	3	4	4	
Permitted Phases												
Actuated Green, G (s)	15.1	46.2		1.9	33.0	33.0		7.4	7.4	7.0	7.0	
Effective Green, g (s)	15.1	46.2		1.9	33.0	33.0		7.4	7.4	7.0	7.0	
Actuated g/C Ratio	0.17	0.53		0.02	0.38	0.38		0.09	0.09	0.08	0.08	
Clearance Time (s)	6.0	6.0		6.0	6.0	6.0		6.0	6.0	6.0	6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0		3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	276	1685		37	1287	575		151	135	136	133	
v/s Ratio Prot	c0.19	0.29		0.01	c0.36	0.03		c0.04	0.01	c0.07	0.01	
v/s Ratio Perm												
v/c Ratio	1.07	0.54		0.46	0.93	0.08		0.44	0.07	0.82	0.07	
Uniform Delay, d1	35.7	13.2		41.8	25.7	17.1		37.6	36.4	39.1	36.7	
Progression Factor	1.00	1.00		1.00	1.00	1.00		1.00	1.00	1.00	1.00	
Incremental Delay, d2	74.7	0.4		8.8	12.2	0.1		2.0	0.2	31.5	0.2	
Delay (s)	110.4	13.6		50.6	37.9	17.1		39.6	36.6	70.6	36.9	
Level of Service	F	B		D	D	B		D	D	E	D	
Approach Delay (s)		37.2			36.1			37.7			54.1	
Approach LOS		D			D			D			D	

Intersection Summary			
HCM 2000 Control Delay	38.0	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.89		
Actuated Cycle Length (s)	86.5	Sum of lost time (s)	24.0
Intersection Capacity Utilization	72.9%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	660	455	420	790	0	0	0	0	180	0	445
Future Volume (vph)	0	660	455	420	790	0	0	0	0	180	0	445
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0	4.0	6.0	6.0					6.0		6.0
Lane Util. Factor		0.95	1.00	1.00	0.95					0.97		1.00
Frt		1.00	0.85	1.00	1.00					1.00		0.85
Flt Protected		1.00	1.00	0.95	1.00					0.95		1.00
Satd. Flow (prot)		3167	1417	1687	3374					3303		1524
Flt Permitted		1.00	1.00	0.95	1.00					0.95		1.00
Satd. Flow (perm)		3167	1417	1687	3374					3303		1524
Peak-hour factor, PHF	0.92	0.92	0.92	0.73	0.73	0.73	0.92	0.92	0.92	0.74	0.74	0.74
Adj. Flow (vph)	0	717	495	575	1082	0	0	0	0	243	0	601
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	72
Lane Group Flow (vph)	0	717	495	575	1082	0	0	0	0	243	0	529
Heavy Vehicles (%)	14%	14%	14%	7%	7%	7%	2%	2%	2%	6%	6%	6%
Turn Type		NA	Free	Prot	NA					Prot		Prot
Protected Phases		2		1	6					4		4
Permitted Phases			Free									
Actuated Green, G (s)		31.0	130.0	42.0	79.0					39.0		39.0
Effective Green, g (s)		31.0	130.0	42.0	79.0					39.0		39.0
Actuated g/C Ratio		0.24	1.00	0.32	0.61					0.30		0.30
Clearance Time (s)		6.0		6.0	6.0					6.0		6.0
Vehicle Extension (s)		5.0		3.0	5.0					3.0		3.0
Lane Grp Cap (vph)		755	1417	545	2050					990		457
v/s Ratio Prot		c0.23		c0.34	0.32					0.07		c0.35
v/s Ratio Perm			0.35									
v/c Ratio		0.95	0.35	1.06	0.53					0.25		1.16
Uniform Delay, d1		48.7	0.0	44.0	14.7					34.4		45.5
Progression Factor		1.00	1.00	0.39	0.09					1.00		1.00
Incremental Delay, d2		22.5	0.7	49.0	0.4					0.1		92.9
Delay (s)		71.3	0.7	66.0	1.8					34.5		138.4
Level of Service		E	A	E	A					C		F
Approach Delay (s)		42.4			24.1			0.0			108.5	
Approach LOS		D			C			A			F	

Intersection Summary			
HCM 2000 Control Delay	49.3	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	1.06		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	86.0%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	505	335	0	0	740	630	470	0	180	0	0	0
Future Volume (vph)	505	335	0	0	740	630	470	0	180	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0			6.0	4.0	6.0		6.0			
Lane Util. Factor	1.00	0.95			0.95	1.00	1.00		1.00			
Frt	1.00	1.00			1.00	0.85	1.00		0.85			
Flt Protected	0.95	1.00			1.00	1.00	0.95		1.00			
Satd. Flow (prot)	1641	3282			3438	1538	1656		1482			
Flt Permitted	0.95	1.00			1.00	1.00	0.95		1.00			
Satd. Flow (perm)	1641	3282			3438	1538	1656		1482			
Peak-hour factor, PHF	0.87	0.87	0.87	0.90	0.90	0.90	0.78	0.78	0.78	0.92	0.92	0.92
Adj. Flow (vph)	580	385	0	0	822	700	603	0	231	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	116	0	0	0
Lane Group Flow (vph)	580	385	0	0	822	700	603	0	115	0	0	0
Heavy Vehicles (%)	10%	10%	10%	5%	5%	5%	9%	9%	9%	2%	2%	2%
Turn Type	Prot	NA			NA	Free	Prot		Prot			
Protected Phases	5	2			6		8		8			
Permitted Phases		2			6	Free						
Actuated Green, G (s)	41.0	76.0			29.0	130.0	42.0		42.0			
Effective Green, g (s)	41.0	76.0			29.0	130.0	42.0		42.0			
Actuated g/C Ratio	0.32	0.58			0.22	1.00	0.32		0.32			
Clearance Time (s)	6.0	6.0			6.0		6.0		6.0			
Vehicle Extension (s)	5.0	5.0			5.0		3.0		3.0			
Lane Grp Cap (vph)	517	1918			766	1538	535		478			
v/s Ratio Prot	c0.35	0.12			c0.24		c0.36		0.08			
v/s Ratio Perm						0.46						
v/c Ratio	1.12	0.20			1.07	0.46	1.13		0.24			
Uniform Delay, d1	44.5	12.7			50.5	0.0	44.0		32.3			
Progression Factor	0.14	0.01			1.00	1.00	1.00		1.00			
Incremental Delay, d2	64.7	0.2			53.9	1.0	78.8		0.3			
Delay (s)	70.9	0.3			104.4	1.0	122.8		32.5			
Level of Service	E	A			F	A	F		C			
Approach Delay (s)		42.7			56.9			97.8			0.0	
Approach LOS		D			E			F			A	

Intersection Summary			
HCM 2000 Control Delay	63.0	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.11		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	86.0%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	5	0	0	6	0	52	5	971	31	37	168	0
Future Volume (vph)	5	0	0	6	0	52	5	971	31	37	168	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0				6.0	6.0	6.0	6.0		6.0	6.0	
Lane Util. Factor	1.00				1.00	1.00	1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00				1.00	0.97	1.00	1.00		1.00	1.00	
Flpb, ped/bikes	1.00				1.00	1.00	1.00	1.00		1.00	1.00	
Frt	1.00				1.00	0.85	1.00	1.00		1.00	1.00	
Flt Protected	0.95				0.95	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770				1253	1090	1752	3489		1626	3252	
Flt Permitted	0.75				0.76	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1402				999	1090	1752	3489		1626	3252	
Peak-hour factor, PHF	0.92	0.92	0.92	0.71	0.71	0.71	0.86	0.86	0.86	0.92	0.92	0.92
Adj. Flow (vph)	5	0	0	8	0	73	6	1129	36	40	183	0
RTOR Reduction (vph)	0	0	0	0	0	68	0	2	0	0	0	0
Lane Group Flow (vph)	5	0	0	0	8	5	6	1163	0	40	183	0
Confl. Bikes (#/hr)						5						
Heavy Vehicles (%)	2%	2%	2%	44%	44%	44%	3%	3%	3%	11%	11%	11%
Turn Type	Perm			Perm	NA	Perm	Prot	NA		Prot	NA	
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4			8		8						
Actuated Green, G (s)	5.4				5.4	5.4	1.0	52.4		4.1	55.5	
Effective Green, g (s)	5.4				5.4	5.4	1.0	52.4		4.1	55.5	
Actuated g/C Ratio	0.07				0.07	0.07	0.01	0.66		0.05	0.69	
Clearance Time (s)	6.0				6.0	6.0	6.0	6.0		6.0	6.0	
Vehicle Extension (s)	3.0				3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	94				67	73	21	2288		83	2258	
v/s Ratio Prot							0.00	c0.33		c0.02	c0.06	
v/s Ratio Perm	0.00				c0.01	0.00						
v/c Ratio	0.05				0.12	0.07	0.29	0.51		0.48	0.08	
Uniform Delay, d1	34.9				35.0	34.9	39.1	7.1		36.9	3.9	
Progression Factor	1.00				1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.2				0.8	0.4	7.4	0.2		4.4	0.0	
Delay (s)	35.1				35.8	35.3	46.5	7.3		41.2	4.0	
Level of Service	D				D	D	D	A		D	A	
Approach Delay (s)		35.1			35.3			7.5			10.6	
Approach LOS		D			D			A			B	

Intersection Summary			
HCM 2000 Control Delay	9.6	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.47		
Actuated Cycle Length (s)	79.9	Sum of lost time (s)	18.0
Intersection Capacity Utilization	54.5%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	30	961	30	128	958	49	59	10	30	244	10	257
Future Volume (vph)	30	961	30	128	958	49	59	10	30	244	10	257
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0		6.0	6.0	6.0		6.0	6.0	6.0	6.0	
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00		1.00	1.00	0.95	0.95	
Frt	1.00	1.00		1.00	1.00	0.85		1.00	0.85	1.00	0.87	
Flt Protected	0.95	1.00		0.95	1.00	1.00		0.96	1.00	0.95	1.00	
Satd. Flow (prot)	1736	3456		1719	3438	1538		1787	1583	1681	1529	
Flt Permitted	0.95	1.00		0.95	1.00	1.00		0.96	1.00	0.95	1.00	
Satd. Flow (perm)	1736	3456		1719	3438	1538		1787	1583	1681	1529	
Peak-hour factor, PHF	0.87	0.87	0.87	0.86	0.86	0.86	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	34	1105	34	149	1114	57	64	11	33	265	11	279
RTOR Reduction (vph)	0	2	0	0	0	32	0	0	30	0	236	0
Lane Group Flow (vph)	34	1137	0	149	1114	25	0	75	3	238	81	0
Heavy Vehicles (%)	4%	4%	4%	5%	5%	5%	2%	2%	2%	2%	2%	2%
Turn Type	Prot	NA		Prot	NA	Prot	Split	NA	Prot	Split	NA	
Protected Phases	5	2		1	6	6	3	3	3	4	4	
Permitted Phases												
Actuated Green, G (s)	2.9	32.8		8.1	38.0	38.0		7.5	7.5	13.1	13.1	
Effective Green, g (s)	2.9	32.8		8.1	38.0	38.0		7.5	7.5	13.1	13.1	
Actuated g/C Ratio	0.03	0.38		0.09	0.44	0.44		0.09	0.09	0.15	0.15	
Clearance Time (s)	6.0	6.0		6.0	6.0	6.0		6.0	6.0	6.0	6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0		3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	58	1325		162	1528	683		156	138	257	234	
v/s Ratio Prot	0.02	c0.33		c0.09	c0.32	0.02		c0.04	0.00	c0.14	0.05	
v/s Ratio Perm												
v/c Ratio	0.59	0.86		0.92	0.73	0.04		0.48	0.02	0.93	0.35	
Uniform Delay, d1	40.7	24.2		38.4	19.5	13.4		37.1	35.6	35.7	32.4	
Progression Factor	1.00	1.00		1.00	1.00	1.00		1.00	1.00	1.00	1.00	
Incremental Delay, d2	14.2	5.7		47.2	1.8	0.0		2.3	0.1	36.5	0.9	
Delay (s)	54.9	29.9		85.6	21.3	13.4		39.5	35.7	72.2	33.3	
Level of Service	D	C		F	C	B		D	D	E	C	
Approach Delay (s)		30.6			28.2			38.3			50.0	
Approach LOS		C			C			D			D	

Intersection Summary			
HCM 2000 Control Delay	33.3	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.84		
Actuated Cycle Length (s)	85.5	Sum of lost time (s)	24.0
Intersection Capacity Utilization	75.3%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	755	480	255	665	0	0	0	0	295	0	470
Future Volume (vph)	0	755	480	255	665	0	0	0	0	295	0	470
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0	4.0	6.0	6.0					6.0		6.0
Lane Util. Factor		0.95	1.00	1.00	0.95					0.97		1.00
Frt		1.00	0.85	1.00	1.00					1.00		0.85
Flt Protected		1.00	1.00	0.95	1.00					0.95		1.00
Satd. Flow (prot)		3471	1553	1719	3438					3367		1553
Flt Permitted		1.00	1.00	0.95	1.00					0.95		1.00
Satd. Flow (perm)		3471	1553	1719	3438					3367		1553
Peak-hour factor, PHF	0.87	0.87	0.87	0.86	0.86	0.86	0.92	0.92	0.92	0.91	0.91	0.91
Adj. Flow (vph)	0	868	552	297	773	0	0	0	0	324	0	516
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	137
Lane Group Flow (vph)	0	868	552	297	773	0	0	0	0	324	0	379
Heavy Vehicles (%)	4%	4%	4%	5%	5%	5%	2%	2%	2%	4%	4%	4%
Turn Type		NA	Free	Prot	NA					Prot		Prot
Protected Phases		2		1	6					4		4
Permitted Phases			Free									
Actuated Green, G (s)		29.1	90.0	18.1	53.2					24.8		24.8
Effective Green, g (s)		29.1	90.0	18.1	53.2					24.8		24.8
Actuated g/C Ratio		0.32	1.00	0.20	0.59					0.28		0.28
Clearance Time (s)		6.0		6.0	6.0					6.0		6.0
Vehicle Extension (s)		5.0		3.0	5.0					3.0		3.0
Lane Grp Cap (vph)		1122	1553	345	2032					927		427
v/s Ratio Prot		c0.25		c0.17	0.22					0.10		c0.24
v/s Ratio Perm			0.36									
v/c Ratio		0.77	0.36	0.86	0.38					0.35		0.89
Uniform Delay, d1		27.5	0.0	34.7	9.7					26.1		31.3
Progression Factor		1.00	1.00	0.04	0.00					1.00		1.00
Incremental Delay, d2		5.2	0.6	10.1	0.2					0.2		19.5
Delay (s)		32.7	0.6	11.6	0.2					26.4		50.7
Level of Service		C	A	B	A					C		D
Approach Delay (s)		20.2			3.3			0.0			41.3	
Approach LOS		C			A			A			D	

Intersection Summary			
HCM 2000 Control Delay	20.1	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.83		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	77.2%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	480	570	0	0	555	445	365	0	420	0	0	0
Future Volume (vph)	480	570	0	0	555	445	365	0	420	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0			6.0	4.0	6.0		6.0			
Lane Util. Factor	1.00	0.95			0.95	1.00	1.00		1.00			
Frt	1.00	1.00			1.00	0.85	1.00		0.85			
Flt Protected	0.95	1.00			1.00	1.00	0.95		1.00			
Satd. Flow (prot)	1752	3505			3505	1568	1703		1524			
Flt Permitted	0.95	1.00			1.00	1.00	0.95		1.00			
Satd. Flow (perm)	1752	3505			3505	1568	1703		1524			
Peak-hour factor, PHF	0.92	0.92	0.92	0.91	0.91	0.91	0.67	0.67	0.67	0.92	0.92	0.92
Adj. Flow (vph)	522	620	0	0	610	489	545	0	627	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	176	0	0	0
Lane Group Flow (vph)	522	620	0	0	610	489	545	0	451	0	0	0
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	6%	6%	6%	2%	2%	2%
Turn Type	Prot	NA			NA	Free	Prot		Prot			
Protected Phases	5	2			6		8		8			
Permitted Phases		2			6	Free						
Actuated Green, G (s)	26.0	50.0			18.0	90.0	28.0		28.0			
Effective Green, g (s)	26.0	50.0			18.0	90.0	28.0		28.0			
Actuated g/C Ratio	0.29	0.56			0.20	1.00	0.31		0.31			
Clearance Time (s)	6.0	6.0			6.0		6.0		6.0			
Vehicle Extension (s)	5.0	5.0			5.0		3.0		3.0			
Lane Grp Cap (vph)	506	1947			701	1568	529		474			
v/s Ratio Prot	c0.30	0.18			c0.17		c0.32		0.30			
v/s Ratio Perm						0.31						
v/c Ratio	1.03	0.32			0.87	0.31	1.03		0.95			
Uniform Delay, d1	32.0	10.8			34.9	0.0	31.0		30.3			
Progression Factor	0.10	0.17			1.00	1.00	1.00		1.00			
Incremental Delay, d2	39.7	0.4			13.9	0.5	47.1		29.4			
Delay (s)	42.8	2.2			48.8	0.5	78.1		59.7			
Level of Service	D	A			D	A	E		E			
Approach Delay (s)		20.7			27.3			68.3			0.0	
Approach LOS		C			C			E			A	

Intersection Summary			
HCM 2000 Control Delay	39.2	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.99		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	77.2%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	25	0	0	12	0	85	5	376	3	25	495	0
Future Volume (vph)	25	0	0	12	0	85	5	376	3	25	495	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0				6.0	6.0	6.0	6.0		6.0	6.0	
Lane Util. Factor	1.00				1.00	1.00	1.00	0.95		1.00	0.95	
Frt	1.00				1.00	0.85	1.00	1.00		1.00	1.00	
Flt Protected	0.95				0.95	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770				1577	1568	1752	3501		1719	3438	
Flt Permitted	0.74				0.76	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1385				1257	1568	1752	3501		1719	3438	
Peak-hour factor, PHF	0.92	0.92	0.92	0.58	0.58	0.58	0.86	0.86	0.86	0.91	0.91	0.91
Adj. Flow (vph)	27	0	0	21	0	147	6	437	3	27	544	0
RTOR Reduction (vph)	0	0	0	0	0	126	0	1	0	0	0	0
Lane Group Flow (vph)	27	0	0	0	21	21	6	439	0	27	544	0
Heavy Vehicles (%)	2%	2%	2%	3%	3%	3%	3%	3%	3%	5%	5%	5%
Parking (#/hr)					0							
Turn Type	Perm			Perm	NA	Prot	Prot	NA		Prot	NA	
Protected Phases		4			8	8	5	2		1	6	
Permitted Phases	4			8								
Actuated Green, G (s)	6.2				6.2	6.2	0.8	18.4		1.0	18.6	
Effective Green, g (s)	6.2				6.2	6.2	0.8	18.4		1.0	18.6	
Actuated g/C Ratio	0.14				0.14	0.14	0.02	0.42		0.02	0.43	
Clearance Time (s)	6.0				6.0	6.0	6.0	6.0		6.0	6.0	
Vehicle Extension (s)	3.0				3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	196				178	222	32	1477		39	1466	
v/s Ratio Prot						0.01	0.00	0.13		c0.02	c0.16	
v/s Ratio Perm	c0.02				0.02							
v/c Ratio	0.14				0.12	0.09	0.19	0.30		0.69	0.37	
Uniform Delay, d1	16.4				16.3	16.3	21.1	8.3		21.1	8.5	
Progression Factor	1.00				1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.3				0.3	0.2	2.8	0.1		41.8	0.2	
Delay (s)	16.7				16.6	16.4	23.9	8.4		62.9	8.7	
Level of Service	B				B	B	C	A		E	A	
Approach Delay (s)		16.7			16.5			8.6			11.2	
Approach LOS		B			B			A			B	

Intersection Summary			
HCM 2000 Control Delay	11.1	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.33		
Actuated Cycle Length (s)	43.6	Sum of lost time (s)	18.0
Intersection Capacity Utilization	38.8%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	271	821	17	15	997	103	61	0	105	184	0	17
Future Volume (vph)	271	821	17	15	997	103	61	0	105	184	0	17
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0		6.0	6.0	6.0		6.0	6.0	6.0	6.0	
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00		1.00	1.00	0.95	0.95	
Frt	1.00	1.00		1.00	1.00	0.85		1.00	0.85	1.00	0.97	
Flt Protected	0.95	1.00		0.95	1.00	1.00		0.95	1.00	0.95	0.96	
Satd. Flow (prot)	1583	3157		1687	3374	1509		1770	1583	1681	1656	
Flt Permitted	0.95	1.00		0.95	1.00	1.00		0.95	1.00	0.95	0.96	
Satd. Flow (perm)	1583	3157		1687	3374	1509		1770	1583	1681	1656	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	295	892	18	16	1084	112	66	0	114	200	0	18
RTOR Reduction (vph)	0	1	0	0	0	70	0	0	104	0	99	0
Lane Group Flow (vph)	295	909	0	16	1084	42	0	66	10	110	9	0
Heavy Vehicles (%)	14%	14%	14%	7%	7%	7%	2%	2%	2%	2%	2%	2%
Turn Type	Prot	NA		Prot	NA	Prot	Split	NA	Prot	Split	NA	
Protected Phases	5	2		1	6	6	3	3	3	4	4	
Permitted Phases												
Actuated Green, G (s)	16.1	48.3		0.9	33.1	33.1		7.4	7.4	7.0	7.0	
Effective Green, g (s)	16.1	48.3		0.9	33.1	33.1		7.4	7.4	7.0	7.0	
Actuated g/C Ratio	0.18	0.55		0.01	0.38	0.38		0.08	0.08	0.08	0.08	
Clearance Time (s)	6.0	6.0		6.0	6.0	6.0		6.0	6.0	6.0	6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0		3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	290	1740		17	1274	570		149	133	134	132	
v/s Ratio Prot	c0.19	0.29		0.01	c0.32	0.03		c0.04	0.01	c0.07	0.01	
v/s Ratio Perm												
v/c Ratio	1.02	0.52		0.94	0.85	0.07		0.44	0.07	0.82	0.07	
Uniform Delay, d1	35.8	12.4		43.3	25.0	17.4		38.1	36.9	39.7	37.3	
Progression Factor	1.00	1.00		1.00	1.00	1.00		1.00	1.00	1.00	1.00	
Incremental Delay, d2	57.3	0.3		188.5	5.7	0.1		2.1	0.2	31.5	0.2	
Delay (s)	93.1	12.7		231.9	30.6	17.5		40.2	37.2	71.2	37.5	
Level of Service	F	B		F	C	B		D	D	E	D	
Approach Delay (s)		32.4			32.1			38.3			54.5	
Approach LOS		C			C			D			D	

Intersection Summary			
HCM 2000 Control Delay	34.3	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.84		
Actuated Cycle Length (s)	87.6	Sum of lost time (s)	24.0
Intersection Capacity Utilization	69.9%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	690	420	260	730	0	0	0	0	105	0	385
Future Volume (vph)	0	690	420	260	730	0	0	0	0	105	0	385
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0	4.0	6.0	6.0					6.0		6.0
Lane Util. Factor		0.95	1.00	1.00	0.95					0.97		1.00
Frt		1.00	0.85	1.00	1.00					1.00		0.85
Flt Protected		1.00	1.00	0.95	1.00					0.95		1.00
Satd. Flow (prot)		3167	1417	1687	3374					3303		1524
Flt Permitted		1.00	1.00	0.95	1.00					0.95		1.00
Satd. Flow (perm)		3167	1417	1687	3374					3303		1524
Peak-hour factor, PHF	0.92	0.92	0.92	0.73	0.73	0.73	0.92	0.92	0.92	0.74	0.74	0.74
Adj. Flow (vph)	0	750	457	356	1000	0	0	0	0	142	0	520
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	75
Lane Group Flow (vph)	0	750	457	356	1000	0	0	0	0	142	0	445
Heavy Vehicles (%)	14%	14%	14%	7%	7%	7%	2%	2%	2%	6%	6%	6%
Turn Type		NA	Free	Prot	NA					Prot		Prot
Protected Phases		2		1	6					4		4
Permitted Phases			Free									
Actuated Green, G (s)		40.3	130.0	30.7	77.0					41.0		41.0
Effective Green, g (s)		40.3	130.0	30.7	77.0					41.0		41.0
Actuated g/C Ratio		0.31	1.00	0.24	0.59					0.32		0.32
Clearance Time (s)		6.0		6.0	6.0					6.0		6.0
Vehicle Extension (s)		5.0		3.0	5.0					3.0		3.0
Lane Grp Cap (vph)		981	1417	398	1998					1041		480
v/s Ratio Prot		c0.24		c0.21	0.30					0.04		c0.29
v/s Ratio Perm			0.32									
v/c Ratio		0.76	0.32	0.89	0.50					0.14		0.93
Uniform Delay, d1		40.6	0.0	48.1	15.4					31.8		43.0
Progression Factor		1.00	1.00	0.38	0.15					1.00		1.00
Incremental Delay, d2		5.7	0.6	18.4	0.5					0.1		23.9
Delay (s)		46.2	0.6	36.9	2.7					31.9		67.0
Level of Service		D	A	D	A					C		E
Approach Delay (s)		28.9			11.7			0.0			59.4	
Approach LOS		C			B			A			E	

Intersection Summary			
HCM 2000 Control Delay	28.0	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.86		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	76.3%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	525	270	0	0	545	570	445	0	165	0	0	0
Future Volume (vph)	525	270	0	0	545	570	445	0	165	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0			6.0	4.0	6.0		6.0			
Lane Util. Factor	1.00	0.95			0.95	1.00	1.00		1.00			
Frt	1.00	1.00			1.00	0.85	1.00		0.85			
Flt Protected	0.95	1.00			1.00	1.00	0.95		1.00			
Satd. Flow (prot)	1641	3282			3438	1538	1656		1482			
Flt Permitted	0.95	1.00			1.00	1.00	0.95		1.00			
Satd. Flow (perm)	1641	3282			3438	1538	1656		1482			
Peak-hour factor, PHF	0.87	0.87	0.87	0.90	0.90	0.90	0.78	0.78	0.78	0.92	0.92	0.92
Adj. Flow (vph)	603	310	0	0	606	633	571	0	212	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	113	0	0	0
Lane Group Flow (vph)	603	310	0	0	606	633	571	0	99	0	0	0
Heavy Vehicles (%)	10%	10%	10%	5%	5%	5%	9%	9%	9%	2%	2%	2%
Turn Type	Prot	NA			NA	Free	Prot		Prot			
Protected Phases	5	2			6		8		8			
Permitted Phases		2			6	Free						
Actuated Green, G (s)	46.0	75.0			23.0	130.0	43.0		43.0			
Effective Green, g (s)	46.0	75.0			23.0	130.0	43.0		43.0			
Actuated g/C Ratio	0.35	0.58			0.18	1.00	0.33		0.33			
Clearance Time (s)	6.0	6.0			6.0		6.0		6.0			
Vehicle Extension (s)	5.0	5.0			5.0		3.0		3.0			
Lane Grp Cap (vph)	580	1893			608	1538	547		490			
v/s Ratio Prot	c0.37	0.09			c0.18		c0.34		0.07			
v/s Ratio Perm						0.41						
v/c Ratio	1.04	0.16			1.00	0.41	1.04		0.20			
Uniform Delay, d1	42.0	12.8			53.5	0.0	43.5		31.2			
Progression Factor	0.26	0.20			1.00	1.00	1.00		1.00			
Incremental Delay, d2	41.6	0.2			35.7	0.8	50.4		0.2			
Delay (s)	52.6	2.7			89.2	0.8	93.9		31.4			
Level of Service	D	A			F	A	F		C			
Approach Delay (s)		35.7			44.0			77.0			0.0	
Approach LOS		D			D			E			A	

Intersection Summary			
HCM 2000 Control Delay	50.2	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	1.03		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	76.3%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	5	0	0	5	0	42	5	789	26	31	142	0
Future Volume (vph)	5	0	0	5	0	42	5	789	26	31	142	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0				6.0	6.0	6.0	6.0		6.0	6.0	
Lane Util. Factor	1.00				1.00	1.00	1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00				1.00	0.97	1.00	1.00		1.00	1.00	
Flpb, ped/bikes	1.00				1.00	1.00	1.00	1.00		1.00	1.00	
Frt	1.00				1.00	0.85	1.00	1.00		1.00	1.00	
Flt Protected	0.95				0.95	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770				1253	1086	1752	3488		1626	3252	
Flt Permitted	1.00				1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1863				1319	1086	1752	3488		1626	3252	
Peak-hour factor, PHF	0.92	0.92	0.92	0.71	0.71	0.71	0.86	0.86	0.86	0.92	0.92	0.92
Adj. Flow (vph)	5	0	0	7	0	59	6	917	30	34	154	0
RTOR Reduction (vph)	0	0	0	0	0	56	0	2	0	0	0	0
Lane Group Flow (vph)	5	0	0	0	7	3	6	945	0	34	154	0
Confl. Bikes (#/hr)						5						
Heavy Vehicles (%)	2%	2%	2%	44%	44%	44%	3%	3%	3%	11%	11%	11%
Turn Type	Perm			Perm	NA	Perm	Prot	NA		Prot	NA	
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4			8		8						
Actuated Green, G (s)	3.7				3.7	3.7	1.0	42.6		2.6	44.2	
Effective Green, g (s)	3.7				3.7	3.7	1.0	42.6		2.6	44.2	
Actuated g/C Ratio	0.06				0.06	0.06	0.01	0.64		0.04	0.66	
Clearance Time (s)	6.0				6.0	6.0	6.0	6.0		6.0	6.0	
Vehicle Extension (s)	3.0				3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	103				72	60	26	2221		63	2148	
v/s Ratio Prot							0.00	c0.27		c0.02	0.05	
v/s Ratio Perm	0.00				c0.01	0.00						
v/c Ratio	0.05				0.10	0.05	0.23	0.43		0.54	0.07	
Uniform Delay, d1	29.9				30.0	29.9	32.6	6.1		31.6	4.0	
Progression Factor	1.00				1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.2				0.6	0.4	4.5	0.1		8.6	0.0	
Delay (s)	30.1				30.6	30.3	37.1	6.2		40.2	4.1	
Level of Service	C				C	C	D	A		D	A	
Approach Delay (s)		30.1			30.4			6.4			10.6	
Approach LOS		C			C			A			B	

Intersection Summary			
HCM 2000 Control Delay	8.4	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.41		
Actuated Cycle Length (s)	66.9	Sum of lost time (s)	18.0
Intersection Capacity Utilization	49.3%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	27	941	27	117	873	45	54	9	30	239	9	234
Future Volume (vph)	27	941	27	117	873	45	54	9	30	239	9	234
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0		6.0	6.0	6.0		6.0	6.0	6.0	6.0	
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00		1.00	1.00	0.95	0.95	
Frt	1.00	1.00		1.00	1.00	0.85		1.00	0.85	1.00	0.87	
Flt Protected	0.95	1.00		0.95	1.00	1.00		0.96	1.00	0.95	1.00	
Satd. Flow (prot)	1736	3457		1719	3438	1538		1786	1583	1681	1530	
Flt Permitted	0.95	1.00		0.95	1.00	1.00		0.96	1.00	0.95	1.00	
Satd. Flow (perm)	1736	3457		1719	3438	1538		1786	1583	1681	1530	
Peak-hour factor, PHF	0.87	0.87	0.87	0.86	0.86	0.86	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	31	1082	31	136	1015	52	59	10	33	260	10	254
RTOR Reduction (vph)	0	2	0	0	0	29	0	0	30	0	215	0
Lane Group Flow (vph)	31	1111	0	136	1015	23	0	69	3	234	75	0
Heavy Vehicles (%)	4%	4%	4%	5%	5%	5%	2%	2%	2%	2%	2%	2%
Turn Type	Prot	NA		Prot	NA	Prot	Split	NA	Prot	Split	NA	
Protected Phases	5	2		1	6	6	3	3	3	4	4	
Permitted Phases												
Actuated Green, G (s)	2.9	32.8		8.1	38.0	38.0		7.3	7.3	13.1	13.1	
Effective Green, g (s)	2.9	32.8		8.1	38.0	38.0		7.3	7.3	13.1	13.1	
Actuated g/C Ratio	0.03	0.38		0.09	0.45	0.45		0.09	0.09	0.15	0.15	
Clearance Time (s)	6.0	6.0		6.0	6.0	6.0		6.0	6.0	6.0	6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0		3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	59	1329		163	1531	685		152	135	258	234	
v/s Ratio Prot	0.02	c0.32		c0.08	c0.30	0.02		c0.04	0.00	c0.14	0.05	
v/s Ratio Perm												
v/c Ratio	0.53	0.84		0.83	0.66	0.03		0.45	0.02	0.91	0.32	
Uniform Delay, d1	40.5	23.8		37.9	18.6	13.3		37.1	35.7	35.5	32.1	
Progression Factor	1.00	1.00		1.00	1.00	1.00		1.00	1.00	1.00	1.00	
Incremental Delay, d2	8.2	4.7		29.1	1.1	0.0		2.1	0.1	32.3	0.8	
Delay (s)	48.7	28.5		67.1	19.7	13.3		39.3	35.8	67.8	32.9	
Level of Service	D	C		E	B	B		D	D	E	C	
Approach Delay (s)		29.1			24.8			38.1			48.5	
Approach LOS		C			C			D			D	

Intersection Summary			
HCM 2000 Control Delay	31.1	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.81		
Actuated Cycle Length (s)	85.3	Sum of lost time (s)	24.0
Intersection Capacity Utilization	73.2%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	790	420	150	610	0	0	0	0	175	0	425
Future Volume (vph)	0	790	420	150	610	0	0	0	0	175	0	425
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0	4.0	6.0	6.0					6.0		6.0
Lane Util. Factor		0.95	1.00	1.00	0.95					0.97		1.00
Frt		1.00	0.85	1.00	1.00					1.00		0.85
Flt Protected		1.00	1.00	0.95	1.00					0.95		1.00
Satd. Flow (prot)		3471	1553	1719	3438					3367		1553
Flt Permitted		1.00	1.00	0.95	1.00					0.95		1.00
Satd. Flow (perm)		3471	1553	1719	3438					3367		1553
Peak-hour factor, PHF	0.87	0.87	0.87	0.86	0.86	0.86	0.92	0.92	0.92	0.91	0.91	0.91
Adj. Flow (vph)	0	908	483	174	709	0	0	0	0	192	0	467
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	159
Lane Group Flow (vph)	0	908	483	174	709	0	0	0	0	192	0	308
Heavy Vehicles (%)	4%	4%	4%	5%	5%	5%	2%	2%	2%	4%	4%	4%
Turn Type		NA	Free	Prot	NA					Prot		Prot
Protected Phases		2		1	6					4		4
Permitted Phases			Free									
Actuated Green, G (s)		36.5	90.0	12.8	55.3					22.7		22.7
Effective Green, g (s)		36.5	90.0	12.8	55.3					22.7		22.7
Actuated g/C Ratio		0.41	1.00	0.14	0.61					0.25		0.25
Clearance Time (s)		6.0		6.0	6.0					6.0		6.0
Vehicle Extension (s)		5.0		3.0	5.0					3.0		3.0
Lane Grp Cap (vph)		1407	1553	244	2112					849		391
v/s Ratio Prot		c0.26		c0.10	0.21					0.06		c0.20
v/s Ratio Perm			0.31									
v/c Ratio		0.65	0.31	0.71	0.34					0.23		0.79
Uniform Delay, d1		21.5	0.0	36.8	8.4					26.7		31.4
Progression Factor		1.00	1.00	0.26	0.01					1.00		1.00
Incremental Delay, d2		2.3	0.5	7.4	0.2					0.1		10.0
Delay (s)		23.8	0.5	17.0	0.3					26.8		41.4
Level of Service		C	A	B	A					C		D
Approach Delay (s)		15.7			3.6			0.0			37.2	
Approach LOS		B			A			A			D	

Intersection Summary			
HCM 2000 Control Delay	16.9	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	75.1%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	495	470	0	0	410	400	350	0	385	0	0	0
Future Volume (vph)	495	470	0	0	410	400	350	0	385	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0			6.0	4.0	6.0		6.0			
Lane Util. Factor	1.00	0.95			0.95	1.00	1.00		1.00			
Frt	1.00	1.00			1.00	0.85	1.00		0.85			
Flt Protected	0.95	1.00			1.00	1.00	0.95		1.00			
Satd. Flow (prot)	1752	3505			3505	1568	1703		1524			
Flt Permitted	0.95	1.00			1.00	1.00	0.95		1.00			
Satd. Flow (perm)	1752	3505			3505	1568	1703		1524			
Peak-hour factor, PHF	0.92	0.92	0.92	0.91	0.91	0.91	0.67	0.67	0.67	0.92	0.92	0.92
Adj. Flow (vph)	538	511	0	0	451	440	522	0	575	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	236	0	0	0
Lane Group Flow (vph)	538	511	0	0	451	440	522	0	339	0	0	0
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	6%	6%	6%	2%	2%	2%
Turn Type	Prot	NA			NA	Free	Prot		Prot			
Protected Phases	5	2			6		8		8			
Permitted Phases		2			6	Free						
Actuated Green, G (s)	27.0	50.6			17.6	90.0	27.4		27.4			
Effective Green, g (s)	27.0	50.6			17.6	90.0	27.4		27.4			
Actuated g/C Ratio	0.30	0.56			0.20	1.00	0.30		0.30			
Clearance Time (s)	6.0	6.0			6.0		6.0		6.0			
Vehicle Extension (s)	5.0	5.0			5.0		3.0		3.0			
Lane Grp Cap (vph)	525	1970			685	1568	518		463			
v/s Ratio Prot	c0.31	0.15			c0.13		c0.31		0.22			
v/s Ratio Perm						0.28						
v/c Ratio	1.02	0.26			0.66	0.28	1.01		0.73			
Uniform Delay, d1	31.5	10.1			33.4	0.0	31.3		28.0			
Progression Factor	0.25	0.30			1.00	1.00	1.00		1.00			
Incremental Delay, d2	40.8	0.3			4.9	0.4	41.5		5.9			
Delay (s)	48.7	3.3			38.3	0.4	72.8		33.9			
Level of Service	D	A			D	A	E		C			
Approach Delay (s)		26.6			19.6			52.4			0.0	
Approach LOS		C			B			D			A	

Intersection Summary			
HCM 2000 Control Delay	33.9	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.93		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	75.1%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	25	0	0	10	0	69	5	299	2	22	427	0
Future Volume (vph)	25	0	0	10	0	69	5	299	2	22	427	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0				6.0	6.0	6.0	6.0		6.0	6.0	
Lane Util. Factor	1.00				1.00	1.00	1.00	0.95		1.00	0.95	
Frt	1.00				1.00	0.85	1.00	1.00		1.00	1.00	
Flt Protected	0.95				0.95	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770				1577	1568	1752	3502		1719	3438	
Flt Permitted	0.75				0.76	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1390				1257	1568	1752	3502		1719	3438	
Peak-hour factor, PHF	0.92	0.92	0.92	0.58	0.58	0.58	0.86	0.86	0.86	0.91	0.91	0.91
Adj. Flow (vph)	27	0	0	17	0	119	6	348	2	24	469	0
RTOR Reduction (vph)	0	0	0	0	0	102	0	1	0	0	0	0
Lane Group Flow (vph)	27	0	0	0	17	17	6	349	0	24	469	0
Heavy Vehicles (%)	2%	2%	2%	3%	3%	3%	3%	3%	3%	5%	5%	5%
Parking (#/hr)					0							
Turn Type	Perm			Perm	NA	Prot	Prot	NA		Prot	NA	
Protected Phases		4			8	8	5	2		1	6	
Permitted Phases	4			8								
Actuated Green, G (s)	5.9				5.9	5.9	0.9	17.2		1.0	17.3	
Effective Green, g (s)	5.9				5.9	5.9	0.9	17.2		1.0	17.3	
Actuated g/C Ratio	0.14				0.14	0.14	0.02	0.41		0.02	0.41	
Clearance Time (s)	6.0				6.0	6.0	6.0	6.0		6.0	6.0	
Vehicle Extension (s)	3.0				3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	194				176	219	37	1430		40	1412	
v/s Ratio Prot						0.01	0.00	0.10		c0.01	c0.14	
v/s Ratio Perm	c0.02				0.01							
v/c Ratio	0.14				0.10	0.08	0.16	0.24		0.60	0.33	
Uniform Delay, d1	15.9				15.8	15.7	20.2	8.2		20.4	8.5	
Progression Factor	1.00				1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.3				0.2	0.1	2.1	0.1		21.9	0.1	
Delay (s)	16.2				16.0	15.9	22.3	8.3		42.3	8.6	
Level of Service	B				B	B	C	A		D	A	
Approach Delay (s)		16.2			15.9			8.5			10.2	
Approach LOS		B			B			A			B	

Intersection Summary			
HCM 2000 Control Delay	10.5	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.30		
Actuated Cycle Length (s)	42.1	Sum of lost time (s)	18.0
Intersection Capacity Utilization	36.3%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	255	773	16	14	975	101	58	0	99	173	0	16
Future Volume (vph)	255	773	16	14	975	101	58	0	99	173	0	16
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0		6.0	6.0	6.0		6.0	6.0	6.0	6.0	
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00		1.00	1.00	0.95	0.95	
Frt	1.00	1.00		1.00	1.00	0.85		1.00	0.85	1.00	0.97	
Flt Protected	0.95	1.00		0.95	1.00	1.00		0.95	1.00	0.95	0.96	
Satd. Flow (prot)	1583	3157		1687	3374	1509		1770	1583	1681	1656	
Flt Permitted	0.95	1.00		0.95	1.00	1.00		0.95	1.00	0.95	0.96	
Satd. Flow (perm)	1583	3157		1687	3374	1509		1770	1583	1681	1656	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	277	840	17	15	1060	110	63	0	108	188	0	17
RTOR Reduction (vph)	0	1	0	0	0	68	0	0	99	0	94	0
Lane Group Flow (vph)	277	856	0	15	1060	42	0	63	9	103	8	0
Heavy Vehicles (%)	14%	14%	14%	7%	7%	7%	2%	2%	2%	2%	2%	2%
Turn Type	Prot	NA		Prot	NA	Prot	Split	NA	Prot	Split	NA	
Protected Phases	5	2		1	6	6	3	3	3	4	4	
Permitted Phases												
Actuated Green, G (s)	16.1	48.3		0.9	33.1	33.1		7.3	7.3	7.0	7.0	
Effective Green, g (s)	16.1	48.3		0.9	33.1	33.1		7.3	7.3	7.0	7.0	
Actuated g/C Ratio	0.18	0.55		0.01	0.38	0.38		0.08	0.08	0.08	0.08	
Clearance Time (s)	6.0	6.0		6.0	6.0	6.0		6.0	6.0	6.0	6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0		3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	291	1742		17	1276	570		147	132	134	132	
v/s Ratio Prot	c0.17	0.27		0.01	c0.31	0.03		c0.04	0.01	c0.06	0.00	
v/s Ratio Perm												
v/c Ratio	0.95	0.49		0.88	0.83	0.07		0.43	0.07	0.77	0.06	
Uniform Delay, d1	35.3	12.0		43.2	24.7	17.4		38.1	37.0	39.5	37.2	
Progression Factor	1.00	1.00		1.00	1.00	1.00		1.00	1.00	1.00	1.00	
Incremental Delay, d2	39.7	0.2		159.7	4.7	0.1		2.0	0.2	22.8	0.2	
Delay (s)	75.0	12.3		203.0	29.4	17.4		40.1	37.2	62.3	37.4	
Level of Service	E	B		F	C	B		D	D	E	D	
Approach Delay (s)		27.6			30.5			38.3			49.9	
Approach LOS		C			C			D			D	

Intersection Summary			
HCM 2000 Control Delay	31.2	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.81		
Actuated Cycle Length (s)	87.5	Sum of lost time (s)	24.0
Intersection Capacity Utilization	68.0%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	575	470	280	730	0	0	0	0	105	0	360
Future Volume (vph)	0	575	470	280	730	0	0	0	0	105	0	360
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0	4.0	6.0	6.0					6.0		6.0
Lane Util. Factor		0.95	1.00	1.00	0.95					0.97		1.00
Frt		1.00	0.85	1.00	1.00					1.00		0.85
Flt Protected		1.00	1.00	0.95	1.00					0.95		1.00
Satd. Flow (prot)		3167	1417	1687	3374					3303		1524
Flt Permitted		1.00	1.00	0.95	1.00					0.95		1.00
Satd. Flow (perm)		3167	1417	1687	3374					3303		1524
Peak-hour factor, PHF	0.92	0.92	0.92	0.73	0.73	0.73	0.92	0.92	0.92	0.74	0.74	0.74
Adj. Flow (vph)	0	625	511	384	1000	0	0	0	0	142	0	486
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	79
Lane Group Flow (vph)	0	625	511	384	1000	0	0	0	0	142	0	407
Heavy Vehicles (%)	14%	14%	14%	7%	7%	7%	2%	2%	2%	6%	6%	6%
Turn Type		NA	Free	Prot	NA					Prot		Prot
Protected Phases		2		1	6					4		4
Permitted Phases			Free									
Actuated Green, G (s)		31.6	110.0	28.1	65.7					32.3		32.3
Effective Green, g (s)		31.6	110.0	28.1	65.7					32.3		32.3
Actuated g/C Ratio		0.29	1.00	0.26	0.60					0.29		0.29
Clearance Time (s)		6.0		6.0	6.0					6.0		6.0
Vehicle Extension (s)		5.0		3.0	5.0					3.0		3.0
Lane Grp Cap (vph)		909	1417	430	2015					969		447
v/s Ratio Prot		c0.20		c0.23	0.30					0.04		c0.27
v/s Ratio Perm			0.36									
v/c Ratio		0.69	0.36	0.89	0.50					0.15		0.91
Uniform Delay, d1		34.8	0.0	39.5	12.7					28.7		37.5
Progression Factor		1.00	1.00	0.38	0.10					1.00		1.00
Incremental Delay, d2		4.2	0.7	17.4	0.5					0.1		22.5
Delay (s)		39.0	0.7	32.5	1.7					28.7		59.9
Level of Service		D	A	C	A					C		E
Approach Delay (s)		21.8			10.3			0.0			52.9	
Approach LOS		C			B			A			D	

Intersection Summary			
HCM 2000 Control Delay	22.9	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.83		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	71.3%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	480	200	0	0	595	340	415	0	160	0	0	0
Future Volume (vph)	480	200	0	0	595	340	415	0	160	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0			6.0	4.0	6.0		6.0			
Lane Util. Factor	1.00	0.95			0.95	1.00	1.00		1.00			
Frt	1.00	1.00			1.00	0.85	1.00		0.85			
Flt Protected	0.95	1.00			1.00	1.00	0.95		1.00			
Satd. Flow (prot)	1641	3282			3438	1538	1656		1482			
Flt Permitted	0.95	1.00			1.00	1.00	0.95		1.00			
Satd. Flow (perm)	1641	3282			3438	1538	1656		1482			
Peak-hour factor, PHF	0.87	0.87	0.87	0.90	0.90	0.90	0.78	0.78	0.78	0.92	0.92	0.92
Adj. Flow (vph)	552	230	0	0	661	378	532	0	205	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	139	0	0	0
Lane Group Flow (vph)	552	230	0	0	661	378	532	0	66	0	0	0
Heavy Vehicles (%)	10%	10%	10%	5%	5%	5%	9%	9%	9%	2%	2%	2%
Turn Type	Prot	NA			NA	Free	Prot		Prot			
Protected Phases	5	2			6		8		8			
Permitted Phases		2			6	Free						
Actuated Green, G (s)	36.0	64.0			22.0	110.0	34.0		34.0			
Effective Green, g (s)	36.0	64.0			22.0	110.0	34.0		34.0			
Actuated g/C Ratio	0.33	0.58			0.20	1.00	0.31		0.31			
Clearance Time (s)	6.0	6.0			6.0		6.0		6.0			
Vehicle Extension (s)	5.0	5.0			5.0		3.0		3.0			
Lane Grp Cap (vph)	537	1909			687	1538	511		458			
v/s Ratio Prot	c0.34	0.07			c0.19		c0.32		0.04			
v/s Ratio Perm						0.25						
v/c Ratio	1.03	0.12			0.96	0.25	1.04		0.14			
Uniform Delay, d1	37.0	10.3			43.6	0.0	38.0		27.5			
Progression Factor	0.26	0.14			1.00	1.00	1.00		1.00			
Incremental Delay, d2	41.1	0.1			26.2	0.4	50.9		0.1			
Delay (s)	50.8	1.6			69.8	0.4	88.9		27.6			
Level of Service	D	A			E	A	F		C			
Approach Delay (s)		36.3			44.6			71.9			0.0	
Approach LOS		D			D			E			A	

Intersection Summary			
HCM 2000 Control Delay	49.9	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	1.02		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	71.3%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	5	0	0	4	0	35	5	661	21	26	117	0
Future Volume (vph)	5	0	0	4	0	35	5	661	21	26	117	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0				6.0	6.0	6.0	6.0		6.0	6.0	
Lane Util. Factor	1.00				1.00	1.00	1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00				1.00	0.97	1.00	1.00		1.00	1.00	
Flpb, ped/bikes	1.00				1.00	1.00	1.00	1.00		1.00	1.00	
Frt	1.00				1.00	0.85	1.00	1.00		1.00	1.00	
Flt Protected	0.95				0.95	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770				1253	1088	1752	3489		1626	3252	
Flt Permitted	1.00				1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1863				1319	1088	1752	3489		1626	3252	
Peak-hour factor, PHF	0.92	0.92	0.92	0.71	0.71	0.71	0.86	0.86	0.86	0.92	0.92	0.92
Adj. Flow (vph)	5	0	0	6	0	49	6	769	24	28	127	0
RTOR Reduction (vph)	0	0	0	0	0	46	0	2	0	0	0	0
Lane Group Flow (vph)	5	0	0	0	6	3	6	791	0	28	127	0
Confl. Bikes (#/hr)						5						
Heavy Vehicles (%)	2%	2%	2%	44%	44%	44%	3%	3%	3%	11%	11%	11%
Turn Type	Perm			Perm	NA	Perm	Prot	NA		Prot	NA	
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4			8		8						
Actuated Green, G (s)	3.6				3.6	3.6	0.9	34.7		2.4	36.2	
Effective Green, g (s)	3.6				3.6	3.6	0.9	34.7		2.4	36.2	
Actuated g/C Ratio	0.06				0.06	0.06	0.02	0.59		0.04	0.62	
Clearance Time (s)	6.0				6.0	6.0	6.0	6.0		6.0	6.0	
Vehicle Extension (s)	3.0				3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	114				80	66	26	2062		66	2005	
v/s Ratio Prot							0.00	c0.23		c0.02	0.04	
v/s Ratio Perm	0.00				c0.00	0.00						
v/c Ratio	0.04				0.07	0.05	0.23	0.38		0.42	0.06	
Uniform Delay, d1	25.9				26.0	25.9	28.6	6.3		27.5	4.5	
Progression Factor	1.00				1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.2				0.4	0.3	4.5	0.1		4.3	0.0	
Delay (s)	26.1				26.4	26.2	33.1	6.5		31.8	4.5	
Level of Service	C				C	C	C	A		C	A	
Approach Delay (s)		26.1			26.2			6.7			9.4	
Approach LOS		C			C			A			A	

Intersection Summary			
HCM 2000 Control Delay	8.2	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.36		
Actuated Cycle Length (s)	58.7	Sum of lost time (s)	18.0
Intersection Capacity Utilization	45.6%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	26	864	26	114	847	44	52	9	27	219	9	227
Future Volume (vph)	26	864	26	114	847	44	52	9	27	219	9	227
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0		6.0	6.0	6.0		6.0	6.0	6.0	6.0	
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00		1.00	1.00	0.95	0.95	
Frt	1.00	1.00		1.00	1.00	0.85		1.00	0.85	1.00	0.87	
Flt Protected	0.95	1.00		0.95	1.00	1.00		0.96	1.00	0.95	1.00	
Satd. Flow (prot)	1736	3456		1719	3438	1538		1787	1583	1681	1530	
Flt Permitted	0.95	1.00		0.95	1.00	1.00		0.96	1.00	0.95	1.00	
Satd. Flow (perm)	1736	3456		1719	3438	1538		1787	1583	1681	1530	
Peak-hour factor, PHF	0.87	0.87	0.87	0.86	0.86	0.86	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	30	993	30	133	985	51	57	10	29	238	10	247
RTOR Reduction (vph)	0	2	0	0	0	28	0	0	27	0	209	0
Lane Group Flow (vph)	30	1021	0	133	985	23	0	67	2	214	72	0
Heavy Vehicles (%)	4%	4%	4%	5%	5%	5%	2%	2%	2%	2%	2%	2%
Turn Type	Prot	NA		Prot	NA	Prot	Split	NA	Prot	Split	NA	
Protected Phases	5	2		1	6	6	3	3	3	4	4	
Permitted Phases												
Actuated Green, G (s)	2.8	32.3		8.1	37.6	37.6		7.1	7.1	12.8	12.8	
Effective Green, g (s)	2.8	32.3		8.1	37.6	37.6		7.1	7.1	12.8	12.8	
Actuated g/C Ratio	0.03	0.38		0.10	0.45	0.45		0.08	0.08	0.15	0.15	
Clearance Time (s)	6.0	6.0		6.0	6.0	6.0		6.0	6.0	6.0	6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0		3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	57	1324		165	1533	685		150	133	255	232	
v/s Ratio Prot	0.02	c0.30		c0.08	c0.29	0.01		c0.04	0.00	c0.13	0.05	
v/s Ratio Perm												
v/c Ratio	0.53	0.77		0.81	0.64	0.03		0.45	0.02	0.84	0.31	
Uniform Delay, d1	40.1	22.8		37.3	18.1	13.1		36.7	35.4	34.7	31.8	
Progression Factor	1.00	1.00		1.00	1.00	1.00		1.00	1.00	1.00	1.00	
Incremental Delay, d2	8.5	2.8		24.1	0.9	0.0		2.1	0.1	20.8	0.8	
Delay (s)	48.6	25.6		61.5	19.1	13.1		38.8	35.5	55.6	32.6	
Level of Service	D	C		E	B	B		D	D	E	C	
Approach Delay (s)		26.3			23.6			37.8			42.5	
Approach LOS		C			C			D			D	

Intersection Summary			
HCM 2000 Control Delay	28.4	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.76		
Actuated Cycle Length (s)	84.3	Sum of lost time (s)	24.0
Intersection Capacity Utilization	70.1%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	640	470	160	615	0	0	0	0	180	0	390
Future Volume (vph)	0	640	470	160	615	0	0	0	0	180	0	390
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0	4.0	6.0	6.0					6.0		6.0
Lane Util. Factor		0.95	1.00	1.00	0.95					0.97		1.00
Frt		1.00	0.85	1.00	1.00					1.00		0.85
Flt Protected		1.00	1.00	0.95	1.00					0.95		1.00
Satd. Flow (prot)		3471	1553	1719	3438					3367		1553
Flt Permitted		1.00	1.00	0.95	1.00					0.95		1.00
Satd. Flow (perm)		3471	1553	1719	3438					3367		1553
Peak-hour factor, PHF	0.87	0.87	0.87	0.86	0.86	0.86	0.92	0.92	0.92	0.91	0.91	0.91
Adj. Flow (vph)	0	736	540	186	715	0	0	0	0	198	0	429
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	154
Lane Group Flow (vph)	0	736	540	186	715	0	0	0	0	198	0	275
Heavy Vehicles (%)	4%	4%	4%	5%	5%	5%	2%	2%	2%	4%	4%	4%
Turn Type		NA	Free	Prot	NA					Prot		Prot
Protected Phases		2		1	6					4		4
Permitted Phases			Free									
Actuated Green, G (s)		36.1	90.0	14.2	56.3					21.7		21.7
Effective Green, g (s)		36.1	90.0	14.2	56.3					21.7		21.7
Actuated g/C Ratio		0.40	1.00	0.16	0.63					0.24		0.24
Clearance Time (s)		6.0		6.0	6.0					6.0		6.0
Vehicle Extension (s)		5.0		3.0	5.0					3.0		3.0
Lane Grp Cap (vph)		1392	1553	271	2150					811		374
v/s Ratio Prot		c0.21		c0.11	0.21					0.06		c0.18
v/s Ratio Perm			0.35									
v/c Ratio		0.53	0.35	0.69	0.33					0.24		0.74
Uniform Delay, d1		20.5	0.0	35.8	8.0					27.5		31.5
Progression Factor		1.00	1.00	0.35	0.02					1.00		1.00
Incremental Delay, d2		1.4	0.6	4.6	0.2					0.2		7.3
Delay (s)		21.9	0.6	17.3	0.4					27.7		38.8
Level of Service		C	A	B	A					C		D
Approach Delay (s)		12.9			3.9			0.0			35.3	
Approach LOS		B			A			A			D	

Intersection Summary			
HCM 2000 Control Delay	15.0	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.62		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	70.4%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	440	380	0	0	455	230	320	0	370	0	0	0
Future Volume (vph)	440	380	0	0	455	230	320	0	370	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0			6.0	4.0	6.0		6.0			
Lane Util. Factor	1.00	0.95			0.95	1.00	1.00		1.00			
Frt	1.00	1.00			1.00	0.85	1.00		0.85			
Flt Protected	0.95	1.00			1.00	1.00	0.95		1.00			
Satd. Flow (prot)	1752	3505			3505	1568	1703		1524			
Flt Permitted	0.95	1.00			1.00	1.00	0.95		1.00			
Satd. Flow (perm)	1752	3505			3505	1568	1703		1524			
Peak-hour factor, PHF	0.92	0.92	0.92	0.91	0.91	0.91	0.67	0.67	0.67	0.92	0.92	0.92
Adj. Flow (vph)	478	413	0	0	500	253	478	0	552	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	288	0	0	0
Lane Group Flow (vph)	478	413	0	0	500	253	478	0	264	0	0	0
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	6%	6%	6%	2%	2%	2%
Turn Type	Prot	NA			NA	Free	Prot		Prot			
Protected Phases	5	2			6		8		8			
Permitted Phases		2			6	Free						
Actuated Green, G (s)	26.9	50.1			17.2	90.0	27.9		27.9			
Effective Green, g (s)	26.9	50.1			17.2	90.0	27.9		27.9			
Actuated g/C Ratio	0.30	0.56			0.19	1.00	0.31		0.31			
Clearance Time (s)	6.0	6.0			6.0		6.0		6.0			
Vehicle Extension (s)	5.0	5.0			5.0		3.0		3.0			
Lane Grp Cap (vph)	523	1951			669	1568	527		472			
v/s Ratio Prot	c0.27	0.12			c0.14		c0.28		0.17			
v/s Ratio Perm						0.16						
v/c Ratio	0.91	0.21			0.75	0.16	0.91		0.56			
Uniform Delay, d1	30.4	10.0			34.3	0.0	29.8		25.9			
Progression Factor	0.27	0.33			1.00	1.00	1.00		1.00			
Incremental Delay, d2	19.1	0.2			7.5	0.2	19.2		1.4			
Delay (s)	27.2	3.6			41.8	0.2	49.0		27.3			
Level of Service	C	A			D	A	D		C			
Approach Delay (s)		16.3			27.8			37.4			0.0	
Approach LOS		B			C			D			A	

Intersection Summary			
HCM 2000 Control Delay	27.7	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.87		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	70.4%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	25	0	0	9	0	58	5	250	2	19	375	0
Future Volume (vph)	25	0	0	9	0	58	5	250	2	19	375	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0				6.0	6.0	6.0	6.0		6.0	6.0	
Lane Util. Factor	1.00				1.00	1.00	1.00	0.95		1.00	0.95	
Frt	1.00				1.00	0.85	1.00	1.00		1.00	1.00	
Flt Protected	0.95				0.95	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770				1577	1568	1752	3501		1719	3438	
Flt Permitted	0.75				0.76	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1392				1257	1568	1752	3501		1719	3438	
Peak-hour factor, PHF	0.92	0.92	0.92	0.58	0.58	0.58	0.86	0.86	0.86	0.91	0.91	0.91
Adj. Flow (vph)	27	0	0	16	0	100	6	291	2	21	412	0
RTOR Reduction (vph)	0	0	0	0	0	86	0	1	0	0	0	0
Lane Group Flow (vph)	27	0	0	0	16	14	6	292	0	21	412	0
Heavy Vehicles (%)	2%	2%	2%	3%	3%	3%	3%	3%	3%	5%	5%	5%
Parking (#/hr)					0							
Turn Type	Perm			Perm	NA	Prot	Prot	NA		Prot	NA	
Protected Phases		4			8	8	5	2		1	6	
Permitted Phases	4			8								
Actuated Green, G (s)	5.8				5.8	5.8	0.9	17.1		1.0	17.2	
Effective Green, g (s)	5.8				5.8	5.8	0.9	17.1		1.0	17.2	
Actuated g/C Ratio	0.14				0.14	0.14	0.02	0.41		0.02	0.41	
Clearance Time (s)	6.0				6.0	6.0	6.0	6.0		6.0	6.0	
Vehicle Extension (s)	3.0				3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	192				174	217	37	1428		41	1411	
v/s Ratio Prot						0.01	0.00	0.08		c0.01	c0.12	
v/s Ratio Perm	c0.02				0.01							
v/c Ratio	0.14				0.09	0.06	0.16	0.20		0.51	0.29	
Uniform Delay, d1	15.9				15.8	15.7	20.1	8.0		20.2	8.3	
Progression Factor	1.00				1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.3				0.2	0.1	2.1	0.1		10.4	0.1	
Delay (s)	16.2				16.0	15.8	22.2	8.1		30.6	8.4	
Level of Service	B				B	B	C	A		C	A	
Approach Delay (s)		16.2			15.8			8.4			9.5	
Approach LOS		B			B			A			A	

Intersection Summary			
HCM 2000 Control Delay	10.1	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.27		
Actuated Cycle Length (s)	41.9	Sum of lost time (s)	18.0
Intersection Capacity Utilization	35.0%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	255	773	16	14	934	97	58	0	99	173	0	16
Future Volume (vph)	255	773	16	14	934	97	58	0	99	173	0	16
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0		6.0	6.0	6.0		6.0	6.0	6.0	6.0	
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00		1.00	1.00	0.95	0.95	
Frt	1.00	1.00		1.00	1.00	0.85		1.00	0.85	1.00	0.97	
Flt Protected	0.95	1.00		0.95	1.00	1.00		0.95	1.00	0.95	0.96	
Satd. Flow (prot)	1583	3157		1687	3374	1509		1770	1583	1681	1656	
Flt Permitted	0.95	1.00		0.95	1.00	1.00		0.95	1.00	0.95	0.96	
Satd. Flow (perm)	1583	3157		1687	3374	1509		1770	1583	1681	1656	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	277	840	17	15	1015	105	63	0	108	188	0	17
RTOR Reduction (vph)	0	1	0	0	0	65	0	0	99	0	94	0
Lane Group Flow (vph)	277	856	0	15	1015	40	0	63	9	103	8	0
Heavy Vehicles (%)	14%	14%	14%	7%	7%	7%	2%	2%	2%	2%	2%	2%
Turn Type	Prot	NA		Prot	NA	Prot	Split	NA	Prot	Split	NA	
Protected Phases	5	2		1	6	6	3	3	3	4	4	
Permitted Phases												
Actuated Green, G (s)	16.1	48.3		0.9	33.1	33.1		7.3	7.3	7.0	7.0	
Effective Green, g (s)	16.1	48.3		0.9	33.1	33.1		7.3	7.3	7.0	7.0	
Actuated g/C Ratio	0.18	0.55		0.01	0.38	0.38		0.08	0.08	0.08	0.08	
Clearance Time (s)	6.0	6.0		6.0	6.0	6.0		6.0	6.0	6.0	6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0		3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	291	1742		17	1276	570		147	132	134	132	
v/s Ratio Prot	c0.17	0.27		0.01	c0.30	0.03		c0.04	0.01	c0.06	0.00	
v/s Ratio Perm												
v/c Ratio	0.95	0.49		0.88	0.80	0.07		0.43	0.07	0.77	0.06	
Uniform Delay, d1	35.3	12.0		43.2	24.2	17.4		38.1	37.0	39.5	37.2	
Progression Factor	1.00	1.00		1.00	1.00	1.00		1.00	1.00	1.00	1.00	
Incremental Delay, d2	39.7	0.2		159.7	3.5	0.1		2.0	0.2	22.8	0.2	
Delay (s)	75.0	12.3		203.0	27.7	17.4		40.1	37.2	62.3	37.4	
Level of Service	E	B		F	C	B		D	D	E	D	
Approach Delay (s)		27.6			29.1			38.3			49.9	
Approach LOS		C			C			D			D	

Intersection Summary			
HCM 2000 Control Delay	30.7	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	87.5	Sum of lost time (s)	24.0
Intersection Capacity Utilization	66.9%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	585	460	285	685	0	0	0	0	110	0	360
Future Volume (vph)	0	585	460	285	685	0	0	0	0	110	0	360
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0	4.0	6.0	6.0					6.0		6.0
Lane Util. Factor		0.95	1.00	1.00	0.95					0.97		1.00
Frt		1.00	0.85	1.00	1.00					1.00		0.85
Flt Protected		1.00	1.00	0.95	1.00					0.95		1.00
Satd. Flow (prot)		3167	1417	1687	3374					3303		1524
Flt Permitted		1.00	1.00	0.95	1.00					0.95		1.00
Satd. Flow (perm)		3167	1417	1687	3374					3303		1524
Peak-hour factor, PHF	0.92	0.92	0.92	0.73	0.73	0.73	0.92	0.92	0.92	0.74	0.74	0.74
Adj. Flow (vph)	0	636	500	390	938	0	0	0	0	149	0	486
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	96
Lane Group Flow (vph)	0	636	500	390	938	0	0	0	0	149	0	390
Heavy Vehicles (%)	14%	14%	14%	7%	7%	7%	2%	2%	2%	6%	6%	6%
Turn Type		NA	Free	Prot	NA					Prot		Prot
Protected Phases		2		1	6					4		4
Permitted Phases			Free									
Actuated Green, G (s)		32.1	110.0	28.8	66.9					31.1		31.1
Effective Green, g (s)		32.1	110.0	28.8	66.9					31.1		31.1
Actuated g/C Ratio		0.29	1.00	0.26	0.61					0.28		0.28
Clearance Time (s)		6.0		6.0	6.0					6.0		6.0
Vehicle Extension (s)		5.0		3.0	5.0					3.0		3.0
Lane Grp Cap (vph)		924	1417	441	2052					933		430
v/s Ratio Prot		c0.20		c0.23	0.28					0.05		c0.26
v/s Ratio Perm			0.35									
v/c Ratio		0.69	0.35	0.88	0.46					0.16		0.91
Uniform Delay, d1		34.5	0.0	39.0	11.7					29.6		38.1
Progression Factor		1.00	1.00	0.40	0.08					1.00		1.00
Incremental Delay, d2		4.2	0.7	16.0	0.4					0.1		22.3
Delay (s)		38.7	0.7	31.4	1.3					29.7		60.4
Level of Service		D	A	C	A					C		E
Approach Delay (s)		22.0			10.1			0.0			53.2	
Approach LOS		C			B			A			D	

Intersection Summary			
HCM 2000 Control Delay	23.3	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	71.4%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	485	210	0	0	520	350	450	0	160	0	0	0
Future Volume (vph)	485	210	0	0	520	350	450	0	160	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0			6.0	4.0	6.0		6.0			
Lane Util. Factor	1.00	0.95			0.95	1.00	1.00		1.00			
Frt	1.00	1.00			1.00	0.85	1.00		0.85			
Flt Protected	0.95	1.00			1.00	1.00	0.95		1.00			
Satd. Flow (prot)	1641	3282			3438	1538	1656		1482			
Flt Permitted	0.95	1.00			1.00	1.00	0.95		1.00			
Satd. Flow (perm)	1641	3282			3438	1538	1656		1482			
Peak-hour factor, PHF	0.87	0.87	0.87	0.90	0.90	0.90	0.78	0.78	0.78	0.92	0.92	0.92
Adj. Flow (vph)	557	241	0	0	578	389	577	0	205	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	128	0	0	0
Lane Group Flow (vph)	557	241	0	0	578	389	577	0	77	0	0	0
Heavy Vehicles (%)	10%	10%	10%	5%	5%	5%	9%	9%	9%	2%	2%	2%
Turn Type	Prot	NA			NA	Free	Prot		Prot			
Protected Phases	5	2			6		8		8			
Permitted Phases		2			6	Free						
Actuated Green, G (s)	36.0	61.0			19.0	110.0	37.0		37.0			
Effective Green, g (s)	36.0	61.0			19.0	110.0	37.0		37.0			
Actuated g/C Ratio	0.33	0.55			0.17	1.00	0.34		0.34			
Clearance Time (s)	6.0	6.0			6.0		6.0		6.0			
Vehicle Extension (s)	5.0	5.0			5.0		3.0		3.0			
Lane Grp Cap (vph)	537	1820			593	1538	557		498			
v/s Ratio Prot	c0.34	0.07			c0.17		c0.35		0.05			
v/s Ratio Perm						0.25						
v/c Ratio	1.04	0.13			0.97	0.25	1.04		0.15			
Uniform Delay, d1	37.0	11.8			45.3	0.0	36.5		25.6			
Progression Factor	0.27	0.17			1.00	1.00	1.00		1.00			
Incremental Delay, d2	43.7	0.1			31.2	0.4	47.7		0.1			
Delay (s)	53.5	2.1			76.5	0.4	84.2		25.7			
Level of Service	D	A			E	A	F		C			
Approach Delay (s)		38.0			45.9			68.9			0.0	
Approach LOS		D			D			E			A	

Intersection Summary			
HCM 2000 Control Delay	50.5	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	1.02		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	71.4%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	5	0	0	4	0	33	5	615	20	26	121	0
Future Volume (vph)	5	0	0	4	0	33	5	615	20	26	121	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0				6.0	6.0	6.0	6.0		6.0	6.0	
Lane Util. Factor	1.00				1.00	1.00	1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00				1.00	0.97	1.00	1.00		1.00	1.00	
Flpb, ped/bikes	1.00				1.00	1.00	1.00	1.00		1.00	1.00	
Frt	1.00				1.00	0.85	1.00	1.00		1.00	1.00	
Flt Protected	0.95				0.95	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770				1253	1089	1752	3488		1626	3252	
Flt Permitted	1.00				1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1863				1319	1089	1752	3488		1626	3252	
Peak-hour factor, PHF	0.92	0.92	0.92	0.71	0.71	0.71	0.86	0.86	0.86	0.92	0.92	0.92
Adj. Flow (vph)	5	0	0	6	0	46	6	715	23	28	132	0
RTOR Reduction (vph)	0	0	0	0	0	43	0	2	0	0	0	0
Lane Group Flow (vph)	5	0	0	0	6	3	6	736	0	28	132	0
Confl. Bikes (#/hr)						5						
Heavy Vehicles (%)	2%	2%	2%	44%	44%	44%	3%	3%	3%	11%	11%	11%
Turn Type	Perm			Perm	NA	Perm	Prot	NA		Prot	NA	
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4			8		8						
Actuated Green, G (s)	3.6				3.6	3.6	0.9	32.5		2.4	34.0	
Effective Green, g (s)	3.6				3.6	3.6	0.9	32.5		2.4	34.0	
Actuated g/C Ratio	0.06				0.06	0.06	0.02	0.58		0.04	0.60	
Clearance Time (s)	6.0				6.0	6.0	6.0	6.0		6.0	6.0	
Vehicle Extension (s)	3.0				3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	118				84	69	27	2006		69	1956	
v/s Ratio Prot							0.00	c0.21		c0.02	0.04	
v/s Ratio Perm	0.00				c0.00	0.00						
v/c Ratio	0.04				0.07	0.04	0.22	0.37		0.41	0.07	
Uniform Delay, d1	24.8				24.9	24.8	27.5	6.5		26.4	4.7	
Progression Factor	1.00				1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.1				0.4	0.3	4.1	0.1		3.9	0.0	
Delay (s)	25.0				25.2	25.1	31.6	6.6		30.2	4.7	
Level of Service	C				C	C	C	A		C	A	
Approach Delay (s)		25.0			25.1			6.8			9.2	
Approach LOS		C			C			A			A	

Intersection Summary			
HCM 2000 Control Delay	8.3	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.34		
Actuated Cycle Length (s)	56.5	Sum of lost time (s)	18.0
Intersection Capacity Utilization	44.3%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	25	864	25	110	818	42	51	8	27	219	8	219
Future Volume (vph)	25	864	25	110	818	42	51	8	27	219	8	219
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0		6.0	6.0	6.0		6.0	6.0	6.0	6.0	
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00		1.00	1.00	0.95	0.95	
Frt	1.00	1.00		1.00	1.00	0.85		1.00	0.85	1.00	0.87	
Flt Protected	0.95	1.00		0.95	1.00	1.00		0.96	1.00	0.95	1.00	
Satd. Flow (prot)	1736	3456		1719	3438	1538		1786	1583	1681	1530	
Flt Permitted	0.95	1.00		0.95	1.00	1.00		0.96	1.00	0.95	1.00	
Satd. Flow (perm)	1736	3456		1719	3438	1538		1786	1583	1681	1530	
Peak-hour factor, PHF	0.87	0.87	0.87	0.86	0.86	0.86	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	29	993	29	128	951	49	55	9	29	238	9	238
RTOR Reduction (vph)	0	2	0	0	0	26	0	0	27	0	202	0
Lane Group Flow (vph)	29	1020	0	128	951	23	0	64	2	214	69	0
Heavy Vehicles (%)	4%	4%	4%	5%	5%	5%	2%	2%	2%	2%	2%	2%
Turn Type	Prot	NA		Prot	NA	Prot	Split	NA	Prot	Split	NA	
Protected Phases	5	2		1	6	6	3	3	3	4	4	
Permitted Phases												
Actuated Green, G (s)	1.9	34.2		7.1	39.4	39.4		7.0	7.0	12.8	12.8	
Effective Green, g (s)	1.9	34.2		7.1	39.4	39.4		7.0	7.0	12.8	12.8	
Actuated g/C Ratio	0.02	0.40		0.08	0.46	0.46		0.08	0.08	0.15	0.15	
Clearance Time (s)	6.0	6.0		6.0	6.0	6.0		6.0	6.0	6.0	6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0		3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	38	1388		143	1591	712		146	130	252	230	
v/s Ratio Prot	0.02	c0.30		c0.07	c0.28	0.01		c0.04	0.00	c0.13	0.04	
v/s Ratio Perm												
v/c Ratio	0.76	0.74		0.90	0.60	0.03		0.44	0.02	0.85	0.30	
Uniform Delay, d1	41.4	21.6		38.6	17.0	12.5		37.2	35.9	35.2	32.2	
Progression Factor	1.00	1.00		1.00	1.00	1.00		1.00	1.00	1.00	1.00	
Incremental Delay, d2	60.7	2.1		45.2	0.6	0.0		2.1	0.1	22.5	0.7	
Delay (s)	102.1	23.7		83.8	17.6	12.5		39.3	35.9	57.7	32.9	
Level of Service	F	C		F	B	B		D	D	E	C	
Approach Delay (s)		25.8			24.9			38.2			43.8	
Approach LOS		C			C			D			D	

Intersection Summary			
HCM 2000 Control Delay	29.0	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	85.1	Sum of lost time (s)	24.0
Intersection Capacity Utilization	69.6%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	650	460	165	580	0	0	0	0	185	0	390
Future Volume (vph)	0	650	460	165	580	0	0	0	0	185	0	390
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0	4.0	6.0	6.0					6.0		6.0
Lane Util. Factor		0.95	1.00	1.00	0.95					0.97		1.00
Frt		1.00	0.85	1.00	1.00					1.00		0.85
Flt Protected		1.00	1.00	0.95	1.00					0.95		1.00
Satd. Flow (prot)		3471	1553	1719	3438					3367		1553
Flt Permitted		1.00	1.00	0.95	1.00					0.95		1.00
Satd. Flow (perm)		3471	1553	1719	3438					3367		1553
Peak-hour factor, PHF	0.87	0.87	0.87	0.86	0.86	0.86	0.92	0.92	0.92	0.91	0.91	0.91
Adj. Flow (vph)	0	747	529	192	674	0	0	0	0	203	0	429
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	179
Lane Group Flow (vph)	0	747	529	192	674	0	0	0	0	203	0	250
Heavy Vehicles (%)	4%	4%	4%	5%	5%	5%	2%	2%	2%	4%	4%	4%
Turn Type		NA	Free	Prot	NA					Prot		Prot
Protected Phases		2		1	6					4		4
Permitted Phases			Free									
Actuated Green, G (s)		37.2	90.0	14.4	57.6					20.4		20.4
Effective Green, g (s)		37.2	90.0	14.4	57.6					20.4		20.4
Actuated g/C Ratio		0.41	1.00	0.16	0.64					0.23		0.23
Clearance Time (s)		6.0		6.0	6.0					6.0		6.0
Vehicle Extension (s)		5.0		3.0	5.0					3.0		3.0
Lane Grp Cap (vph)		1434	1553	275	2200					763		352
v/s Ratio Prot		c0.22		c0.11	0.20					0.06		c0.16
v/s Ratio Perm			0.34									
v/c Ratio		0.52	0.34	0.70	0.31					0.27		0.71
Uniform Delay, d1		19.7	0.0	35.7	7.3					28.6		32.1
Progression Factor		1.00	1.00	0.33	0.03					1.00		1.00
Incremental Delay, d2		1.4	0.6	6.1	0.2					0.2		6.6
Delay (s)		21.1	0.6	18.0	0.4					28.8		38.7
Level of Service		C	A	B	A					C		D
Approach Delay (s)		12.6			4.3			0.0			35.5	
Approach LOS		B			A			A			D	

Intersection Summary			
HCM 2000 Control Delay	15.2	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	72.6%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	445	390	0	0	385	235	360	0	380	0	0	0
Future Volume (vph)	445	390	0	0	385	235	360	0	380	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0			6.0	4.0	6.0		6.0			
Lane Util. Factor	1.00	0.95			0.95	1.00	1.00		1.00			
Frt	1.00	1.00			1.00	0.85	1.00		0.85			
Flt Protected	0.95	1.00			1.00	1.00	0.95		1.00			
Satd. Flow (prot)	1752	3505			3505	1568	1703		1524			
Flt Permitted	0.95	1.00			1.00	1.00	0.95		1.00			
Satd. Flow (perm)	1752	3505			3505	1568	1703		1524			
Peak-hour factor, PHF	0.92	0.92	0.92	0.91	0.91	0.91	0.67	0.67	0.67	0.92	0.92	0.92
Adj. Flow (vph)	484	424	0	0	423	258	537	0	567	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	269	0	0	0
Lane Group Flow (vph)	484	424	0	0	423	258	537	0	298	0	0	0
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	6%	6%	6%	2%	2%	2%
Turn Type	Prot	NA			NA	Free	Prot		Prot			
Protected Phases	5	2			6		8		8			
Permitted Phases		2			6	Free						
Actuated Green, G (s)	25.0	48.6			17.6	90.0	29.4		29.4			
Effective Green, g (s)	25.0	48.6			17.6	90.0	29.4		29.4			
Actuated g/C Ratio	0.28	0.54			0.20	1.00	0.33		0.33			
Clearance Time (s)	6.0	6.0			6.0		6.0		6.0			
Vehicle Extension (s)	5.0	5.0			5.0		3.0		3.0			
Lane Grp Cap (vph)	486	1892			685	1568	556		497			
v/s Ratio Prot	c0.28	0.12			c0.12		c0.32		0.20			
v/s Ratio Perm						0.16						
v/c Ratio	1.00	0.22			0.62	0.16	0.97		0.60			
Uniform Delay, d1	32.4	10.8			33.1	0.0	29.8		25.4			
Progression Factor	0.33	0.34			1.00	1.00	1.00		1.00			
Incremental Delay, d2	36.8	0.3			4.1	0.2	29.4		2.0			
Delay (s)	47.5	3.9			37.3	0.2	59.2		27.4			
Level of Service	D	A			D	A	E		C			
Approach Delay (s)		27.1			23.2			42.9			0.0	
Approach LOS		C			C			D			A	

Intersection Summary			
HCM 2000 Control Delay	32.6	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.89		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	72.6%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	25	0	0	9	0	53	5	223	2	20	384	0
Future Volume (vph)	25	0	0	9	0	53	5	223	2	20	384	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0				6.0	6.0	6.0	6.0		6.0	6.0	
Lane Util. Factor	1.00				1.00	1.00	1.00	0.95		1.00	0.95	
Frt	1.00				1.00	0.85	1.00	1.00		1.00	1.00	
Flt Protected	0.95				0.95	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770				1577	1568	1752	3501		1719	3438	
Flt Permitted	0.75				0.76	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1392				1257	1568	1752	3501		1719	3438	
Peak-hour factor, PHF	0.92	0.92	0.92	0.58	0.58	0.58	0.86	0.86	0.86	0.91	0.91	0.91
Adj. Flow (vph)	27	0	0	16	0	91	6	259	2	22	422	0
RTOR Reduction (vph)	0	0	0	0	0	79	0	1	0	0	0	0
Lane Group Flow (vph)	27	0	0	0	16	12	6	260	0	22	422	0
Heavy Vehicles (%)	2%	2%	2%	3%	3%	3%	3%	3%	3%	5%	5%	5%
Parking (#/hr)					0							
Turn Type	Perm			Perm	NA	Prot	Prot	NA		Prot	NA	
Protected Phases		4			8	8	5	2		1	6	
Permitted Phases	4			8								
Actuated Green, G (s)	5.8				5.8	5.8	0.9	17.7		1.1	17.9	
Effective Green, g (s)	5.8				5.8	5.8	0.9	17.7		1.1	17.9	
Actuated g/C Ratio	0.14				0.14	0.14	0.02	0.42		0.03	0.42	
Clearance Time (s)	6.0				6.0	6.0	6.0	6.0		6.0	6.0	
Vehicle Extension (s)	3.0				3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	189				171	213	37	1454		44	1444	
v/s Ratio Prot						0.01	0.00	0.07		c0.01	c0.12	
v/s Ratio Perm	c0.02				0.01							
v/c Ratio	0.14				0.09	0.06	0.16	0.18		0.50	0.29	
Uniform Delay, d1	16.2				16.1	16.0	20.5	7.9		20.5	8.2	
Progression Factor	1.00				1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.3				0.2	0.1	2.1	0.1		8.7	0.1	
Delay (s)	16.6				16.3	16.1	22.5	7.9		29.1	8.3	
Level of Service	B				B	B	C	A		C	A	
Approach Delay (s)		16.6			16.2			8.3			9.3	
Approach LOS		B			B			A			A	

Intersection Summary			
HCM 2000 Control Delay	10.1	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.27		
Actuated Cycle Length (s)	42.6	Sum of lost time (s)	18.0
Intersection Capacity Utilization	35.0%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	282	855	18	15	997	103	64	0	109	191	0	18
Future Volume (vph)	282	855	18	15	997	103	64	0	109	191	0	18
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0		6.0	6.0	6.0		6.0	6.0	6.0	6.0	
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00		1.00	1.00	0.95	0.95	
Frt	1.00	1.00		1.00	1.00	0.85		1.00	0.85	1.00	0.97	
Flt Protected	0.95	1.00		0.95	1.00	1.00		0.95	1.00	0.95	0.96	
Satd. Flow (prot)	1583	3157		1687	3374	1509		1770	1583	1681	1655	
Flt Permitted	0.95	1.00		0.95	1.00	1.00		0.95	1.00	0.95	0.96	
Satd. Flow (perm)	1583	3157		1687	3374	1509		1770	1583	1681	1655	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	307	929	20	16	1084	112	70	0	118	208	0	20
RTOR Reduction (vph)	0	1	0	0	0	72	0	0	106	0	105	0
Lane Group Flow (vph)	307	948	0	16	1084	40	0	70	12	114	9	0
Heavy Vehicles (%)	14%	14%	14%	7%	7%	7%	2%	2%	2%	2%	2%	2%
Turn Type	Prot	NA		Prot	NA	Prot	Split	NA	Prot	Split	NA	
Protected Phases	5	2		1	6	6	3	3	3	4	4	
Permitted Phases												
Actuated Green, G (s)	16.0	45.8		1.9	31.7	31.7		9.2	9.2	7.0	7.0	
Effective Green, g (s)	16.0	45.8		1.9	31.7	31.7		9.2	9.2	7.0	7.0	
Actuated g/C Ratio	0.18	0.52		0.02	0.36	0.36		0.10	0.10	0.08	0.08	
Clearance Time (s)	6.0	6.0		6.0	6.0	6.0		6.0	6.0	6.0	6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0		3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	288	1644		36	1216	544		185	165	133	131	
v/s Ratio Prot	c0.19	0.30		0.01	c0.32	0.03		c0.04	0.01	c0.07	0.01	
v/s Ratio Perm												
v/c Ratio	1.07	0.58		0.44	0.89	0.07		0.38	0.07	0.86	0.07	
Uniform Delay, d1	36.0	14.4		42.5	26.5	18.5		36.7	35.5	40.0	37.4	
Progression Factor	1.00	1.00		1.00	1.00	1.00		1.00	1.00	1.00	1.00	
Incremental Delay, d2	71.6	0.5		8.5	8.5	0.1		1.3	0.2	38.6	0.2	
Delay (s)	107.5	14.9		51.0	35.0	18.5		38.0	35.7	78.5	37.7	
Level of Service	F	B		D	D	B		D	D	E	D	
Approach Delay (s)		37.5			33.7			36.6			58.1	
Approach LOS		D			C			D			E	

Intersection Summary			
HCM 2000 Control Delay	37.5	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.86		
Actuated Cycle Length (s)	87.9	Sum of lost time (s)	24.0
Intersection Capacity Utilization	70.7%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	795	360	390	615	0	0	0	0	495	0	500
Future Volume (vph)	0	795	360	390	615	0	0	0	0	495	0	500
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0	4.0	6.0	6.0					6.0		6.0
Lane Util. Factor		0.95	1.00	1.00	0.95					0.97		1.00
Frt		1.00	0.85	1.00	1.00					1.00		0.85
Flt Protected		1.00	1.00	0.95	1.00					0.95		1.00
Satd. Flow (prot)		3167	1417	1687	3374					3303		1524
Flt Permitted		1.00	1.00	0.95	1.00					0.95		1.00
Satd. Flow (perm)		3167	1417	1687	3374					3303		1524
Peak-hour factor, PHF	0.92	0.92	0.92	0.73	0.73	0.73	0.92	0.92	0.92	0.74	0.74	0.74
Adj. Flow (vph)	0	864	391	534	842	0	0	0	0	669	0	676
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	124
Lane Group Flow (vph)	0	864	391	534	842	0	0	0	0	669	0	552
Heavy Vehicles (%)	14%	14%	14%	7%	7%	7%	2%	2%	2%	6%	6%	6%
Turn Type		NA	Free	Prot	NA					Prot		Prot
Protected Phases		2		1	6					4		4
Permitted Phases			Free									
Actuated Green, G (s)		35.0	130.0	38.0	79.0					39.0		39.0
Effective Green, g (s)		35.0	130.0	38.0	79.0					39.0		39.0
Actuated g/C Ratio		0.27	1.00	0.29	0.61					0.30		0.30
Clearance Time (s)		6.0		6.0	6.0					6.0		6.0
Vehicle Extension (s)		5.0		3.0	5.0					3.0		3.0
Lane Grp Cap (vph)		852	1417	493	2050					990		457
v/s Ratio Prot		c0.27		c0.32	0.25					0.20		c0.36
v/s Ratio Perm			0.28									
v/c Ratio		1.01	0.28	1.08	0.41					0.68		1.21
Uniform Delay, d1		47.5	0.0	46.0	13.3					39.9		45.5
Progression Factor		1.00	1.00	0.31	0.08					1.00		1.00
Incremental Delay, d2		34.4	0.5	60.7	0.3					1.8		112.7
Delay (s)		81.9	0.5	74.8	1.3					41.8		158.2
Level of Service		F	A	E	A					D		F
Approach Delay (s)		56.5			29.8			0.0			100.3	
Approach LOS		E			C			A			F	

Intersection Summary			
HCM 2000 Control Delay	62.1	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.10		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	85.2%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	605	685	0	0	625	790	380	0	160	0	0	0
Future Volume (vph)	605	685	0	0	625	790	380	0	160	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0			6.0	4.0	6.0		6.0			
Lane Util. Factor	1.00	0.95			0.95	1.00	1.00		1.00			
Frt	1.00	1.00			1.00	0.85	1.00		0.85			
Flt Protected	0.95	1.00			1.00	1.00	0.95		1.00			
Satd. Flow (prot)	1641	3282			3438	1538	1656		1482			
Flt Permitted	0.95	1.00			1.00	1.00	0.95		1.00			
Satd. Flow (perm)	1641	3282			3438	1538	1656		1482			
Peak-hour factor, PHF	0.87	0.87	0.87	0.90	0.90	0.90	0.78	0.78	0.78	0.92	0.92	0.92
Adj. Flow (vph)	695	787	0	0	694	878	487	0	205	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	128	0	0	0
Lane Group Flow (vph)	695	787	0	0	694	878	487	0	77	0	0	0
Heavy Vehicles (%)	10%	10%	10%	5%	5%	5%	9%	9%	9%	2%	2%	2%
Turn Type	Prot	NA			NA	Free	Prot		Prot			
Protected Phases	5	2			6		8		8			
Permitted Phases		2			6	Free						
Actuated Green, G (s)	51.0	83.0			26.0	130.0	35.0		35.0			
Effective Green, g (s)	51.0	83.0			26.0	130.0	35.0		35.0			
Actuated g/C Ratio	0.39	0.64			0.20	1.00	0.27		0.27			
Clearance Time (s)	6.0	6.0			6.0		6.0		6.0			
Vehicle Extension (s)	5.0	5.0			5.0		3.0		3.0			
Lane Grp Cap (vph)	643	2095			687	1538	445		399			
v/s Ratio Prot	c0.42	0.24			c0.20		c0.29		0.05			
v/s Ratio Perm						0.57						
v/c Ratio	1.08	0.38			1.01	0.57	1.09		0.19			
Uniform Delay, d1	39.5	11.2			52.0	0.0	47.5		36.6			
Progression Factor	0.22	0.00			1.00	1.00	1.00		1.00			
Incremental Delay, d2	44.0	0.3			36.9	1.5	70.7		0.2			
Delay (s)	52.6	0.3			88.9	1.5	118.2		36.9			
Level of Service	D	A			F	A	F		D			
Approach Delay (s)		24.9			40.1			94.1			0.0	
Approach LOS		C			D			F			A	

Intersection Summary			
HCM 2000 Control Delay	44.0	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	1.07		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	85.2%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	5	0	0	7	0	53	5	1003	33	60	276	0
Future Volume (vph)	5	0	0	7	0	53	5	1003	33	60	276	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0				6.0	6.0	6.0	6.0		6.0	6.0	
Lane Util. Factor	1.00				1.00	1.00	1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00				1.00	0.97	1.00	1.00		1.00	1.00	
Flpb, ped/bikes	1.00				1.00	1.00	1.00	1.00		1.00	1.00	
Frt	1.00				1.00	0.85	1.00	1.00		1.00	1.00	
Flt Protected	0.95				0.95	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770				1253	1089	1752	3488		1626	3252	
Flt Permitted	0.75				0.76	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1399				999	1089	1752	3488		1626	3252	
Peak-hour factor, PHF	0.92	0.92	0.92	0.71	0.71	0.71	0.86	0.86	0.86	0.92	0.92	0.92
Adj. Flow (vph)	5	0	0	10	0	75	6	1166	38	65	300	0
RTOR Reduction (vph)	0	0	0	0	0	70	0	2	0	0	0	0
Lane Group Flow (vph)	5	0	0	0	10	5	6	1202	0	65	300	0
Confl. Bikes (#/hr)						5						
Heavy Vehicles (%)	2%	2%	2%	44%	44%	44%	3%	3%	3%	11%	11%	11%
Turn Type	Perm			Perm	NA	Perm	Prot	NA		Prot	NA	
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4			8		8						
Actuated Green, G (s)	5.4				5.4	5.4	0.9	51.7		6.7	57.5	
Effective Green, g (s)	5.4				5.4	5.4	0.9	51.7		6.7	57.5	
Actuated g/C Ratio	0.07				0.07	0.07	0.01	0.63		0.08	0.70	
Clearance Time (s)	6.0				6.0	6.0	6.0	6.0		6.0	6.0	
Vehicle Extension (s)	3.0				3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	92				65	71	19	2204		133	2285	
v/s Ratio Prot							0.00	c0.34		c0.04	c0.09	
v/s Ratio Perm	0.00				c0.01	0.00						
v/c Ratio	0.05				0.15	0.07	0.32	0.55		0.49	0.13	
Uniform Delay, d1	35.8				36.0	35.8	40.1	8.5		35.9	4.0	
Progression Factor	1.00				1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.2				1.1	0.4	9.3	0.3		2.8	0.0	
Delay (s)	36.1				37.1	36.3	49.5	8.7		38.7	4.0	
Level of Service	D				D	D	D	A		D	A	
Approach Delay (s)		36.1			36.4			8.9			10.2	
Approach LOS		D			D			A			B	

Intersection Summary			
HCM 2000 Control Delay	10.7	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.50		
Actuated Cycle Length (s)	81.8	Sum of lost time (s)	18.0
Intersection Capacity Utilization	55.4%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	26	1019	26	114	847	44	52	9	32	259	9	227
Future Volume (vph)	26	1019	26	114	847	44	52	9	32	259	9	227
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0		6.0	6.0	6.0		6.0	6.0	6.0	6.0	
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00		1.00	1.00	0.95	0.95	
Frt	1.00	1.00		1.00	1.00	0.85		1.00	0.85	1.00	0.87	
Flt Protected	0.95	1.00		0.95	1.00	1.00		0.96	1.00	0.95	1.00	
Satd. Flow (prot)	1736	3458		1719	3438	1538		1787	1583	1681	1532	
Flt Permitted	0.95	1.00		0.95	1.00	1.00		0.96	1.00	0.95	1.00	
Satd. Flow (perm)	1736	3458		1719	3438	1538		1787	1583	1681	1532	
Peak-hour factor, PHF	0.87	0.87	0.87	0.86	0.86	0.86	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	30	1171	30	133	985	51	57	10	35	282	10	247
RTOR Reduction (vph)	0	2	0	0	0	29	0	0	32	0	206	0
Lane Group Flow (vph)	30	1199	0	133	985	22	0	67	3	254	79	0
Heavy Vehicles (%)	4%	4%	4%	5%	5%	5%	2%	2%	2%	2%	2%	2%
Turn Type	Prot	NA		Prot	NA	Prot	Split	NA	Prot	Split	NA	
Protected Phases	5	2		1	6	6	3	3	3	4	4	
Permitted Phases												
Actuated Green, G (s)	2.9	32.9		7.0	37.0	37.0		7.2	7.2	14.1	14.1	
Effective Green, g (s)	2.9	32.9		7.0	37.0	37.0		7.2	7.2	14.1	14.1	
Actuated g/C Ratio	0.03	0.39		0.08	0.43	0.43		0.08	0.08	0.17	0.17	
Clearance Time (s)	6.0	6.0		6.0	6.0	6.0		6.0	6.0	6.0	6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0		3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	59	1335		141	1493	667		151	133	278	253	
v/s Ratio Prot	0.02	c0.35		c0.08	c0.29	0.01		c0.04	0.00	c0.15	0.05	
v/s Ratio Perm												
v/c Ratio	0.51	0.90		0.94	0.66	0.03		0.44	0.02	0.91	0.31	
Uniform Delay, d1	40.4	24.6		38.9	19.1	13.8		37.1	35.8	35.0	31.3	
Progression Factor	1.00	1.00		1.00	1.00	1.00		1.00	1.00	1.00	1.00	
Incremental Delay, d2	6.7	8.3		58.4	1.1	0.0		2.1	0.1	32.1	0.7	
Delay (s)	47.2	32.9		97.3	20.2	13.9		39.2	35.8	67.1	32.0	
Level of Service	D	C		F	C	B		D	D	E	C	
Approach Delay (s)		33.2			28.7			38.0			48.5	
Approach LOS		C			C			D			D	

Intersection Summary			
HCM 2000 Control Delay	34.3	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.86		
Actuated Cycle Length (s)	85.2	Sum of lost time (s)	24.0
Intersection Capacity Utilization	75.5%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	925	385	240	525	0	0	0	0	740	0	480
Future Volume (vph)	0	925	385	240	525	0	0	0	0	740	0	480
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0	4.0	6.0	6.0					6.0		6.0
Lane Util. Factor		0.95	1.00	1.00	0.95					0.97		1.00
Frt		1.00	0.85	1.00	1.00					1.00		0.85
Flt Protected		1.00	1.00	0.95	1.00					0.95		1.00
Satd. Flow (prot)		3471	1553	1719	3438					3367		1553
Flt Permitted		1.00	1.00	0.95	1.00					0.95		1.00
Satd. Flow (perm)		3471	1553	1719	3438					3367		1553
Peak-hour factor, PHF	0.87	0.87	0.87	0.86	0.86	0.86	0.92	0.92	0.92	0.91	0.91	0.91
Adj. Flow (vph)	0	1063	443	279	610	0	0	0	0	813	0	527
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	218
Lane Group Flow (vph)	0	1063	443	279	610	0	0	0	0	813	0	309
Heavy Vehicles (%)	4%	4%	4%	5%	5%	5%	2%	2%	2%	4%	4%	4%
Turn Type		NA	Free	Prot	NA					Prot		Prot
Protected Phases		2		1	6					4		4
Permitted Phases			Free									
Actuated Green, G (s)		36.6	100.0	18.4	61.0					27.0		27.0
Effective Green, g (s)		36.6	100.0	18.4	61.0					27.0		27.0
Actuated g/C Ratio		0.37	1.00	0.18	0.61					0.27		0.27
Clearance Time (s)		6.0		6.0	6.0					6.0		6.0
Vehicle Extension (s)		5.0		3.0	5.0					3.0		3.0
Lane Grp Cap (vph)		1270	1553	316	2097					909		419
v/s Ratio Prot		c0.31		c0.16	0.18					c0.24		0.20
v/s Ratio Perm			0.29									
v/c Ratio		0.84	0.29	0.88	0.29					0.89		0.74
Uniform Delay, d1		29.0	0.0	39.8	9.2					35.1		33.3
Progression Factor		1.00	1.00	0.20	0.00					1.00		1.00
Incremental Delay, d2		6.7	0.5	16.3	0.2					11.2		6.7
Delay (s)		35.6	0.5	24.2	0.2					46.3		40.0
Level of Service		D	A	C	A					D		D
Approach Delay (s)		25.3			7.7			0.0			43.8	
Approach LOS		C			A			A			D	

Intersection Summary			
HCM 2000 Control Delay	27.8	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.87		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	76.8%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	580	1085	0	0	470	560	295	0	360	0	0	0
Future Volume (vph)	580	1085	0	0	470	560	295	0	360	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0			6.0	4.0	6.0		6.0			
Lane Util. Factor	1.00	0.95			0.95	1.00	1.00		1.00			
Frt	1.00	1.00			1.00	0.85	1.00		0.85			
Flt Protected	0.95	1.00			1.00	1.00	0.95		1.00			
Satd. Flow (prot)	1752	3505			3505	1568	1703		1524			
Flt Permitted	0.95	1.00			1.00	1.00	0.95		1.00			
Satd. Flow (perm)	1752	3505			3505	1568	1703		1524			
Peak-hour factor, PHF	0.92	0.92	0.92	0.91	0.91	0.91	0.67	0.67	0.67	0.92	0.92	0.92
Adj. Flow (vph)	630	1179	0	0	516	615	440	0	537	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	71	0	0	0
Lane Group Flow (vph)	630	1179	0	0	516	615	440	0	466	0	0	0
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	6%	6%	6%	2%	2%	2%
Turn Type	Prot	NA			NA	Free	Prot		Prot			
Protected Phases	5	2			6		8		8			
Permitted Phases		2			6	Free						
Actuated Green, G (s)	35.0	60.0			19.0	100.0	28.0		28.0			
Effective Green, g (s)	35.0	60.0			19.0	100.0	28.0		28.0			
Actuated g/C Ratio	0.35	0.60			0.19	1.00	0.28		0.28			
Clearance Time (s)	6.0	6.0			6.0		6.0		6.0			
Vehicle Extension (s)	5.0	5.0			5.0		3.0		3.0			
Lane Grp Cap (vph)	613	2103			665	1568	476		426			
v/s Ratio Prot	c0.36	0.34			c0.15		0.26		c0.31			
v/s Ratio Perm						0.39						
v/c Ratio	1.03	0.56			0.78	0.39	0.92		1.09			
Uniform Delay, d1	32.5	12.1			38.5	0.0	35.0		36.0			
Progression Factor	0.20	0.22			1.00	1.00	1.00		1.00			
Incremental Delay, d2	33.7	0.5			8.6	0.7	23.7		71.7			
Delay (s)	40.2	3.2			47.1	0.7	58.7		107.7			
Level of Service	D	A			D	A	E		F			
Approach Delay (s)		16.1			21.9			85.7			0.0	
Approach LOS		B			C			F			A	

Intersection Summary			
HCM 2000 Control Delay	35.1	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.99		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	76.8%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	25	0	0	17	0	87	5	388	4	37	722	0
Future Volume (vph)	25	0	0	17	0	87	5	388	4	37	722	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0				6.0	6.0	6.0	6.0		6.0	6.0	
Lane Util. Factor	1.00				1.00	1.00	1.00	0.95		1.00	0.95	
Frt	1.00				1.00	0.85	1.00	1.00		1.00	1.00	
Flt Protected	0.95				0.95	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770				1577	1568	1752	3499		1719	3438	
Flt Permitted	0.74				0.76	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1375				1257	1568	1752	3499		1719	3438	
Peak-hour factor, PHF	0.92	0.92	0.92	0.58	0.58	0.58	0.86	0.86	0.86	0.91	0.91	0.91
Adj. Flow (vph)	27	0	0	29	0	150	6	451	5	41	793	0
RTOR Reduction (vph)	0	0	0	0	0	128	0	1	0	0	0	0
Lane Group Flow (vph)	27	0	0	0	29	22	6	455	0	41	793	0
Heavy Vehicles (%)	2%	2%	2%	3%	3%	3%	3%	3%	3%	5%	5%	5%
Parking (#/hr)					0							
Turn Type	Perm			Perm	NA	Prot	Prot	NA		Prot	NA	
Protected Phases		4			8	8	5	2		1	6	
Permitted Phases	4			8								
Actuated Green, G (s)	8.2				8.2	8.2	0.9	26.0		2.8	27.9	
Effective Green, g (s)	8.2				8.2	8.2	0.9	26.0		2.8	27.9	
Actuated g/C Ratio	0.15				0.15	0.15	0.02	0.47		0.05	0.51	
Clearance Time (s)	6.0				6.0	6.0	6.0	6.0		6.0	6.0	
Vehicle Extension (s)	3.0				3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	205				187	233	28	1654		87	1744	
v/s Ratio Prot						0.01	0.00	0.13		c0.02	c0.23	
v/s Ratio Perm	0.02				c0.02							
v/c Ratio	0.13				0.16	0.10	0.21	0.28		0.47	0.45	
Uniform Delay, d1	20.3				20.4	20.2	26.7	8.8		25.4	8.7	
Progression Factor	1.00				1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.3				0.4	0.2	3.8	0.1		4.0	0.2	
Delay (s)	20.6				20.8	20.4	30.5	8.9		29.4	8.9	
Level of Service	C				C	C	C	A		C	A	
Approach Delay (s)		20.6			20.4			9.2			9.9	
Approach LOS		C			C			A			A	

Intersection Summary			
HCM 2000 Control Delay	11.1	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.41		
Actuated Cycle Length (s)	55.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	47.2%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Interchange Justification Report
Appendix I
Synchro™ Build Condition I-93 Exit 4A Connector Intersection Analysis Reports

I-93 Exit 4A

Prepared for:

Town of Derry
Town of Londonderry
New Hampshire Department of Transportation

Prepared by:

CLD and Louis Berger

Version: 2
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NHDOT Project Number: 13065
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CLD/Towns Project Number 05-0244

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Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (vph)	980	0	0	0	1730	0
Future Volume (vph)	980	0	0	0	1730	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0				6.0	
Lane Util. Factor	0.97				0.97	
Frt	1.00				1.00	
Flt Protected	0.95				0.95	
Satd. Flow (prot)	3433				3433	
Flt Permitted	0.95				0.95	
Satd. Flow (perm)	3433				3433	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	1043	0	0	0	1840	0
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	1043	0	0	0	1840	0
Turn Type	Prot				Prot	
Protected Phases	2				4	
Permitted Phases						
Actuated Green, G (s)	28.0				50.0	
Effective Green, g (s)	28.0				50.0	
Actuated g/C Ratio	0.31				0.56	
Clearance Time (s)	6.0				6.0	
Vehicle Extension (s)	3.0				3.0	
Lane Grp Cap (vph)	1068				1907	
v/s Ratio Prot	c0.30				c0.54	
v/s Ratio Perm						
v/c Ratio	0.98				0.96	
Uniform Delay, d1	30.7				19.2	
Progression Factor	1.14				1.00	
Incremental Delay, d2	20.6				13.8	
Delay (s)	55.7				33.0	
Level of Service	E				C	
Approach Delay (s)	55.7		0.0			33.0
Approach LOS	E		A			C

Intersection Summary			
HCM 2000 Control Delay	41.2	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.97		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	145.8%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SBL	SBR	NWL	NWR
Lane Configurations										
Traffic Volume (vph)	0	1730	0	0	980	1390	0	0	0	795
Future Volume (vph)	0	1730	0	0	980	1390	0	0	0	795
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0			6.0	6.0			6.0	6.0
Lane Util. Factor		0.95			0.95	0.88			1.00	0.95
Frt		1.00			1.00	0.85			0.85	0.85
Flt Protected		1.00			1.00	1.00			1.00	1.00
Satd. Flow (prot)		3539			3539	2787			1583	1504
Flt Permitted		1.00			1.00	1.00			1.00	1.00
Satd. Flow (perm)		3539			3539	2787			1583	1504
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	1840	0	0	1043	1479	0	0	0	846
RTOR Reduction (vph)	0	0	0	0	0	18	0	0	0	0
Lane Group Flow (vph)	0	1840	0	0	1043	1461	0	0	423	423
Turn Type		NA			NA	Perm			Prot	Prot
Protected Phases		2			2				4	4
Permitted Phases	2					2				
Actuated Green, G (s)		51.0			51.0	51.0			27.0	27.0
Effective Green, g (s)		51.0			51.0	51.0			27.0	27.0
Actuated g/C Ratio		0.57			0.57	0.57			0.30	0.30
Clearance Time (s)		6.0			6.0	6.0			6.0	6.0
Vehicle Extension (s)		3.0			3.0	3.0			3.0	3.0
Lane Grp Cap (vph)		2005			2005	1579			474	451
v/s Ratio Prot		0.52			0.29				0.27	c0.28
v/s Ratio Perm						c0.52				
v/c Ratio		0.92			0.52	0.93			0.89	0.94
Uniform Delay, d1		17.6			12.0	17.8			30.1	30.7
Progression Factor		0.01			1.00	1.00			1.00	1.00
Incremental Delay, d2		2.7			1.0	10.7			18.7	27.2
Delay (s)		3.0			13.0	28.5			48.8	57.8
Level of Service		A			B	C			D	E
Approach Delay (s)		3.0			22.0		0.0		53.3	
Approach LOS		A			C		A		D	

Intersection Summary			
HCM 2000 Control Delay	20.4	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.93		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	131.6%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (vph)	875	0	0	0	1545	0
Future Volume (vph)	875	0	0	0	1545	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0				6.0	
Lane Util. Factor	0.97				0.97	
Frt	1.00				1.00	
Flt Protected	0.95				0.95	
Satd. Flow (prot)	3433				3433	
Flt Permitted	0.95				0.95	
Satd. Flow (perm)	3433				3433	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	931	0	0	0	1644	0
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	931	0	0	0	1644	0
Turn Type	Prot				Prot	
Protected Phases	2				4	
Permitted Phases						
Actuated Green, G (s)	26.0				42.0	
Effective Green, g (s)	26.0				42.0	
Actuated g/C Ratio	0.32				0.52	
Clearance Time (s)	6.0				6.0	
Vehicle Extension (s)	3.0				3.0	
Lane Grp Cap (vph)	1115				1802	
v/s Ratio Prot	c0.27				c0.48	
v/s Ratio Perm						
v/c Ratio	0.83				0.91	
Uniform Delay, d1	25.0				17.3	
Progression Factor	1.18				1.00	
Incremental Delay, d2	6.6				7.5	
Delay (s)	36.1				24.8	
Level of Service	D				C	
Approach Delay (s)	36.1		0.0			24.8
Approach LOS	D		A			C

Intersection Summary			
HCM 2000 Control Delay	28.9	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.88		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	131.8%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SBL	SBR	NWL	NWR
Lane Configurations										
Traffic Volume (vph)	0	1545	0	0	875	1240	0	0	0	710
Future Volume (vph)	0	1545	0	0	875	1240	0	0	0	710
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0			6.0	6.0			6.0	6.0
Lane Util. Factor		0.95			0.95	0.88			1.00	0.95
Frt		1.00			1.00	0.85			0.85	0.85
Flt Protected		1.00			1.00	1.00			1.00	1.00
Satd. Flow (prot)		3539			3539	2787			1583	1504
Flt Permitted		1.00			1.00	1.00			1.00	1.00
Satd. Flow (perm)		3539			3539	2787			1583	1504
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	1644	0	0	931	1319	0	0	0	755
RTOR Reduction (vph)	0	0	0	0	0	34	0	0	0	0
Lane Group Flow (vph)	0	1644	0	0	931	1285	0	0	378	377
Turn Type		NA			NA	Perm			Prot	Prot
Protected Phases		2			2				4	4
Permitted Phases						2				
Actuated Green, G (s)		43.0			43.0	43.0			25.0	25.0
Effective Green, g (s)		43.0			43.0	43.0			25.0	25.0
Actuated g/C Ratio		0.54			0.54	0.54			0.31	0.31
Clearance Time (s)		6.0			6.0	6.0			6.0	6.0
Vehicle Extension (s)		3.0			3.0	3.0			3.0	3.0
Lane Grp Cap (vph)		1902			1902	1498			494	470
v/s Ratio Prot		c0.46			0.26				0.24	c0.25
v/s Ratio Perm						0.46				
v/c Ratio		0.86			0.49	0.86			0.77	0.80
Uniform Delay, d1		16.0			11.6	15.9			24.8	25.2
Progression Factor		0.07			1.00	1.00			1.00	1.00
Incremental Delay, d2		2.3			0.9	6.6			10.8	13.5
Delay (s)		3.5			12.5	22.4			35.6	38.7
Level of Service		A			B	C			D	D
Approach Delay (s)		3.5			18.3		0.0		37.2	
Approach LOS		A			B		A		D	

Intersection Summary			
HCM 2000 Control Delay	16.1	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.84		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	117.6%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (vph)	1135	0	0	0	1770	0
Future Volume (vph)	1135	0	0	0	1770	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0				6.0	
Lane Util. Factor	0.97				0.97	
Frt	1.00				1.00	
Flt Protected	0.95				0.95	
Satd. Flow (prot)	3433				3433	
Flt Permitted	0.95				0.95	
Satd. Flow (perm)	3433				3433	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	1207	0	0	0	1883	0
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	1207	0	0	0	1883	0
Turn Type	Prot				Prot	
Protected Phases	2				4	
Permitted Phases						
Actuated Green, G (s)	31.0				47.0	
Effective Green, g (s)	31.0				47.0	
Actuated g/C Ratio	0.34				0.52	
Clearance Time (s)	6.0				6.0	
Vehicle Extension (s)	3.0				3.0	
Lane Grp Cap (vph)	1182				1792	
v/s Ratio Prot	c0.35				c0.55	
v/s Ratio Perm						
v/c Ratio	1.02				1.05	
Uniform Delay, d1	29.5				21.5	
Progression Factor	0.53				1.00	
Incremental Delay, d2	28.7				36.0	
Delay (s)	44.3				57.5	
Level of Service	D				E	
Approach Delay (s)	44.3		0.0			57.5
Approach LOS	D		A			E

Intersection Summary			
HCM 2000 Control Delay	52.3	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	1.04		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	143.4%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SBL	SBR	NWL	NWR
Lane Configurations										
Traffic Volume (vph)	0	1770	0	0	1135	1205	0	0	0	865
Future Volume (vph)	0	1770	0	0	1135	1205	0	0	0	865
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0			6.0	6.0			6.0	6.0
Lane Util. Factor		0.95			0.95	0.88			1.00	0.95
Frt		1.00			1.00	0.85			0.85	0.85
Flt Protected		1.00			1.00	1.00			1.00	1.00
Satd. Flow (prot)		3539			3539	2787			1583	1504
Flt Permitted		1.00			1.00	1.00			1.00	1.00
Satd. Flow (perm)		3539			3539	2787			1583	1504
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	1883	0	0	1207	1282	0	0	0	920
RTOR Reduction (vph)	0	0	0	0	0	16	0	0	0	0
Lane Group Flow (vph)	0	1883	0	0	1207	1266	0	0	460	460
Turn Type	Perm	NA			NA	Perm			Prot	Prot
Protected Phases		2			2				4	4
Permitted Phases	2					2				
Actuated Green, G (s)		50.0			50.0	50.0			28.0	28.0
Effective Green, g (s)		50.0			50.0	50.0			28.0	28.0
Actuated g/C Ratio		0.56			0.56	0.56			0.31	0.31
Clearance Time (s)		6.0			6.0	6.0			6.0	6.0
Vehicle Extension (s)		3.0			3.0	3.0			3.0	3.0
Lane Grp Cap (vph)		1966			1966	1548			492	467
v/s Ratio Prot		c0.53			0.34				0.29	c0.31
v/s Ratio Perm						0.45				
v/c Ratio		0.96			0.61	0.82			0.93	0.99
Uniform Delay, d1		19.0			13.5	16.3			30.1	30.8
Progression Factor		1.13			1.00	1.00			1.00	1.00
Incremental Delay, d2		1.7			1.4	4.9			25.1	37.4
Delay (s)		23.1			14.9	21.2			55.2	68.2
Level of Service		C			B	C			E	E
Approach Delay (s)		23.1			18.2		0.0		61.7	
Approach LOS		C			B		A		E	

Intersection Summary			
HCM 2000 Control Delay	27.5	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.97		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	129.2%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (vph)	1010	0	0	0	1575	0
Future Volume (vph)	1010	0	0	0	1575	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0				6.0	
Lane Util. Factor	0.97				0.97	
Frt	1.00				1.00	
Flt Protected	0.95				0.95	
Satd. Flow (prot)	3433				3433	
Flt Permitted	0.95				0.95	
Satd. Flow (perm)	3433				3433	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	1074	0	0	0	1676	0
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	1074	0	0	0	1676	0
Turn Type	Prot				Prot	
Protected Phases	2				4	
Permitted Phases						
Actuated Green, G (s)	27.0				41.0	
Effective Green, g (s)	27.0				41.0	
Actuated g/C Ratio	0.34				0.51	
Clearance Time (s)	6.0				6.0	
Vehicle Extension (s)	3.0				3.0	
Lane Grp Cap (vph)	1158				1759	
v/s Ratio Prot	c0.31				c0.49	
v/s Ratio Perm						
v/c Ratio	0.93				0.95	
Uniform Delay, d1	25.6				18.6	
Progression Factor	1.13				1.00	
Incremental Delay, d2	11.9				12.1	
Delay (s)	40.7				30.7	
Level of Service	D				C	
Approach Delay (s)	40.7		0.0			30.7
Approach LOS	D		A			C

Intersection Summary			
HCM 2000 Control Delay	34.6	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.94		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	129.3%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SBL	SBR	NWL	NWR
Lane Configurations										
Traffic Volume (vph)	0	1575	0	0	1010	1075	0	0	0	770
Future Volume (vph)	0	1575	0	0	1010	1075	0	0	0	770
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0			6.0	6.0			6.0	6.0
Lane Util. Factor		0.95			0.95	0.88			1.00	0.95
Frt		1.00			1.00	0.85			0.85	0.85
Flt Protected		1.00			1.00	1.00			1.00	1.00
Satd. Flow (prot)		3539			3539	2787			1583	1504
Flt Permitted		1.00			1.00	1.00			1.00	1.00
Satd. Flow (perm)		3539			3539	2787			1583	1504
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	1676	0	0	1074	1144	0	0	0	819
RTOR Reduction (vph)	0	0	0	0	0	30	0	0	0	0
Lane Group Flow (vph)	0	1676	0	0	1074	1114	0	0	410	409
Turn Type	Perm	NA			NA	Perm			Prot	Prot
Protected Phases		2			2				4	4
Permitted Phases	2					2				
Actuated Green, G (s)		42.0			42.0	42.0			26.0	26.0
Effective Green, g (s)		42.0			42.0	42.0			26.0	26.0
Actuated g/C Ratio		0.52			0.52	0.52			0.32	0.32
Clearance Time (s)		6.0			6.0	6.0			6.0	6.0
Vehicle Extension (s)		3.0			3.0	3.0			3.0	3.0
Lane Grp Cap (vph)		1857			1857	1463			514	488
v/s Ratio Prot		c0.47			0.30				0.26	c0.27
v/s Ratio Perm						0.40				
v/c Ratio		0.90			0.58	0.76			0.80	0.84
Uniform Delay, d1		17.2			13.0	15.0			24.6	25.0
Progression Factor		0.04			1.00	1.00			1.00	1.00
Incremental Delay, d2		2.7			1.3	3.8			12.2	15.7
Delay (s)		3.4			14.3	18.8			36.8	40.8
Level of Service		A			B	B			D	D
Approach Delay (s)		3.4			16.6		0.0		38.8	
Approach LOS		A			B		A		D	

Intersection Summary			
HCM 2000 Control Delay	15.8	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.88		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	115.2%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Movement	NBT	NBR	SBL	SBT	SWL	SWR
Lane Configurations						
Traffic Volume (vph)	0	0	1575	0	460	0
Future Volume (vph)	0	0	1575	0	460	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)			6.0		6.0	
Lane Util. Factor			0.97		0.97	
Frt			1.00		1.00	
Flt Protected			0.95		0.95	
Satd. Flow (prot)			3433		3433	
Flt Permitted			0.95		0.95	
Satd. Flow (perm)			3433		3433	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	0	1676	0	489	0
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	0	0	1676	0	489	0
Turn Type			Prot		Prot	
Protected Phases			4		2	
Permitted Phases						
Actuated Green, G (s)			57.0		21.0	
Effective Green, g (s)			57.0		21.0	
Actuated g/C Ratio			0.63		0.23	
Clearance Time (s)			6.0		6.0	
Vehicle Extension (s)			3.0		3.0	
Lane Grp Cap (vph)			2174		801	
v/s Ratio Prot			c0.49		c0.14	
v/s Ratio Perm						
v/c Ratio			0.77		0.61	
Uniform Delay, d1			11.8		30.8	
Progression Factor			1.00		1.16	
Incremental Delay, d2			2.7		3.4	
Delay (s)			14.5		39.3	
Level of Service			B		D	
Approach Delay (s)	0.0			14.5	39.3	
Approach LOS	A			B	D	

Intersection Summary			
HCM 2000 Control Delay	20.1	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.73		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	122.3%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBL	SBR	NWL	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations										
Traffic Volume (vph)	0	0	0	255	0	1575	0	0	460	1225
Future Volume (vph)	0	0	0	255	0	1575	0	0	460	1225
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)			6.0	6.0		6.0			6.0	6.0
Lane Util. Factor			1.00	0.95		0.95			0.95	0.88
Frt			0.85	0.85		1.00			1.00	0.85
Flt Protected			1.00	1.00		1.00			1.00	1.00
Satd. Flow (prot)			1583	1504		3539			3539	2787
Flt Permitted			1.00	1.00		1.00			1.00	1.00
Satd. Flow (perm)			1583	1504		3539			3539	2787
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	0	0	271	0	1676	0	0	489	1303
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	102
Lane Group Flow (vph)	0	0	136	135	0	1676	0	0	489	1201
Turn Type			Prot	Prot	Perm	NA			NA	Perm
Protected Phases			4	4		2			2	
Permitted Phases					2					2
Actuated Green, G (s)			13.7	13.7		64.3			64.3	64.3
Effective Green, g (s)			13.7	13.7		64.3			64.3	64.3
Actuated g/C Ratio			0.15	0.15		0.71			0.71	0.71
Clearance Time (s)			6.0	6.0		6.0			6.0	6.0
Vehicle Extension (s)			3.0	3.0		3.0			3.0	3.0
Lane Grp Cap (vph)			240	228		2528			2528	1991
v/s Ratio Prot			0.09	c0.09		c0.47			0.14	
v/s Ratio Perm										0.43
v/c Ratio			0.57	0.59		0.66			0.19	0.60
Uniform Delay, d1			35.4	35.5		7.0			4.3	6.4
Progression Factor			1.00	1.00		0.43			1.00	1.00
Incremental Delay, d2			3.1	4.1		0.9			0.2	1.4
Delay (s)			38.4	39.6		3.9			4.4	7.8
Level of Service			D	D		A			A	A
Approach Delay (s)	0.0		39.0			3.9			6.9	
Approach LOS	A		D			A			A	

Intersection Summary			
HCM 2000 Control Delay	7.9	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	97.8%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Movement	NBT	NBR	SBL	SBT	SWL	SWR
Lane Configurations						
Traffic Volume (vph)	0	0	1405	0	410	0
Future Volume (vph)	0	0	1405	0	410	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)			6.0		6.0	
Lane Util. Factor			0.97		0.97	
Frt			1.00		1.00	
Flt Protected			0.95		0.95	
Satd. Flow (prot)			3433		3433	
Flt Permitted			0.95		0.95	
Satd. Flow (perm)			3433		3433	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	0	1495	0	436	0
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	0	0	1495	0	436	0
Turn Type			Prot		Prot	
Protected Phases			4		2	
Permitted Phases						
Actuated Green, G (s)			57.0		21.0	
Effective Green, g (s)			57.0		21.0	
Actuated g/C Ratio			0.63		0.23	
Clearance Time (s)			6.0		6.0	
Vehicle Extension (s)			3.0		3.0	
Lane Grp Cap (vph)			2174		801	
v/s Ratio Prot			c0.44		c0.13	
v/s Ratio Perm						
v/c Ratio			0.69		0.54	
Uniform Delay, d1			10.7		30.3	
Progression Factor			1.00		1.17	
Incremental Delay, d2			1.8		2.6	
Delay (s)			12.5		38.1	
Level of Service			B		D	
Approach Delay (s)	0.0			12.5	38.1	
Approach LOS	A			B	D	

Intersection Summary			
HCM 2000 Control Delay	18.3	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	112.7%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBL	SBR	NWL	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations										
Traffic Volume (vph)	0	0	0	225	0	1405	0	0	410	1090
Future Volume (vph)	0	0	0	225	0	1405	0	0	410	1090
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)			6.0	6.0		6.0			6.0	6.0
Lane Util. Factor			1.00	0.95		0.95			0.95	0.88
Frt			0.85	0.85		1.00			1.00	0.85
Flt Protected			1.00	1.00		1.00			1.00	1.00
Satd. Flow (prot)			1583	1504		3539			3539	2787
Flt Permitted			1.00	1.00		1.00			1.00	1.00
Satd. Flow (perm)			1583	1504		3539			3539	2787
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	0	0	239	0	1495	0	0	436	1160
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	133
Lane Group Flow (vph)	0	0	120	119	0	1495	0	0	436	1027
Turn Type			Prot	Prot	Perm	NA			NA	Perm
Protected Phases			4	4		2			2	
Permitted Phases					2					2
Actuated Green, G (s)			13.3	13.3		64.7			64.7	64.7
Effective Green, g (s)			13.3	13.3		64.7			64.7	64.7
Actuated g/C Ratio			0.15	0.15		0.72			0.72	0.72
Clearance Time (s)			6.0	6.0		6.0			6.0	6.0
Vehicle Extension (s)			3.0	3.0		3.0			3.0	3.0
Lane Grp Cap (vph)			233	222		2544			2544	2003
v/s Ratio Prot			0.08	c0.08		c0.42			0.12	
v/s Ratio Perm										0.37
v/c Ratio			0.52	0.54		0.59			0.17	0.51
Uniform Delay, d1			35.4	35.5		6.2			4.1	5.6
Progression Factor			1.00	1.00		0.45			1.00	1.00
Incremental Delay, d2			1.9	2.5		0.7			0.1	0.9
Delay (s)			37.3	38.0		3.5			4.2	6.6
Level of Service			D	D		A			A	A
Approach Delay (s)	0.0		37.6			3.5			5.9	
Approach LOS	A		D			A			A	

Intersection Summary			
HCM 2000 Control Delay	7.1	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.58		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	88.2%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	NBT	NBR	SBL	SBT	SWL	SWR
Lane Configurations						
Traffic Volume (vph)	0	0	1550	0	420	0
Future Volume (vph)	0	0	1550	0	420	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)			6.0		6.0	
Lane Util. Factor			0.97		0.97	
Frt			1.00		1.00	
Flt Protected			0.95		0.95	
Satd. Flow (prot)			3433		3433	
Flt Permitted			0.95		0.95	
Satd. Flow (perm)			3433		3433	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	0	1649	0	447	0
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	0	0	1649	0	447	0
Turn Type			Prot		Prot	
Protected Phases			4		2	
Permitted Phases						
Actuated Green, G (s)			58.0		20.0	
Effective Green, g (s)			58.0		20.0	
Actuated g/C Ratio			0.64		0.22	
Clearance Time (s)			6.0		6.0	
Vehicle Extension (s)			3.0		3.0	
Lane Grp Cap (vph)			2212		762	
v/s Ratio Prot			c0.48		c0.13	
v/s Ratio Perm						
v/c Ratio			0.75		0.59	
Uniform Delay, d1			10.9		31.3	
Progression Factor			1.00		1.20	
Incremental Delay, d2			2.3		3.3	
Delay (s)			13.3		40.9	
Level of Service			B		D	
Approach Delay (s)	0.0			13.3	40.9	
Approach LOS	A			B	D	

Intersection Summary			
HCM 2000 Control Delay	19.2	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	122.3%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBL	SBR	NWL	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations										
Traffic Volume (vph)	0	0	0	135	0	1550	0	0	420	1245
Future Volume (vph)	0	0	0	135	0	1550	0	0	420	1245
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)			6.0	6.0		6.0			6.0	6.0
Lane Util. Factor			1.00	0.95		0.95			0.95	0.88
Frt			0.85	0.85		1.00			1.00	0.85
Flt Protected			1.00	1.00		1.00			1.00	1.00
Satd. Flow (prot)			1583	1504		3539			3539	2787
Flt Permitted			1.00	1.00		1.00			1.00	1.00
Satd. Flow (perm)			1583	1504		3539			3539	2787
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	0	0	144	0	1649	0	0	447	1324
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	201
Lane Group Flow (vph)	0	0	72	72	0	1649	0	0	447	1123
Turn Type			Prot	Prot	Perm	NA			NA	Perm
Protected Phases			4	4		2			2	
Permitted Phases					2					2
Actuated Green, G (s)			10.7	10.7		67.3			67.3	67.3
Effective Green, g (s)			10.7	10.7		67.3			67.3	67.3
Actuated g/C Ratio			0.12	0.12		0.75			0.75	0.75
Clearance Time (s)			6.0	6.0		6.0			6.0	6.0
Vehicle Extension (s)			3.0	3.0		3.0			3.0	3.0
Lane Grp Cap (vph)			188	178		2646			2646	2084
v/s Ratio Prot			0.05	c0.05		c0.47			0.13	
v/s Ratio Perm										0.40
v/c Ratio			0.38	0.40		0.62			0.17	0.54
Uniform Delay, d1			36.6	36.7		5.4			3.3	4.8
Progression Factor			1.00	1.00		0.51			1.00	1.00
Incremental Delay, d2			1.3	1.5		0.7			0.1	1.0
Delay (s)			37.9	38.2		3.4			3.4	5.8
Level of Service			D	D		A			A	A
Approach Delay (s)	0.0		38.1			3.4			5.2	
Approach LOS	A		D			A			A	

Intersection Summary			
HCM 2000 Control Delay	5.7	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.59		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	97.8%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Movement	NBT	NBR	SBL	SBT	SWL	SWR
Lane Configurations						
Traffic Volume (vph)	0	0	1380	0	375	0
Future Volume (vph)	0	0	1380	0	375	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)			6.0		6.0	
Lane Util. Factor			0.97		0.97	
Frt			1.00		1.00	
Flt Protected			0.95		0.95	
Satd. Flow (prot)			3433		3433	
Flt Permitted			0.95		0.95	
Satd. Flow (perm)			3433		3433	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	0	1468	0	399	0
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	0	0	1468	0	399	0
Turn Type			Prot		Prot	
Protected Phases			4		2	
Permitted Phases						
Actuated Green, G (s)			56.0		22.0	
Effective Green, g (s)			56.0		22.0	
Actuated g/C Ratio			0.62		0.24	
Clearance Time (s)			6.0		6.0	
Vehicle Extension (s)			3.0		3.0	
Lane Grp Cap (vph)			2136		839	
v/s Ratio Prot			c0.43		c0.12	
v/s Ratio Perm						
v/c Ratio			0.69		0.48	
Uniform Delay, d1			11.2		29.1	
Progression Factor			1.00		1.21	
Incremental Delay, d2			1.8		1.9	
Delay (s)			13.0		37.2	
Level of Service			B		D	
Approach Delay (s)	0.0			13.0	37.2	
Approach LOS	A			B	D	

Intersection Summary			
HCM 2000 Control Delay	18.2	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	112.7%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBL	SBR	NWL	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations										
Traffic Volume (vph)	0	0	0	120	0	1380	0	0	375	1110
Future Volume (vph)	0	0	0	120	0	1380	0	0	375	1110
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)			6.0	6.0		6.0			6.0	6.0
Lane Util. Factor			1.00	0.95		0.95			0.95	0.88
Frt			0.85	0.85		1.00			1.00	0.85
Flt Protected			1.00	1.00		1.00			1.00	1.00
Satd. Flow (prot)			1583	1504		3539			3539	2787
Flt Permitted			1.00	1.00		1.00			1.00	1.00
Satd. Flow (perm)			1583	1504		3539			3539	2787
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	0	0	128	0	1468	0	0	399	1181
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	226
Lane Group Flow (vph)	0	0	64	64	0	1468	0	0	399	955
Turn Type			Prot	Prot	Perm	NA			NA	Perm
Protected Phases			4	4		2			2	
Permitted Phases					2					2
Actuated Green, G (s)			10.2	10.2		67.8			67.8	67.8
Effective Green, g (s)			10.2	10.2		67.8			67.8	67.8
Actuated g/C Ratio			0.11	0.11		0.75			0.75	0.75
Clearance Time (s)			6.0	6.0		6.0			6.0	6.0
Vehicle Extension (s)			3.0	3.0		3.0			3.0	3.0
Lane Grp Cap (vph)			179	170		2666			2666	2099
v/s Ratio Prot			0.04	c0.04		c0.41			0.11	
v/s Ratio Perm										0.34
v/c Ratio			0.36	0.38		0.55			0.15	0.46
Uniform Delay, d1			36.9	37.0		4.7			3.1	4.2
Progression Factor			1.00	1.00		0.50			1.00	1.00
Incremental Delay, d2			1.2	1.4		0.6			0.1	0.7
Delay (s)			38.1	38.4		2.9			3.2	4.9
Level of Service			D	D		A			A	A
Approach Delay (s)	0.0		38.2			2.9			4.5	
Approach LOS	A		D			A			A	

Intersection Summary			
HCM 2000 Control Delay	5.1	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.53		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	88.2%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Interchange Justification Report
Appendix J
Synchro™ Build Condition NH 102 Intersection Queuing Reports

I-93 Exit 4A

Prepared for:

Town of Derry
Town of Londonderry
New Hampshire Department of Transportation

Prepared by:

CLD and Louis Berger

Version: 2
October 10, 2019

NHDOT Project Number: 13065
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CLD/Towns Project Number 05-0244

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Queuing and Blocking Report
Alt A 2040 AM Peak 12/28/2017

Intersection: 5: NH 102 & Gilcrest Road

Movement	EB	EB	EB	WB	WB	SB	SB	SB	SB	SB	SB	NE	NE	NE	NE	NE
Directions Served	L	T	R	LT	R	L	L	R	R	R	>	<	<	L	L	LR
Maximum Queue (ft)	375	396	250	499	514	113	154	210	233	246	104	196	300	415	419	300
Average Queue (ft)	317	339	242	384	370	41	66	113	138	154	17	90	225	394	390	297
95th Queue (ft)	444	478	278	609	601	96	123	174	205	221	64	173	387	406	426	318
Link Distance (ft)	356	356		488	488			672	672	672				340	340	
Upstream Blk Time (%)	33	50		31	24									53	43	
Queuing Penalty (veh)	0	0		0	0									654	529	
Storage Bay Dist (ft)			225			275	275				225	275	275		275	
Storage Blk Time (%)		0	68							1			0	54	42	25
Queuing Penalty (veh)		0	88							0			1	149	326	181

Intersection: 6: NH 102 & Hampton Drive/Garden Lane

Movement	SE	SE	SE	NW	NW	NE	NE	NE	NE	NE	SW	SW	SW	SW	SW	SW
Directions Served	L	LT	R	LT	R	L	L	T	T	TR	L	L	T	T	T	R
Maximum Queue (ft)	200	326	200	145	122	209	300	699	713	698	55	80	254	250	290	297
Average Queue (ft)	180	304	146	41	65	115	246	566	560	553	10	31	173	160	149	164

95th Queue (ft)	244	328	276	99	116	182	371	789	790	776	38	65	239	224	238	277
Link Distance (ft)		291		256				672	672	672			352	352	352	
Upstream Blk Time (%)		60						5	2	2				0		
Queuing Penalty (veh)		0						44	16	18				0		
Storage Bay Dist (ft)	175		175		100	275	275				275	275			275	
Storage Blk Time (%)	12	62	1	1	5	0	0	47					0	0	1	
Queuing Penalty (veh)	59	293	5	1	2	0	2	152					0	1	4	

Intersection: 7: NH 102 & Exit 4 SB Off

Movement	EB	EB	WB	WB	SB	SB	SB
Directions Served	T	T	T	T	L	R	R
Maximum Queue (ft)	773	699	345	383	202	188	189
Average Queue (ft)	724	524	158	225	154	109	53
95th Queue (ft)	831	699	295	339	217	256	187
Link Distance (ft)	540	540	335	335	138	138	138
Upstream Blk Time (%)	76	10	0	1	11	11	3
Queuing Penalty (veh)	510	64	1	4	47	45	13
Storage Bay Dist (ft)							
Storage Blk Time (%)							
Queuing Penalty (veh)							

Intersection: 8: NH 102 & Exit 4 NB Off

Movement	NB	NB	NB	NB	NE	NE	NE	NE	SW	SW	SW	B24	B24
Directions Served	<	<	R	R	L	L	T	T	T	T	R	T	T
Maximum Queue (ft)	367	346	215	194	523	520	186	98	733	742	301	7	20
Average Queue (ft)	253	238	114	41	389	405	24	43	522	536	35	0	2
95th Queue (ft)	358	337	200	146	491	495	70	86	798	805	233	5	22
Link Distance (ft)	799	799	799	799			722	722	786	786	786	676	676
Upstream Blk Time (%)									1	1			

Queuing Penalty (veh)									2	4
Storage Bay Dist (ft)					550	550				
Storage Blk Time (%)					0	0				
Queuing Penalty (veh)					0	0				

Intersection: 9: NH 102 & St. Charles Street/Londonderry Road

Movement	SE	SE	NW	NE	NE	NE	SW	SW	SW
Directions Served	LT	R	LTR	L	T	TR	L	T	TR
Maximum Queue (ft)	108	52	11	70	94	116	49	189	196
Average Queue (ft)	40	14	1	28	24	33	6	90	105
95th Queue (ft)	85	42	7	60	71	84	35	162	180
Link Distance (ft)	542		400		676	676		288	288
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)		225		350			100		
Storage Blk Time (%)								5	
Queuing Penalty (veh)								0	

Intersection: 10: NH 102 & Fordway/Madden Hill Road

Movement	SE	NW	NE	SW
Directions Served	LTR	LTR	TR	LT
Maximum Queue (ft)	118	368	395	531
Average Queue (ft)	37	190	178	221
95th Queue (ft)	83	323	323	430
Link Distance (ft)	323	459	1062	560
Upstream Blk Time (%)				1
Queuing Penalty (veh)				0
Storage Bay Dist (ft)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

Queuing and Blocking Report
Alt A 2040 PM Peak 01/02/2018

Intersection: 5: NH 102 & Gilcrest Road

Movement	EB	EB	EB	WB	WB	SB	SB	SB	SB	SB	SB	NE	NE	NE	NE	NE
Directions Served	L	T	R	LT	R	L	L	R	R	R	>	<	<	L	L	LR
Maximum Queue (ft)	368	401	250	518	517	111	143	192	252	290	121	273	300	386	391	300
Average Queue (ft)	142	365	247	448	322	40	69	103	145	161	22	205	281	353	307	238
95th Queue (ft)	313	451	277	615	661	88	116	177	216	243	83	320	356	380	403	340
Link Distance (ft)	356	356		487	487			666	666	666				340	340	
Upstream Blk Time (%)	3	85		58	28									31	5	
Queuing Penalty (veh)	0	0		0	0									280	44	
Storage Bay Dist (ft)			225			275	275				225	275	275		275	
Storage Blk Time (%)		12	82							1	0	2	18	37	7	4
Queuing Penalty (veh)		40	104							2	0	11	82	122	37	21

Intersection: 6: NH 102 & Hampton Drive/Garden Lane

Movement	SE	SE	SE	NW	NW	NE	NE	NE	NE	NE	SW	SW	SW	SW	SW	SW
Directions Served	L	LT	R	LT	R	L	L	T	T	TR	L	L	T	T	T	R
Maximum Queue (ft)	200	341	200	194	125	287	300	682	640	491	105	300	483	496	552	300
Average Queue (ft)	147	307	196	79	68	277	291	500	296	161	37	123	323	308	392	288
95th Queue (ft)	236	320	217	150	127	312	323	802	615	313	88	295	426	403	558	341
Link Distance (ft)		291		253				666	666	666			358	358	358	

Upstream Blk Time (%)		56		0				6	1	0			3	1	14
Queuing Penalty (veh)		0		0				31	3	0			29	9	125
Storage Bay Dist (ft)	175		175		100	275	275				275	275			275
Storage Blk Time (%)	8	26	41	8	5	6	50	0				0	15	4	24
Queuing Penalty (veh)	80	236	326	5	4	24	192	1				0	20	43	125

Intersection: 7: NH 102 & Exit 4 SB Off

Movement	EB	EB	WB	WB	SB	SB	SB
Directions Served	T	T	T	T	L	R	R
Maximum Queue (ft)	435	409	273	295	201	196	192
Average Queue (ft)	295	200	159	200	147	128	74
95th Queue (ft)	430	344	228	265	219	268	219
Link Distance (ft)	540	540	335	335	138	138	138
Upstream Blk Time (%)					20	16	8
Queuing Penalty (veh)					107	83	41
Storage Bay Dist (ft)							
Storage Blk Time (%)							
Queuing Penalty (veh)							

Intersection: 8: NH 102 & Exit 4 NB Off

Movement	NB	NB	NB	NB	NE	NE	NE	NE	SW	SW
Directions Served	<	<	R	R	L	L	T	T	T	T
Maximum Queue (ft)	852	851	850	831	496	484	306	285	256	268
Average Queue (ft)	820	824	818	699	335	333	114	56	137	149
95th Queue (ft)	842	844	840	947	545	542	455	193	230	238
Link Distance (ft)	799	799	799	799			722	722	786	786
Upstream Blk Time (%)	41	82	47	5			1			
Queuing Penalty (veh)	0	0	0	0			9			
Storage Bay Dist (ft)					550	550				
Storage Blk Time (%)					1	2	0			
Queuing Penalty (veh)					1	4	3			

Intersection: 9: NH 102 & St. Charles Street/Londonderry Road

Movement	SE	SE	NW	NE	NE	NE	SW	SW	SW
Directions Served	LT	R	LTR	L	T	TR	L	T	TR
Maximum Queue (ft)	99	57	77	217	195	221	58	222	231
Average Queue (ft)	51	29	11	95	74	89	5	102	122
95th Queue (ft)	87	53	46	169	169	192	30	184	203
Link Distance (ft)	542		400		676	676		288	288
Upstream Blk Time (%)								0	0
Queuing Penalty (veh)								0	0
Storage Bay Dist (ft)		225		350			100		
Storage Blk Time (%)								7	
Queuing Penalty (veh)								0	

Intersection: 10: NH 102 & Fordway/Madden Hill Road

Movement	SE	NW	NE	SW
Directions Served	LTR	LTR	TR	LT
Maximum Queue (ft)	176	361	627	462
Average Queue (ft)	60	185	307	151
95th Queue (ft)	124	336	562	339
Link Distance (ft)	323	459	1062	560
Upstream Blk Time (%)		1		1
Queuing Penalty (veh)		0		0
Storage Bay Dist (ft)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

Queuing and Blocking Report
Alt B 2040 AM Peak 12/28/2017

Intersection: 5: NH 102 & Gilcrest Road

Movement	EB	EB	EB	WB	WB	SB	SB	SB	SB	SB	SB	NE	NE	NE	NE	NE

Directions Served	L	T	R	LT	R	L	L	R	R	R	>	<	<	L	L	LR
Maximum Queue (ft)	394	388	250	471	429	89	109	158	191	217	44	185	300	422	418	300
Average Queue (ft)	319	331	237	329	252	29	52	53	72	92	6	91	238	393	392	298
95th Queue (ft)	431	478	287	539	464	71	96	120	144	163	26	164	388	405	409	306
Link Distance (ft)	356	356		488	488			672	672	672				340	340	
Upstream Blk Time (%)	24	42		14	4									51	44	
Queuing Penalty (veh)	0	0		0	0									611	533	
Storage Bay Dist (ft)			225			275	275				225	275	275		275	
Storage Blk Time (%)		1	60							0			0	52	44	33
Queuing Penalty (veh)		3	75							0			1	140	329	232

Intersection: 6: NH 102 & Hampton Drive/Garden Lane

Movement	SE	SE	SE	NW	NW	NE	NE	NE	NE	NE	SW	SW	SW	SW	SW	SW
Directions Served	L	LT	R	LT	R	L	L	T	T	TR	L	L	T	T	T	R
Maximum Queue (ft)	200	344	200	147	123	214	300	690	708	700	61	256	390	346	381	299
Average Queue (ft)	170	303	158	36	61	119	225	544	560	567	9	34	239	229	206	175
95th Queue (ft)	249	352	278	95	115	193	370	758	770	757	37	107	327	316	335	314
Link Distance (ft)		291		256				672	672	672			352	352	352	
Upstream Blk Time (%)		61						2	1	2			0	0	0	

Queuing Penalty (veh)		0						14	11	20			2	1	2
Storage Bay Dist (ft)	175		175		100	275	275				275	275			275
Storage Blk Time (%)	11	62	3	1	5		0	38				0	3	1	2
Queuing Penalty (veh)	52	281	13	1	2		1	119				0	1	4	7

Intersection: 7: NH 102 & Exit 4 SB Off

Movement	EB	EB	WB	WB	SB	SB	SB
Directions Served	T	T	T	T	L	R	R
Maximum Queue (ft)	765	686	304	342	204	197	195
Average Queue (ft)	719	515	111	172	148	122	69
95th Queue (ft)	827	692	220	291	215	263	213
Link Distance (ft)	540	540	335	335	138	138	138
Upstream Blk Time (%)	75	8	0	0	12	12	4
Queuing Penalty (veh)	485	51	0	1	51	52	17
Storage Bay Dist (ft)							
Storage Blk Time (%)							
Queuing Penalty (veh)							

Intersection: 8: NH 102 & Exit 4 NB Off

Movement	NB	NB	NB	NB	NE	NE	NE	NE	SW	SW	SW	B24
Directions Served	<	<	R	R	L	L	T	T	T	T	R	T
Maximum Queue (ft)	378	361	216	178	480	482	251	101	614	639	492	15
Average Queue (ft)	243	238	128	53	368	374	31	43	412	431	80	1
95th Queue (ft)	347	342	198	159	467	469	134	89	600	623	378	11
Link Distance (ft)	799	799	799	799			722	722	786	786	786	676
Upstream Blk Time (%)											0	
Queuing Penalty (veh)											1	
Storage Bay Dist (ft)					550	550						
Storage Blk Time (%)					0	0						
Queuing Penalty (veh)					0	0						

Intersection: 9: NH 102 & St. Charles Street/Londonderry Road

Movement	SE	SE	NW	NE	NE	NE	SW	SW	SW
Directions Served	LT	R	LTR	L	T	TR	L	T	TR
Maximum Queue (ft)	33	113	12	88	77	98	34	203	230
Average Queue (ft)	9	46	1	30	11	22	6	81	114
95th Queue (ft)	31	83	7	70	46	66	26	161	198
Link Distance (ft)	542		400		676	676		288	288
Upstream Blk Time (%)								0	0
Queuing Penalty (veh)								0	0
Storage Bay Dist (ft)		225		350			100		
Storage Blk Time (%)								2	
Queuing Penalty (veh)								0	

Intersection: 10: NH 102 & Fordway/Madden Hill Road

Movement	SE	NW	NE	SW
Directions Served	LTR	LTR	TR	LT
Maximum Queue (ft)	92	328	354	498
Average Queue (ft)	31	163	148	231
95th Queue (ft)	70	266	289	418
Link Distance (ft)	323	459	1062	560
Upstream Blk Time (%)				0
Queuing Penalty (veh)				0
Storage Bay Dist (ft)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

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Intersection: 5: NH 102 & Gilcrest Road

Movement	EB	EB	EB	WB	WB	SB	SB	SB	SB	SB	SB	NE	NE	NE	NE	NE
Directions Served	L	T	R	LT	R	L	L	R	R	R	>	<	<	L	L	LR

Maximum Queue (ft)	360	399	250	523	510	156	181	204	224	244	76	277	300	378	373	300
Average Queue (ft)	125	374	250	460	269	56	84	103	138	148	22	220	273	345	259	216
95th Queue (ft)	273	385	250	600	586	119	149	176	209	218	60	321	355	396	396	327
Link Distance (ft)	356	356		487	487			666	666	666				340	340	
Upstream Blk Time (%)	2	89		49	11									23	2	
Queuing Penalty (veh)	0	0		0	0									207	20	
Storage Bay Dist (ft)			225			275	275				225	275	275		275	
Storage Blk Time (%)		8	86							1		6	19	23	4	3
Queuing Penalty (veh)		26	110							2		26	88	75	19	14

Intersection: 6: NH 102 & Hampton Drive/Garden Lane

Movement	SE	SE	SE	NW	NW	NE	NE	NE	NE	NE	SW	SW	SW	SW	SW	SW
Directions Served	L	LT	R	LT	R	L	L	T	T	TR	L	L	T	T	T	R
Maximum Queue (ft)	200	343	200	228	125	287	298	547	472	269	126	299	477	424	541	300
Average Queue (ft)	145	309	196	99	79	240	254	251	165	139	41	126	322	303	377	290
95th Queue (ft)	234	325	215	196	138	321	329	554	370	229	98	298	428	388	534	340
Link Distance (ft)		291		253				666	666	666			358	358	358	
Upstream Blk Time (%)		55		0				1	0				4	1	12	
Queuing Penalty (veh)		0		0				5	0				33	13	106	

Storage Bay Dist (ft)	175		175		100	275	275				275	275			275
Storage Blk Time (%)	6	28	42	14	7	2	18	0				0	18	6	21
Queuing Penalty (veh)	52	244	330	9	6	7	66	0				0	24	57	109

Intersection: 7: NH 102 & Exit 4 SB Off

Movement	EB	EB	WB	WB	SB	SB	SB
Directions Served	T	T	T	T	L	R	R
Maximum Queue (ft)	606	516	288	347	200	212	192
Average Queue (ft)	419	309	189	235	145	124	80
95th Queue (ft)	657	523	257	317	219	267	228
Link Distance (ft)	540	540	335	335	138	138	138
Upstream Blk Time (%)	8	1	0	1	20	16	7
Queuing Penalty (veh)	51	8	0	7	111	90	41
Storage Bay Dist (ft)							
Storage Blk Time (%)							
Queuing Penalty (veh)							

Intersection: 8: NH 102 & Exit 4 NB Off

Movement	NB	NB	NB	NB	NE	NE	NE	NE	SW	SW	SW
Directions Served	<	<	R	R	L	L	T	T	T	T	R
Maximum Queue (ft)	847	849	846	819	460	454	256	125	221	229	51
Average Queue (ft)	786	791	708	536	296	302	104	61	111	137	2
95th Queue (ft)	909	917	1062	927	482	489	400	114	196	205	38
Link Distance (ft)	799	799	799	799			722	722	786	786	786
Upstream Blk Time (%)	31	59	30	2			1				
Queuing Penalty (veh)	0	0	0	0			5				
Storage Bay Dist (ft)					550	550					
Storage Blk Time (%)					0	1					
Queuing Penalty (veh)					0	2					

Intersection: 9: NH 102 & St. Charles Street/Londonderry Road

Movement	SE	SE	NW	NE	NE	NE	SW	SW	SW

Directions Served	LT	R	LTR	L	T	TR	L	T	TR
Maximum Queue (ft)	110	65	72	189	212	227	40	212	268
Average Queue (ft)	51	37	10	84	61	77	4	95	138
95th Queue (ft)	94	60	43	154	153	177	23	178	232
Link Distance (ft)	542		400		676	676		288	288
Upstream Blk Time (%)								0	0
Queuing Penalty (veh)								0	0
Storage Bay Dist (ft)		225		350			100		
Storage Blk Time (%)								5	
Queuing Penalty (veh)								0	

Intersection: 10: NH 102 & Fordway/Madden Hill Road

Movement	SE	NW	NE	SW
Directions Served	LTR	LTR	TR	LT
Maximum Queue (ft)	146	286	626	468
Average Queue (ft)	51	160	288	149
95th Queue (ft)	110	254	529	355
Link Distance (ft)	323	459	1062	560
Upstream Blk Time (%)				2
Queuing Penalty (veh)				0
Storage Bay Dist (ft)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

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Intersection: 5: NH 102 & Gilcrest Road

Movement	EB	EB	EB	WB	WB	SB	SB	SB	SB	SB	SB	NE	NE	NE	NE	NE
Directions Served	L	T	R	LT	R	L	L	R	R	R	>	<	<	L	L	LR
Maximum Queue (ft)	386	386	250	522	528	125	136	198	216	207	109	135	300	423	421	300

Average Queue (ft)	359	268	195	443	421	42	63	68	83	97	16	54	216	395	393	293
95th Queue (ft)	418	485	309	625	642	94	114	140	157	171	63	118	406	409	414	347
Link Distance (ft)	356	356		488	488			672	672	672				340	340	
Upstream Blk Time (%)	66	23		40	49									70	54	
Queuing Penalty (veh)	0	0		0	0									799	620	
Storage Bay Dist (ft)			225			275	275				225	275	275		275	
Storage Blk Time (%)		3	32							0			0	71	49	34
Queuing Penalty (veh)		7	49							0			1	150	366	228

Intersection: 6: NH 102 & Hampton Drive/Garden Lane

Movement	SE	SE	SE	NW	NW	NE	NE	NE	NE	NE	SW	SW	SW	SW	SW	SW
Directions Served	L	LT	R	LT	R	L	L	T	T	TR	L	L	T	T	T	R
Maximum Queue (ft)	200	315	200	152	121	130	300	714	727	710	72	226	325	320	288	223
Average Queue (ft)	142	208	121	43	72	47	233	642	572	494	17	47	228	216	189	59
95th Queue (ft)	225	333	237	107	120	102	415	825	822	764	49	127	314	297	275	150
Link Distance (ft)		291		256				672	672	672			352	352	352	
Upstream Blk Time (%)		7						30	3	1			0	0		
Queuing Penalty (veh)		0						269	31	13			0	0		
Storage Bay Dist (ft)	175		175		100	275	275				275	275			275	

Storage Blk Time (%)	4	20	2	1	8		0	82					1	0	0
Queuing Penalty (veh)	11	57	6	1	3		1	123					1	1	0

Intersection: 7: NH 102 & Exit 4 SB Off

Movement	EB	EB	WB	WB	SB	SB	SB
Directions Served	T	T	T	T	L	R	R
Maximum Queue (ft)	774	708	178	238	139	208	194
Average Queue (ft)	742	507	72	118	62	183	65
95th Queue (ft)	759	724	142	205	117	223	206
Link Distance (ft)	540	540	335	335	138	138	138
Upstream Blk Time (%)	87	11			0	25	4
Queuing Penalty (veh)	584	76			2	94	14
Storage Bay Dist (ft)							
Storage Blk Time (%)							
Queuing Penalty (veh)							

Intersection: 8: NH 102 & Exit 4 NB Off

Movement	NB	NB	NB	NB	NE	NE	NE	NE	SW	SW	SW	B24	B24
Directions Served	<	<	R	R	L	L	T	T	T	T	R	T	T
Maximum Queue (ft)	490	456	289	254	446	443	60	64	735	724	516	30	34
Average Queue (ft)	275	250	157	95	314	314	8	14	486	514	51	0	0
95th Queue (ft)	444	418	248	226	408	400	36	46	706	727	291	0	3
Link Distance (ft)	799	799	799	799			722	722	786	786	786	676	676
Upstream Blk Time (%)									0	0			
Queuing Penalty (veh)									1	2			
Storage Bay Dist (ft)					550	550							
Storage Blk Time (%)													
Queuing Penalty (veh)													

Intersection: 9: NH 102 & St. Charles Street/Londonderry Road

Movement	SE	SE	NE	NE	NE	SW	SW	SW
Directions Served	LT	R	L	T	TR	L	T	TR
Maximum Queue (ft)	42	112	133	90	86	49	204	196

Average Queue (ft)	9	49	48	15	16	5	89	112
95th Queue (ft)	31	88	107	54	59	28	163	180
Link Distance (ft)	542			676	676		288	288
Upstream Blk Time (%)								
Queuing Penalty (veh)								
Storage Bay Dist (ft)		225	350			100		
Storage Blk Time (%)							4	
Queuing Penalty (veh)							0	

Intersection: 10: NH 102 & Fordway/Madden Hill Road

Movement	SE	NW	NE	SW
Directions Served	LTR	LTR	TR	LT
Maximum Queue (ft)	60	301	452	496
Average Queue (ft)	19	157	183	210
95th Queue (ft)	49	266	374	415
Link Distance (ft)	323	459	1062	560
Upstream Blk Time (%)				2
Queuing Penalty (veh)				0
Storage Bay Dist (ft)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

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Intersection: 5: NH 102 & Gilcrest Road

Movement	EB	EB	EB	WB	WB	SB	SB	SB	SB	SB	SB	NE	NE	NE	NE	NE
Directions Served	L	T	R	LT	R	L	L	R	R	R	>	<	<	L	L	LR
Maximum Queue (ft)	368	410	250	527	530	138	161	272	350	304	216	287	300	387	389	300
Average Queue (ft)	234	364	240	498	410	63	85	141	174	178	38	201	284	355	309	257

95th Queue (ft)	419	440	299	551	681	121	144	232	280	270	138	322	354	387	428	345
Link Distance (ft)	356	356		487	487			666	666	666				340	340	
Upstream Blk Time (%)	14	69		84	29									39	11	
Queuing Penalty (veh)	0	0		0	0									370	100	
Storage Bay Dist (ft)			225			275	275				225	275	275		275	
Storage Blk Time (%)		36	54					0		5	0	3	18	43	10	8
Queuing Penalty (veh)		99	80					0		9	0	16	89	131	62	38

Intersection: 6: NH 102 & Hampton Drive/Garden Lane

Movement	SE	SE	SE	NW	NW	NE	NE	NE	NE	NE	SW	SW	SW	SW	SW	SW
Directions Served	L	LT	R	LT	R	L	L	T	T	TR	L	L	T	T	T	R
Maximum Queue (ft)	199	331	200	264	125	280	300	612	528	460	136	300	512	422	431	300
Average Queue (ft)	135	307	197	160	96	181	244	336	229	190	68	176	349	319	297	238
95th Queue (ft)	219	317	211	274	155	276	336	702	487	356	123	352	471	401	396	344
Link Distance (ft)		291		253				666	666	666			358	358	358	
Upstream Blk Time (%)		62		10				5	0	0			6	2	2	
Queuing Penalty (veh)		0		19				29	0	0			54	21	17	
Storage Bay Dist (ft)	175		175		100	275	275				275	275			275	
Storage Blk Time (%)	5	16	56	34	17	0	2	26				0	17	7	2	

Queuing Penalty (veh)	36	113	342	28	19	1	11	110				0	33	51	12

Intersection: 7: NH 102 & Exit 4 SB Off

Movement	EB	EB	WB	WB	SB	SB	SB
Directions Served	T	T	T	T	L	R	R
Maximum Queue (ft)	765	707	338	354	144	200	190
Average Queue (ft)	663	528	226	252	55	163	54
95th Queue (ft)	884	798	331	349	118	252	187
Link Distance (ft)	540	540	335	335	138	138	138
Upstream Blk Time (%)	58	19	2	3	1	22	5
Queuing Penalty (veh)	366	116	11	19	4	107	24
Storage Bay Dist (ft)							
Storage Blk Time (%)							
Queuing Penalty (veh)							

Intersection: 8: NH 102 & Exit 4 NB Off

Movement	NB	NB	NB	NB	NE	NE	NE	NE	SW	SW
Directions Served	<	<	R	R	L	L	T	T	T	T
Maximum Queue (ft)	854	852	842	827	353	298	64	58	277	294
Average Queue (ft)	716	715	653	525	209	204	20	22	155	178
95th Queue (ft)	1005	1010	1055	923	303	268	54	54	240	266
Link Distance (ft)	799	799	799	799			722	722	786	786
Upstream Blk Time (%)	32	49	32	4						
Queuing Penalty (veh)	0	0	0	0						
Storage Bay Dist (ft)					550	550				
Storage Blk Time (%)										
Queuing Penalty (veh)										

Intersection: 9: NH 102 & St. Charles Street/Londonderry Road

Movement	SE	SE	NW	NE	NE	NE	SW	SW	SW
Directions Served	LT	R	LTR	L	T	TR	L	T	TR
Maximum Queue (ft)	41	97	85	288	177	200	25	196	255
Average Queue (ft)	13	46	13	112	37	47	3	83	118
95th Queue (ft)	37	79	52	216	125	152	18	154	201

Link Distance (ft)	542		400		676	676		288	288
Upstream Blk Time (%)									0
Queuing Penalty (veh)									0
Storage Bay Dist (ft)		225		350			100		
Storage Blk Time (%)				0				4	
Queuing Penalty (veh)				0				0	

Intersection: 10: NH 102 & Fordway/Madden Hill Road

Movement	SE	NW	NE	SW
Directions Served	LTR	LTR	TR	LT
Maximum Queue (ft)	94	268	614	402
Average Queue (ft)	29	150	291	127
95th Queue (ft)	72	244	550	277
Link Distance (ft)	323	459	1062	560
Upstream Blk Time (%)				0
Queuing Penalty (veh)				0
Storage Bay Dist (ft)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

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Intersection: 5: NH 102 & Gilcrest Road

Movement	EB	EB	EB	WB	WB	SB	SB	SB	SB	SB	SB	NE	NE	NE	NE	NE
Directions Served	L	T	R	LT	R	L	L	R	R	R	>	<	<	L	L	LR
Maximum Queue (ft)	395	386	250	520	522	141	174	262	346	316	213	160	300	422	423	300
Average Queue (ft)	350	271	206	443	412	53	81	86	110	123	27	63	231	394	393	296
95th Queue (ft)	431	495	308	602	624	114	154	184	223	228	118	131	402	407	415	318

Link Distance (ft)	356	356		488	488			672	672	672				340	340	
Upstream Blk Time (%)	54	33		33	36									64	53	
Queuing Penalty (veh)	0	0		0	0									743	613	
Storage Bay Dist (ft)			225			275	275				225	275	275		275	
Storage Blk Time (%)		1	41				0	0		1	0		0	66	49	35
Queuing Penalty (veh)		1	64				0	0		1	0		0	140	365	235

Intersection: 6: NH 102 & Hampton Drive/Garden Lane

Movement	SE	SE	SE	NW	NW	NE	NE	NE	NE	NE	SW	SW	SW	SW	SW	SW
Directions Served	L	LT	R	LT	R	L	L	T	T	TR	L	L	T	T	T	R
Maximum Queue (ft)	200	310	200	217	123	134	300	706	720	700	81	216	378	338	322	275
Average Queue (ft)	137	213	121	53	70	48	242	612	593	546	20	52	226	216	191	79
95th Queue (ft)	235	345	239	133	125	105	410	836	822	791	57	145	337	310	283	199
Link Distance (ft)		291		256				672	672	672			352	352	352	
Upstream Blk Time (%)		9		0				20	5	3			0	0	0	
Queuing Penalty (veh)		0		1				174	44	24			2	0	0	
Storage Bay Dist (ft)	175		175		100	275	275				275	275			275	
Storage Blk Time (%)	5	22	1	1	10		0	77					2	0	0	
Queuing Penalty (veh)	17	66	2	1	4		1	117					1	1	0	

Intersection: 7: NH 102 & Exit 4 SB Off

Movement	EB	EB	WB	WB	SB	SB	SB
Directions Served	T	T	T	T	L	R	R
Maximum Queue (ft)	772	708	245	294	140	218	202
Average Queue (ft)	737	524	106	160	59	173	82
95th Queue (ft)	776	692	189	253	113	255	225
Link Distance (ft)	540	540	335	335	138	138	138
Upstream Blk Time (%)	85	10		0	0	23	4
Queuing Penalty (veh)	580	66		0	2	85	17
Storage Bay Dist (ft)							
Storage Blk Time (%)							
Queuing Penalty (veh)							

Intersection: 8: NH 102 & Exit 4 NB Off

Movement	NB	NB	NB	NB	NE	NE	NE	NE	SW	SW	SW	B24	B24
Directions Served	<	<	R	R	L	L	T	T	T	T	R	T	T
Maximum Queue (ft)	410	391	274	253	425	438	59	69	806	822	576	91	100
Average Queue (ft)	261	237	171	121	307	310	13	18	584	599	82	13	15
95th Queue (ft)	376	351	257	248	391	391	44	53	845	851	401	102	114
Link Distance (ft)	799	799	799	799			722	722	786	786	786	676	676
Upstream Blk Time (%)									4	4			
Queuing Penalty (veh)									19	19			
Storage Bay Dist (ft)					550	550							
Storage Blk Time (%)													
Queuing Penalty (veh)													

Intersection: 9: NH 102 & St. Charles Street/Londonderry Road

Movement	SE	SE	NW	NE	NE	NE	SW	SW	SW
Directions Served	LT	R	LTR	L	T	TR	L	T	TR
Maximum Queue (ft)	38	135	11	141	84	118	35	222	225
Average Queue (ft)	9	50	1	48	15	21	5	104	128
95th Queue (ft)	32	94	8	105	55	76	24	187	206
Link Distance (ft)	542		400		676	676		288	288
Upstream Blk Time (%)								0	
Queuing Penalty (veh)								0	

Storage Bay Dist (ft)		225		350			100	
Storage Blk Time (%)								5
Queuing Penalty (veh)								0

Intersection: 10: NH 102 & Fordway/Madden Hill Road

Movement	SE	NW	NE	SW
Directions Served	LTR	LTR	TR	LT
Maximum Queue (ft)	69	327	431	510
Average Queue (ft)	20	162	177	218
95th Queue (ft)	56	261	350	401
Link Distance (ft)	323	459	1062	560
Upstream Blk Time (%)				0
Queuing Penalty (veh)				0
Storage Bay Dist (ft)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

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Intersection: 5: NH 102 & Gilcrest Road

Movement	EB	EB	EB	WB	WB	SB	SB	SB	SB	SB	SB	NE	NE	NE	NE	NE
Directions Served	L	T	R	LT	R	L	L	R	R	R	>	<	<	L	L	LR
Maximum Queue (ft)	376	405	250	530	512	142	215	299	341	268	177	287	300	386	386	300
Average Queue (ft)	185	371	248	498	436	68	95	137	161	166	33	238	281	352	318	265
95th Queue (ft)	358	406	266	553	664	132	168	238	259	247	121	324	344	395	421	344
Link Distance (ft)	356	356		487	487			666	666	666				340	340	
Upstream Blk Time (%)	4	84		84	33									35	11	

Queuing Penalty (veh)	0	0		0	0									343	108	
Storage Bay Dist (ft)			225			275	275				225	275	275		275	
Storage Blk Time (%)		47	51				0	0		4	0	3	23	34	12	10
Queuing Penalty (veh)		132	75				0	0		7	0	18	114	107	72	52

Intersection: 6: NH 102 & Hampton Drive/Garden Lane

Movement	SE	SE	SE	NW	NW	NE	NE	NE	NE	NE	SW	SW	SW	SW	SW	SW
Directions Served	L	LT	R	LT	R	L	L	T	T	TR	L	L	T	T	T	R
Maximum Queue (ft)	200	333	200	267	125	279	280	307	260	231	136	300	501	400	505	300
Average Queue (ft)	128	307	195	178	97	184	203	158	124	137	63	160	340	313	298	244
95th Queue (ft)	222	317	217	303	155	265	275	253	209	220	117	337	450	392	413	351
Link Distance (ft)		291		253				666	666	666			358	358	358	
Upstream Blk Time (%)		64		15									5	2	2	
Queuing Penalty (veh)		0		29									43	15	21	
Storage Bay Dist (ft)	175		175		100	275	275				275	275			275	
Storage Blk Time (%)	5	20	56	41	24	0	1					0	18	7	3	
Queuing Penalty (veh)	38	144	345	33	28	1	6					0	35	49	19	

Intersection: 7: NH 102 & Exit 4 SB Off

Movement	EB	EB	WB	WB	SB	SB	SB
Directions Served	T	T	T	T	L	R	R

Maximum Queue (ft)	749	644	365	406	137	207	191
Average Queue (ft)	603	456	264	301	47	168	49
95th Queue (ft)	857	709	362	403	103	251	176
Link Distance (ft)	540	540	335	335	138	138	138
Upstream Blk Time (%)	33	5	2	6	1	19	5
Queuing Penalty (veh)	213	32	15	44	3	92	24
Storage Bay Dist (ft)							
Storage Blk Time (%)							
Queuing Penalty (veh)							

Intersection: 8: NH 102 & Exit 4 NB Off

Movement	NB	NB	NB	NB	NE	NE	NE	NE	SW	SW
Directions Served	<	<	R	R	L	L	T	T	T	T
Maximum Queue (ft)	814	812	770	761	349	306	124	95	355	357
Average Queue (ft)	688	682	571	484	219	210	41	42	198	214
95th Queue (ft)	949	946	956	848	313	284	99	82	314	323
Link Distance (ft)	799	799	799	799			722	722	786	786
Upstream Blk Time (%)	19	28	19	2						
Queuing Penalty (veh)	0	0	0	0						
Storage Bay Dist (ft)					550	550				
Storage Blk Time (%)										
Queuing Penalty (veh)										

Intersection: 9: NH 102 & St. Charles Street/Londonderry Road

Movement	SE	SE	NW	NE	NE	NE	SW	SW	SW
Directions Served	LT	R	LTR	L	T	TR	L	T	TR
Maximum Queue (ft)	54	106	86	318	203	210	70	289	280
Average Queue (ft)	11	49	12	157	41	49	3	126	158
95th Queue (ft)	38	83	53	274	137	152	21	219	251
Link Distance (ft)	542		400		676	676		288	288
Upstream Blk Time (%)								0	0
Queuing Penalty (veh)								1	2
Storage Bay Dist (ft)		225		350			100		
Storage Blk Time (%)				0				12	
Queuing Penalty (veh)				1				1	

Intersection: 10: NH 102 & Fordway/Madden Hill Road

Movement	SE	NW	NE	SW
Directions Served	LTR	LTR	TR	LT
Maximum Queue (ft)	106	391	663	538
Average Queue (ft)	34	181	303	177
95th Queue (ft)	80	315	561	428
Link Distance (ft)	323	459	1062	560
Upstream Blk Time (%)				4
Queuing Penalty (veh)				0
Storage Bay Dist (ft)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

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Intersection: 5: NH 102 & Gilcrest Road

Movement	EB	EB	EB	WB	WB	SB	SB	SB	SB	SB	SB	NE	NE	NE	NE	NE
Directions Served	L	T	R	LT	R	L	L	R	R	R	>	<	<	L	L	LR
Maximum Queue (ft)	386	397	250	490	464	113	134	182	198	209	57	158	300	424	413	300
Average Queue (ft)	326	290	227	354	281	38	56	71	87	101	15	83	196	391	393	297
95th Queue (ft)	440	485	294	569	526	87	103	134	160	170	44	154	373	415	403	309
Link Distance (ft)	356	356		488	488			672	672	672				340	340	
Upstream Blk Time (%)	35	32		21	8									43	42	
Queuing Penalty (veh)	0	0		0	0									489	483	
Storage Bay Dist (ft)			225			275	275				225	275	275		275	

Storage Blk Time (%)		2	50							0			0	44	40	32
Queuing Penalty (veh)		6	77							0			0	93	296	215

Intersection: 6: NH 102 & Hampton Drive/Garden Lane

Movement	SE	SE	SE	NW	NW	NE	NE	NE	NE	NE	SW	SW	SW	SW	SW	SW
Directions Served	L	LT	R	LT	R	L	L	T	T	TR	L	L	T	T	T	R
Maximum Queue (ft)	200	316	200	154	123	125	299	525	568	515	60	73	247	255	207	129
Average Queue (ft)	137	241	131	46	71	57	114	283	320	353	14	35	165	158	135	44
95th Queue (ft)	237	351	252	116	121	110	240	453	487	499	42	66	239	229	211	102
Link Distance (ft)		291		256				672	672	672			352	352	352	
Upstream Blk Time (%)		14						0	0							
Queuing Penalty (veh)		0						0	0							
Storage Bay Dist (ft)	175		175		100	275	275				275	275			275	
Storage Blk Time (%)	2	32	1	2	7		0	7					0			
Queuing Penalty (veh)	7	94	4	2	3		0	10					0			

Intersection: 7: NH 102 & Exit 4 SB Off

Movement	EB	EB	WB	WB	SB	SB	SB
Directions Served	T	T	T	T	L	R	R
Maximum Queue (ft)	594	544	149	200	214	196	150
Average Queue (ft)	379	330	78	117	190	102	8
95th Queue (ft)	585	534	133	174	202	252	66
Link Distance (ft)	540	540	335	335	138	138	138

Upstream Blk Time (%)	4	1			49	8	1
Queuing Penalty (veh)	29	8			273	45	4
Storage Bay Dist (ft)							
Storage Blk Time (%)							
Queuing Penalty (veh)							

Intersection: 8: NH 102 & Exit 4 NB Off

Movement	NB	NB	NB	NB	NE	NE	NE	NE	SW	SW	SW	B24	B24
Directions Served	<	<	R	R	L	L	T	T	T	T	R	T	T
Maximum Queue (ft)	446	440	308	254	510	511	348	284	703	720	839	83	181
Average Queue (ft)	292	266	195	149	388	401	114	105	518	547	603	0	5
95th Queue (ft)	451	435	285	272	507	524	338	210	714	730	879	0	49
Link Distance (ft)	799	799	799	799			722	722	786	786	786	676	676
Upstream Blk Time (%)							1		0	0	2		
Queuing Penalty (veh)							7		0	0	12		
Storage Bay Dist (ft)					550	550							
Storage Blk Time (%)					0	1							
Queuing Penalty (veh)					0	5							

Intersection: 9: NH 102 & St. Charles Street/Londonderry Road

Movement	SE	SE	NW	NE	NE	NE	SW	SW	SW
Directions Served	LT	R	LTR	L	T	TR	L	T	TR
Maximum Queue (ft)	41	108	18	186	92	115	72	191	208
Average Queue (ft)	8	53	2	75	15	29	13	144	179
95th Queue (ft)	30	92	13	147	57	84	45	196	224
Link Distance (ft)	542		400		676	676		144	144
Upstream Blk Time (%)								4	14
Queuing Penalty (veh)								35	116
Storage Bay Dist (ft)		180		360			65		
Storage Blk Time (%)							0	17	
Queuing Penalty (veh)							0	2	

Intersection: 10: NH 102 & Fordway/Madden Hill Road

Movement	SE	NW	NW	NE	NE	B19	SW	B23
Directions Served	LTR	L	R	T	R	T	LT	T

Maximum Queue (ft)	52	372	125	248	125	181	365	281
Average Queue (ft)	13	187	27	164	64	29	260	47
95th Queue (ft)	40	311	100	272	143	112	397	230
Link Distance (ft)	325	446		164		1231	277	409
Upstream Blk Time (%)		0		7			10	2
Queuing Penalty (veh)		0		58			0	0
Storage Bay Dist (ft)			100		100			
Storage Blk Time (%)		32	0	13	0			
Queuing Penalty (veh)		10	0	24	1			

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Intersection: 5: NH 102 & Gilcrest Road

Movement	EB	EB	EB	WB	WB	SB	SB	SB	SB	SB	SB	NE	NE	NE	NE	NE
Directions Served	L	T	R	LT	R	L	L	R	R	R	>	<	<	L	L	LR
Maximum Queue (ft)	369	391	250	528	519	129	158	244	288	243	155	266	300	377	385	300
Average Queue (ft)	188	287	219	486	433	54	76	115	145	152	27	181	254	339	308	258
95th Queue (ft)	354	477	307	587	681	112	132	203	228	223	87	293	365	398	406	345
Link Distance (ft)	356	356		487	487			666	666	666				340	340	
Upstream Blk Time (%)	3	42		83	38									18	7	
Queuing Penalty (veh)	0	0		0	0									168	63	
Storage Bay Dist (ft)			225			275	275				225	275	275		275	
Storage Blk Time (%)		16	45					0		1	0	2	8	27	10	7
Queuing Penalty (veh)		41	61					0		2	0	9	40	78	60	36

Intersection: 6: NH 102 & Hampton Drive/Garden Lane

Movement	SE	SE	SE	NW	NW	NE	NE	NE	NE	NE	SW	SW	SW	SW	SW	SW
Directions Served	L	LT	R	LT	R	L	L	T	T	TR	L	L	T	T	T	R
Maximum Queue (ft)	200	334	200	245	125	266	293	344	337	272	134	300	459	377	410	300
Average Queue (ft)	155	309	199	113	81	171	188	166	169	167	48	130	319	302	270	233
95th Queue (ft)	240	322	205	213	143	257	274	260	264	250	103	298	418	372	374	342
Link Distance (ft)		291		253				666	666	666			358	358	358	
Upstream Blk Time (%)		64		3									2	1	1	
Queuing Penalty (veh)		0		6									19	6	11	
Storage Bay Dist (ft)	175		175		100	275	275				275	275			275	
Storage Blk Time (%)	2	28	52	19	6	0	2	0				0	13	4	2	
Queuing Penalty (veh)	18	195	319	16	6	1	11	1				0	23	25	9	

Intersection: 7: NH 102 & Exit 4 SB Off

Movement	EB	EB	WB	WB	SB	SB	SB
Directions Served	T	T	T	T	L	R	R
Maximum Queue (ft)	536	486	291	315	214	205	188
Average Queue (ft)	256	211	208	239	189	159	25
95th Queue (ft)	431	384	277	298	201	261	127
Link Distance (ft)	540	540	335	335	138	138	138
Upstream Blk Time (%)	0	0		0	37	13	1
Queuing Penalty (veh)	2	0		2	267	95	9
Storage Bay Dist (ft)							
Storage Blk Time (%)							

Queuing Penalty (veh)

Intersection: 8: NH 102 & Exit 4 NB Off

Movement	NB	NB	NB	NB	NE	NE	NE	NE	SW	SW	SW
Directions Served	<	<	R	R	L	L	T	T	T	T	R
Maximum Queue (ft)	856	851	848	832	406	400	331	292	294	354	421
Average Queue (ft)	782	781	745	644	275	276	179	175	162	203	60
95th Queue (ft)	959	966	1024	967	386	386	280	267	254	300	287
Link Distance (ft)	799	799	799	799			722	722	786	786	786
Upstream Blk Time (%)	37	56	43	6							
Queuing Penalty (veh)	0	0	0	0							
Storage Bay Dist (ft)					550	550					
Storage Blk Time (%)											
Queuing Penalty (veh)											

Intersection: 9: NH 102 & St. Charles Street/Londonderry Road

Movement	SE	SE	NW	NE	NE	NE	B24	SW	SW	SW
Directions Served	LT	R	LTR	L	T	TR	T	L	T	TR
Maximum Queue (ft)	62	119	124	384	576	522	21	71	192	222
Average Queue (ft)	16	58	16	280	158	129	1	9	140	191
95th Queue (ft)	45	99	67	410	479	395	17	38	189	212
Link Distance (ft)	542		400		676	676	786		144	144
Upstream Blk Time (%)					0	0			10	48
Queuing Penalty (veh)					2	5			57	261
Storage Bay Dist (ft)		180		360				65		
Storage Blk Time (%)				5	1			0	42	
Queuing Penalty (veh)				35	5			0	4	

Intersection: 10: NH 102 & Fordway/Madden Hill Road

Movement	SE	NW	NW	NE	NE	B19	SW	B23
Directions Served	LTR	L	R	T	R	T	LT	T
Maximum Queue (ft)	88	483	125	255	125	1144	381	416
Average Queue (ft)	26	288	54	231	73	539	219	81
95th Queue (ft)	66	523	139	277	155	1268	413	312
Link Distance (ft)	325	446		164		1233	277	409

Upstream Blk Time (%)	22		23		4	19	4
Queuing Penalty (veh)	0		343		62	0	0
Storage Bay Dist (ft)		100		100			
Storage Blk Time (%)	57	0	24	0			
Queuing Penalty (veh)	28	0	53	2			

Interchange Justification Report
Appendix K
Synchro™ Build Condition NH 28 Intersection Queuing Reports

I-93 Exit 4A

Prepared for:

Town of Derry
Town of Londonderry
New Hampshire Department of Transportation

Prepared by:

CLD and Louis Berger

Version: 2
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NHDOT Project Number: 13065
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CLD/Towns Project Number 05-0244

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Queuing and Blocking Report
Alt A 2040 AM Peak 12/28/2017

Intersection: 1: Vista Ridge/Symmes Drive & NH 28

Movement	EB	EB	EB	WB	WB	WB	WB	NB	NB	B12	SB	SB
Directions Served	L	T	TR	L	T	T	R	LT	R	T	L	LTR
Maximum Queue (ft)	363	270	298	141	502	503	357	148	85	9	137	135
Average Queue (ft)	213	124	144	15	310	320	59	56	54	0	66	68
95th Queue (ft)	349	213	252	85	468	480	214	128	90	6	115	122
Link Distance (ft)	414	414	414		755	755		131		155	368	368
Upstream Blk Time (%)	0							1				
Queuing Penalty (veh)	0							0				
Storage Bay Dist (ft)				450			500		10			
Storage Blk Time (%)					2	1	0	33	46			
Queuing Penalty (veh)					0	1	0	35	28			

Intersection: 2: Exit 5 SB On/Exit 5 SB Off & NH 28

Movement	EB	EB	EB	B19	B19	WB	WB	WB	SB	SB	SB
Directions Served	T	T	R	T	T	L	T	T	L	L	R
Maximum Queue (ft)	725	759	375	92	91	608	164	160	194	140	453
Average Queue (ft)	410	382	139	15	17	297	20	14	86	34	83
95th Queue (ft)	705	727	426	119	132	645	88	79	158	97	332
Link Distance (ft)	782	782		755	755	592	592	592	502	502	502
Upstream Blk Time (%)	5	5				2					0
Queuing Penalty (veh)	28	27				7					0
Storage Bay Dist (ft)			350								
Storage Blk Time (%)		13	0								
Queuing Penalty (veh)		59	1								

Intersection: 3: Exit 5 NB Off & NH 28

Movement	EB	EB	EB	WB	WB	WB	NB	NB
Directions Served	L	T	T	T	T	R	L	R
Maximum Queue (ft)	618	558	520	503	506	397	770	419
Average Queue (ft)	444	276	72	426	361	18	430	28
95th Queue (ft)	752	571	333	600	595	169	746	273

Link Distance (ft)	592	592	592	481	481	481	798	798
Upstream Blk Time (%)	4	0	0	20	5	0	2	1
Queuing Penalty (veh)	10	0	0	92	24	1	0	0
Storage Bay Dist (ft)								
Storage Blk Time (%)								
Queuing Penalty (veh)								

Intersection: 4: NH 28 & Liberty Drive

Movement	EB	WB	WB	NB	NB	NB	SB	SB	SB
Directions Served	L	LT	R	L	T	TR	L	T	TR
Maximum Queue (ft)	33	62	104	33	198	215	66	45	44
Average Queue (ft)	5	6	44	5	61	69	22	6	10
95th Queue (ft)	23	34	89	22	140	155	53	27	33
Link Distance (ft)	154		502		332	332		841	841
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)		100		250			225		
Storage Blk Time (%)			1		0				
Queuing Penalty (veh)			0		0				

Queuing and Blocking Report
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Intersection: 1: NH 28 & Symmes Drive

Movement	EB	EB	EB	WB	WB	WB	WB	NB	NB	SB	SB	B14
Directions Served	L	T	TR	L	T	T	R	LT	R	L	LTR	T
Maximum Queue (ft)	70	346	353	219	314	297	65	116	85	363	451	181
Average Queue (ft)	23	191	220	89	186	167	15	46	28	187	288	34
95th Queue (ft)	58	298	327	182	294	281	46	94	70	369	474	157
Link Distance (ft)	402	402	402		755	755		131		368	368	226
Upstream Blk Time (%)								0		0	19	5
Queuing Penalty (veh)								0		0	0	0
Storage Bay Dist (ft)				450			500		10			
Storage Blk Time (%)								39	20			
Queuing Penalty (veh)								12	14			

Intersection: 2: Exit 5 SB On/Exit 5 SB Off & NH 28

Movement	EB	EB	WB	WB	WB	SB	SB	SB
Directions Served	T	T	L	T	T	L	L	R
Maximum Queue (ft)	314	298	268	130	144	199	162	58
Average Queue (ft)	182	162	101	38	30	104	59	2
95th Queue (ft)	281	267	208	98	94	165	125	43
Link Distance (ft)	782	782	592	592	592	502	502	502
Upstream Blk Time (%)								
Queuing Penalty (veh)								
Storage Bay Dist (ft)								
Storage Blk Time (%)		0						
Queuing Penalty (veh)		0						

Intersection: 3: Exit 5 NB Off & NH 28

Movement	EB	EB	EB	WB	WB	NB	NB
Directions Served	L	T	T	T	T	L	R
Maximum Queue (ft)	559	307	202	206	201	660	485
Average Queue (ft)	295	59	20	98	102	252	37
95th Queue (ft)	573	239	126	177	181	533	286
Link Distance (ft)	592	592	592	481	481	798	798
Upstream Blk Time (%)	1	0	0			1	0
Queuing Penalty (veh)	3	0	0			0	0
Storage Bay Dist (ft)							
Storage Blk Time (%)							
Queuing Penalty (veh)							

Intersection: 4: NH 28 & Liberty Drive

Movement	EB	WB	WB	NB	NB	NB	SB	SB	SB
Directions Served	L	LT	R	L	T	TR	L	T	TR
Maximum Queue (ft)	59	42	102	26	111	147	48	103	105
Average Queue (ft)	19	7	38	4	36	43	12	34	43
95th Queue (ft)	48	29	83	19	85	98	35	78	87
Link Distance (ft)	154		502		332	332		841	841
Upstream Blk Time (%)									

Queuing Penalty (veh)							
Storage Bay Dist (ft)		100		250			225
Storage Blk Time (%)			0				
Queuing Penalty (veh)			0				

Queuing and Blocking Report
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Intersection: 1: Vista Ridge/Symmes Drive & NH 28

Movement	EB	EB	EB	WB	WB	WB	WB	NB	NB	SB	SB
Directions Served	L	T	TR	L	T	T	R	LT	R	L	LTR
Maximum Queue (ft)	331	259	259	51	448	456	115	154	85	139	139
Average Queue (ft)	188	127	140	10	264	271	45	65	58	72	67
95th Queue (ft)	299	219	228	34	428	427	96	131	89	121	121
Link Distance (ft)	414	414	414		755	755		131		368	368
Upstream Blk Time (%)	0							1			
Queuing Penalty (veh)	1							0			
Storage Bay Dist (ft)				450			500		10		
Storage Blk Time (%)					2	1		35	48		
Queuing Penalty (veh)					0	1		37	29		

Intersection: 2: Exit 5 SB On/Exit 5 SB Off & NH 28

Movement	EB	EB	EB	WB	WB	WB	SB	SB	SB
Directions Served	T	T	R	L	T	T	L	L	R
Maximum Queue (ft)	673	672	375	471	156	145	161	120	390
Average Queue (ft)	330	284	60	166	28	24	56	15	52
95th Queue (ft)	578	564	284	390	99	82	120	61	268
Link Distance (ft)	782	782		592	592	592	502	502	502
Upstream Blk Time (%)	0	0		0					0
Queuing Penalty (veh)	1	0		0					0
Storage Bay Dist (ft)			350						
Storage Blk Time (%)		5	0						
Queuing Penalty (veh)		21	0						

Intersection: 3: Exit 5 NB Off & NH 28

Movement	EB	EB	EB	WB	WB	NB	NB
Directions Served	L	T	T	T	T	L	R
Maximum Queue (ft)	614	566	582	365	296	711	118
Average Queue (ft)	414	262	92	188	132	351	4
95th Queue (ft)	756	573	388	328	274	624	86
Link Distance (ft)	592	592	592	481	481	798	798
Upstream Blk Time (%)	5	0	0		0	0	
Queuing Penalty (veh)	13	0	1		0	0	
Storage Bay Dist (ft)							
Storage Blk Time (%)							
Queuing Penalty (veh)							

Intersection: 4: NH 28 & Liberty Drive

Movement	EB	WB	WB	NB	NB	NB	SB	SB	SB
Directions Served	L	LT	R	L	T	TR	L	T	TR
Maximum Queue (ft)	33	44	107	26	133	154	69	42	39
Average Queue (ft)	5	3	37	4	45	57	16	5	7
95th Queue (ft)	24	22	81	18	104	123	46	26	25
Link Distance (ft)	154		502		332	332		841	841
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)		100		250			225		
Storage Blk Time (%)			0						
Queuing Penalty (veh)									

Queuing and Blocking Report
Alt B 2040 PM Peak 01/02/2018

Intersection: 1: NH 28 & Symmes Drive

Movement	EB	EB	EB	B13	WB	WB	WB	WB	NB	NB	SB	SB	B14
Directions Served	L	T	TR	T	L	T	T	R	LT	R	L	LTR	T
Maximum Queue (ft)	73	350	383	46	162	276	272	64	130	85	290	352	16
Average Queue (ft)	24	193	217	8	74	156	137	10	45	28	110	185	1
95th Queue (ft)	58	324	358	79	136	243	234	36	95	70	225	325	13

Link Distance (ft)	402	402	402	215		755	755		131		368	368	226
Upstream Blk Time (%)		0	1	1					1			1	
Queuing Penalty (veh)		0	0	0					0			0	
Storage Bay Dist (ft)					450			500		10			
Storage Blk Time (%)									37	21			
Queuing Penalty (veh)									11	13			

Intersection: 2: Exit 5 SB On/Exit 5 SB Off & NH 28

Movement	EB	EB	B19	WB	WB	WB	SB	SB	SB
Directions Served	T	T	T	L	T	T	L	L	R
Maximum Queue (ft)	349	328	6	240	112	96	127	97	48
Average Queue (ft)	172	155	0	74	31	25	67	27	2
95th Queue (ft)	307	292	5	164	84	74	112	73	35
Link Distance (ft)	782	782	755	592	592	592	502	502	502
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)									
Storage Blk Time (%)		0							
Queuing Penalty (veh)		0							

Intersection: 3: Exit 5 NB Off & NH 28

Movement	EB	EB	EB	WB	WB	NB	NB
Directions Served	L	T	T	T	T	L	R
Maximum Queue (ft)	579	425	181	151	168	424	37
Average Queue (ft)	302	78	20	53	69	201	1
95th Queue (ft)	610	307	117	120	141	387	27
Link Distance (ft)	592	592	592	481	481	798	798
Upstream Blk Time (%)	1	0					
Queuing Penalty (veh)	4	0					
Storage Bay Dist (ft)							
Storage Blk Time (%)							
Queuing Penalty (veh)							

Intersection: 4: NH 28 & Liberty Drive

Movement	EB	WB	WB	NB	NB	NB	SB	SB	SB

Directions Served	L	LT	R	L	T	TR	L	T	TR
Maximum Queue (ft)	48	38	102	26	83	115	39	89	96
Average Queue (ft)	16	6	31	3	26	32	10	24	36
95th Queue (ft)	43	26	83	15	65	77	32	64	77
Link Distance (ft)	154		502		332	332		841	841
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)		100		250			225		
Storage Blk Time (%)			1						
Queuing Penalty (veh)			0						

Queuing and Blocking Report
Alt C 2040 AM Peak 12/27/2017

Intersection: 1: Vista Ridge/Symmes Drive & NH 28

Movement	EB	EB	EB	WB	WB	WB	WB	NB	NB	B12	SB	SB
Directions Served	L	T	TR	L	T	T	R	LT	R	T	L	LTR
Maximum Queue (ft)	303	235	251	40	394	397	114	161	85	5	119	128
Average Queue (ft)	165	113	136	9	219	233	36	57	56	0	60	67
95th Queue (ft)	270	195	221	29	350	362	84	130	90	3	108	114
Link Distance (ft)	414	414	414		755	755		131		155	368	368
Upstream Blk Time (%)								2				
Queuing Penalty (veh)								0				
Storage Bay Dist (ft)				450			500		10			
Storage Blk Time (%)					0			30	44			
Queuing Penalty (veh)					0			30	26			

Intersection: 2: Exit 5 SB On/Exit 5 SB Off & NH 28

Movement	EB	EB	EB	B19	B19	WB	WB	WB	SB	SB	SB
Directions Served	T	T	R	T	T	L	T	T	L	L	R
Maximum Queue (ft)	578	551	324	22	18	404	127	128	116	75	264
Average Queue (ft)	252	203	42	1	1	150	25	20	54	13	27
95th Queue (ft)	499	484	224	16	17	327	76	73	101	48	170
Link Distance (ft)	782	782		755	755	592	592	592	502	502	502
Upstream Blk Time (%)	1	1									

Queuing Penalty (veh)	3	4	
Storage Bay Dist (ft)			350
Storage Blk Time (%)		3	0
Queuing Penalty (veh)		16	0

Intersection: 3: Exit 5 NB Off & NH 28

Movement	EB	EB	EB	WB	WB	NB	NB
Directions Served	L	T	T	T	T	L	R
Maximum Queue (ft)	608	447	194	398	379	595	88
Average Queue (ft)	362	172	29	189	135	288	3
95th Queue (ft)	661	452	190	333	271	493	65
Link Distance (ft)	592	592	592	481	481	798	798
Upstream Blk Time (%)	3	0		0	0	0	
Queuing Penalty (veh)	7	0		0	0	0	
Storage Bay Dist (ft)							
Storage Blk Time (%)							
Queuing Penalty (veh)							

Intersection: 4: NH 28 & Liberty Drive

Movement	EB	WB	WB	NB	NB	NB	SB	SB	SB
Directions Served	L	LT	R	L	T	TR	L	T	TR
Maximum Queue (ft)	23	48	93	30	103	118	53	44	33
Average Queue (ft)	3	3	32	5	37	36	14	3	6
95th Queue (ft)	17	21	75	21	85	89	39	18	22
Link Distance (ft)	154		502		332	332		841	841
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)		100		250			225		
Storage Blk Time (%)			0						
Queuing Penalty (veh)			0						

Queuing and Blocking Report
Alt C 2040 PM Peak 12/27/2017

Intersection: 1: NH 28 & Symmes Drive

Movement	EB	EB	EB	WB	WB	WB	WB	NB	NB	SB	SB
Directions Served	L	T	TR	L	T	T	R	LT	R	L	LTR
Maximum Queue (ft)	59	298	349	156	283	280	64	109	77	231	291
Average Queue (ft)	18	158	197	70	148	136	13	44	25	87	163
95th Queue (ft)	48	250	310	130	245	237	45	90	63	175	267
Link Distance (ft)	402	402	402		755	755		131		368	368
Upstream Blk Time (%)			0					0			
Queuing Penalty (veh)			0					0			
Storage Bay Dist (ft)				450			500		10		
Storage Blk Time (%)								35	19		
Queuing Penalty (veh)								9	12		

Intersection: 2: Exit 5 SB On/Exit 5 SB Off & NH 28

Movement	EB	EB	EB	WB	WB	WB	SB	SB
Directions Served	T	T	R	L	T	T	L	L
Maximum Queue (ft)	304	263	88	180	108	120	148	118
Average Queue (ft)	153	117	5	77	34	31	72	32
95th Queue (ft)	263	224	57	167	88	93	127	88
Link Distance (ft)	782	782		592	592	592	502	502
Upstream Blk Time (%)								
Queuing Penalty (veh)								
Storage Bay Dist (ft)			350					
Storage Blk Time (%)								
Queuing Penalty (veh)								

Intersection: 3: Exit 5 NB Off & NH 28

Movement	EB	EB	EB	WB	WB	NB	NB
Directions Served	L	T	T	T	T	L	R
Maximum Queue (ft)	595	329	48	145	173	380	57
Average Queue (ft)	256	43	5	59	78	175	2
95th Queue (ft)	508	185	27	127	152	303	41
Link Distance (ft)	592	592	592	481	481	798	798
Upstream Blk Time (%)	1						
Queuing Penalty (veh)	2						
Storage Bay Dist (ft)							

Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 4: NH 28 & Liberty Drive

Movement	EB	WB	WB	NB	NB	NB	SB	SB	SB
Directions Served	L	LT	R	L	T	TR	L	T	TR
Maximum Queue (ft)	46	37	93	26	60	71	46	61	84
Average Queue (ft)	16	4	27	2	21	20	9	19	28
95th Queue (ft)	42	22	67	13	49	51	32	49	67
Link Distance (ft)	154		502		332	332		841	841
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)		100		250			225		
Storage Blk Time (%)			0						
Queuing Penalty (veh)			0						

Queuing and Blocking Report
Alt D 2040 AM Peak 01/02/2018

Intersection: 1: Vista Ridge/Symmes Drive & NH 28

Movement	EB	EB	EB	WB	WB	WB	WB	NB	NB	SB	SB
Directions Served	L	T	TR	L	T	T	R	LT	R	L	LTR
Maximum Queue (ft)	330	238	272	47	333	370	122	169	85	121	130
Average Queue (ft)	182	110	133	9	212	223	46	58	55	63	66
95th Queue (ft)	326	201	232	33	324	335	98	134	88	109	116
Link Distance (ft)	414	414	414		755	755		131		368	368
Upstream Blk Time (%)	0							2			
Queuing Penalty (veh)	0							0			
Storage Bay Dist (ft)				450			500		10		
Storage Blk Time (%)					0	0		28	47		
Queuing Penalty (veh)					0	0		28	27		

Intersection: 2: Exit 5 SB On/Exit 5 SB Off & NH 28

Movement	EB	EB	EB	WB	WB	WB	SB	SB	SB

Directions Served	T	T	R	L	T	T	L	L	R
Maximum Queue (ft)	418	394	284	318	110	123	123	68	301
Average Queue (ft)	225	167	16	131	23	22	51	11	26
95th Queue (ft)	373	324	123	270	71	74	99	41	166
Link Distance (ft)	782	782		592	592	592	502	502	502
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)			350						
Storage Blk Time (%)		0	0						
Queuing Penalty (veh)		0	0						

Intersection: 3: Exit 5 NB Off & NH 28

Movement	EB	EB	EB	WB	WB	NB	NB
Directions Served	L	T	T	T	T	L	R
Maximum Queue (ft)	604	481	354	366	305	723	464
Average Queue (ft)	338	158	27	187	122	353	58
95th Queue (ft)	637	422	180	354	275	692	387
Link Distance (ft)	592	592	592	481	481	798	798
Upstream Blk Time (%)	1			0		4	2
Queuing Penalty (veh)	3			1		0	0
Storage Bay Dist (ft)							
Storage Blk Time (%)							
Queuing Penalty (veh)							

Intersection: 4: NH 28 & Liberty Drive

Movement	EB	WB	WB	NB	NB	NB	SB	SB	SB
Directions Served	L	LT	R	L	T	TR	L	T	TR
Maximum Queue (ft)	33	37	73	26	121	116	45	47	42
Average Queue (ft)	4	3	27	3	37	35	15	5	5
95th Queue (ft)	22	19	67	16	90	88	38	25	26
Link Distance (ft)	154		502		332	332		841	841
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)		100		250			225		
Storage Blk Time (%)									
Queuing Penalty (veh)									

Queuing and Blocking Report
Alt D 2040 PM Peak 12/28/2017

Intersection: 1: NH 28 & Symmes Drive

Movement	EB	EB	EB	WB	WB	WB	WB	NB	NB	SB	SB
Directions Served	L	T	TR	L	T	T	R	LT	R	L	LTR
Maximum Queue (ft)	60	271	318	182	273	234	61	116	69	231	294
Average Queue (ft)	19	159	184	76	133	116	11	37	23	91	159
95th Queue (ft)	48	247	285	144	221	196	39	82	56	184	263
Link Distance (ft)	402	402	402		755	755		131		368	368
Upstream Blk Time (%)			0					0			
Queuing Penalty (veh)			0					0			
Storage Bay Dist (ft)				450			500		10		
Storage Blk Time (%)								29	18		
Queuing Penalty (veh)								8	11		

Intersection: 2: Exit 5 SB On/Exit 5 SB Off & NH 28

Movement	EB	EB	WB	WB	WB	SB	SB
Directions Served	T	T	L	T	T	L	L
Maximum Queue (ft)	279	235	237	127	139	122	87
Average Queue (ft)	139	109	89	39	33	65	30
95th Queue (ft)	248	218	185	98	96	111	74
Link Distance (ft)	782	782	592	592	592	502	502
Upstream Blk Time (%)							
Queuing Penalty (veh)							
Storage Bay Dist (ft)							
Storage Blk Time (%)							
Queuing Penalty (veh)							

Intersection: 3: Exit 5 NB Off & NH 28

Movement	EB	EB	EB	WB	WB	NB	NB
Directions Served	L	T	T	T	T	L	R
Maximum Queue (ft)	538	245	48	146	145	429	42
Average Queue (ft)	250	46	7	52	54	195	0
95th Queue (ft)	495	202	34	111	119	365	0

Link Distance (ft)	592	592	592	481	481	798	798
Upstream Blk Time (%)	1	0					
Queuing Penalty (veh)	3	0					
Storage Bay Dist (ft)							
Storage Blk Time (%)							
Queuing Penalty (veh)							

Intersection: 4: NH 28 & Liberty Drive

Movement	EB	WB	WB	NB	NB	NB	SB	SB	SB
Directions Served	L	LT	R	L	T	TR	L	T	TR
Maximum Queue (ft)	57	33	80	25	66	84	43	82	83
Average Queue (ft)	18	4	19	2	20	22	9	19	28
95th Queue (ft)	46	22	55	14	52	56	28	52	64
Link Distance (ft)	154		502		332	332		841	841
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)		100		250			225		
Storage Blk Time (%)			0						
Queuing Penalty (veh)			0						

Queuing and Blocking Report
Alt F 2040 AM Peak 12/28/2017

Intersection: 1: Vista Ridge/Symmes Drive & NH 28

Movement	EB	EB	EB	WB	WB	WB	WB	NB	NB	B12	SB	SB
Directions Served	L	T	TR	L	T	T	R	LT	R	T	L	LTR
Maximum Queue (ft)	391	353	361	43	442	462	117	191	85	53	148	173
Average Queue (ft)	225	178	186	12	251	263	39	80	61	2	80	79
95th Queue (ft)	369	357	370	37	399	410	87	178	96	22	129	139
Link Distance (ft)	414	414	414		755	755		131		155	368	368
Upstream Blk Time (%)	0	2	3					7				
Queuing Penalty (veh)	1	6	10					0				
Storage Bay Dist (ft)				450			500		10			
Storage Blk Time (%)					1	0		28	55			
Queuing Penalty (veh)					0	0		30	35			

Intersection: 2: Exit 5 SB On/Exit 5 SB Off & NH 28

Movement	EB	EB	EB	B19	B19	WB	WB	WB	SB	SB	SB
Directions Served	T	T	R	T	T	L	T	T	L	L	R
Maximum Queue (ft)	873	885	375	508	533	585	146	119	423	389	458
Average Queue (ft)	637	630	240	214	217	249	14	8	267	216	138
95th Queue (ft)	1000	1030	536	746	751	535	66	50	461	429	450
Link Distance (ft)	782	782		755	755	592	592	592	502	502	502
Upstream Blk Time (%)	30	29		6	7	1			3	0	1
Queuing Penalty (veh)	172	164		34	41	4			10	1	4
Storage Bay Dist (ft)			350								
Storage Blk Time (%)		33	0								
Queuing Penalty (veh)		120	2								

Intersection: 3: Exit 5 NB Off & NH 28

Movement	EB	EB	EB	WB	WB	WB	NB	NB
Directions Served	L	T	T	T	T	R	L	R
Maximum Queue (ft)	616	604	628	501	487	186	604	332
Average Queue (ft)	431	385	242	334	216	7	331	32
95th Queue (ft)	724	704	681	542	465	98	592	275
Link Distance (ft)	592	592	592	481	481	481	798	798
Upstream Blk Time (%)	3	6	5	8	1	0	1	1
Queuing Penalty (veh)	13	24	23	36	3	0	0	0
Storage Bay Dist (ft)								
Storage Blk Time (%)								
Queuing Penalty (veh)								

Intersection: 4: NH 28 & Liberty Drive

Movement	EB	WB	WB	NB	NB	NB	SB	SB	SB
Directions Served	L	LT	R	L	T	TR	L	T	TR
Maximum Queue (ft)	33	57	116	26	203	237	112	45	51
Average Queue (ft)	6	6	42	2	71	93	31	6	10
95th Queue (ft)	25	31	90	13	156	186	74	28	35
Link Distance (ft)	154		502		332	332		841	841
Upstream Blk Time (%)									

Queuing Penalty (veh)												
Storage Bay Dist (ft)		100		250			225					
Storage Blk Time (%)			0		0							
Queuing Penalty (veh)			0		0							

Queuing and Blocking Report
Alt F 2040 PM Peak 12/28/2017

Intersection: 1: NH 28 & Symmes Drive

Movement	EB	EB	EB	B13	WB	WB	WB	WB	NB	NB	SB	SB
Directions Served	L	T	TR	T	L	T	T	R	LT	R	L	LTR
Maximum Queue (ft)	73	400	432	99	162	287	265	71	126	83	267	366
Average Queue (ft)	22	220	242	13	69	159	140	13	45	29	112	189
95th Queue (ft)	55	367	393	100	130	256	245	44	93	69	214	316
Link Distance (ft)	402	402	402	215		755	755		131		368	368
Upstream Blk Time (%)		1	1	1					0			0
Queuing Penalty (veh)		0	0	0					0			0
Storage Bay Dist (ft)					450			500		10		
Storage Blk Time (%)									37	21		
Queuing Penalty (veh)									12	13		

Intersection: 2: Exit 5 SB On/Exit 5 SB Off & NH 28

Movement	EB	EB	EB	B19	B19	WB	WB	WB	SB	SB	SB
Directions Served	T	T	R	T	T	L	T	T	L	L	R
Maximum Queue (ft)	556	566	375	34	32	340	110	98	358	312	57
Average Queue (ft)	284	257	43	1	1	136	12	11	243	197	8
95th Queue (ft)	497	487	239	25	23	304	52	52	343	307	81
Link Distance (ft)	782	782		755	755	592	592	592	502	502	502
Upstream Blk Time (%)	0	0									
Queuing Penalty (veh)	3	3									
Storage Bay Dist (ft)			350								
Storage Blk Time (%)		3	0								
Queuing Penalty (veh)		12	0								

Intersection: 3: Exit 5 NB Off & NH 28

Movement	EB	EB	EB	WB	WB	NB	NB
Directions Served	L	T	T	T	T	L	R
Maximum Queue (ft)	618	523	228	209	171	493	439
Average Queue (ft)	313	155	54	92	82	200	49
95th Queue (ft)	687	420	182	177	159	432	258
Link Distance (ft)	592	592	592	481	481	798	798
Upstream Blk Time (%)	3	0	0			0	0
Queuing Penalty (veh)	16	2	0			0	0
Storage Bay Dist (ft)							
Storage Blk Time (%)							
Queuing Penalty (veh)							

Intersection: 4: NH 28 & Liberty Drive

Movement	EB	WB	WB	NB	NB	NB	SB	SB	SB
Directions Served	L	LT	R	L	T	TR	L	T	TR
Maximum Queue (ft)	47	47	129	25	123	162	70	136	138
Average Queue (ft)	17	10	42	3	37	49	21	43	53
95th Queue (ft)	44	34	92	17	90	111	51	100	111
Link Distance (ft)	154		502		332	332		841	841
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)		100		250			225		
Storage Blk Time (%)			1						
Queuing Penalty (veh)			0						

Interchange Justification Report
Appendix L
Synchro™ Build Condition I-93 Exit 4A Connector Intersection Queuing Reports

I-93 Exit 4A

Prepared for:

Town of Derry
Town of Londonderry
New Hampshire Department of Transportation

Prepared by:

CLD and Louis Berger

Version: 2
October 10, 2019

NHDOT Project Number: 13065
Federal Project Number: IM-0931(201)
CLD/Towns Project Number 05-0244

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Alternative A – AM Peak Hour

Intersection: 11: Exit 4A SB On/Exit 4A SB Off & Connector Road

Movement	WB	WB	SB	SB
Directions Served	L	L	L	L
Maximum Queue (ft)	339	368	546	489
Average Queue (ft)	286	292	371	310
95th Queue (ft)	355	372	532	442
Link Distance (ft)	320	320	531	531
Upstream Blk Time (%)	5	6	1	0
Queuing Penalty (veh)	23	30	0	0
Storage Bay Dist (ft)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

Intersection: 12: Exit 4A NB Off & Connector Road & Exit 4A NB On

Movement	EB	EB	WB	WB	WB	WB	B3	B3	NW	NW
Directions Served	LT	T	T	T	R	R	T	T	LR	R
Maximum Queue (ft)	100	100	359	428	225	212	1054	1868	409	344
Average Queue (ft)	41	43	169	324	211	196	213	361	276	230
95th Queue (ft)	87	90	297	514	273	268	946	1282	371	320
Link Distance (ft)	320	320	330	330			3032	3032	473	473
Upstream Blk Time (%)			1	10				0		
Queuing Penalty (veh)			0	0				0		
Storage Bay Dist (ft)					200	200				
Storage Blk Time (%)				2	9	7				
Queuing Penalty (veh)				34	43	35				

Alternative A – PM Peak Hour

Intersection: 11: Exit 4A SB On/Exit 4A SB Off & Connector Road

Movement	WB	WB	SB	SB
Directions Served	L	L	L	L
Maximum Queue (ft)	312	322	473	380
Average Queue (ft)	221	228	318	258
95th Queue (ft)	299	307	440	363
Link Distance (ft)	320	320	531	531
Upstream Blk Time (%)	0	0	0	
Queuing Penalty (veh)	0	1	0	
Storage Bay Dist (ft)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

Intersection: 12: Exit 4A NB Off & Connector Road & Exit 4A NB On

Movement	EB	EB	WB	WB	WB	WB	B3	NW	NW
Directions Served	T	T	T	T	R	R	T	LR	R
Maximum Queue (ft)	108	108	209	305	223	211	11	310	280
Average Queue (ft)	51	47	123	142	145	154	1	220	168
95th Queue (ft)	97	99	187	258	268	265	7	296	265
Link Distance (ft)	320	320	330	330			3032	473	473

Upstream Blk Time (%)	0		
Queuing Penalty (veh)	0		
Storage Bay Dist (ft)		**200**	**200**
Storage Blk Time (%)	0	1	2
Queuing Penalty (veh)	1	5	7

Alternative B – AM Peak Hour

Intersection: 11: Exit 4A SB On/Exit 4A SB Off & Connector Road

Movement	WB	WB	SB	SB
Directions Served	L	L	L	L
Maximum Queue (ft)	341	351	552	509
Average Queue (ft)	330	332	437	377
95th Queue (ft)	**348**	**354**	**603**	**552**
Link Distance (ft)	**319**	**319**	**525**	**525**
Upstream Blk Time (%)	21	22	9	4
Queuing Penalty (veh)	118	126	0	0
Storage Bay Dist (ft)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

Intersection: 12: Exit 4A NB Off & Connector Road & Exit 4A NB On

Movement	**EB**	**EB**	WB	WB	WB	WB	B3	B3	**NW**	**NW**
Directions Served	T	T	T	T	R	R	T	T	LR	R
Maximum Queue (ft)	98	101	420	432	225	212	2112	2162	516	518
Average Queue (ft)	53	55	336	367	219	133	806	895	462	447
95th Queue (ft)	**91**	**99**	**482**	**497**	**261**	**269**	**2368**	**2398**	**568**	**581**
Link Distance (ft)	**319**	**319**	**328**	**328**			**3031**	**3031**	**467**	**467**
Upstream Blk Time (%)			24	29					64	58
Queuing Penalty (veh)			0	0					0	0
Storage Bay Dist (ft)					**200**	**200**				
Storage Blk Time (%)	0			23	4	2				
Queuing Penalty (veh)	0			281	22	10				

Alternative B – PM Peak Hour

Intersection: 11: Exit 4A SB On/Exit 4A SB Off & Connector Road

Movement	WB	WB	SB	SB
Directions Served	L	L	L	L
Maximum Queue (ft)	338	336	544	503
Average Queue (ft)	264	270	372	317
95th Queue (ft)	**341**	**347**	**539**	**471**
Link Distance (ft)	**319**	**319**	**525**	**525**
Upstream Blk Time (%)	1	2	3	1
Queuing Penalty (veh)	6	10	0	0
Storage Bay Dist (ft)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

Intersection: 12: Exit 4A NB Off & Connector Road & Exit 4A NB On

Movement	EB	EB	WB	WB	WB	WB	B3	B3	NW	NW
Directions Served	T	T	T	T	R	R	T	T	LR	R
Maximum Queue (ft)	109	114	264	344	225	212	29	37	409	350
Average Queue (ft)	59	60	149	161	124	115	1	2	247	203
95th Queue (ft)	**103**	**112**	**226**	**276**	**264**	**249**	**21**	**32**	**370**	**316**
Link Distance (ft)	**319**	**319**	**328**	**328**			**3031**	**3031**	**467**	**467**
Upstream Blk Time (%)			0	0					0	
Queuing Penalty (veh)			0	0					0	
Storage Bay Dist (ft)					**200**	**200**				
Storage Blk Time (%)	1			1	1	1				
Queuing Penalty (veh)	0			8	4	3				

Alternative C – AM Peak Hour

Intersection: 11: Exit 4A SB On/Exit 4A SB Off & Connector Road

Movement	SB	SB	SW	SW
Directions Served	L	L	L	L
Maximum Queue (ft)	449	360	201	205
Average Queue (ft)	252	202	127	133
95th Queue (ft)	374	315	183	196
Link Distance (ft)	520	520	585	585
Upstream Blk Time (%)	0			
Queuing Penalty (veh)	0			
Storage Bay Dist (ft)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

Intersection: 12: Connector Road & Exit 4A NB Off & Exit 4A NB On

Movement	NW	NW	NE	NE	SW	SW	SW	SW	B3	B3
Directions Served	LR	R	T	T	T	T	R	R	T	T
Maximum Queue (ft)	196	151	192	197	526	629	225	212	418	932
Average Queue (ft)	113	43	111	113	100	337	212	205	34	96
95th Queue (ft)	176	120	170	173	318	653	275	261	296	535
Link Distance (ft)	470	470	585	585	548	548			1040	1040
Upstream Blk Time (%)					0	2			0	1
Queuing Penalty (veh)					0	0			0	0
Storage Bay Dist (ft)							200	200		
Storage Blk Time (%)			10			0	10	5		
Queuing Penalty (veh)			0			1	23	12		

Alternative C – PM Peak Hour

Intersection: 11: Exit 4A SB On/Exit 4A SB Off & Connector Road

Movement	SB	SB	SW	SW
Directions Served	L	L	L	L
Maximum Queue (ft)	366	336	183	189
Average Queue (ft)	224	178	110	115
95th Queue (ft)	315	291	168	174

Link Distance (ft)	520	520	585	585
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

Intersection: 12: Connector Road & Exit 4A NB Off & Exit 4A NB On

Movement	NW	NW	NE	NE	SW	SW	SW	SW	B3	B3
Directions Served	LR	R	T	T	T	T	R	R	T	T
Maximum Queue (ft)	171	145	160	156	467	567	225	212	68	297
Average Queue (ft)	105	34	93	94	69	236	190	180	4	12
95th Queue (ft)	159	102	143	148	218	530	309	303	60	166
Link Distance (ft)	470	470	585	585	548	548			1040	1040
Upstream Blk Time (%)					0	1				0
Queuing Penalty (veh)					0	0				0
Storage Bay Dist (ft)							200	200		
Storage Blk Time (%)			5			0	9	3		
Queuing Penalty (veh)			0			1	19	7		

Alternative D – AM Peak Hour

Intersection: 11: Exit 4A SB On/Exit 4A SB Off & Connector Road

Movement	SB	SB	SW	SW
Directions Served	L	L	L	L
Maximum Queue (ft)	386	335	199	196
Average Queue (ft)	238	184	114	119
95th Queue (ft)	341	293	170	177
Link Distance (ft)	520	520	585	585
Upstream Blk Time (%)	0			
Queuing Penalty (veh)	0			
Storage Bay Dist (ft)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

Intersection: 12: Connector Road & Exit 4A NB Off & Exit 4A NB On

Movement	NW	NW	**NE**	**NE**	SW	SW	SW	SW	B3	B3
Directions Served	LR	R	T	T	T	T	R	R	T	T
Maximum Queue (ft)	141	94	213	206	181	628	225	212	207	454
Average Queue (ft)	75	12	114	114	44	243	199	192	7	34
95th Queue (ft)	127	52	179	186	107	563	291	289	146	294
Link Distance (ft)	470	470	585	585	548	548			1040	1040
Upstream Blk Time (%)						1			0	0
Queuing Penalty (veh)						0			0	0
Storage Bay Dist (ft)							200	200		
Storage Blk Time (%)			8			0	5	3		
Queuing Penalty (veh)			0			1	11	7		

Alternative D – PM Peak Hour

Intersection: 11: Exit 4A SB On/Exit 4A SB Off & Connector Road

Movement	SB	SB	SW	SW
Directions Served	L	L	L	L
Maximum Queue (ft)	340	298	167	163
Average Queue (ft)	226	177	102	103
95th Queue (ft)	313	281	151	152
Link Distance (ft)	520	520	585	585
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

Intersection: 12: Connector Road & Exit 4A NB Off & Exit 4A NB On

Movement	NW	NW	NE	NE	SW	SW	SW	SW	B3
Directions Served	LR	R	**T**	**T**	T	T	R	R	T
Maximum Queue (ft)	126	89	161	171	224	511	225	212	222
Average Queue (ft)	66	10	88	89	44	173	167	163	7
95th Queue (ft)	109	48	141	143	120	440	318	308	149
Link Distance (ft)	470	470	585	585	548	548			1040
Upstream Blk Time (%)						0			0
Queuing Penalty (veh)						0			0
Storage Bay Dist (ft)							200	200	
Storage Blk Time (%)			3			0	6	2	
Queuing Penalty (veh)			0			0	10	4	

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Interchange Justification Report
Appendix M
HCS Build Condition Freeway Operation Reports

I-93 Exit 4A

Prepared for:

Town of Derry
Town of Londonderry
New Hampshire Department of Transportation

Prepared by:

CLD and Louis Berger

Version: 2
October 10, 2019

NHDOT Project Number: 13065
Federal Project Number: IM-0931(201)
CLD/Towns Project Number 05-0244

HCS 2010 Facilities Report

Project Information

Analyst	PK/LCG	Agency	Fuss and O'Neill
Jurisdiction		Time Period Analyzed	AM Peak - NB w/Overlap
Analysis Year	2040 4A South Alt. A - AM-NB	Date	3/8/2019
Project Description	I-93 NB - from S. of Exit 4 to N of Exit 5		

Facility Global Input

Jam Density, pc/mi/ln	190.0	Density at Capacity, pc/mi/ln	45.0
Queue Discharge Capacity Drop, %	7	Total Segments	13
Total Time Periods	1	Time Period Duration, min	15

Segment Geometric Data

No.	Coded	Analyzed	Name	Length, ft	Lanes
1	Basic	Basic	a>b	5280	4
2	Diverge	Diverge	b>c	1500	4
3	Basic	Basic	c>d	4525	4
4	Merge	Merge	d>e	1500	4
5	Overlap	Basic	e>f	700	4
6	Diverge	Diverge	f>g	1500	4
7	Basic	Basic	g>h	3310	4
8	Merge	Merge	h>i	1500	4
9	Basic	Basic	i>j	6215	4
10	Diverge	Diverge	j>k	1500	4
11	Basic	Basic	k>l	4100	4
12	Merge	Merge	l>m	1500	4
13	Basic	Basic	m>n	5280	4

Facility Segment Data

Segment 1: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.979	3662	9600	0.38	70.0	13.1	B

Segment 2: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.77	0.979	0.964	3662	977	9600	4200	0.38	0.23	68.7	61.0	13.3	0.0	A

Segment 3: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.979	2874	9600	0.30	70.0	10.3	A

Segment 4: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.90	0.979	0.983	4733	1859	9600	2100	0.49	0.89	64.8	62.7	18.3	19.3	B

Segment 5: Overlap

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.964	4734	9488	0.50	64.8	18.3	B

Segment 6: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.81	0.964	0.969	4734	1013	9600	2100	0.49	0.48	67.0	60.9	17.7	20.2	C

Segment 7: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.964	3857	9600	0.40	70.0	13.8	B

Segment 8: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.81	0.964	0.969	5628	1771	9600	2100	0.59	0.84	63.2	60.5	22.3	24.9	C

Segment 9: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.964	5391	9600	0.56	69.7	19.3	C

Segment 10: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.75	0.964	0.956	5391	907	9600	2100	0.56	0.43	67.3	61.2	20.0	24.5	C

Segment 11: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.964	4674	9600	0.49	70.0	16.7	B

Segment 12: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.83	0.964	0.972	6081	1407	9600	2100	0.63	0.67	63.1	60.2	24.1	25.7	C

Segment 13: Basic								
Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.964	5926	9600	0.62	69.1	21.4	C

Facility Time Period Results

T	Speed, mi/h	Density, pc/mi/ln	Density, veh/mi/ln	Travel Time, min	LOS
1	68.5	16.9	16.4	6.4	B

Facility Overall Results

Space Mean Speed, mi/h	68.5	Density, veh/mi/ln	16.4
Average Travel Time, min	6.4		

HCS 2010 Facilities Report

Project Information

Analyst	PK/LCG	Agency	Fuss and O'Neill
Jurisdiction		Time Period Analyzed	AM Peak - SB
Analysis Year	2040 - 4A South Alt. A AM - SB Overlap	Date	3/8/2019
Project Description	I-93 SB - from N of Exit 5 to S of Exit 4		

Facility Global Input

Jam Density, pc/mi/ln	190.0	Density at Capacity, pc/mi/ln	45.0
Queue Discharge Capacity Drop, %	7	Total Segments	15
Total Time Periods	1	Time Period Duration, min	15

Segment Geometric Data

No.	Coded	Analyzed	Name	Length, ft	Lanes
1	Basic	Basic	a->b	5280	4
2	Diverge	Diverge	b->c	1500	4
3	Basic	Basic	c->d	3920	4
4	Merge	Merge	d->e	1500	4
5	Basic	Basic	e->f	7615	4
6	Diverge	Diverge	f>g	1500	4
7	Basic	Basic	g>h	3165	4
8	Merge	Merge	h>i	1500	4
9	Overlap	Basic	i>j	650	4
10	Diverge	Diverge	j>k	1500	4
11	Basic	Basic	k>l	2650	4
12	Merge	Merge	l>m	1500	4
13	Basic	Basic	m>n	600	4
14	Merge	Merge	l>m	1500	4
15	Basic	Basic	m>n	5280	4

Facility Segment Data

Segment 1: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.970	5994	9600	0.62	69.0	21.7	C

Segment 2: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.74	0.970	0.972	5994	869	9600	2100	0.62	0.41	67.3	61.3	22.3	24.2	C

Segment 3: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.970	5308	9600	0.55	69.8	19.0	C

Segment 4: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.84	0.970	0.953	6401	1093	9600	2100	0.67	0.52	64.1	62.3	25.0	21.2	C

Segment 5: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.970	6268	9600	0.65	68.4	22.9	C

Segment 6: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.80	0.970	0.965	6268	2241	9600	4200	0.65	0.53	64.8	57.8	24.2	19.0	B

Segment 7: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.970	4370	9600	0.46	70.0	15.6	B

Segment 8: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.80	0.970	0.965	5639	1269	9600	2100	0.59	0.60	63.8	61.1	22.1	23.3	C

Segment 9: Overlap

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.970	5445	9600	0.57	63.8	22.1	C

Segment 10: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.80	0.970	0.965	5445	1587	9600	2100	0.57	0.76	65.3	59.5	20.8	25.8	C

Segment 11: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.970	4102	9600	0.43	70.0	14.7	B

Segment 12: Merge

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS

	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.82	0.980	0.970	4751	691	9600	1900	0.49	0.36	64.8	62.2	18.3	14.6	B

Segment 13: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	4657	9600	0.49	70.0	16.6	B

Segment 14: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.82	0.980	0.970	6618	1961	9600	2100	0.69	0.93	62.6	59.9	26.4	25.7	C

Segment 15: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	6350	9600	0.66	68.3	23.3	C

Facility Time Period Results

T	Speed, mi/h	Density, pc/mi/ln	Density, veh/mi/ln	Travel Time, min	LOS
1	67.7	21.1	20.5	6.7	C

Facility Overall Results

Space Mean Speed, mi/h	67.7	Density, veh/mi/ln	20.5
Average Travel Time, min	6.7		

HCS 2010 Facilities Report

Project Information

Analyst	PK/LCG	Agency	Fuss and O'Neill
Jurisdiction		Time Period Analyzed	PM Peak - NB Overlap
Analysis Year	2040 4A South Alt. A - PM-NB	Date	3/8/2019
Project Description	I-93 NB - from S. of Exit 4 to N of Exit 5		

Facility Global Input

Jam Density, pc/mi/ln	190.0	Density at Capacity, pc/mi/ln	45.0
Queue Discharge Capacity Drop, %	7	Total Segments	13
Total Time Periods	1	Time Period Duration, min	15

Segment Geometric Data

No.	Coded	Analyzed	Name	Length, ft	Lanes
1	Basic	Basic	a->b	5280	4
2	Diverge	Diverge	b.->c	1500	4
3	Basic	Basic	c->d	4525	4
4	Merge	Merge	d>e	1500	4
5	Overlap	Basic	e>f	700	4
6	Diverge	Diverge	f>g	1500	4
7	Basic	Basic	g > h	3310	4
8	Merge	Merge	h > j	1500	4
9	Basic	Basic	i > j	6215	4
10	Diverge	Diverge	j > k	1500	4
11	Basic	Basic	k > l	4100	4
12	Merge	Merge	l > m	1500	4
13	Basic	Basic	m > n	5280	4

Facility Segment Data

Segment 1: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.979	6303	9600	0.66	68.4	23.0	C

Segment 2: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.92	0.979	0.991	6303	2287	9600	4200	0.66	0.54	64.7	57.7	24.4	11.0	B

Segment 3: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.979	4037	9600	0.42	70.0	14.4	B

Segment 4: Merge															
Time Period	**PHF**		**fHV**		**Flow Rate (pc/h)**		**Capacity (pc/h)**		**d/c Ratio**		**Speed (mi/h)**		**Density (pc/mi/ln)**		**LOS**
	F	**R**	**F**	**R**	**Freeway**	**Ramp**	**Freeway**	**Ramp**	**F**	**R**	**F**	**R**	**Freeway**	**Ramp**	
1	0.94	0.87	0.979	0.988	5509	1472	9600	2100	0.57	0.70	64.6	62.6	21.3	20.1	C

Segment 5: Overlap								
Time Period	**PHF**	**fHV**	**Flow Rate (pc/h)**	**Capacity (pc/h)**	**d/c Ratio**	**Speed (mi/h)**	**Density (pc/mi/ln)**	**LOS**
1	0.94	0.985	5379	9600	0.56	64.6	21.3	C

Segment 6: Diverge															
Time Period	**PHF**		**fHV**		**Flow Rate (pc/h)**		**Capacity (pc/h)**		**d/c Ratio**		**Speed (mi/h)**		**Density (pc/mi/ln)**		**LOS**
	F	**R**	**F**	**R**	**Freeway**	**Ramp**	**Freeway**	**Ramp**	**F**	**R**	**F**	**R**	**Freeway**	**Ramp**	
1	0.94	0.84	0.985	0.983	5379	860	9600	2100	0.56	0.41	67.4	61.3	20.0	21.8	C

Segment 7: Basic								
Time Period	**PHF**	**fHV**	**Flow Rate (pc/h)**	**Capacity (pc/h)**	**d/c Ratio**	**Speed (mi/h)**	**Density (pc/mi/ln)**	**LOS**
1	0.94	0.985	4612	9600	0.48	70.0	16.5	B

Segment 8: Merge															
Time Period	**PHF**		**fHV**		**Flow Rate (pc/h)**		**Capacity (pc/h)**		**d/c Ratio**		**Speed (mi/h)**		**Density (pc/mi/ln)**		**LOS**
	F	**R**	**F**	**R**	**Freeway**	**Ramp**	**Freeway**	**Ramp**	**F**	**R**	**F**	**R**	**Freeway**	**Ramp**	
1	0.94	0.84	0.985	0.983	6114	1502	9600	2100	0.64	0.72	63.1	60.4	24.2	25.3	C

Segment 9: Basic								
Time Period	**PHF**	**fHV**	**Flow Rate (pc/h)**	**Capacity (pc/h)**	**d/c Ratio**	**Speed (mi/h)**	**Density (pc/mi/ln)**	**LOS**
1	0.94	0.985	5951	9600	0.62	69.0	21.6	C

Segment 10: Diverge															
Time Period	**PHF**		**fHV**		**Flow Rate (pc/h)**		**Capacity (pc/h)**		**d/c Ratio**		**Speed (mi/h)**		**Density (pc/mi/ln)**		**LOS**
	F	**R**	**F**	**R**	**Freeway**	**Ramp**	**Freeway**	**Ramp**	**F**	**R**	**F**	**R**	**Freeway**	**Ramp**	
1	0.94	0.67	0.985	0.964	5951	1215	9600	2100	0.62	0.58	66.4	60.4	22.4	28.1	D

Segment 11: Basic								
Time Period	**PHF**	**fHV**	**Flow Rate (pc/h)**	**Capacity (pc/h)**	**d/c Ratio**	**Speed (mi/h)**	**Density (pc/mi/ln)**	**LOS**
1	0.94	0.985	5103	9600	0.53	69.9	18.3	C

Segment 12: Merge															
Time Period	**PHF**		**fHV**		**Flow Rate (pc/h)**		**Capacity (pc/h)**		**d/c Ratio**		**Speed (mi/h)**		**Density (pc/mi/ln)**		**LOS**
	F	**R**	**F**	**R**	**Freeway**	**Ramp**	**Freeway**	**Ramp**	**F**	**R**	**F**	**R**	**Freeway**	**Ramp**	
1	0.94	0.89	0.985	0.988	6155	1052	9600	2100	0.64	0.50	63.4	60.7	24.3	24.4	C

Segment 13: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.985	6102	9600	0.64	68.8	22.2	C

Facility Time Period Results

T	Speed, mi/h	Density, pc/mi/ln	Density, veh/mi/ln	Travel Time, min	LOS
1	68.0	20.5	20.2	6.4	C

Facility Overall Results

Space Mean Speed, mi/h	68.0	Density, veh/mi/ln	20.2
Average Travel Time, min	6.4		

HCS 2010 Facilities Report

Project Information

Analyst	PK/LCG	Agency	Fuss and O'Neill
Jurisdiction		Time Period Analyzed	PM Peak - SB
Analysis Year	2040 - 4A South Alt. A PM - SB Overlap	Date	3/8/2019
Project Description	I-93 SB - from N of Exit 5 to S of Exit 4		

Facility Global Input

Jam Density, pc/mi/ln	190.0	Density at Capacity, pc/mi/ln	45.0
Queue Discharge Capacity Drop, %	7	Total Segments	15
Total Time Periods	1	Time Period Duration, min	15

Segment Geometric Data

No.	Coded	Analyzed	Name	Length, ft	Lanes
1	Basic	Basic	a->b	5280	4
2	Diverge	Diverge	b->c	1500	4
3	Basic	Basic	c->d	3920	4
4	Merge	Merge	d->e	1500	4
5	Basic	Basic	e->f	7615	4
6	Diverge	Diverge	f>g	1500	4
7	Basic	Basic	g>h	3165	4
8	Merge	Merge	h>i	1500	4
9	Overlap	Basic	i>j	650	4
10	Diverge	Diverge	j>k	1500	4
11	Basic	Basic	k>l	2650	4
12	Merge	Merge	l>m	1500	4
13	Basic	Basic	m>n	600	4
14	Merge	Merge	n>o	1500	4
15	Basic	Basic	o>p	5280	4

Facility Segment Data

Segment 1: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.982	5931	9600	0.62	69.1	21.5	C

Segment 2: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.89	0.982	0.979	5931	883	9600	2100	0.62	0.42	67.2	61.3	22.1	24.0	C

Segment 3: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.982	5102	9600	0.53	69.9	18.3	C

Segment 4: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.81	0.982	0.978	6030	928	9600	2100	0.63	0.44	64.6	62.9	23.3	19.3	B

Segment 5: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.982	5899	9600	0.61	69.1	21.3	C

Segment 6: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.84	0.982	0.979	5899	1879	9600	4200	0.61	0.45	65.9	58.7	22.4	15.9	B

Segment 7: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.982	4225	9600	0.44	72.2	14.6	B

Segment 8: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.84	0.982	0.979	5289	1064	9600	2100	0.55	0.51	64.2	61.6	20.6	21.4	C

Segment 9: Overlap

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.982	5173	9600	0.54	64.2	20.6	C

Segment 10: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.84	0.982	0.979	5173	1921	9600	2100	0.54	0.91	64.0	58.6	20.2	26.4	C

Segment 11: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	3468	9600	0.36	70.0	12.4	B

Segment 12: Merge

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS

	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.82	0.980	0.980	3785	317	9600	1900	0.39	0.17	65.6	62.7	14.4	10.0	A

Segment 13: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	3745	9600	0.39	70.0	13.4	B

Segment 14: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.82	0.980	0.980	4660	915	9600	2000	0.49	0.46	65.2	62.9	17.9	15.2	B

Segment 15: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	4543	9600	0.47	70.0	16.2	B

Facility Time Period Results

T	Speed, mi/h	Density, pc/mi/ln	Density, veh/mi/ln	Travel Time, min	LOS
1	68.5	18.8	18.4	6.6	C

Facility Overall Results

Space Mean Speed, mi/h	68.5	Density, veh/mi/ln	18.4
Average Travel Time, min	6.6		

HCS 2010 Facilities Report

Project Information

Analyst	PK/LCG	Agency	Fuss and O'Neill
Jurisdiction		Time Period Analyzed	AM Peak - NB w/Overlap
Analysis Year	2040 4A South Alt. B - AM-NB	Date	3/8/2019
Project Description	I-93 NB - from S. of Exit 4 to N of Exit 5		

Facility Global Input

Jam Density, pc/mi/ln	190.0	Density at Capacity, pc/mi/ln	45.0
Queue Discharge Capacity Drop, %	7	Total Segments	13
Total Time Periods	1	Time Period Duration, min	15

Segment Geometric Data

No.	Coded	Analyzed	Name	Length, ft	Lanes
1	Basic	Basic	a>b	5280	4
2	Diverge	Diverge	b>c	1500	4
3	Basic	Basic	c>d	4525	4
4	Merge	Merge	d>e	1500	4
5	Overlap	Basic	e>f	700	4
6	Diverge	Diverge	f>g	1500	4
7	Basic	Basic	g>h	3310	4
8	Merge	Merge	h>i	1500	4
9	Basic	Basic	i>j	6215	4
10	Diverge	Diverge	j>k	1500	4
11	Basic	Basic	k>l	4100	4
12	Merge	Merge	l>m	1500	4
13	Basic	Basic	m>n	5280	4

Facility Segment Data

Segment 1: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.979	3673	9600	0.38	70.0	13.1	B

Segment 2: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.77	0.979	0.964	3673	983	9600	4200	0.38	0.23	68.7	61.0	13.4	0.0	A

Segment 3: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.979	2690	9600	0.30	70.0	9.6	A

Segment 4: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.90	0.979	0.983	4790	2165	9600	2100	0.53	1.03	53.3	62.2	45.0	20.8	C

Segment 5: Overlap

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.964	4790	9600	0.52	53.3	45.0	C

Segment 6: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.81	0.964	0.969	4790	1102	9600	2100	0.52	0.52	66.7	60.7	18.0	20.8	C

Segment 7: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.964	3688	9600	0.43	70.0	13.2	B

Segment 8: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.81	0.964	0.969	5223	1535	9600	2100	0.59	0.73	63.9	61.3	20.4	22.7	C

Segment 9: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.964	5223	9600	0.56	69.9	18.7	C

Segment 10: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.75	0.964	0.956	5223	851	9600	2100	0.56	0.41	67.4	61.3	19.4	23.6	C

Segment 11: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.964	4372	9600	0.49	70.0	15.6	B

Segment 12: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.83	0.964	0.972	5729	1357	9600	2100	0.64	0.65	63.5	60.7	22.6	24.4	C

Segment 13: Basic								
Time Period	**PHF**	**fHV**	**Flow Rate (pc/h)**	**Capacity (pc/h)**	**d/c Ratio**	**Speed (mi/h)**	**Density (pc/mi/ln)**	**LOS**
1	0.94	0.964	5729	9600	0.62	69.4	20.6	C

Facility Time Period Results

T	Speed, mi/h	Density, pc/mi/ln	Density, veh/mi/ln	Travel Time, min	LOS
1	67.6	17.8	17.3	6.5	B

Facility Overall Results

Space Mean Speed, mi/h	67.6	Density, veh/mi/ln	17.3
Average Travel Time, min	6.5		

HCS 2010 Facilities Report

Project Information

Analyst	PK/LCG	Agency	Fuss and O'Neill
Jurisdiction		Time Period Analyzed	AM Peak - SB with Overlap
Analysis Year	2040 - 4A South Alt. B AM - SB Overlap	Date	3/8/2019
Project Description	I-93 SB - from N of Exit 5 to S of Exit 4		

Facility Global Input

Jam Density, pc/mi/ln	190.0	Density at Capacity, pc/mi/ln	45.0
Queue Discharge Capacity Drop, %	7	Total Segments	15
Total Time Periods	1	Time Period Duration, min	15

Segment Geometric Data

No.	Coded	Analyzed	Name	Length, ft	Lanes
1	Basic	Basic	a->b	5280	4
2	Diverge	Diverge	b->c	1500	4
3	Basic	Basic	c->d	3920	4
4	Merge	Merge	d->e	1500	4
5	Basic	Basic	e->f	7615	4
6	Diverge	Diverge	f>g	1500	4
7	Basic	Basic	g>h	3165	4
8	Merge	Merge	h>i	1500	4
9	Overlap	Basic	i>j	650	4
10	Diverge	Diverge	j>k	1500	4
11	Basic	Basic	k>l	2650	4
12	Merge	Merge	l>m	1500	4
13	Basic	Basic	m>n	600	4
14	Merge	Merge	l>m	1500	4
15	Basic	Basic	m>n	5280	4

Facility Segment Data

Segment 1: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.970	6043	9600	0.63	68.9	21.9	C

Segment 2: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.74	0.970	0.972	6043	681	9600	2100	0.63	0.32	67.7	61.8	22.3	23.5	C

Segment 3: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.970	5506	9600	0.57	69.6	19.8	C

Segment 4: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.84	0.970	0.953	6355	849	9600	2100	0.66	0.40	64.3	62.7	24.7	20.0	B

Segment 5: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.970	6251	9600	0.65	68.5	22.8	C

Segment 6: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.80	0.970	0.965	6251	2293	9600	4200	0.65	0.55	64.7	57.7	24.2	19.3	B

Segment 7: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.970	4310	9600	0.45	70.0	15.4	B

Segment 8: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.80	0.970	0.965	5780	1470	9600	2100	0.60	0.70	63.3	60.6	22.8	24.6	C

Segment 9: Overlap

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.970	5555	9600	0.58	63.3	22.8	C

Segment 10: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.80	0.970	0.965	5555	1697	9600	2100	0.58	0.81	64.9	59.2	21.4	26.7	C

Segment 11: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	4076	9600	0.42	70.0	14.6	B

Segment 12: Merge

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS

	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.82	0.980	0.970	4811	735	9600	1900	0.50	0.39	64.7	62.2	18.6	15.0	B

Segment 13: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	4711	9600	0.49	70.0	16.8	B

Segment 14: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.82	0.980	0.970	6641	1930	9600	2100	0.69	0.92	62.6	59.9	26.5	25.6	C

Segment 15: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	6378	9600	0.66	68.2	23.4	C

Facility Time Period Results

T	Speed, mi/h	Density, pc/mi/ln	Density, veh/mi/ln	Travel Time, min	LOS
1	67.7	21.3	20.7	6.7	C

Facility Overall Results

Space Mean Speed, mi/h	67.7	Density, veh/mi/ln	20.7
Average Travel Time, min	6.7		

HCS 2010 Facilities Report

Project Information

Analyst	PK/LCG	Agency	Fuss and O'Neill
Jurisdiction		Time Period Analyzed	PM Peak - NB Overlap
Analysis Year	2040 4A South Alt. B - PM-NB	Date	3/8/2019
Project Description	I-93 NB - from S. of Exit 4 to N of Exit 5		

Facility Global Input

Jam Density, pc/mi/ln	190.0	Density at Capacity, pc/mi/ln	45.0
Queue Discharge Capacity Drop, %	7	Total Segments	13
Total Time Periods	1	Time Period Duration, min	15

Segment Geometric Data

No.	Coded	Analyzed	Name	Length, ft	Lanes
1	Basic	Basic	a->b	5280	4
2	Diverge	Diverge	b.->c	1500	4
3	Basic	Basic	c->d	4525	4
4	Merge	Merge	d>e	1500	4
5	Overlap	Basic	e>f	700	4
6	Diverge	Diverge	f>g	1500	4
7	Basic	Basic	g > h	3310	4
8	Merge	Merge	h > j	1500	4
9	Basic	Basic	i > j	6215	4
10	Diverge	Diverge	j > k	1500	4
11	Basic	Basic	k > l	4100	4
12	Merge	Merge	l > m	1500	4
13	Basic	Basic	m > n	5280	4

Facility Segment Data

Segment 1: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.979	6324	9600	0.66	68.3	23.1	C

Segment 2: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.92	0.979	0.991	6324	2298	9600	4200	0.66	0.55	64.7	57.7	24.4	11.2	B

Segment 3: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.979	4048	9600	0.42	70.0	14.5	B

Segment 4: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.87	0.979	0.988	5758	1710	9600	2100	0.60	0.81	64.1	61.9	22.5	21.9	C

Segment 5: Overlap

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.985	5611	9600	0.58	64.1	22.5	C

Segment 6: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.84	0.985	0.983	5611	933	9600	2100	0.58	0.44	67.1	61.1	20.9	23.1	C

Segment 7: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.985	4779	9600	0.50	70.0	17.1	B

Segment 8: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.84	0.985	0.983	6081	1302	9600	2100	0.63	0.62	63.4	60.8	24.0	24.4	C

Segment 9: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.985	5940	9600	0.62	69.1	21.5	C

Segment 10: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.67	0.985	0.964	5940	1138	9600	2100	0.62	0.54	66.6	60.6	22.3	27.7	C

Segment 11: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.985	5146	9600	0.54	69.9	18.4	C

Segment 12: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.89	0.985	0.988	6164	1018	9600	2100	0.64	0.48	63.3	60.7	24.3	24.3	C

Segment 13: Basic								
Time Period	**PHF**	**fHV**	**Flow Rate (pc/h)**	**Capacity (pc/h)**	**d/c Ratio**	**Speed (mi/h)**	**Density (pc/mi/ln)**	**LOS**
1	0.94	0.985	6113	9600	0.64	68.8	22.2	C

Facility Time Period Results

T	Speed, mi/h	Density, pc/mi/ln	Density, veh/mi/ln	Travel Time, min	LOS
1	68.0	20.7	20.3	6.4	C

Facility Overall Results

Space Mean Speed, mi/h	68.0	Density, veh/mi/ln	20.3
Average Travel Time, min	6.4		

HCS 2010 Facilities Report

Project Information

Analyst	PK/LCG	Agency	Fuss and O'Neill
Jurisdiction		Time Period Analyzed	PM Peak - SB with Overlap
Analysis Year	2040 - 4A South Alt. B PM - SB Overlap	Date	3/8/2019
Project Description	I-93 SB - from N of Exit 5 to S of Exit 4		

Facility Global Input

Jam Density, pc/mi/ln	190.0	Density at Capacity, pc/mi/ln	45.0
Queue Discharge Capacity Drop, %	7	Total Segments	15
Total Time Periods	1	Time Period Duration, min	15

Segment Geometric Data

No.	Coded	Analyzed	Name	Length, ft	Lanes
1	Basic	Basic	a->b	5280	4
2	Diverge	Diverge	b->c	1500	4
3	Basic	Basic	c->d	3920	4
4	Merge	Merge	d->e	1500	4
5	Basic	Basic	e->f	7615	4
6	Diverge	Diverge	f>g	1500	4
7	Basic	Basic	g>h	3165	4
8	Merge	Merge	h>i	1500	4
9	Overlap	Basic	i>j	650	4
10	Diverge	Diverge	j>k	1500	4
11	Basic	Basic	k>l	2650	4
12	Merge	Merge	l>m	1500	4
13	Basic	Basic	m>n	600	4
14	Merge	Merge	n>o	1500	4
15	Basic	Basic	o>p	5280	4

Facility Segment Data

Segment 1: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.982	5947	9600	0.62	69.0	21.6	C

Segment 2: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.89	0.982	0.979	5947	693	9600	2100	0.62	0.33	67.6	61.7	22.0	23.2	C

Segment 3: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.982	5297	9600	0.55	69.8	19.0	C

Segment 4: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.81	0.982	0.978	6017	720	9600	2100	0.63	0.34	64.6	63.1	23.3	18.4	B

Segment 5: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.982	5915	9600	0.62	69.1	21.4	C

Segment 6: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.84	0.982	0.979	5915	1915	9600	4200	0.62	0.46	65.8	58.7	22.5	16.2	B

Segment 7: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.982	4209	9600	0.44	70.0	15.0	B

Segment 8: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.84	0.982	0.979	5437	1228	9600	2100	0.57	0.58	63.9	61.3	21.3	22.5	C

Segment 9: Overlap

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.982	5303	9600	0.55	63.9	21.3	C

Segment 10: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.84	0.982	0.979	5303	2055	9600	2100	0.55	0.98	63.6	58.3	20.8	27.5	C

Segment 11: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	3479	9600	0.36	70.0	12.4	B

Segment 12: Merge

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS

	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.82	0.980	0.980	3815	336	9600	1900	0.40	0.18	65.5	62.7	14.6	10.2	B

Segment 13: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	3772	9600	0.39	70.0	13.5	B

Segment 14: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.82	0.980	0.980	4674	902	9600	2000	0.49	0.45	65.1	62.9	17.9	15.2	B

Segment 15: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	4559	9600	0.47	70.0	16.3	B

Facility Time Period Results

T	Speed, mi/h	Density, pc/mi/ln	Density, veh/mi/ln	Travel Time, min	LOS
1	68.3	19.0	18.7	6.6	C

Facility Overall Results

Space Mean Speed, mi/h	68.3	Density, veh/mi/ln	18.7
Average Travel Time, min	6.6		

HCS 2010 Facilities Report

Project Information

Analyst	PK/LCG	Agency	Fuss and O'Neill
Jurisdiction		Time Period Analyzed	AM Peak - NB
Analysis Year	2040 4A North Alt. C - AM-NB	Date	3/8/2019
Project Description	I-93 NB - from S. of Exit 4 to N of Exit 5		

Facility Global Input

Jam Density, pc/mi/ln	190.0	Density at Capacity, pc/mi/ln	45.0
Queue Discharge Capacity Drop, %	7	Total Segments	13
Total Time Periods	1	Time Period Duration, min	15

Segment Geometric Data

No.	Coded	Analyzed	Name	Length, ft	Lanes
1	Basic	Basic	a->b	5280	4
2	Diverge	Diverge	b.->c	1500	4
3	Basic	Basic	c->d	4525	4
4	Merge	Merge	d->e	1500	4
5	Basic	Basic	e->f	4497	4
6	Diverge	Diverge	f > g	1500	4
7	Basic	Basic	g > h	2702	4
8	Merge	Merge	h > j	1500	4
9	Basic	Basic	i > j	1626	4
10	Diverge	Diverge	j > k	1500	4
11	Basic	Basic	k > l	4100	4
12	Merge	Merge	l > m	1500	4
13	Basic	Basic	m > n	5280	4

Facility Segment Data

Segment 1: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.979	3548	9600	0.37	70.0	12.7	B

Segment 2: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.77	0.979	0.964	3548	1017	9600	4200	0.37	0.24	68.4	60.9	13.0	0.0	A

Segment 3: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.979	2727	9600	0.28	70.0	9.7	A

Segment 4: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.90	0.979	0.983	4677	1950	9600	2100	0.49	0.93	64.7	62.6	18.1	19.5	B

Segment 5: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.964	4674	9600	0.49	70.0	16.7	B

Segment 6: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.81	0.964	0.969	4674	325	9600	2100	0.49	0.15	69.0	62.7	16.9	16.7	B

Segment 7: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.964	4392	9600	0.46	70.0	15.7	B

Segment 8: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.81	0.964	0.969	5953	1561	9600	2100	0.62	0.74	64.1	61.9	23.2	21.9	C

Segment 9: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.964	5744	9600	0.60	69.4	20.7	C

Segment 10: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.75	0.964	0.956	5744	802	9600	2100	0.60	0.38	67.5	61.5	21.3	25.4	C

Segment 11: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.964	5109	9600	0.53	69.9	18.3	C

Segment 12: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.83	0.964	0.972	6125	1016	9600	2100	0.64	0.48	63.4	60.8	24.2	24.2	C

Segment 13: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.964	6014	9600	0.63	68.9	21.8	C

Facility Time Period Results

T	Speed, mi/h	Density, pc/mi/ln	Density, veh/mi/ln	Travel Time, min	LOS
1	68.6	17.0	16.4	6.1	B

Facility Overall Results

Space Mean Speed, mi/h	68.6	Density, veh/mi/ln	16.4
Average Travel Time, min	6.1		

HCS 2010 Facilities Report

Project Information

Analyst	PK/LCG	Agency	Fuss and O'Neill
Jurisdiction		Time Period Analyzed	AM Peak - SB
Analysis Year	2040 4A North Alt C AM - SB	Date	3/8/2019
Project Description	I-93 SB - from N of Exit 5 to S of Exit 4		

Facility Global Input

Jam Density, pc/mi/ln	190.0	Density at Capacity, pc/mi/ln	45.0
Queue Discharge Capacity Drop, %	7	Total Segments	15
Total Time Periods	1	Time Period Duration, min	15

Segment Geometric Data

No.	Coded	Analyzed	Name	Length, ft	Lanes
1	Basic	Basic	a->b	5280	4
2	Diverge	Diverge	b->c	1500	4
3	Basic	Basic	c->d	3920	4
4	Merge	Merge	d->e	1500	4
5	Basic	Basic	e->f	2705	4
6	Diverge	Diverge	f>g	1500	4
7	Basic	Basic	g>h	2850	4
8	Merge	Merge	h>i	1500	4
9	Basic	Basic	i>j	4675	4
10	Diverge	Diverge	j>k	1500	4
11	Basic	Basic	k>l	2550	4
12	Merge	Merge	l>m	1500	4
13	Basic	Basic	m>n	600	4
14	Merge	Merge	n>o	1500	4
15	Basic	Basic	o>p	5280	4

Facility Segment Data

Segment 1: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.970	5994	9600	0.62	69.0	21.7	C

Segment 2: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.74	0.970	0.972	5994	646	9600	2100	0.62	0.31	67.8	61.9	22.1	23.1	C

Segment 3: Basic

Time	PHF	fHV	Flow Rate	Capacity	d/c	Speed	Density	LOS

Period			(pc/h)	(pc/h)	Ratio	(mi/h)	(pc/mi/ln)	
1	0.94	0.970	5484	9600	0.57	69.7	19.7	C

Segment 4: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.84	0.970	0.953	6421	937	9600	2100	0.67	0.45	64.2	62.5	25.0	20.6	C

Segment 5: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.970	6306	9600	0.66	68.4	23.0	C

Segment 6: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.84	0.970	0.967	6306	1939	9600	2100	0.66	0.92	64.3	58.6	24.5	32.9	D

Segment 7: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.970	4579	9600	0.48	70.0	16.4	B

Segment 8: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.84	0.970	0.967	5145	566	9600	2100	0.54	0.27	65.4	63.7	19.7	15.1	B

Segment 9: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	5031	9600	0.52	70.0	18.0	B

Segment 10: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.95	0.980	0.975	5031	1215	9600	2100	0.52	0.58	66.4	60.4	18.9	22.4	C

Segment 11: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	3810	9600	0.40	70.0	13.6	B

Segment 12: Merge

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS

	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.82	0.980	0.970	4728	918	9600	1900	0.49	0.48	64.7	62.1	18.3	15.5	B

Segment 13: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	4603	9600	0.48	70.0	16.4	B

Segment 14: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.82	0.980	0.970	6401	1798	9600	2100	0.67	0.86	63.3	60.8	25.3	24.3	C

Segment 15: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	6155	9600	0.64	68.7	22.4	C

Facility Time Period Results

T	Speed, mi/h	Density, pc/mi/ln	Density, veh/mi/ln	Travel Time, min	LOS
1	68.1	20.3	19.8	6.4	C

Facility Overall Results

Space Mean Speed, mi/h	68.1	Density, veh/mi/ln	19.8
Average Travel Time, min	6.4		

HCS 2010 Facilities Report

Project Information

Analyst	PK/LCG	Agency	Fuss and O'Neill
Jurisdiction		Time Period Analyzed	PM Peak - NB
Analysis Year	2040 4A North Alt. C - PM-NB	Date	3/8/2019
Project Description	I-93 NB - from S. of Exit 4 to N of Exit 5		

Facility Global Input

Jam Density, pc/mi/ln	190.0	Density at Capacity, pc/mi/ln	45.0
Queue Discharge Capacity Drop, %	7	Total Segments	13
Total Time Periods	1	Time Period Duration, min	15

Segment Geometric Data

No.	Coded	Analyzed	Name	Length, ft	Lanes
1	Basic	Basic	a->b	5280	4
2	Diverge	Diverge	b.->c	1500	4
3	Basic	Basic	c->d	4525	4
4	Merge	Merge	d->e	1500	4
5	Basic	Basic	e->f	4497	4
6	Diverge	Diverge	f > g	1500	4
7	Basic	Basic	g > h	2702	4
8	Merge	Merge	h > j	1500	4
9	Basic	Basic	i > j	1626	4
10	Diverge	Diverge	j > k	1500	4
11	Basic	Basic	k > l	4100	4
12	Merge	Merge	l > m	1500	4
13	Basic	Basic	m > n	5280	4

Facility Segment Data

Segment 1: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.979	6112	9600	0.64	68.8	22.2	C

Segment 2: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.92	0.979	0.991	6112	2369	9600	4200	0.64	0.56	64.4	57.5	23.7	11.1	B

Segment 3: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.979	3765	9600	0.39	70.0	13.4	B

Segment 4: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.87	0.979	0.988	5306	1541	9600	2100	0.55	0.73	64.7	62.6	20.5	19.8	B

Segment 5: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.985	5173	9600	0.54	69.9	18.5	C

Segment 6: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.84	0.985	0.983	5173	279	9600	2100	0.54	0.13	68.9	62.8	18.8	18.4	B

Segment 7: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.985	4925	9600	0.51	70.0	17.6	B

Segment 8: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.84	0.985	0.983	6245	1320	9600	2100	0.65	0.63	64.1	62.0	24.4	21.8	C

Segment 9: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.985	6102	9600	0.64	68.8	22.2	C

Segment 10: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.67	0.985	0.964	6102	1068	9600	2100	0.64	0.51	66.7	60.8	22.9	28.0	C

Segment 11: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.985	5357	9600	0.56	69.8	19.2	C

Segment 12: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.89	0.985	0.988	6119	762	9600	2100	0.64	0.36	63.6	61.1	24.1	23.1	C

Segment 13: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.985	6081	9600	0.63	68.8	22.1	C

Facility Time Period Results

T	Speed, mi/h	Density, pc/mi/ln	Density, veh/mi/ln	Travel Time, min	LOS
1	68.3	20.0	19.7	6.2	C

Facility Overall Results

Space Mean Speed, mi/h	68.3	Density, veh/mi/ln	19.7
Average Travel Time, min	6.2		

HCS 2010 Facilities Report

Project Information

Analyst	PK/LCG	Agency	Fuss and O'Neill
Jurisdiction		Time Period Analyzed	PM Peak - SB
Analysis Year	2040 4A North Alt C PM - SB	Date	3/8/2019
Project Description	I-93 SB - from N of Exit 5 to S of Exit 4		

Facility Global Input

Jam Density, pc/mi/ln	190.0	Density at Capacity, pc/mi/ln	45.0
Queue Discharge Capacity Drop, %	7	Total Segments	15
Total Time Periods	1	Time Period Duration, min	15

Segment Geometric Data

No.	Coded	Analyzed	Name	Length, ft	Lanes
1	Basic	Basic	a->b	5280	4
2	Diverge	Diverge	b->c	1500	4
3	Basic	Basic	c->d	3920	4
4	Merge	Merge	d->e	1500	4
5	Basic	Basic	e->f	2705	4
6	Diverge	Diverge	f>g	1500	4
7	Basic	Basic	g>h	2850	4
8	Merge	Merge	h>i	1500	4
9	Basic	Basic	i>j	4675	4
10	Diverge	Diverge	j>k	1500	4
11	Basic	Basic	k>l	2550	4
12	Merge	Merge	l>m	1500	4
13	Basic	Basic	m>n	600	4
14	Merge	Merge	n>o	1500	4
15	Basic	Basic	o>p	5280	4

Facility Segment Data

Segment 1: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.982	5877	9600	0.61	69.2	21.2	C

Segment 2: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.89	0.982	0.979	5877	658	9600	2100	0.61	0.31	67.7	61.8	21.7	22.7	C

Segment 3: Basic

Time	PHF	fHV	Flow Rate	Capacity	d/c	Speed	Density	LOS

Period		(pc/h)	(pc/h)	Ratio	(mi/h)	(pc/mi/ln)	
1	0.94	0.982	5260	9600	0.55	69.8	18.8	C

Segment 4: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.81	0.982	0.978	6055	795	9600	2100	0.63	0.38	64.6	63.0	23.4	18.8	B

Segment 5: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.982	5942	9600	0.62	69.1	21.5	C

Segment 6: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.86	0.982	0.981	5942	1665	9600	2100	0.62	0.79	65.1	59.3	22.8	30.2	D

Segment 7: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.985	4407	9600	0.46	70.0	15.7	B

Segment 8: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.86	0.985	0.981	4893	486	9600	2100	0.51	0.23	65.5	63.9	18.7	14.0	B

Segment 9: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	4874	9600	0.51	70.0	17.4	B

Segment 10: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.92	0.980	0.986	4874	1598	9600	2100	0.51	0.76	65.0	59.4	18.7	23.6	C

Segment 11: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	3300	9600	0.34	70.0	11.8	B

Segment 12: Merge

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS

	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.82	0.980	0.980	3723	423	9600	1900	0.39	0.22	65.5	62.7	14.2	10.2	B

Segment 13: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	3669	9600	0.38	70.0	13.1	B

Segment 14: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.82	0.980	0.980	4509	840	9600	2100	0.47	0.40	65.7	63.8	17.2	14.4	B

Segment 15: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	4402	9600	0.46	70.0	15.7	B

Facility Time Period Results

T	Speed, mi/h	Density, pc/mi/ln	Density, veh/mi/ln	Travel Time, min	LOS
1	68.6	18.1	17.8	6.4	C

Facility Overall Results

Space Mean Speed, mi/h	68.6	Density, veh/mi/ln	17.8
Average Travel Time, min	6.4		

HCS 2010 Facilities Report

Project Information

Analyst	PK/LCG	Agency	Fuss and O'Neill
Jurisdiction		Time Period Analyzed	AM Peak - NB
Analysis Year	2040 4A North Alt D - AM - NB	Date	3/8/2019
Project Description	I-93 NB - from S. of Exit 4 to N of Exit 5		

Facility Global Input

Jam Density, pc/mi/ln	190.0	Density at Capacity, pc/mi/ln	45.0
Queue Discharge Capacity Drop, %	7	Total Segments	13
Total Time Periods	1	Time Period Duration, min	15

Segment Geometric Data

No.	Coded	Analyzed	Name	Length, ft	Lanes
1	Basic	Basic	a->b	5280	4
2	Diverge	Diverge	b.->c	1500	4
3	Basic	Basic	c->d	4525	4
4	Merge	Merge	d->e	1500	4
5	Basic	Basic	e->f	4497	4
6	Diverge	Diverge	f > g	1500	4
7	Basic	Basic	g > h	2702	4
8	Merge	Merge	h > j	1500	4
9	Basic	Basic	i > j	1626	4
10	Diverge	Diverge	j > k	1500	4
11	Basic	Basic	k > l	4100	4
12	Merge	Merge	l > m	1500	4
13	Basic	Basic	m > n	5280	4

Facility Segment Data

Segment 1: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.979	3548	9600	0.37	70.0	12.7	B

Segment 2: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.77	0.979	0.964	3548	1058	9600	4200	0.37	0.25	68.2	60.8	13.0	0.0	A

Segment 3: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS

1	0.94	0.979	2695	9600	0.28	70.0	9.6	A

Segment 4: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.90	0.979	0.983	4583	1888	9600	2100	0.48	0.90	64.8	62.8	17.7	19.0	B

Segment 5: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.964	4580	9600	0.48	70.0	16.4	B

Segment 6: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.81	0.964	0.969	4580	172	9600	2100	0.48	0.08	69.4	63.1	16.5	15.7	B

Segment 7: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.964	4431	9600	0.46	70.0	15.8	B

Segment 8: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.81	0.964	0.969	6017	1586	9600	2100	0.63	0.76	64.0	61.8	23.5	22.2	C

Segment 9: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.964	5805	9600	0.60	69.3	20.9	C

Segment 10: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.75	0.964	0.956	5805	851	9600	2100	0.60	0.41	67.3	61.3	21.6	25.8	C

Segment 11: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.964	5132	9600	0.53	69.9	18.4	C

Segment 12: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	

1	0.94	0.83	0.964	0.972	6167	1035	9600	2100	0.64	0.49	63.4	60.7	24.3	24.4	C

Segment 13: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.964	6053	9600	0.63	68.9	22.0	C

Facility Time Period Results

T	Speed, mi/h	Density, pc/mi/ln	Density, veh/mi/ln	Travel Time, min	LOS
1	68.6	17.0	16.4	6.1	B

Facility Overall Results

Space Mean Speed, mi/h	68.6	Density, veh/mi/ln	16.4
Average Travel Time, min	6.1		

HCS 2010 Facilities Report

Project Information

Analyst	PK/LCG	Agency	Fuss and O'Neill
Jurisdiction		Time Period Analyzed	AM Peak - SB
Analysis Year	2040 4A North Alt D AM - SB	Date	3/8/2019
Project Description	I-93 SB - from N of Exit 5 to S of Exit 4		

Facility Global Input

Jam Density, pc/mi/ln	190.0	Density at Capacity, pc/mi/ln	45.0
Queue Discharge Capacity Drop, %	7	Total Segments	15
Total Time Periods	1	Time Period Duration, min	15

Segment Geometric Data

No.	Coded	Analyzed	Name	Length, ft	Lanes
1	Basic	Basic	a->b	5280	4
2	Diverge	Diverge	b->c	1500	4
3	Basic	Basic	c->d	3920	4
4	Merge	Merge	d->e	1500	4
5	Basic	Basic	e->f	2705	4
6	Diverge	Diverge	f>g	1500	4
7	Basic	Basic	g>h	2850	4
8	Merge	Merge	h>i	1500	4
9	Basic	Basic	i>j	4675	4
10	Diverge	Diverge	j>k	1500	4
11	Basic	Basic	k>l	2550	4
12	Merge	Merge	l>m	1500	4
13	Basic	Basic	m>n	600	4
14	Merge	Merge	n>o	1500	4
15	Basic	Basic	o>p	5280	4

Facility Segment Data

Segment 1: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.970	5994	9600	0.62	69.0	21.7	C

Segment 2: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.74	0.970	0.972	5994	653	9600	2100	0.62	0.31	67.7	61.8	22.1	23.1	C

Segment 3: Basic

Time	PHF	fHV	Flow Rate	Capacity	d/c	Speed	Density	LOS

Period			(pc/h)	(pc/h)	Ratio	(mi/h)	(pc/mi/ln)	
1	0.94	0.970	5478	9600	0.57	69.7	19.7	C

Segment 4: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.84	0.970	0.953	6409	931	9600	2100	0.67	0.44	64.2	62.5	25.0	20.5	C

Segment 5: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.970	6295	9600	0.66	68.4	23.0	C

Segment 6: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.84	0.970	0.967	6295	1908	9600	2100	0.66	0.91	64.4	58.7	24.4	32.7	D

Segment 7: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.970	4595	9600	0.48	70.0	16.4	B

Segment 8: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.84	0.970	0.967	5112	517	9600	2100	0.53	0.25	65.4	63.8	19.5	14.8	B

Segment 9: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	5004	9600	0.52	70.0	17.9	B

Segment 10: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.95	0.980	0.975	5004	1188	9600	2100	0.52	0.57	66.5	60.5	18.8	22.1	C

Segment 11: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	3810	9600	0.40	70.0	13.6	B

Segment 12: Merge

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS

	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.82	0.980	0.970	4728	918	9600	1900	0.49	0.48	64.7	62.1	18.3	15.5	B

Segment 13: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	4603	9600	0.48	70.0	16.4	B

Segment 14: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.82	0.980	0.970	6388	1785	9600	2100	0.67	0.85	63.3	60.8	25.2	24.2	C

Segment 15: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	6144	9600	0.64	68.7	22.4	C

Facility Time Period Results

T	Speed, mi/h	Density, pc/mi/ln	Density, veh/mi/ln	Travel Time, min	LOS
1	68.1	20.3	19.7	6.4	C

Facility Overall Results

Space Mean Speed, mi/h	68.1	Density, veh/mi/ln	19.7
Average Travel Time, min	6.4		

HCS 2010 Facilities Report

Project Information

Analyst	PK/LCG	Agency	Fuss and O'Neill
Jurisdiction		Time Period Analyzed	PM Peak - NB
Analysis Year	2040 4A North Alt D - PM-NB	Date	3/8/2019
Project Description	I-93 NB - from S. of Exit 4 to N of Exit 5		

Facility Global Input

Jam Density, pc/mi/ln	190.0	Density at Capacity, pc/mi/ln	45.0
Queue Discharge Capacity Drop, %	7	Total Segments	13
Total Time Periods	1	Time Period Duration, min	15

Segment Geometric Data

No.	Coded	Analyzed	Name	Length, ft	Lanes
1	Basic	Basic	a->b	5280	4
2	Diverge	Diverge	b.->c	1500	4
3	Basic	Basic	c->d	4525	4
4	Merge	Merge	d->e	1500	4
5	Basic	Basic	e->f	4497	4
6	Diverge	Diverge	f > g	1500	4
7	Basic	Basic	g > h	2702	4
8	Merge	Merge	h > j	1500	4
9	Basic	Basic	i > j	1626	4
10	Diverge	Diverge	j > k	1500	4
11	Basic	Basic	k > l	4100	4
12	Merge	Merge	l > m	1500	4
13	Basic	Basic	m > n	5280	4

Facility Segment Data

Segment 1: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.979	6112	9600	0.64	68.8	22.2	C

Segment 2: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.92	0.979	0.991	6112	2468	9600	4200	0.64	0.59	64.1	57.3	23.8	11.8	B

Segment 3: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.979	3667	9600	0.38	70.0	13.1	B

Segment 4: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.87	0.979	0.988	5162	1495	9600	2100	0.54	0.71	64.8	62.8	19.9	19.1	B

Segment 5: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.985	5033	9600	0.52	70.0	18.0	B

Segment 6: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.84	0.985	0.983	5033	145	9600	2100	0.52	0.07	69.2	63.1	18.2	17.2	B

Segment 7: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.985	4903	9600	0.51	70.0	17.5	B

Segment 8: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.84	0.985	0.983	6247	1344	9600	2100	0.65	0.64	64.0	62.0	24.4	21.9	C

Segment 9: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.985	6102	9600	0.64	68.8	22.2	C

Segment 10: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.67	0.985	0.964	6102	1146	9600	2100	0.64	0.55	66.5	60.6	22.9	28.4	D

Segment 11: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.985	5303	9600	0.55	69.8	19.0	C

Segment 12: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.89	0.985	0.988	6076	773	9600	2100	0.63	0.37	63.7	61.2	23.8	23.0	C

Segment 13: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.985	6037	9600	0.63	68.9	21.9	C

Facility Time Period Results

T	Speed, mi/h	Density, pc/mi/ln	Density, veh/mi/ln	Travel Time, min	LOS
1	68.4	19.8	19.5	6.2	C

Facility Overall Results

Space Mean Speed, mi/h	68.4	Density, veh/mi/ln	19.5
Average Travel Time, min	6.2		

HCS 2010 Facilities Report

Project Information

Analyst	PK/LCG	Agency	Fuss and O'Neill
Jurisdiction		Time Period Analyzed	PM Peak - SB
Analysis Year	2040 4A North Alt D PM - SB	Date	3/8/2019
Project Description	I-93 SB - from N of Exit 5 to S of Exit 4		

Facility Global Input

Jam Density, pc/mi/ln	190.0	Density at Capacity, pc/mi/ln	45.0
Queue Discharge Capacity Drop, %	7	Total Segments	15
Total Time Periods	1	Time Period Duration, min	15

Segment Geometric Data

No.	Coded	Analyzed	Name	Length, ft	Lanes
1	Basic	Basic	a->b	5280	4
2	Diverge	Diverge	b->c	1500	4
3	Basic	Basic	c->d	3920	4
4	Merge	Merge	d->e	1500	4
5	Basic	Basic	e->f	2705	4
6	Diverge	Diverge	f>g	1500	4
7	Basic	Basic	g>h	2850	4
8	Merge	Merge	h>i	1500	4
9	Basic	Basic	i>j	4675	4
10	Diverge	Diverge	j>k	1500	4
11	Basic	Basic	k>l	2550	4
12	Merge	Merge	l>m	1500	4
13	Basic	Basic	m>n	600	4
14	Merge	Merge	n>o	1500	4
15	Basic	Basic	o>p	5280	4

Facility Segment Data

Segment 1: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.982	5872	9600	0.61	69.2	21.2	C

Segment 2: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.89	0.982	0.979	5872	664	9600	2100	0.61	0.32	67.8	61.8	21.7	22.7	C

Segment 3: Basic

Time	PHF	fHV	Flow Rate	Capacity	d/c	Speed	Density	LOS

Period			(pc/h)	(pc/h)	Ratio	(mi/h)	(pc/mi/ln)	
1	0.94	0.982	5249	9600	0.55	69.9	18.8	C

Segment 4: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.81	0.982	0.978	6038	789	9600	2100	0.63	0.38	64.6	63.0	23.4	18.7	B

Segment 5: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.982	5926	9600	0.62	69.1	21.4	C

Segment 6: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.86	0.982	0.981	5926	1636	9600	2100	0.62	0.78	65.2	59.4	22.7	30.0	D

Segment 7: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.985	4417	9600	0.46	70.0	15.8	B

Segment 8: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.86	0.985	0.981	4861	444	9600	2100	0.51	0.21	65.6	63.9	18.5	13.7	B

Segment 9: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	4847	9600	0.50	70.0	17.3	B

Segment 10: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.92	0.980	0.986	4847	1565	9600	2100	0.50	0.75	65.1	59.5	18.6	23.4	C

Segment 11: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	3305	9600	0.34	70.0	11.8	B

Segment 12: Merge

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS

	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.82	0.980	0.980	3728	423	9600	1900	0.39	0.22	65.5	62.7	14.2	10.3	B

Segment 13: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	3675	9600	0.38	70.0	13.1	B

Segment 14: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.82	0.980	0.980	4515	840	9600	2100	0.47	0.40	65.7	63.8	17.2	14.4	B

Segment 15: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	4407	9600	0.46	70.0	15.7	B

Facility Time Period Results

T	Speed, mi/h	Density, pc/mi/ln	Density, veh/mi/ln	Travel Time, min	LOS
1	68.6	18.1	17.8	6.4	C

Facility Overall Results

Space Mean Speed, mi/h	68.6	Density, veh/mi/ln	17.8
Average Travel Time, min	6.4		

HCS 2010 Facilities Report

Project Information

Analyst	PK/LCG	Agency	CLD
Jurisdiction		Time Period Analyzed	AM Peak - NB
Analysis Year	2040 Alternative F - AM-NB	Date	6/8/2017
Project Description	I-93 NB - from S. of Exit 4 to N of Exit 5		

Facility Global Input

Jam Density, pc/mi/ln	190.0	Density at Capacity, pc/mi/ln	45.0
Queue Discharge Capacity Drop, %	7	Total Segments	9
Total Time Periods	1	Time Period Duration, min	15

Segment Geometric Data

No.	Coded	Analyzed	Name	Length, ft	Lanes
1	Basic	Basic	a->b	5280	4
2	Diverge	Diverge	b.->c	1500	4
3	Basic	Basic	c->d	4525	4
4	Merge	Merge	d->e	1500	4
5	Basic	Basic	e->f	11825	4
6	Diverge	Diverge	f->g	1500	4
7	Basic	Basic	g->h	4100	4
8	Merge	Merge	h->i	1500	4
9	Basic	Basic	i->j	5280	4

Facility Segment Data

Segment 1: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.979	3542	9600	0.37	70.0	12.7	B

Segment 2: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.77	0.979	0.964	3542	1105	9600	4200	0.37	0.26	68.0	60.7	13.0	0.0	A

Segment 3: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.979	2437	9600	0.28	70.0	8.7	A

Segment 4: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	

1	0.94	0.90	0.979	0.983	4537	2622	9600	2100	0.55	1.25	53.3	61.7	45.0	21.9	C

Segment 5: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.964	4537	9600	0.55	70.0	16.2	B

Segment 6: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.75	0.964	0.956	4537	753	9600	2100	0.55	0.36	67.8	61.6	16.7	20.6	C

Segment 7: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.964	3784	9600	0.49	70.0	13.5	B

Segment 8: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.83	0.964	0.972	5513	1729	9600	2100	0.67	0.82	63.4	60.7	21.7	24.3	C

Segment 9: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.964	5513	9600	0.65	69.6	19.8	C

Facility Time Period Results

T	Speed, mi/h	Density, pc/mi/ln	Density, veh/mi/ln	Travel Time, min	LOS
1	68.4	16.3	15.8	6.1	B

Facility Overall Results

Space Mean Speed, mi/h	68.4	Density, veh/mi/ln	15.8
Average Travel Time, min	6.1		

HCS 2010 Facilities Report

Project Information

Analyst	PK/LCG	Agency	
Jurisdiction		Time Period Analyzed	AM Peak - SB
Analysis Year	2040 - Alternative F AM-SB	Date	6/18/2017
Project Description	I-93 SB - from N of Exit 5 to S of Exit 4		

Facility Global Input

Jam Density, pc/mi/ln	190.0	Density at Capacity, pc/mi/ln	45.0
Queue Discharge Capacity Drop, %	7	Total Segments	11
Total Time Periods	1	Time Period Duration, min	15

Segment Geometric Data

No.	Coded	Analyzed	Name	Length, ft	Lanes
1	Basic	Basic	a->b	5280	4
2	Diverge	Diverge	b->c	1500	4
3	Basic	Basic	c->d	3920	4
4	Merge	Merge	d->e	1500	4
5	Basic	Basic	e->f	11730	4
6	Diverge	Diverge	f->g	1500	4
7	Basic	Basic	g->h	2550	4
8	Merge	Merge	h->i	1500	4
9	Basic	Basic	i->j	600	4
10	Merge	Merge	j->k	1500	4
11	Basic	Basic	l->m	5280	4

Facility Segment Data

Segment 1: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.970	5582	9600	0.58	69.6	20.1	C

Segment 2: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.74	0.970	0.972	5582	1383	9600	2100	0.58	0.66	65.9	60.0	21.2	25.1	C

Segment 3: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.970	4491	9600	0.47	70.0	16.0	B

Segment 4: Merge

Time	PHF	fHV	Flow Rate	Capacity	d/c	Speed	Density	LOS

Period					(pc/h)		(pc/h)		Ratio		(mi/h)		(pc/mi/ln)		
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.84	0.970	0.953	5428	937	9600	2100	0.57	0.45	64.8	62.9	20.9	17.5	B

Segment 5: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.970	5314	9600	0.55	69.8	19.0	C

Segment 6: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.95	0.970	0.975	5314	1792	9600	2100	0.55	0.85	64.6	59.0	20.6	26.2	C

Segment 7: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	3457	9600	0.36	70.0	12.3	B

Segment 8: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.82	0.980	0.970	4796	1339	9600	1900	0.50	0.70	64.3	61.7	18.6	17.5	B

Segment 9: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	4614	9600	0.48	70.0	16.5	B

Segment 10: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.82	0.980	0.970	6387	1773	9600	2000	0.67	0.89	62.8	60.1	25.4	24.2	C

Segment 11: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	6144	9600	0.64	68.7	22.4	C

Facility Time Period Results

T	Speed, mi/h	Density, pc/mi/ln	Density, veh/mi/ln	Travel Time, min	LOS
1	68.5	19.3	18.8	6.1	C

Facility Overall Results

Space Mean Speed, mi/h	68.5	Density, veh/mi/ln	18.8
Average Travel Time, min	6.1		

HCS 2010 Facilities Report

Project Information

Analyst	PK/LCG	Agency	CLD
Jurisdiction		Time Period Analyzed	PM Peak - NB
Analysis Year	2040 Alternative F PM - NB	Date	6/27/2017
Project Description	I-93 NB - from S. of Exit 4 to N of Exit 5		

Facility Global Input

Jam Density, pc/mi/ln	190.0	Density at Capacity, pc/mi/ln	45.0
Queue Discharge Capacity Drop, %	7	Total Segments	9
Total Time Periods	1	Time Period Duration, min	15

Segment Geometric Data

No.	Coded	Analyzed	Name	Length, ft	Lanes
1	Basic	Basic	a->b	5280	4
2	Diverge	Diverge	b.->c	1500	4
3	Basic	Basic	c->d	4525	4
4	Merge	Merge	d->e	1500	4
5	Basic	Basic	e->f	11825	4
6	Diverge	Diverge	f->g	1500	4
7	Basic	Basic	g->h	4100	4
8	Merge	Merge	h->i	1500	4
9	Basic	Basic	i->j	5280	4

Facility Segment Data

Segment 1: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.979	6102	9600	0.64	68.8	22.2	C

Segment 2: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.92	0.979	0.991	6102	2583	9600	4200	0.64	0.62	63.7	57.0	23.9	12.5	B

Segment 3: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.979	3542	9600	0.37	70.0	12.7	B

Segment 4: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	

1	0.94	0.87	0.979	0.988	5613	2071	9600	2100	0.58	0.99	63.7	61.3	22.0	23.0	C

Segment 5: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.985	5443	9600	0.57	69.7	19.5	C

Segment 6: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.67	0.985	0.964	5443	1014	9600	2100	0.57	0.48	66.9	60.9	20.3	25.3	C

Segment 7: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.985	4736	9600	0.49	70.0	16.9	B

Segment 8: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.89	0.985	0.988	6032	1296	9600	2100	0.63	0.62	63.5	60.9	23.7	24.1	C

Segment 9: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.985	5967	9600	0.62	69.0	21.6	C

Facility Time Period Results

T	Speed, mi/h	Density, pc/mi/ln	Density, veh/mi/ln	Travel Time, min	LOS
1	68.6	19.6	19.2	6.1	C

Facility Overall Results

Space Mean Speed, mi/h	68.6	Density, veh/mi/ln	19.2
Average Travel Time, min	6.1		

HCS 2010 Facilities Report

Project Information

Analyst	PK/LCG	Agency	
Jurisdiction		Time Period Analyzed	PM Peak - SB
Analysis Year	2040 Alternative F - PM	Date	6/18/2017
Project Description	I-93 SB - from N of Exit 5 to S of Exit 4		

Facility Global Input

Jam Density, pc/mi/ln	190.0	Density at Capacity, pc/mi/ln	45.0
Queue Discharge Capacity Drop, %	7	Total Segments	11
Total Time Periods	1	Time Period Duration, min	15

Segment Geometric Data

No.	Coded	Analyzed	Name	Length, ft	Lanes
1	Basic	Basic	a->b	5280	4
2	Diverge	Diverge	b->c	1500	4
3	Basic	Basic	c->d	3920	4
4	Merge	Merge	d->e	1500	4
5	Basic	Basic	e->f	11730	4
6	Diverge	Diverge	f->g	1500	4
7	Basic	Basic	g->h	2550	4
8	Merge	Merge	h->i	1500	4
9	Basic	Basic	i->j	600	4
10	Merge	Merge	j->k	1500	4
11	Basic	Basic	l->m	5230	4

Facility Segment Data

Segment 1: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.982	6099	9600	0.64	68.8	22.2	C

Segment 2: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.89	0.982	0.979	6099	1400	9600	2100	0.64	0.67	65.8	59.9	23.2	27.2	C

Segment 3: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.982	4699	9600	0.50	70.0	16.8	B

Segment 4: Merge

Time	PHF	fHV	Flow Rate	Capacity	d/c	Speed	Density	LOS

Period					(pc/h)		(pc/h)		Ratio		(mi/h)		(pc/mi/ln)		
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.81	0.982	0.978	5488	789	9600	2100	0.58	0.38	65.1	63.4	21.1	17.0	B

Segment 5: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.982	5488	9600	0.57	69.7	19.7	C

Segment 6: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.92	0.982	0.986	5488	2359	9600	2100	0.57	1.12	53.3	57.5	45.0	29.6	D

Segment 7: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	3129	9600	0.33	70.0	11.2	B

Segment 8: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.82	0.980	0.980	3739	610	9600	1900	0.39	0.32	65.4	62.6	14.3	11.1	B

Segment 9: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	3739	9600	0.38	70.0	13.4	B

Segment 10: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.82	0.980	0.980	4567	828	9600	2100	0.47	0.39	65.7	63.8	17.4	14.5	B

Segment 11: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	4567	9600	0.46	70.0	16.3	B

Facility Time Period Results

T	Speed, mi/h	Density, pc/mi/ln	Density, veh/mi/ln	Travel Time, min	LOS
1	68.4	19.5	19.1	6.1	C

Facility Overall Results

Space Mean Speed, mi/h	68.4	Density, veh/mi/ln	19.1
Average Travel Time, min	6.1		

Interchange Justification Report
Appendix N
Three-Lane I-93 Sensitivity Analysis

I-93 Exit 4A

Prepared for:

Town of Derry
Town of Londonderry
New Hampshire Department of Transportation

Prepared by:

Fuss & O'Neill and Louis Berger

June 5, 2019

NHDOT Project Number: 13065
Federal Project Number: IM-0931(201)
CLD/Towns Project Number 05-0244

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LIST OF TABLES

1.0 INTRODUCTION

The I-93 Exit 4A Supplemental Draft Environmental Impact Statement (SDEIS) and October 2018 Interchange Justification Report (IJR) assumed four-lanes in each direction would be in operation between I-93 Exits 4 and 5 by 2040. The widening of I-93 to four-lanes in each direction is included in the NHDOT 2019-2028 Ten-Year Plan; however, the opening of the fourth lane to traffic is dependent on a resolution of chloride commitments made in the I-93 Salem to Manchester Improvements Supplemental Record of Decision and Section 401(c) Water Quality Certification. As a result, it is possible that I-93 Exit 4A could be constructed before four-lanes in each direction are operational. A sensitivity analysis was conducted to estimate I-93 freeway operations under a scenario in which there are only three-lanes in each direction. The sensitivity analysis was conducted for the 2040 No Build and Alternative A (the Preferred Alternative). The study area for the sensitivity analysis includes Exits 4 and 5 under the No Build and Exits 4, 4A, and 5 under Alternative A.

The primary assumption is that the forecasted travel patterns predicted by the Southern New Hampshire Planning Commission (SNHPC) travel demand model with four mainline travel lanes in each direction assigned would remain the same if the number of mainline travel lanes assigned were reduced to three. This assumption is reasonable for purposes of a sensitivity analysis because the difference in capacity between three vs. four lanes would be unlikely to cause substantial changes in regional travel patterns.

2.0 THE NO BUILD CONDITION

2.1 Introduction

This section summarizes development of the No Build condition future traffic volumes and freeway operation analysis for the sensitivity analysis.

2.2 Development of the No Build Condition

The future forecasted freeway volumes would be same as presented in the I-93 Exit 4A Interchange Justification Report (IJR) No Build condition volumes. The merge and diverge lane geometry would remain the same as the IJR No Build condition for Exits 4 and 5, with the exception of the I-93 mainline travel lanes adjusted to three through lanes in each direction.

2.3 2040 No Build Condition Freeway Operations Analysis

The sensitivity analysis was performed using Highway Capacity Software (HCS) 2010, version 6.9, to be consistent with IJR. Based on the analysis, one freeway facility would operate above capacity. This includes the I-93 Exit 4 SB off-ramp to NH 102 that would operate at LOS F. This facility would fail due to the off-ramp operating over capacity, thus queueing onto the I-93 mainline. The NH 102 on-ramp to I-93 NB would operate above capacity potentially creating a queue into the NH 102 mainline. These are the same predicted failures that would occur if I-93 operated with four mainline travel lanes in each direction. Table 2-1 contains the Exit 4 No Build condition freeway analysis, and Table 2-2 contains the Exit 5 No Build freeway analysis. Attachment 1 contains the No Build condition HCS freeway operation reports.

Table 2-1. I-93 Exit 4 2040 No Build freeway sensitivity analysis – Three-Lane I-93

Freeway Analysis	Facility Type	Time Period	Demand to Capacity Ratio		Density (pc/mi/ln)	LOS
			Freeway	Ramp		
I-93 Northbound to NH 102	Diverge	AM	0.49	0.26	1.3	A
		PM	0.85	0.61	18.1	B
NH 102 to I-93 Northbound	Merge	AM	0.73	1.25[a]	25.2	C
		PM	0.78	0.99	29.0	D
I-93 Southbound to NH 102	Diverge	AM	0.73	0.84	29.3	D
		PM	0.75	1.10	31.4	F
NH 102 Westbound to I-93 Southbound	Merge	AM	0.66	0.69	23.1	C
		PM	0.52	0.32	16.2	B
NH 102 Eastbound to I-93 Southbound	Merge	AM	0.89	0.85	31.9	D
		PM	0.62	0.40	20.7	C

Notes: LOS = Level of Service; Density = Passenger cars per mile per lane (pc/mi/ln)

Red denotes interstate facilities that would result in failing operations and produce a queue extending to the I-93 mainline.

[a] Because the demand of the on-ramp exceeds the capacity, the ramp could produce a queue extending to NH 102.

Table 2-2. I-93 Exit 5 2040 No Build freeway sensitivity analysis – Three-Lane I-93

Freeway Analysis	Facility Type	Time Period	Demand to Capacity Ratio		Density (pc/mi/ln)	LOS
			Freeway	Ramp		
I-93 Northbound to NH 28	Diverge	AM	0.73	0.37	26.4	C
		PM	0.76	0.49	30.7	D
NH 28 to I-93 Northbound	Merge	AM	0.89	0.83	30.4	D
		PM	0.84	0.62	31.7	D
I-93 Southbound to NH 28	Diverge	AM	0.79	0.73	30.1	D
		PM	0.86	0.74	32.1	D
NH 28 to I-93 Southbound	Merge	AM	0.75	0.45	24.9	C
		PM	0.77	0.38	24.7	C

Notes: LOS = Level of Service; Density = Passenger cars per mile per lane (pc/mi/ln)

3.0 THE 2040 BUILD CONDITION

3.1 Introduction

The Build condition for the sensitivity analysis covers Alternative A. This section summarizes development of the future traffic volumes and freeway operations.

3.2 Development of 2040 Build Condition Volumes

The 2040 Build condition represent the future conditions under Alternative A, which includes the following:

1. New Hampshire Department of Transportation (NHDOT) would complete planned roadway improvements;
2. Woodmont Commons would be fully built out; and
3. Other background growth would follow the forecasted demographic projections listed under Alternative A in the IJR (IJR Tables 3-4, 3-5, and 3-6).

The future 2040 Alternative A volumes representing a sensitivity analysis of the I-93 freeway facilities serving Exits 4, 4A, and 5 relied on the same custom SNHPC travel demand model forecasted volumes as published in the IJR.

3.3 2040 Build Alternative A Freeway Operation

Analysis performed using HCS shows that under Alternative A in the three-lane I-93 scenario, all freeway facilities would operate below capacity. The one failing freeway facility under the No Build condition (the I-93 SB off-ramp to NH 102) would improve to LOS B under Alternative A. Table 3-1 contains the Exit 4 Alternative A freeway analysis compared to the No Build condition, and Table 3-2 contains the Exit 5 Alternative A freeway analysis compared to the No Build condition. Table 3-3 contains the Exit 4A Alternative A freeway analysis. Attachment 2 contains the No Build condition HCS freeway operation reports.

Table 3-1. I-93 Exit 4 2040 Build Alternative A freeway analysis compared to the No Build condition – Three-Lane I-93

Freeway Analysis	Facility Type	Time Period	Demand to Capacity Ratio		Density (pc/mi/ln)	Alt A LOS	No Build LOS
			Freeway	Ramp			
I-93 Northbound to NH 102	Diverge	AM	0.51	0.23	1.2	A	A
		PM	0.88	0.54	17.6	B	B
NH 102 to I-93 Northbound	Merge	AM	0.66	0.89	24.2	C	C
		PM	0.77	0.70	26.9	C	D
I-93 Southbound to NH 102	Diverge	AM	0.76	0.76	29.6	D	D
		PM	0.72	0.91	29.3	D	F
NH 102 Westbound to I-93 Southbound	Merge	AM	0.66	0.36	21.4	C	C
		PM	0.53	0.17	15.8	B	B
NH 102 Eastbound to I-93 Southbound	Merge	AM	0.92	0.93	33.5	D	D
		PM	0.65	0.46	21.5	C	C

Notes: LOS = Level of Service; Density = Passenger cars per mile per lane (pc/mi/ln)

Red denotes interstate facilities that would result in failing operations and would produce a queue extending to the I-93 mainline.

Table 3-2. I-93 Exit 5 2040 Build Alternative A freeway analysis compared to the No Build condition – Three-Lane I-93

Freeway Analysis	Facility Type	Time Period	Demand to Capacity Ratio		Density (pc/mi/ln)	Alt A LOS	No Build LOS
			Freeway	Ramp			
I-93 Northbound to NH 28	Diverge	AM	0.75	0.43	30.3	D	C
		PM	0.83	0.58	33.0	D	D
NH 28 to I-93 Northbound	Merge	AM	0.84	0.67	32.9	D	D
		PM	0.85	0.50	32.3	D	D
I-93 Southbound to NH 28	Diverge	AM	0.83	0.41	30.1	D	D
		PM	0.82	0.42	29.9	D	D
NH 28 to I-93 Southbound	Merge	AM	0.89	0.52	30.1	D	C
		PM	0.84	0.44	27.9	C	C

Notes: LOS = Level of Service; Density = Passenger cars per mile per lane (pc/mi/ln)

Table 3-3. I-93 Exit 4A 2040 Build Alternative A freeway analysis – Three- Lane I-93

Freeway Analysis	Facility Type	Time Period	Demand to Capacity Ratio		Density (pc/mi/ln)	LOS
			Freeway	Ramp		
I-93 Northbound to Connector Roadway	Diverge	AM	0.66	0.48	25.3	C
		PM	0.75	0.41	27.7	C
Connector Roadway to I-93 Northbound	Merge	AM	0.78	0.84	31.0	D
		PM	0.85	0.72	32.6	D
I-93 Southbound to Connector Roadway	Diverge	AM	0.87	0.53	25.6	C
		PM	0.82	0.45	22.5	C
Connector Roadway to I-93 Southbound	Merge	AM	0.78	0.60	30.1	D
		PM	0.73	0.51	27.9	C

Notes: LOS = Level of Service; Density = Passenger cars per mile per lane (pc/mi/ln)

4.0 CONCLUSIONS

Table 4-1 provides a summary of the freeway operations sensitivity analysis by comparing the four-lane versus three-lane scenarios for the No Build and Alternative A. Overall, the results of the sensitivity analysis show that traffic operations on I-93 will operate at an acceptable level with three or four lanes Compared to the I-93 four-lane mainline, a three-lane mainline would result in 11 freeway facilities that would degrade from LOS C to LOS D, but would still operate at an acceptable level. Woodmont Commons would account for a number of these vehicle trips and would need to be fully built out to achieve these forecasted volumes and associated operations.

Similar to the four-lane I-93 analysis presented in the IJR, the three-lane scenario shows Alternative A would have a beneficial effect on the I-93 SB diverge at Exit 4, which would operate over capacity (LOS F) in the PM peak hour in the No Build, but improved to LOS B under Alternative A assuming three-lanes on I-93. Alternative A would also improve operations at the I-93 NB on-ramp from NH 102 at Exit 4, which would operate above its capacity in the No Build condition (potentially creating a queue that might extend back into NH 102 at Intersection #8 in the AM peak hour).

With respect to FHWA Policy Requirement #1 (Operational and Collision Analysis), Alternative A would not adversely impact the traffic and safety issues along the I-93 freeway regardless of whether I-93 is four-lanes or three-lanes in each direction. This includes queuing issues along the ramps serving I-93. Traffic would also be properly distributed between the different roadway classifications (freeway to ramps to principal arterials to collectors to local roadways).

Table 4-1 provides a comparison between the four and three-lane I-93 scenarios. The analysis shows that the traffic changes predicted by the construction of Exit 4A do not “force” construction of the fourth lane and that the Exit 4A project is appropriately considered independently from decisions about the timing of construction of the fourth lane.

Table 4-1. Future 2040 freeway operations summary, Comparison between the Four-lane I-93 and Three-Lane I-93 Scenarios

Ramp	Facility Type	Time Period	No Build	Alt. A	No Build	Alt. A
			Four-Lane I-93		Three-Lane I-93	
I-93 Exit 4						
I-93 Northbound to NH 102	Diverge	AM	A	A	A	A
		PM	B	B	B	B
NH 102 to I-93 Northbound	Merge	AM	C	B	C	C
		PM	C	C	D	C
I-93 Southbound to NH 102	Diverge	AM	C	C	D	D
		PM	F	C	F	D
NH 102 Westbound to I-93 Southbound	Merge	AM	B	B	C	C
		PM	B	A	B	B
NH 102 Eastbound to I-93 Southbound	Merge	AM	C	C	D	D
		PM	B	B	C	C
I-93 Exit 5						
I-93 Northbound to NH 28	Diverge	AM	C	C	C	D
		PM	C	D	D	D
NH 28 to I-93 Northbound	Merge	AM	C	C	D	D
		PM	C	C	D	D
I-93 Southbound to NH 28	Diverge	AM	C	C	D	D
		PM	D	C	D	D
NH 28 to I-93 Southbound	Merge	AM	B	C	C	D
		PM	B	B	C	C
I-93 Exit 4A						
I-93 Northbound to Connector Roadway	Diverge	AM		C		C
		PM		C		C
Connector Roadway to I-93 Northbound	Merge	AM		C		D
		PM		C		D
I-93 Southbound to Connector Roadway	Diverge	AM		B		C
		PM		B		C
Connector Roadway to I-93 Southbound	Merge	AM		C		D
		PM		C		C

Red denotes overall failing operations (LOS E or F).

Interchange Justification Report
Sensitivity Analysis
Attachment 1
HCS No Build Condition Freeway Operation Reports

I-93 Exit 4A

Prepared for:

Town of Derry
Town of Londonderry
New Hampshire Department of Transportation

Prepared by:

Fuss & O'Neill and Louis Berger

Version: 1
June 5, 2019

NHDOT Project Number: 13065
Federal Project Number: IM-0931(201)
CLD/Towns Project Number 05-0244

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HCS 2010 Facilities Report

Project Information

Analyst	MB/LB	Agency	
Jurisdiction		Time Period Analyzed	AM Peak - NB
Analysis Year	2040 No Build AM - NB	Date	3/05/2019
Project Description	I-93 NB - from S. of Exit 4 to N of Exit 5 - Sensitivity Analysis		

Facility Global Input

Jam Density, pc/mi/ln	190.0	Density at Capacity, pc/mi/ln	45.0
Queue Discharge Capacity Drop, %	7	Total Segments	9
Total Time Periods	1	Time Period Duration, min	15

Segment Geometric Data

No.	Coded	Analyzed	Name	Length, ft	Lanes
1	Basic	Basic	a->b	5280	3
2	Diverge	Diverge	b.->c	1500	3
3	Basic	Basic	c->d	4525	3
4	Merge	Merge	d->e	1500	3
5	Basic	Basic	e->f	11825	3
6	Diverge	Diverge	f->g	1500	3
7	Basic	Basic	g->h	4100	3
8	Merge	Merge	h->i	1500	3
9	Basic	Basic	i->j	5280	3

Facility Segment Data

Segment 1: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.979	3537	7200	0.49	70.0	16.8	B

Segment 2: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.77	0.979	0.964	3537	1098	7200	4200	0.49	0.26	65.6	60.7	18.0	1.3	A

Segment 3: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.979	2439	7200	0.37	70.0	11.6	B

Segment 4: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	

1	0.94	0.90	0.979	0.983	4539	2617	7200	2100	0.73	1.25	53.3	60.0	45.0	25.2	C

Segment 5: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.964	4539	7200	0.73	68.9	22.0	C

Segment 6: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.75	0.964	0.956	4539	774	7200	2100	0.73	0.37	65.3	61.5	23.2	26.4	C

Segment 7: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.964	3765	7200	0.64	70.0	17.9	B

Segment 8: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.83	0.964	0.972	5513	1748	7200	2100	0.89	0.83	59.7	57.5	30.8	30.4	D

Segment 9: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.964	5513	7200	0.86	65.3	28.1	D

Facility Time Period Results

T	Speed, mi/h	Density, pc/mi/ln	Density, veh/mi/ln	Travel Time, min	LOS
1	66.8	21.6	20.9	6.3	C

Facility Overall Results

Space Mean Speed, mi/h	66.8	Density, veh/mi/ln	20.9
Average Travel Time, min	6.3		

HCS 2010 Facilities Report

Project Information

Analyst	MB/LB	Agency	
Jurisdiction		Time Period Analyzed	AM Peak - SB
Analysis Year	2040 - No Build AM - SB	Date	3/05/2019
Project Description	I-93 SB - from N of Exit 5 to S of Exit 4 - Sensitivity Analysis		

Facility Global Input

Jam Density, pc/mi/ln	190.0	Density at Capacity, pc/mi/ln	45.0
Queue Discharge Capacity Drop, %	7	Total Segments	11
Total Time Periods	1	Time Period Duration, min	15

Segment Geometric Data

No.	Coded	Analyzed	Name	Length, ft	Lanes
1	Basic	Basic	a->b	5280	3
2	Diverge	Diverge	b->c	1500	3
3	Basic	Basic	c->d	3920	3
4	Merge	Merge	d->e	1500	3
5	Basic	Basic	e->f	11730	3
6	Diverge	Diverge	f->g	1500	3
7	Basic	Basic	g->h	2550	3
8	Merge	Merge	h->i	1500	3
9	Basic	Basic	i->j	600	3
10	Merge	Merge	j->k	1500	3
11	Basic	Basic	l->m	5280	3

Facility Segment Data

Segment 1: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.970	5659	7200	0.79	64.6	29.2	D

Segment 2: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.74	0.970	0.972	5659	1536	7200	2100	0.79	0.73	63.5	59.6	29.7	30.1	D

Segment 3: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.970	4447	7200	0.62	69.1	21.4	C

Segment 4: Merge

Time	PHF	fHV	Flow Rate	Capacity	d/c	Speed	Density	LOS

Period					(pc/h)		(pc/h)		Ratio		(mi/h)		(pc/mi/ln)		
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.84	0.970	0.953	5384	937	7200	2100	0.75	0.45	62.1	60.6	28.9	24.9	C

Segment 5: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.970	5270	7200	0.73	66.4	26.5	D

Segment 6: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.95	0.970	0.975	5270	1754	7200	2100	0.73	0.84	63.0	59.1	27.9	29.3	D

Segment 7: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	3452	7200	0.48	70.0	16.4	B

Segment 8: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.82	0.980	0.970	4772	1320	7200	1900	0.66	0.69	61.7	59.9	25.8	23.1	C

Segment 9: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	4592	7200	0.64	68.7	22.3	C

Segment 10: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.82	0.980	0.970	6377	1785	7200	2100	0.89	0.85	56.7	53.9	37.5	31.9	D

Segment 11: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	6133	7200	0.85	61.8	33.1	D

Facility Time Period Results

T	Speed, mi/h	Density, pc/mi/ln	Density, veh/mi/ln	Travel Time, min	LOS
1	64.6	27.2	26.5	6.5	D

Facility Overall Results

Space Mean Speed, mi/h	64.6	Density, veh/mi/ln	26.5
Average Travel Time, min	6.5		

HCS 2010 Facilities Report

Project Information

Analyst	MB/LB	Agency	
Jurisdiction		Time Period Analyzed	PM Peak - NB
Analysis Year	2040 No Build PM - NB	Date	3/05/2019
Project Description	I-93 NB - from S. of Exit 4 to N of Exit 5 - Sensitivity Analysis		

Facility Global Input

Jam Density, pc/mi/ln	190.0	Density at Capacity, pc/mi/ln	45.0
Queue Discharge Capacity Drop, %	7	Total Segments	9
Total Time Periods	1	Time Period Duration, min	15

Segment Geometric Data

No.	Coded	Analyzed	Name	Length, ft	Lanes
1	Basic	Basic	a->b	5280	3
2	Diverge	Diverge	b.->c	1500	3
3	Basic	Basic	c->d	4525	3
4	Merge	Merge	d->e	1500	3
5	Basic	Basic	e->f	11825	3
6	Diverge	Diverge	f->g	1500	3
7	Basic	Basic	g->h	4100	3
8	Merge	Merge	h->i	1500	3
9	Basic	Basic	i->j	5280	3

Facility Segment Data

Segment 1: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.979	6085	7200	0.85	62.1	32.7	D

Segment 2: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.92	0.979	0.991	6085	2561	7200	4200	0.85	0.61	61.3	57.0	33.1	18.1	B

Segment 3: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.979	3548	7200	0.49	70.0	16.9	B

Segment 4: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	

1	0.94	0.87	0.979	0.988	5619	2071	7200	2100	0.78	0.99	59.3	57.2	31.6	29.0	D

Segment 5: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.985	5449	7200	0.76	65.6	27.7	D

Segment 6: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.67	0.985	0.964	5449	1037	7200	2100	0.76	0.49	64.7	60.9	28.1	30.7	D

Segment 7: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.985	4725	7200	0.66	68.4	23.0	C

Segment 8: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.89	0.985	0.988	6033	1308	7200	2100	0.84	0.62	59.0	56.6	34.1	31.7	D

Segment 9: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.985	5967	7200	0.83	62.8	31.7	D

Facility Time Period Results

T	Speed, mi/h	Density, pc/mi/ln	Density, veh/mi/ln	Travel Time, min	LOS
1	64.4	27.8	27.3	6.5	D

Facility Overall Results

Space Mean Speed, mi/h	64.4	Density, veh/mi/ln	27.3
Average Travel Time, min	6.5		

HCS 2010 Facilities Report

Project Information

Analyst	MB/LB	Agency	
Jurisdiction		Time Period Analyzed	PM Peak - SB
Analysis Year	2040 No Build PM - SB	Date	3/05/2019
Project Description	I-93 SB - from N of Exit 5 to S of Exit 4 - Sensitivity Analysis		

Facility Global Input

Jam Density, pc/mi/ln	190.0	Density at Capacity, pc/mi/ln	45.0
Queue Discharge Capacity Drop, %	7	Total Segments	11
Total Time Periods	1	Time Period Duration, min	15

Segment Geometric Data

No.	Coded	Analyzed	Name	Length, ft	Lanes
1	Basic	Basic	a->b	5280	3
2	Diverge	Diverge	b->c	1500	3
3	Basic	Basic	c->d	3920	3
4	Merge	Merge	d->e	1500	3
5	Basic	Basic	e->f	11730	3
6	Diverge	Diverge	f->g	1500	3
7	Basic	Basic	g->h	2550	3
8	Merge	Merge	h->i	1500	3
9	Basic	Basic	i->j	600	3
10	Merge	Merge	j->k	1500	3
11	Basic	Basic	l->m	5280	3

Facility Segment Data

Segment 1: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.982	6186	7200	0.86	61.4	33.6	D

Segment 2: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.89	0.982	0.979	6186	1555	7200	2100	0.86	0.74	63.5	59.6	32.5	32.1	D

Segment 3: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.982	4631	7200	0.66	68.6	22.5	C

Segment 4: Merge

Time	PHF	fHV	Flow Rate	Capacity	d/c	Speed	Density	LOS

Period					(pc/h)		(pc/h)		Ratio		(mi/h)		(pc/mi/ln)		
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.81	0.982	0.978	5426	795	7200	2100	0.77	0.38	62.2	60.8	29.1	24.7	C

Segment 5: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.982	5426	7200	0.75	65.7	27.5	D

Segment 6: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.92	0.982	0.986	5426	2315	7200	2100	0.75	1.10	53.3	57.7	45.0	31.4	D

Segment 7: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	3111	7200	0.44	70.0	14.8	B

Segment 8: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.82	0.980	0.980	3715	604	7200	1900	0.52	0.32	63.7	62.0	19.4	16.2	B

Segment 9: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	3715	7200	0.51	70.0	17.7	B

Segment 10: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.82	0.980	0.980	4549	834	7200	2100	0.62	0.40	63.7	62.4	23.8	20.7	C

Segment 11: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	4549	7200	0.61	68.8	22.0	C

Facility Time Period Results

T	Speed, mi/h	Density, pc/mi/ln	Density, veh/mi/ln	Travel Time, min	LOS
1	65.0	26.5	26.0	6.4	D

Facility Overall Results

Space Mean Speed, mi/h	65.0	Density, veh/mi/ln	26.0
Average Travel Time, min	6.4		

Interchange Justification Report
Sensitivity Analysis
Attachment 2
HCS Build Condition Freeway Operation Reports

I-93 Exit 4A

Prepared for:

Town of Derry
Town of Londonderry
New Hampshire Department of Transportation

Prepared by:

Fuss & O'Neill and Louis Berger

Version: 1
June 5, 2019

NHDOT Project Number: 13065
Federal Project Number: IM-0931(201)
CLD/Towns Project Number 05-0244

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HCS 2010 Facilities Report

Project Information

Analyst	MB/LB	Agency	
Jurisdiction		Time Period Analyzed	AM Peak - NB w/Overlap
Analysis Year	2040 Alt. A - AM-NB	Date	3/11/2019
Project Description	I-93 NB - from S. of Exit 4 to N of Exit 5 - Sensitivity Analysis		

Facility Global Input

Jam Density, pc/mi/ln	190.0	Density at Capacity, pc/mi/ln	45.0
Queue Discharge Capacity Drop, %	7	Total Segments	13
Total Time Periods	1	Time Period Duration, min	15

Segment Geometric Data

No.	Coded	Analyzed	Name	Length, ft	Lanes
1	Basic	Basic	a>b	5280	3
2	Diverge	Diverge	b>c	1500	3
3	Basic	Basic	c>d	4525	3
4	Merge	Merge	d>e	1500	3
5	Overlap	Basic	e>f	700	3
6	Diverge	Diverge	f>g	1500	3
7	Basic	Basic	g>h	3310	3
8	Merge	Merge	h>i	1500	3
9	Basic	Basic	i>j	6215	3
10	Diverge	Diverge	j>k	1500	3
11	Basic	Basic	k>l	4100	3
12	Merge	Merge	l>m	1500	3
13	Basic	Basic	m>n	5280	3

Facility Segment Data

Segment 1: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.979	3662	7200	0.51	70.0	17.4	B

Segment 2: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.77	0.979	0.964	3662	977	7200	4200	0.51	0.23	65.9	61.0	18.5	1.2	A

Segment 3: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.979	2874	7200	0.40	70.0	13.7	B

Segment 4: Merge														
Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)	LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.90	0.979	0.983	4733	1859	7200	2100	0.66	0.89	62.3	60.8	25.3	24.2	C

Segment 5: Overlap								
Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.964	4734	7116	0.67	62.3	25.3	C

Segment 6: Diverge															
Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.81	0.964	0.969	4734	1013	7200	2100	0.66	0.48	64.7	60.9	24.4	25.3	C

Segment 7: Basic								
Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.964	3857	7200	0.54	69.9	18.4	C

Segment 8: Merge															
Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.81	0.964	0.969	5628	1771	7200	2100	0.78	0.84	59.3	57.0	31.6	31.0	D

Segment 9: Basic								
Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.964	5391	7200	0.75	65.9	27.3	D

Segment 10: Diverge															
Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.75	0.964	0.956	5391	907	7200	2100	0.75	0.43	64.9	61.2	27.7	30.3	D

Segment 11: Basic								
Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.964	4674	7200	0.65	68.5	22.7	C

Segment 12: Merge															
Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.83	0.964	0.972	6081	1407	7200	2100	0.84	0.67	58.4	55.8	34.7	32.9	D

Segment 13: Basic								
Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.964	5926	7200	0.82	63.0	31.3	D

Facility Time Period Results

T	Speed, mi/h	Density, pc/mi/ln	Density, veh/mi/ln	Travel Time, min	LOS
1	65.6	23.5	22.8	6.7	C

Facility Overall Results

Space Mean Speed, mi/h	65.6	Density, veh/mi/ln	22.8
Average Travel Time, min	6.7		

HCS 2010 Facilities Report

Project Information

Analyst	MK/LB	Agency	
Jurisdiction		Time Period Analyzed	AM Peak - SB
Analysis Year	2040 - Alt. A AM - SB	Date	3/11/2019
Project Description	I-93 SB - from N of Exit 5 to S of Exit 4 - Sensitivity Analysis		

Facility Global Input

Jam Density, pc/mi/ln	190.0	Density at Capacity, pc/mi/ln	45.0
Queue Discharge Capacity Drop, %	7	Total Segments	15
Total Time Periods	1	Time Period Duration, min	15

Segment Geometric Data

No.	Coded	Analyzed	Name	Length, ft	Lanes
1	Basic	Basic	a->b	5280	3
2	Diverge	Diverge	b->c	1500	3
3	Basic	Basic	c->d	3920	3
4	Merge	Merge	d->e	1500	3
5	Basic	Basic	e->f	7615	3
6	Diverge	Diverge	f>g	1500	3
7	Basic	Basic	g>h	3165	3
8	Merge	Merge	h>i	1500	3
9	Overlap	Basic	i>j	650	3
10	Diverge	Diverge	j>k	1500	3
11	Basic	Basic	k>l	2650	3
12	Merge	Merge	l>m	1500	3
13	Basic	Basic	m>n	600	3
14	Merge	Merge	l>m	1500	3
15	Basic	Basic	m>n	5280	3

Facility Segment Data

Segment 1: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.970	5994	7200	0.83	62.6	31.9	D

Segment 2: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.74	0.970	0.972	5994	869	7200	2100	0.83	0.41	64.9	61.3	30.8	30.1	D

Segment 3: Basic

Time	PHF	fHV	Flow Rate	Capacity	d/c	Speed	Density	LOS

Period			(pc/h)	(pc/h)	Ratio	(mi/h)	(pc/mi/ln)	
1	0.94		0.970	5308	7200	0.74	66.3	26.7	D

Segment 4: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.84	0.970	0.953	6401	1093	7200	2100	0.89	0.52	58.7	56.4	36.3	30.1	D

Segment 5: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.970	6268	7200	0.87	60.9	34.3	D

Segment 6: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.80	0.970	0.965	6268	2241	7200	4200	0.87	0.53	62.2	57.8	33.6	25.6	C

Segment 7: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.970	4370	7200	0.61	69.2	21.1	C

Segment 8: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.80	0.970	0.965	5639	1269	7200	2100	0.78	0.60	60.1	58.0	31.3	30.1	D

Segment 9: Overlap

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.970	5445	7200	0.76	60.1	31.3	D

Segment 10: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.80	0.970	0.965	5445	1587	7200	2100	0.76	0.76	63.4	59.5	28.6	29.6	D

Segment 11: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.970	4102	7200	0.57	69.7	19.6	C

Segment 12: Merge

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS

	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.82	0.980	0.970	4751	691	7200	1900	0.66	0.36	62.4	60.7	25.4	21.4	C

Segment 13: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	4657	7200	0.65	68.6	22.6	C

Segment 14: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.82	0.980	0.970	6618	1961	7200	2100	0.92	0.93	54.4	51.2	40.6	33.5	D

Segment 15: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	6350	7200	0.88	60.3	35.1	E

Facility Time Period Results

T	Speed, mi/h	Density, pc/mi/ln	Density, veh/mi/ln	Travel Time, min	LOS
1	62.3	30.6	29.7	7.2	D

Facility Overall Results

Space Mean Speed, mi/h	62.3	Density, veh/mi/ln	29.7
Average Travel Time, min	7.2		

HCS 2010 Facilities Report

Project Information

Analyst	MB/LB	Agency	
Jurisdiction		Time Period Analyzed	PM Peak - NB Overlap
Analysis Year	2040 Alt. A - PM-NB	Date	3/11/2019
Project Description	I-93 NB - from S. of Exit 4 to N of Exit 5 - Sensitivity Analysis		

Facility Global Input

Jam Density, pc/mi/ln	190.0	Density at Capacity, pc/mi/ln	45.0
Queue Discharge Capacity Drop, %	7	Total Segments	13
Total Time Periods	1	Time Period Duration, min	15

Segment Geometric Data

No.	Coded	Analyzed	Name	Length, ft	Lanes
1	Basic	Basic	a->b	5280	3
2	Diverge	Diverge	b.->c	1500	3
3	Basic	Basic	c->d	4525	3
4	Merge	Merge	d>e	1500	3
5	Overlap	Basic	e>f	700	3
6	Diverge	Diverge	f>g	1500	3
7	Basic	Basic	g > h	3310	3
8	Merge	Merge	h > j	1500	3
9	Basic	Basic	i > j	6215	3
10	Diverge	Diverge	j > k	1500	3
11	Basic	Basic	k > l	4100	3
12	Merge	Merge	l > m	1500	3
13	Basic	Basic	m > n	5280	3

Facility Segment Data

Segment 1: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.979	6303	7200	0.88	60.6	34.7	D

Segment 2: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.92	0.979	0.991	6303	2287	7200	4200	0.88	0.54	62.0	57.7	33.9	17.6	B

Segment 3: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.979	4037	7200	0.56	69.8	19.3	C

Segment 4: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.87	0.979	0.988	5509	1472	7200	2100	0.77	0.70	61.0	59.2	30.1	26.9	C

Segment 5: Overlap

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.985	5379	7200	0.75	61.0	30.1	C

Segment 6: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.84	0.985	0.983	5379	860	7200	2100	0.75	0.41	65.0	61.3	27.6	27.7	C

Segment 7: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.985	4612	7200	0.64	68.7	22.4	C

Segment 8: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.84	0.985	0.983	6114	1502	7200	2100	0.85	0.72	58.2	55.6	35.0	32.6	D

Segment 9: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.985	5951	7200	0.83	62.9	31.5	D

Segment 10: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.67	0.985	0.964	5951	1215	7200	2100	0.83	0.58	64.2	60.4	30.9	33.0	D

Segment 11: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.985	5103	7200	0.71	67.1	25.4	C

Segment 12: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.89	0.985	0.988	6155	1052	7200	2100	0.85	0.50	58.9	56.5	34.8	32.3	D

Segment 13: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.985	6102	7200	0.85	61.9	32.9	D

Facility Time Period Results

T	Speed, mi/h	Density, pc/mi/ln	Density, veh/mi/ln	Travel Time, min	LOS
1	63.3	29.4	28.9	6.9	D

Facility Overall Results

Space Mean Speed, mi/h	63.3	Density, veh/mi/ln	28.9
Average Travel Time, min	6.9		

HCS 2010 Facilities Report

Project Information

Analyst	MB/LB	Agency	
Jurisdiction		Time Period Analyzed	PM Peak - SB
Analysis Year	2040 - Alt. A PM - SB	Date	3/11/2019
Project Description	I-93 SB - from N of Exit 5 to S of Exit 4 - Sensitivity Analysis		

Facility Global Input

Jam Density, pc/mi/ln	190.0	Density at Capacity, pc/mi/ln	45.0
Queue Discharge Capacity Drop, %	7	Total Segments	15
Total Time Periods	1	Time Period Duration, min	15

Segment Geometric Data

No.	Coded	Analyzed	Name	Length, ft	Lanes
1	Basic	Basic	a->b	5280	3
2	Diverge	Diverge	b->c	1500	3
3	Basic	Basic	c->d	3920	3
4	Merge	Merge	d->e	1500	3
5	Basic	Basic	e->f	7615	3
6	Diverge	Diverge	f>g	1500	3
7	Basic	Basic	g>h	3165	3
8	Merge	Merge	h>i	1500	3
9	Overlap	Basic	i>j	650	3
10	Diverge	Diverge	j>k	1500	3
11	Basic	Basic	k>l	2650	3
12	Merge	Merge	l>m	1500	3
13	Basic	Basic	m>n	600	3
14	Merge	Merge	n>o	1500	3
15	Basic	Basic	o>p	5280	3

Facility Segment Data

Segment 1: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.982	5931	7200	0.82	63.0	31.4	D

Segment 2: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.89	0.982	0.979	5931	883	7200	2100	0.82	0.42	64.9	61.3	30.5	29.9	D

Segment 3: Basic

Time	PHF	fHV	Flow Rate	Capacity	d/c	Speed	Density	LOS

Period			(pc/h)	(pc/h)	Ratio	(mi/h)	(pc/mi/ln)	
1	0.94	0.982	5102	7200	0.71	67.1	25.4	C

Segment 4: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.81	0.982	0.978	6030	928	7200	2100	0.84	0.44	60.4	58.5	33.3	27.9	C

Segment 5: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.982	5899	7200	0.82	63.2	31.1	D

Segment 6: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.84	0.982	0.979	5899	1879	7200	4200	0.82	0.45	63.1	58.7	31.2	22.5	C

Segment 7: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.982	4225	7200	0.59	71.2	19.8	C

Segment 8: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.84	0.982	0.979	5289	1064	7200	2100	0.73	0.51	61.2	59.3	28.8	27.9	C

Segment 9: Overlap

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.982	5173	7200	0.72	61.2	28.8	C

Segment 10: Diverge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.84	0.982	0.979	5173	1921	7200	2100	0.72	0.91	62.5	58.6	27.6	29.3	D

Segment 11: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	3468	7200	0.48	70.0	16.5	B

Segment 12: Merge

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS

	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.82	0.980	0.980	3785	317	7200	1900	0.53	0.17	63.7	62.0	19.8	15.8	B

Segment 13: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	3745	7200	0.52	70.0	17.8	B

Segment 14: Merge

Time Period	PHF		fHV		Flow Rate (pc/h)		Capacity (pc/h)		d/c Ratio		Speed (mi/h)		Density (pc/mi/ln)		LOS
	F	R	F	R	Freeway	Ramp	Freeway	Ramp	F	R	F	R	Freeway	Ramp	
1	0.94	0.82	0.980	0.980	4660	915	7200	2000	0.65	0.46	62.9	61.4	24.7	21.5	C

Segment 15: Basic

Time Period	PHF	fHV	Flow Rate (pc/h)	Capacity (pc/h)	d/c Ratio	Speed (mi/h)	Density (pc/mi/ln)	LOS
1	0.94	0.980	4543	7200	0.63	68.9	22.0	C

Facility Time Period Results

T	Speed, mi/h	Density, pc/mi/ln	Density, veh/mi/ln	Travel Time, min	LOS
1	64.9	26.4	25.9	6.9	D

Facility Overall Results

Space Mean Speed, mi/h	64.9	Density, veh/mi/ln	25.9
Average Travel Time, min	6.9		