Technical Memorandum #1

Existing and Future Conditions Report

I-84 / Route 8 Waterbury Interchange Needs Study

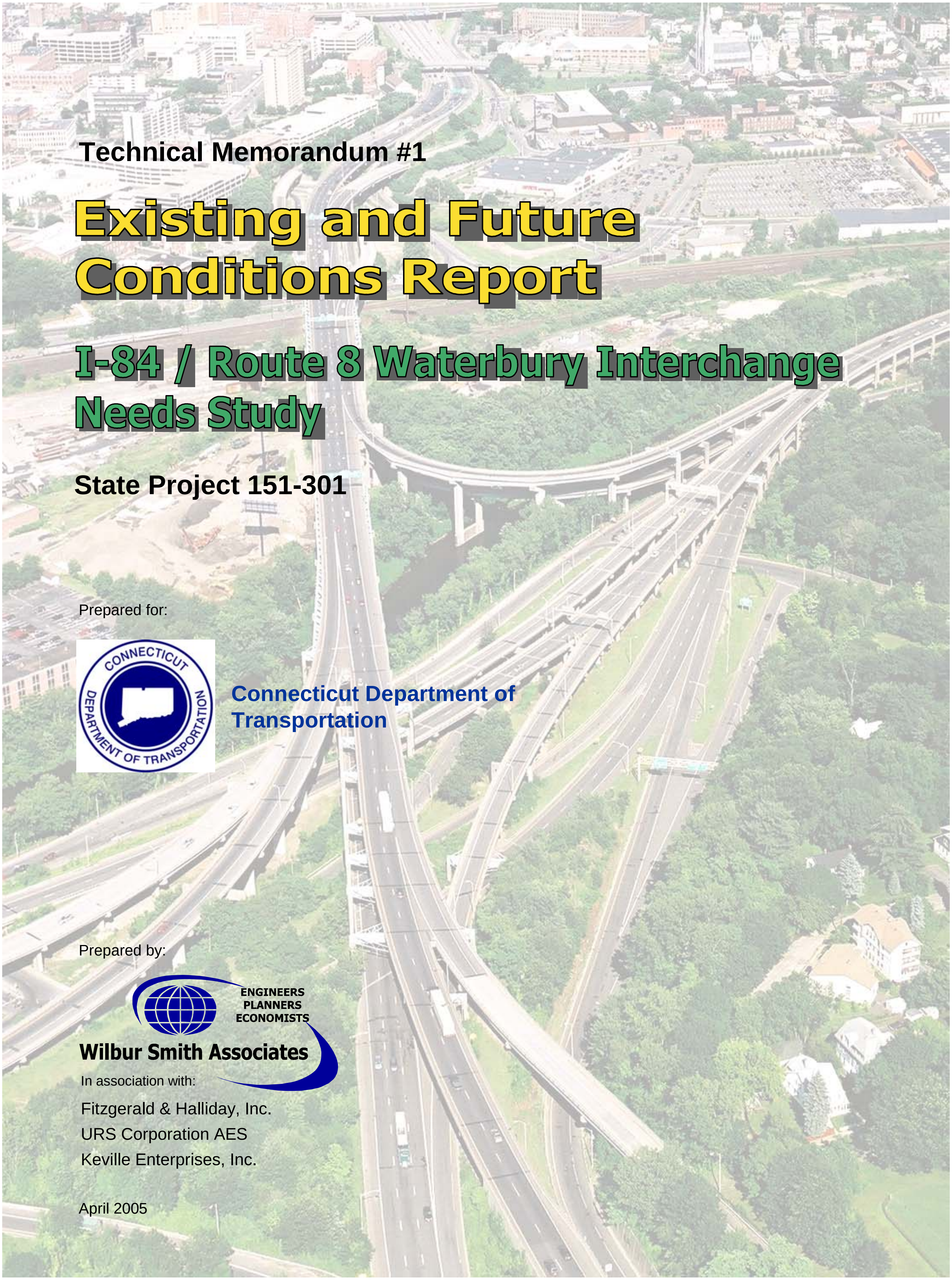
State Project 151-301

ENGINEERS
PLANNERS
ECONOMISTS

Wilbur Smith Associates

In association with:

Fitzgerald & Halliday, Inc.
URS Corporation AES
Keville Enterprises, Inc.



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Prepared for:

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April 2005

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1 Introduction

1.1 Study Background

The Connecticut Department of Transportation (ConnDOT) and Council of Governments Central Naugatuck Valley (COGCNV) have identified the need to evaluate the transportation deficiencies and define the long-term transportation improvements needed along the I-84 corridor between Interchanges 18 and 23 and the Route 8 corridor between Interchanges 30 and 35 in Waterbury. Study participants include ConnDOT, Federal Highway Administration (FHWA), the Wilbur Smith Associates (WSA) consultant team, the COGCNV, and a Study Advisory Committee.

This study, the I-84/Route 8 Waterbury Interchange Needs and Deficiencies Study (I-84WINS), is one part of an overall effort by ConnDOT to look at the future needs of I-84 from the New York to Massachusetts state lines. Previous studies analyzing I-84, including the West of Waterbury (WOW) Needs and Deficiencies Study and the I-84 Deficiencies and Needs Study, have been completed. These studies identified a series of improvements to the interstate, ramps and parallel arterial system. A highway widening and interchange improvement project is currently underway on I-84 from Interchange 23 in Waterbury east to Southington. To the west, Interchange 17 & 18 improvements are entering into design phases, and an Environmental Impact Statement is being prepared for the section of I-84, from Interchange 18 to the New York State Line. Improvements currently being studied or in design will be recognized in this study to provide overall consistency and operational effectiveness of the highway.

1.2 Project Team

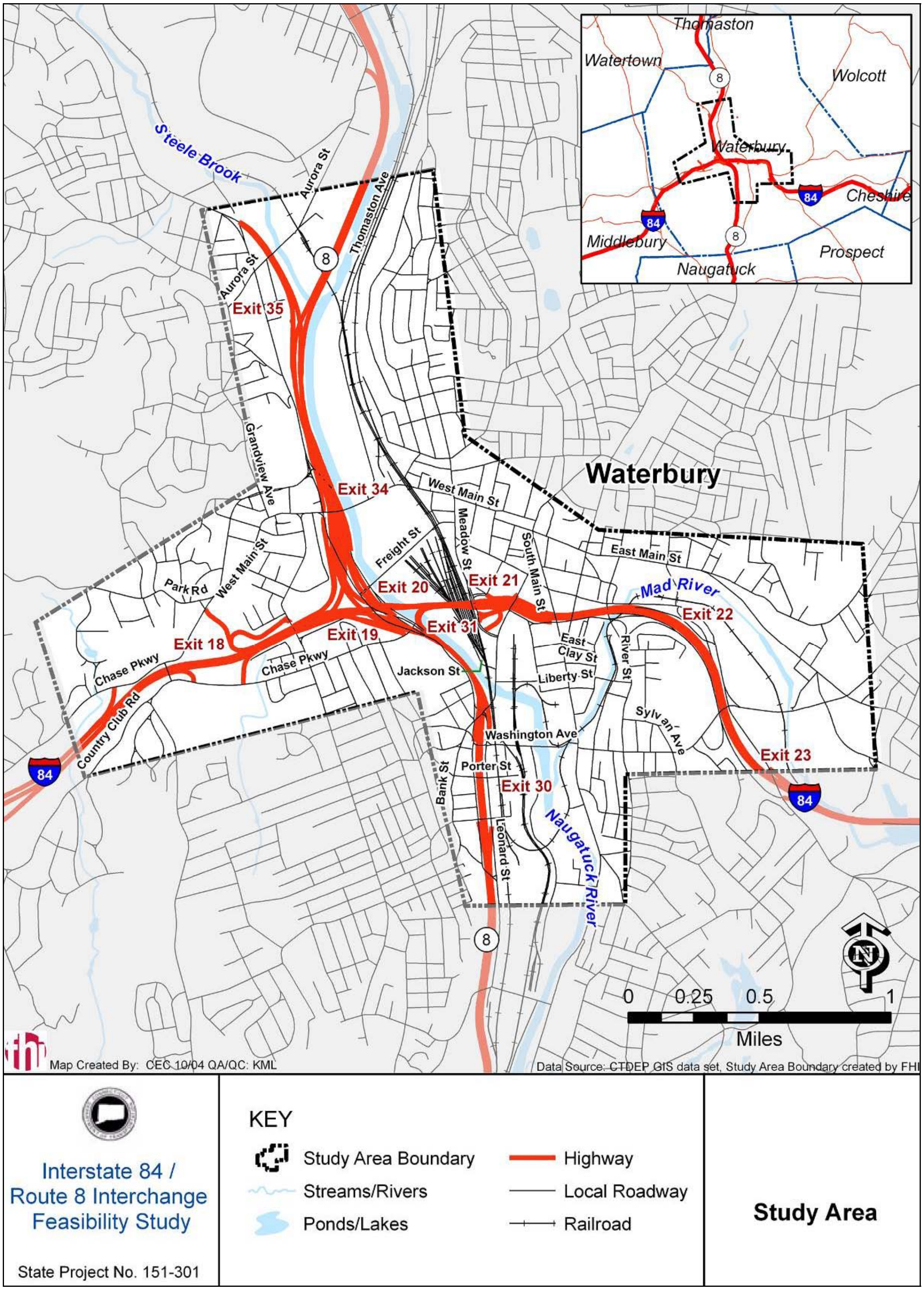
ConnDOT retained Wilbur Smith Associates (WSA) to undertake this needs and deficiencies study. WSA is a multi disciplinary transportation engineering and planning firm with extensive experience in multi-modal transportation studies. Additionally, WSA has subcontracted three other firms to assist in this study. These firms are:

- ***Fitzgerald and Halliday, Inc. (FHI)*** - performing land use planning and environmental analysis
- ***URS Corporation AES –***performing structural analysis and cost estimation
- ***Keville Enterprises, Inc.*** – performing constructability review and construction cost estimation

1.3 Study Area Definition

The study area includes I-84 from Interchange 18 to Interchange 23 as its western and eastern limits, respectively. Along Route 8, the limits are defined from Interchange 30 to Interchange 35 from south to north, respectively. Included in the study area are all major arterials that feed the highway system as well as a significant portion of Downtown Waterbury (as it relates to the state highway system operations). The study area is shown in Figure 1-1.

Figure 1-1: Study Area



1.4 Literature Review

As part of this study, WSA obtained several reports and studies that report transportation and land use issues in the study area. These reports include:

1. *I-84 West of Waterbury (WOW) Needs and Deficiencies Study, 2001* assessed needs and deficiencies of Interstate 84 from Waterbury to Southbury and associated ramps and arterials. Several short-term and long-term improvements were recommended for the interstate mainline as well as entrance and exit ramps between interchanges 13 and 18.

2. *Needs and Deficiencies Analysis in the I-84 Corridor Waterbury to Southington*, prepared for ConnDOT in May 1995. This study identified needs and deficiencies in the Waterbury (Interchange 23) to Southington (Interchange 30) corridor of I-84. Highway widening and interchange improvements are currently underway in the eastern part of this corridor.

3. *Central Naugatuck Valley Regional Plan of Conservation and Development, 1998* developed by the region to address issues affecting transportation and land use region-wide. The plan also identified priority transportation projects including improvements to I-84.

4. *Transportation Trends and Characteristics of the Central Naugatuck Valley Region: 2000*, presents transportation-related statistics for Waterbury and the region. Data includes modal share, journey to work times, and work origin and destination trips.

5. *Route 69 Traffic Operations Study, 2002* addressed capacity and safety issues on Route 69 in the Towns of Prospect and Wolcott, and the City of Waterbury. The study also outlined several congestion management strategies and improvements to increase safety and capacity along this corridor. No improvements were recommended within the limits of this study area.

6. *Central Naugatuck Valley Region Bus Route Study, 2004* presented the findings of ridership surveys conducted on fixed route bus services within the region. It also recommended several routing and scheduling changes based on these surveys and discussions with operators, municipal officials, and local groups.

7. *Connecticut Statewide Bicycle and Pedestrian Transportation Plan* is a comprehensive document designed to aid agencies in the development of bicycle and pedestrian systems as well as establish standards for planning and design of such systems.

1.5 Summary of Data Collection

At the commencement of this study, data was collected from the Connecticut Department of Transportation (ConnDOT), the Council of Governments of the Central Naugatuck Valley (COGCNV), and the City of Waterbury. The data collected was used for analysis and modeling of existing and future conditions within the study area. Additional data was collected by the study team during field reconnaissance visits to the study area. A summary of the data obtained and collected for use is shown below in Table 1-1.

Table 1-1: Summary of Obtained Data

Vehicle classification counts;	Future (2030) A.M. and P.M. Peak Hour and Average Daily Traffic (ADT) No-build traffic volumes;
Previous reports related to the study area or other applicable reports or plans in adjacent areas;	ADT and peak hour volumes on I-84 and Route 8 within the study area;
Signal plans, pavement marking, and signage plans for the study area;	Turning movement counts for intersections within the study area;
Other ConnDOT projects planned or underway within or adjacent to the study area.	Average speed data during A.M. and P.M. peak periods on I-84 and Route 8;
Recent aerial photography of the study area.	Video reconnaissance of conditions on I-84 and Route 8 during A.M. and P.M. peak periods;
Geographic Information Systems (GIS) digital files for base mapping and environmental and socio-economic analysis;	Reconnaissance of roadway geometry and condition on I-84, Route 8, and adjacent intersections;
Growth assumptions for travel demand forecasts in the study area;	Signage and sidewalk reconnaissance of study area;
Bus, rail and other transit information including route maps and schedules;	Original construction plans of I-84/Route 8 viaduct structure
Base mapping and topographic information for the study area;	Geotechnical boring data and reports;
Applicable Intelligent Transportation Systems (ITS) data including incident management, strategic/early deployment, and others;	Plans showing rehabilitation of I-84/Route 8 viaduct structure;
Accident data for the most recent three year period;	Seismic retrofit plans of I-84/Route 8 viaduct structure;
Existing (2002) and future (2030) travel demand model output;	Biennial bridge inspection reports.

1.6 Public Involvement

An Advisory Committee (AC) consisting of representatives of the City of Waterbury, the COGCNV, several state and federal agencies, and key area stakeholders was formed. The group will assist in the collection of data and documents, review analysis and documentation prepared by the study team and provide input and guidance on study recommendations. The committee consists of representatives from the following agencies:

- U.S. Army Corps of Engineers (COE)
- U.S. Fish and Wildlife Services (USFWS)
- City of Waterbury (3 members)
- Connecticut Department of Economic and Community Development (CTDECD)
- Connecticut Department of Environmental Protection (CTDEP)
- Connecticut Office of Policy and Management (CTOPM)
- U.S. Environmental Protection Agency (EPA)
- Federal Highway Administration
- Federal Transit Administration
- Rideworks
- Greater Waterbury Transit District
- Northeast Transportation
- Housatonic Valley Association
- Greater Waterbury Chamber of Commerce
- Neighborhood Housing Services of Waterbury
- Country Club Neighborhood Association
- Bunker Hill Neighborhood Association
- Brooklyn Community Club
- Crownbrook Neighborhood Association
- Town Plot Neighborhood Association
- Council of Governments of Central Naugatuck Valley (COGCNV)
- Waterbury Economic Resource Center
- Waterbury Development Corporation
- Naugatuck Valley Development Corporation
- Connecticut Department of Public Safety

Meetings (6) with the Advisory Committee during this study will provide the opportunity for members to participate in the review of documentation and discuss specific concerns.

Public informational meetings at key milestones throughout the study process provide a forum for the general public to inquire about the study and to provide their input into the study process. A total of four (4) informational meetings (assumed to be evening sessions) are planned at approximately the following milestones:

- Study Initiation/Scoping
- Alternatives Screening
- Alternatives Refinement
- Final Report/Recommendations

Local outreach meetings will also be conducted with local officials, COGCNV, local businesses, and other key stakeholders. The purpose of these meetings is to gain full understanding of study area issues and impact of potential transportation modification on the stakeholders.

1.7 Study Goals and Objectives

Goals are defined to guide the overall direction of the study. Four goals for this study have been developed in consultation with the Advisory Committee.

Some of the key issues with respect to this study are:

Increase safety of the I-84/Route 8 Interchange. This study will examine historical accident data on the freeways and ramps and identify locations where safety is of particular concern. Improvements such as full shoulders, appropriate acceleration and decelerations lengths at ramps, and eliminating dangerous weave conditions and unexpected left-hand entrance and exit ramps, will be considered as a means of reducing accidents.

Address operational deficiencies. The study will review highway capacity issues that affect the interchange such as interchange spacing, weave conditions, lane drops, and arterial operations.

Structural Deficiencies. The study will also address the structural integrity of the interchange. Improvement alternatives must address these deficiencies and anticipate the operational impacts of future demand.

Provide for future growth. The I-84/Route 8 system is important in providing access to existing and developing land uses. Future improvements should support options for development and should accommodate growth in traffic flows, both regionally and locally. It is also important to come to an agreement that proposed corridor improvements address the long-term needs of the City of Waterbury and the region.

Consider alternatives that are financially feasible. The study must address the feasibility of any alternatives based on their ability to be financed. Construction cost estimates will be performed on refined and preferred alternatives. Further analysis will weigh the costs of construction against the benefits of an enhanced transportation system through the region. Comparisons will also be examined for continued maintenance costs of the existing interchange against the costs of constructing and maintaining any improvement alternatives. The study will also identify and evaluate all potential sources of funding to ensure the most effective use of resources is achieved.

1.8 Purpose and Need

The I-84 West of Waterbury Needs & Deficiencies Study identified several deficiencies in the vicinity of the I-84/Route 8 interchange. Operationally, I-84 was found to operate at unacceptable Levels of Service by 2025 throughout this study area. The accident rate on I-84 in the vicinity of the Route 8 interchange was found to be higher than average. Other identified deficiencies that impact safety included insufficient shoulder widths, acceleration and deceleration lanes, and short spacing of entrance and exit ramps causing dangerous weave conditions. Additionally, two major sections of the I-84 eastbound and westbound structure were found to be rated in poor condition.

While a previous study addressed the I-84 corridor from Waterbury to Southbury, this study will identify the needs and deficiencies of the I-84/Route 8 Interchange and its immediate environs. In this study, the future year (2030) will be used as the benchmark condition, against which improvement alternatives will be compared for evaluation to transportation. Each alternative will be screened and evaluated based on its ability to satisfy the goals and alternatives set. Alternatives that pass the screening process will be refined and analyzed in greater detail to develop a set of recommendations that will meet the needs of the City of Waterbury, the region, and the I-84 corridor as a whole.

2 Transportation Assessment

2.1 Modal Share

The information presented in Table 2-1 is included as an indicator of the number of study area residents who use public transit to travel to and from work. While the majority of study area workers do not use public transportation for their work commute, this may reflect a lack of convenient, accessible transit or personal preference. Waterbury has a much higher percentage of commuters that walk (2.8 percent) and use public transit (5.1 percent) than the other 12 towns in the region. The percentage of individuals in the study area who walk to work (at 5.9) is higher than that reported for Waterbury or the region as a whole.

Table 2-1: Work Travel Modes

	2000				
Town	**Workers**	**% Work at Home**	**% Walk to Work**	**% Public Trans.**	**% Other means (Drive)**
Study Area	10,119	1.5	5.9	3.6	87.5
Waterbury	44,256	1.4	2.8	5.1	92.2
COGCNV Region	126,330	2.4	1.8	1.7	83.7

Source: Source: US Census Bureau, Block Group data; COGCNV, *Transportation Trends and Characteristics of the CNVR: 2000*.

2.2 Bus Transportation

The Waterbury area is served by local and intercity bus service. The Bonanza Bus Company provides intercity bus service to Hartford, Danbury and points beyond. Local fixed route service is provided by the State of Connecticut under its CTTransit brand name. The service is contracted out to the Northeast Transportation (NET) Company. NET also provides Americans with Disabilities Act (ADA) paratransit as well as dial-a-ride services throughout the Waterbury area under contract to the State.

The Bonanza Bus Company has 30 departures per day from its Bank Street terminal. Major destinations include Hartford, New York, Danbury, Boston and Providence. The first departure is at 5:45 A.M. with service bound for New York City. The final departure for the day is at 12:05 A.M. with service bound for Hartford. Service operates seven days a week.

Net local service consists of 21 fixed routes and 9 tripper routes serving greater Waterbury. There are 36 buses and 26 paratransit vans providing these services.

The regular adult cash fare for local fixed-route service is $1.25, with the child fare at $1.00. The fare for senior and disabled citizens is $0.60. There are a variety of discounts available for purchasing multiple ride tickets. For example, a 10-ride full-fare pass is $11.25 and a 31-day pass is $45.

The local fixed route services operating in Waterbury are shown in Figure 2-1 and detailed below:

Route #11 - Overlook/Willow: serves Exchange Place, Carlton Towers, Willow Street, Farmington, and Overlook. Weekday service runs approximately every 30 minutes from 6:00 A.M. to 6:22 P.M. Saturday service also runs during the same time period, but hourly.

Route #12 – Hill Street: serves Exchange Place, Grove Street, Hill Street, Moran Street, and Cooke Street. Service runs approximately every 30 minutes from 6:00 A.M. to 6:00 P.M. This service runs on weekdays only.

Route #13 – Oakville/Fairmont: serves Exchange Place, UConn Waterbury, Lewis Fulton Park, Nottingham Towers Apartments, Sunnyside Avenue and Oakville. Weekday service runs hourly from 6:00 A.M. to 6:00 P.M. Saturday service runs hourly from 9:30 A.M. to 5:30 P.M.

Route #15 – Bucks Hill/Farmcrest: serves Exchange Place, North Main Street, Waterbury Plaza, and Farmcrest Drive. Service operates Monday-Saturday hourly from 6:00 A.M. to 6:25 P.M.

Route #16 – Bucks Hill/Montoe: serves Exchange Place, North Main Street, Waterbury Plaza, and Montoe Road. Service operates Monday-Saturday hourly from 5:45 A.M. to 5:58 P.M.

Route #18 – Long Hill/Berkeley: serves Exchange Place, NOW, Inc. East Farm Street, Berkeley Heights and Long Hill. Service operates every 30 minutes from 5:55 A.M. to 6:20 P.M. from Monday to Saturday.

Route #20 – Walnut Street: serves Exchange Place, UConn Waterbury, Walnut Street, the WOW Center, and Oak Street. Service operates hourly Monday-Saturday from 6:00 A.M. to 6:23 P.M.

Route #22 – Wolcott Street/Brass Mill Center: serves Exchange Place, Wolcott Street, Brass Mill Center Mall, Naugatuck Valley Shopping Center, and Sharon Road. Monday-Friday, service operates hourly from 6:05 A.M. to 6:25 P.M. On Saturdays, service operates hourly from 9:30 A.M. to 6:25 P.M.

Route #25 – Hitchcock Lake: serves Exchange Place, East Main Street, Meriden Road, Sunset Gardens, and Deerfield Apartments. Service operates Monday-Friday from 6:00 A.M. to 6:10 P.M. on an hourly basis. On Saturdays, service operates hourly from 9:30 A.M. to 6:10 P.M.

Route #26 – Fairlawn/East Main: serves Exchange Place, East Main Street, Hamilton Park, and East Gate Apartments. Service operates Monday-Friday hourly from 6:00 A.M. to 6:23 P.M. There is no Saturday service.

Route #27 – Reidville/East Main: serves Exchange Place, East Main Street, Hamilton Park, and Reidville. Service operates hourly Monday-Saturday from 5:45 A.M. to 5:58 P.M.

Route #31 – East Mountain: serves Exchange Place, Hamilton Avenue and East Mountain. Service operates hourly Monday-Friday from 6:15 A.M to 6:00 P.M. There is no Saturday service.

Route #32 – Hopeville/Sylvan: serves Exchange Place, St. Mary's Hospital, Baldwin Street, Sylvan Avenue, and Hopeville. Service operates hourly Monday-Friday from 6:15 A.M. to 6:15 P.M. There is no Saturday service.

Route #33 – Hopeville/Baldwin: serves Exchange Place, St. Mary's Hospital, Baldwin Street, and Hopeville. Monday-Friday, service operates at 30 minute intervals from 5:45 A.M. to 6:23 P.M. On Saturdays, service operates hourly from 5:45 A.M. to 6:23 P.M.

Route #35 – Town Plot/New Haven Avenue: serves Exchange Place, Bank Street, Congress Avenue, Town Plot, and New Haven Avenue. Service operates Monday-Saturday hourly from 5:45 A.M. to 5:58 P.M.

Route #36 – Town Plot/Bradley: serves Exchange Place, Bank Street, Congress Avenue, Town Plot, Bradley Avenue, and Holy Cross High School. Service operates Monday-Saturday every hour from 6:00 A.M. to 6:12 P.M.

Route #40 – Town Plot/Highland: serves Exchange Place, Waterbury Railroad Station, Freight Street, Highland Avenue, Kennedy High School, Chase Park, and Town Plot. Service operates hourly Monday-Saturday from 5:45 A.M. to 5:57 P.M.

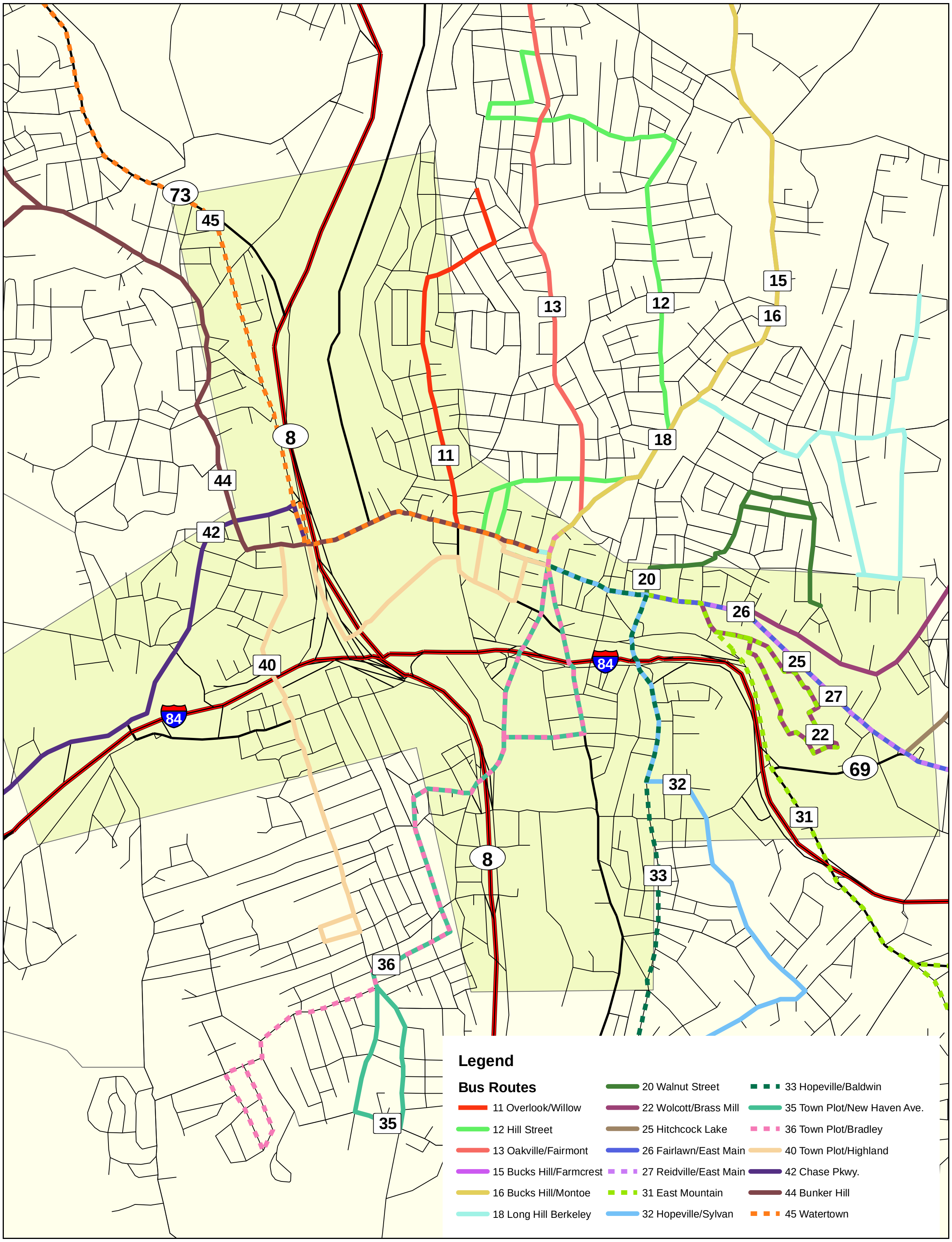
Route #42 – Chase Parkway: serves Exchange Place, West Main Street, Waterbury Hospital, Chase Parkway, and Naugatuck Valley Community College. Service operates Monday-Friday hourly from 6:30 A.M. to 5:59 P.M.

Route #44 – Bunker Hill: serves Exchange Place, West Main Street, Grandview Avenue, Bunker Hill Park, Bunker Hill Avenue, Whitewood Avenue, and the Health Center of Greater Waterbury. Service operates hourly Monday-Friday from 6:10 A.M. to 5:58 P.M. On Saturdays, service operates hourly from 6:30 A.M. to 5:58 P.M.

Route #45 – Watertown: serves Exchange Place, West Main Street, Waterbury Hospital, Watertown Avenue, Municipal Stadium, Oakville, and Watertown. Service operates hourly, Monday-Saturday, from 5:30 A.M. to 6:22 P.M.

Route #J/J4/J5 – Waterbury/Kimberly Avenue: serves Exchange Place, Waterbury Railroad Station, East Main Street, Cheshire, Hamden, and New Haven. Service operates hourly Monday-Friday from 6:15 A.M. to 7:30 P.M. On Saturdays, service operates every two hours from 8:15 A.M. to 6:30 P.M. This route is a variation of the J Route operated by CTTransit New Haven Division.

Figure 2-1: Waterbury Local Fixed Route Bus Service



Source: Council of Governments of the Naugatuck Valley

In addition to the fixed routes, CTTransit-Waterbury, through its contractor NET, provides transportation to qualified individuals with or without disabilities in the Greater Waterbury Area to job sites and to Adult Education through the JobLinks program. Transportation is provided to some of the top industrial and commercial areas in Waterbury, Danbury and Torrington and is scheduled around shift start and end times. Riders currently pay $1 for most fares, or $1.50 for customized neighborhood or evening service. Individuals transitioning off welfare and other eligible low-income individuals can receive up to six weeks of transportation free, after which they pay the regular monthly fares. The 9 tripper routes operated as part of the regular services, or as part of the JobLinks service are as follows:

- Scott Road
- Watertown/Straits Turnpike
- Easter Seal/Avenue of Industry
- Waterville/North Main
- Watertown Industrial Park
- Waterville/Thomaston
- Cheshire Industrial Park
- Naugatuck Industrial Park
- Naugatuck Shuttle

Paratransit service is provided throughout Waterbury by CTTransit-Waterbury, through its contractor Northeast Transportation. As mandated by the American with Disabilities Act of 1990, any individual whose trip ends are within ¾ mile of a fixed route bus route, and who due to a disability is unable to get to, board or exit or understand how to use the bus, qualifies for ADA service. Trips cannot be denied as long as the rules are followed. All of Waterbury is within ¾ mile of a fixed route bus route. In addition, paratransit services are reserved for non-ADA individuals, including elderly persons or persons with a disability whose pick-up or drop-off point is greater than ¾ of a mile from a fixed route bus service. Trips for non-ADA users can be denied because of lack of capacity. The service area includes Cheshire, Middlebury, Naugatuck, Prospect, Thomaston, Waterbury, Watertown and Wolcott. Service operates Monday-Saturday from 6:00A.M. to 6:00 P.M. Requests for this service should be made at least one day in advance. Fares are $2.50 per one-way trip.

In 2004, COGCNV released a bus route study (*Central Naugatuck Valley Region Bus Route Study, June 2004)* that presented the findings of ridership surveys of bus routes within the region. It also recommended several routing and scheduling changes based on these surveys and discussions with operators, municipal officials, and local groups. No routes were recommended for elimination, but some modifications were suggested to better serve areas of potential ridership. In addition, several new stops and shelters were recommended to provide better service along existing routes. Additionally, clear, consistent signage at stops and shelters was recommended to eliminate driver and passenger confusion as well as to create a sense of permanence. Informational kiosks were also recommended at major bus stops to illustrate the bus service in the area.

The COGCNV report also detailed daily ridership on the fixed bus routes in the Waterbury area. The ridership on these routes is shown below in Table 2-2.

Table 2-2: Summary of Waterbury Fixed Route Bus Service and Ridership

Route	Frequency	Weekend Service	Daily Ridership[1]
#11 - Overlook/Willow	30 minutes	Saturday (hourly)	338
#12 – Hill Street	30 minutes	None	235
#13 – Oakville/Fairmont	hourly	Saturday (from 9:00 A.M.)	447
#15 – Bucks Hill/Farmcrest	hourly	Saturday	391
#16 – Bucks Hill/Montoe	hourly	Saturday	279
#18 – Long Hill/Berkeley	30 minutes	Saturday	407
#20 – Walnut Street	hourly	Saturday	219
#22 – Wolcott Street/Brass Mill Center	hourly	Saturday (from 9:30 A.M.)	510
#25 – Hitchcock Lake	hourly	Saturday (from 9:30 A.M.)	301
#26 – Fairlawn/East Main	hourly	None	127
#27 – Reidville/East Main	hourly	Saturday	242
#31 – East Mountain	hourly	None	28
#32 – Hopeville/Sylvan	hourly	None	84
#33 – Hopeville/Baldwin	30 min	Saturday	421
#35 – Town Plot/New Haven Ave	hourly	Saturday	222
#36 – Town Plot/Bradley	hourly	Saturday	245
#40 – Town Plot/Highland	hourly	Saturday	143
#42 – Chase Parkway	hourly	None	173
#44 – Bunker Hill	hourly	Saturday	226
#45 – Watertown	hourly	Saturday	232
#J/J4/J5 – Waterbury/Kimberly Ave[2]	hourly until 7:30 P.M.	Saturday every two hours 8:15 A.M. to 6:30 P.M.	1,370

1. Ridership from Central Naugatuck Valley Region Bus Route Study (COCCNV 2004).
2. Variation of J Route, CTTransit-New Haven Division. Ridership is daily boardings for all variations of this route between New Haven and Waterbury. Source ConnDOT 2001.

2.3 Rail Service

Waterbury is also served by the Waterbury branch of the New Haven Line commuter rail system. ConnDOT operates the New Haven Line through a contract with the Metropolitan Transportation Authority's Metro-North Railroad subsidiary.

The New Haven line serves Waterbury and the rest of Southern Connecticut. This line runs from Grand Central Terminal (GCT), New York City, through Stamford, Norwalk, and Bridgeport to New Haven. In addition, there are three branch lines serving New Canaan, Danbury, and Waterbury. The Waterbury branch connects to the main line at Bridgeport and serves Derby-Shelton, Ansonia, Seymour, Beacon Falls, Naugatuck and

Waterbury. Passengers on the Waterbury line wishing to go to Stamford or New York City must change trains at Bridgeport and continue along the New Haven main line.

Monday-Friday, there are six trains departing from Waterbury beginning at 6:49 A.M. and ending at 9:29 P.M. Frequencies vary between 2 to 4 hours. The first arrival at Waterbury is at 8:53 A.M. and the last arrival at 11:29 P.M. There are six weekday arrivals and frequency again varies from 2 to 4 hours. On weekends and holidays, there are four arrivals and departures to and from Waterbury. The first weekend departure from Waterbury is at 7:21 A.M. and the last is at 7:19 P.M. The first arrival is at 10:27 A.M. and the last arrival is at 11:25 P.M.

Fares from Waterbury to New York are available at peak and off-peak rates as well as 10-trip, weekly, and monthly passes. Peak fares are defined as trips that arrive at GCT on weekdays from 5:00 A.M. to 10 P.M. or depart from GCT on weekdays from 4:00 P.M. to 8:00 P.M. Off-peak fares are in effect at all other times including weekends and holidays. New fares are going into effect on January 1, 2005. The one-way peak fare is $16.50, and the one-way off-peak fare is $12.50. Senior citizens and disabled persons receive a 50% discount off the one-way peak fare for all trips. 10-trip fares from Waterbury to New York are $106.25 and $165.00 for off-peak and peak trips, respectively. Weekly passes are $114.00 and monthly passes are $355.00.

The Waterbury train station is located at 333 Meadow Street on the western edge of the downtown area. Bus connections, taxi service, and parking are available. The station does not have a staffed ticket office. Passengers must buy tickets ahead of time or on the train.

2.4 Park and Ride

There are three park and ride lots in close proximity to the I-84/Route 8 interchange, two are adjacent to I-84, and one is in downtown Waterbury. These lots are detailed below:

Lot	Capacity	Features
Chase Parkway (I-84 Interchange 17-18)	123	P, L, T, B
Route 69 (I-84 Interchange 23)	178	P, L, T, B
Meadow Street (Railroad Station)	7	P, L, T, S, R, B

Source: ConnDOT (P=Paved, L=Lighted, T=Public Telephone, S=Shelter, R-Rail Service, B=Local Bus Service)

The I-84 West of Waterbury Needs and Deficiencies study (2001, Wilbur Smith Associates) identified that these facilities were within capacity. In that study and a subsequent more recent review, a signage inventory indicated that the railroad station was not adequately signed as a park and ride facility.

2.5 Bicyclist and Pedestrian Needs

In the past decade in the United States, transportation officials and stakeholders have emphasized the importance of incorporating pedestrian facilities into the general transportation system. A national survey on pedestrians and bicyclists conducted in 2002 revealed that about 80% of adult Americans take at least one walk lasting five minutes or longer during the summer months. The need for a well integrated transportation system eventually led to the formulation of the Transportation Equity Act for the 21st Century (TEA-21), which seeks in addition to other goals, to expand and improve facilities and safety for bicyclists and pedestrians. Pedestrian accommodations necessary to encourage walking include sidewalks, pedestrian crossings, and street lighting.

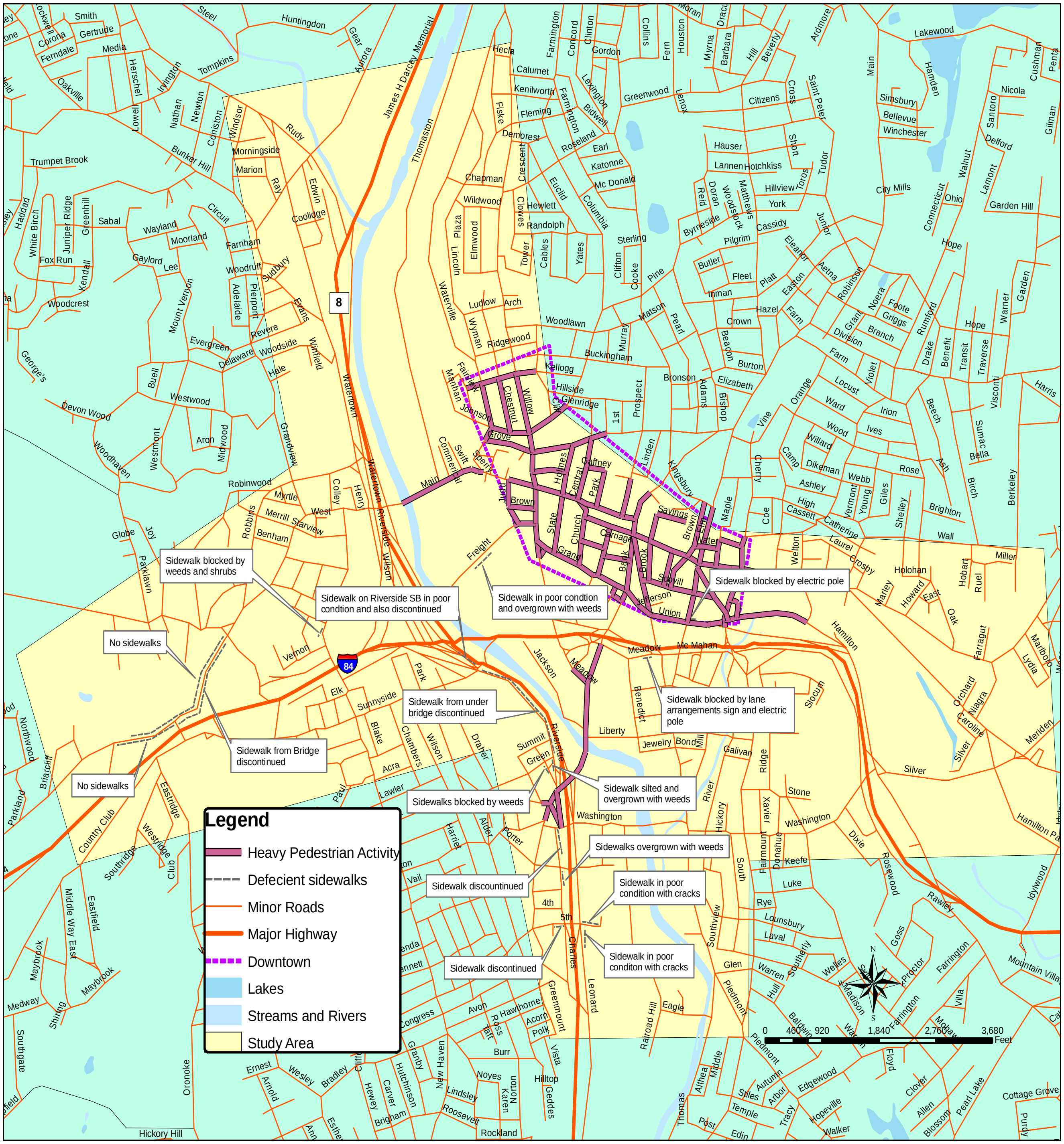
Currently, there are no state designated bicycle routes within the City of Waterbury. However, the designation of two on-street bicycle routes within Waterbury are being pursued by the COGCNV. The first is Route 73, Watertown Ave, West Main and Thomaston Ave running from Watertown, through Waterbury into Thomaston. The second includes Route 69 for its entire length within Waterbury. In the COGCNV Regional Bike Plan, bike lanes were recommended for both of these routes.

Additionally, the COGCNV is pursuing the development of a linear bicycle path along the east side of Naugatuck River in Waterbury. This project is in the preliminary stages, with property acquisition being pursued through private donation. It is envisaged that the Naugatuck Greenway will pass through the study area and any proposed transportation improvements will ensure connectivity to this system.

Most of the pedestrian activities in Waterbury are centered in the downtown area where a majority of the local shopping and commercial facilities are located. Figure 2-2 shows the locations with heavy pedestrian activity. Most of the streets in these areas have sidewalks on both sides of the roadway. The sidewalks are well connected, generally in good condition and serve a large number of pedestrians and bicyclists.

In the remainder of the study area along I-84 and Route 8 however, the number of sidewalks is reduced. The sidewalks in these areas are generally in worse condition than the sidewalks in the downtown area.

Figure 2-2: Pedestrian Needs and Sidewalk Deficiencies



As part of this study field reconnaissance was undertaken to identify the availability of sidewalks around I-84 and Route 8 within the study area. The task involved field verification, photo documentation and sidewalk classification that were based on the following categories:

- Absence of sidewalks
- Discontinuity of sidewalks
- Structural condition of sidewalks

Figure 2-2 shows the locations within the study area with sidewalk deficiencies.

At certain locations within the study area, sidewalks were non existent while at other locations the sidewalks were discontinuous throughout the length of roadway. Some sidewalks were heavily silted and overgrown with weeds and shrubs, as a result of which, some of these sidewalks were rendered impassable. There were other sidewalks that were blocked by roadside infrastructure such as electric poles, traffic signal poles and lane arrangement signs. The findings on the sidewalk inventory are as follows:

Union Street has a sidewalk along its entire length on the south side but no sidewalks on the north side. There are pedestrian crosswalks on Union Street at the intersections of Brass Mill Mall, Brass Mill Drive, Mill Street and South Elm Street and South Main Street. At the Union Street/Brass Mill Mall and Union Street/Brass Mill Drive intersections however, there are no pedestrian-signals even though the crosswalks at these locations are wide. Also on the north side of Union Street just before South Elm Street intersection, the sidewalk is blocked by an electric pole.

Market Square has sidewalks on both sides. However, on the south side of Market square, just west of South Main Street, the sidewalk is blocked by a lane arrangements sign and electric pole.

West Main Street has sidewalks along both sides; however these sidewalks are discontinuous at certain sections particularly from the I-84 Interchange 18 exit ramp to the Chase Parkway Bridge.

Chase Parkway has a sidewalk along its whole length on the south side but no sidewalks on the north side.

Sunnyside Avenue has sidewalks on both sides, however the sidewalk on the west side between Vernon Street and Cynthia Street is rendered impassable by weeds and shrubs.

Riverside Street NB has a sidewalk along its east side. This sidewalk is however discontinuous from Sunnyside Avenue to Bank Street. The sidewalk is also in poor condition, overgrown with weeds and heavily silted. There are no sidewalks on Riverside Street NB along its west side.

Riverside Street SB has no sidewalks along its entire length.

Leonard Street has a sidewalk on the west side which is overgrown with weeds and rendered impassable.

South Leonard Street has a tiny stretch of sidewalk from the Route 8 NB exit ramp to Fifth Street along its east side. This sidewalk however is cracked and is in poor condition. There is no sidewalk on the west side of the South Leonard Street.

Charles Street has sidewalks along its west side from Bank Street to Fifth Street. There is a sidewalk along the east side of Charles Street, however this sidewalk is discontinued midway between Potter Street towards Washington Avenue.

Fifth Street has sidewalks on both sides. The sidewalk on the south side is discontinued just under the Route 8 overpass, while the sidewalk on the north side is cracked and in poor condition, east of the overpass.

3 Land Use and Socioeconomic Analysis

3.1 Land Use, Zoning, and Neighborhood Boundaries

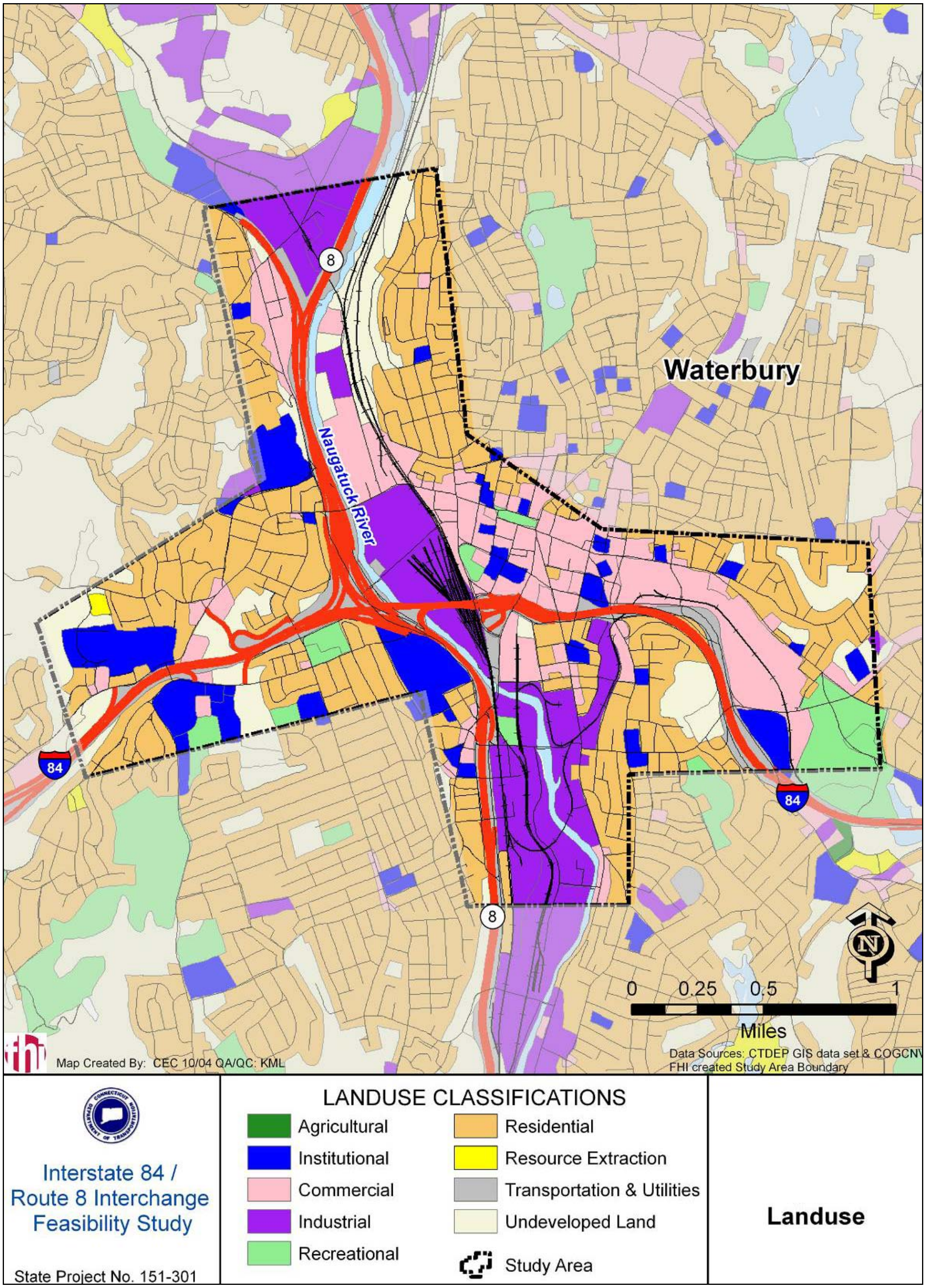
The City of Waterbury is in the process of updating its Plan of Conservation and Development, which is expected to be completed in 2005. Therefore, regional land use maps and the region's Plan of Conservation and Development, as reported herein, were obtained from the Council of Governments of the Central Naugatuck Valley (COGCNV). Limited visual inspections were also conducted in the field.

Land use in study area neighborhoods is a reflection of the historic growth and settlement patterns of Waterbury that were driven by the industrial development of the Naugatuck River Valley in the early nineteenth century. During this period of industrialization, people settled in Waterbury, which is the Naugatuck River Valley's central city. Since World War II, the region's economy has diversified and its residents have become more widely dispersed throughout nearby suburbs.

Like many cities in the northeastern United States, Waterbury has experienced population decline as its suburbs have grown. From 1990 to 2000, the population of the region as a whole increased, while that of Waterbury declined by 1.6 percent. As the city developed farther from its core, residential development became less dense as single-family and small multi-family uses became the dominant land use pattern.

According to Figure 3-1, the predominant land uses in the study area today are residential, industrial, and commercial. Residential land uses in the immediate vicinity of the I-84 and Route 8 interchange are located southwest and northwest of the interchange in the Town Plot neighborhood. Industrial land uses in the immediate vicinity of the I-84 and Route 8 interchange are located to northeast and southeast of the interchange, in the Freight Street area and South Main Street corridor. Commercial land uses, farther from the interchange, are, generally, to the northeast and southeast of the interchange, along the West Main Street and East Main Street corridors. Recreational and institutional land uses, as well as undeveloped land, are also found sporadically throughout the study area. Riverside Cemetery and Chase Park, in particular, are to the immediate southwest of the interchange. Hamilton Park is located on the eastern edge of the study area.

Figure 3-1: Land Use



The study area is characterized by residential neighborhoods, industrial sites, office space, retail, and mixed uses. Downtown Waterbury, according to "City of Waterbury Strategic Economic Development Plan," (March 2001), has 900,000 square feet of office space (predominately Class B and C[1]) and an information technology zone. The industrial sites in the study area, including suspected brownfields, compete with the industrial parks located outside the downtown area, and downtown retail competes with nearby Brass Mill Center and Commons.

Waterbury Partnership 2000, in the "City of Waterbury Strategic Economic Development Plan," identifies the Interstate 84 and Route 8 interchange as "the city's key regional asset for all manner of economic development." This plan recommends the following for the city's land use and zoning:

- Update the City of Waterbury's land use, zoning, and development policies and regulations,
- Designate the Freight Street area a Planned Development District (PDD) to promote private re-development and infrastructure improvements,
- Further develop and enhance the information technology zone (ITZ) in downtown Waterbury,
- Extend the Central Business District (CBD) to include more area north of the Green and both sides of West Main Street,
- Pursue a Special Service District (SSD), encompassing downtown and the Brass Mill Center and Commons,
- Pursue a traffic calming strategy, improve traffic flow, and create more parking around the Green,
- Create stronger historic district guidelines for downtown,
- Coordinate zoning policy with a plan to re-use vacant industrial buildings,
- Curtail the use of "spot zoning," and
- Create disincentives for pre-existing, non-conforming uses.

3.2 Business Activity and Major Employers

As depicted in Figure 3-2, there is a high concentration of employers with 25 or more employees in downtown Waterbury. The figure also depicts the important relationship that exists between the transportation infrastructure and these employment centers. Table 3-1 lists the largest companies within the study area.

[1] (According to the Building Owners and Managers Association, or BOMA, Class B office space is located in buildings "competing for a wide range of users with rents in the average rent range for the area. Building finishes are fair to good for the area and the systems are adequate, but the building does not compete with Class A at the same price." Class C office space, as defined by BOMA, is located in buildings "competing for tenants requiring functional space at rents below the average for the area." In contrast, BOMA defines Class A office space as "the most prestigious" and "competing for premier office users with above average rental rates for the area along with high-quality standard finishes, state of the art systems, exceptional accessibility, and a definite market presence."

Figure 3-2: Major Employers

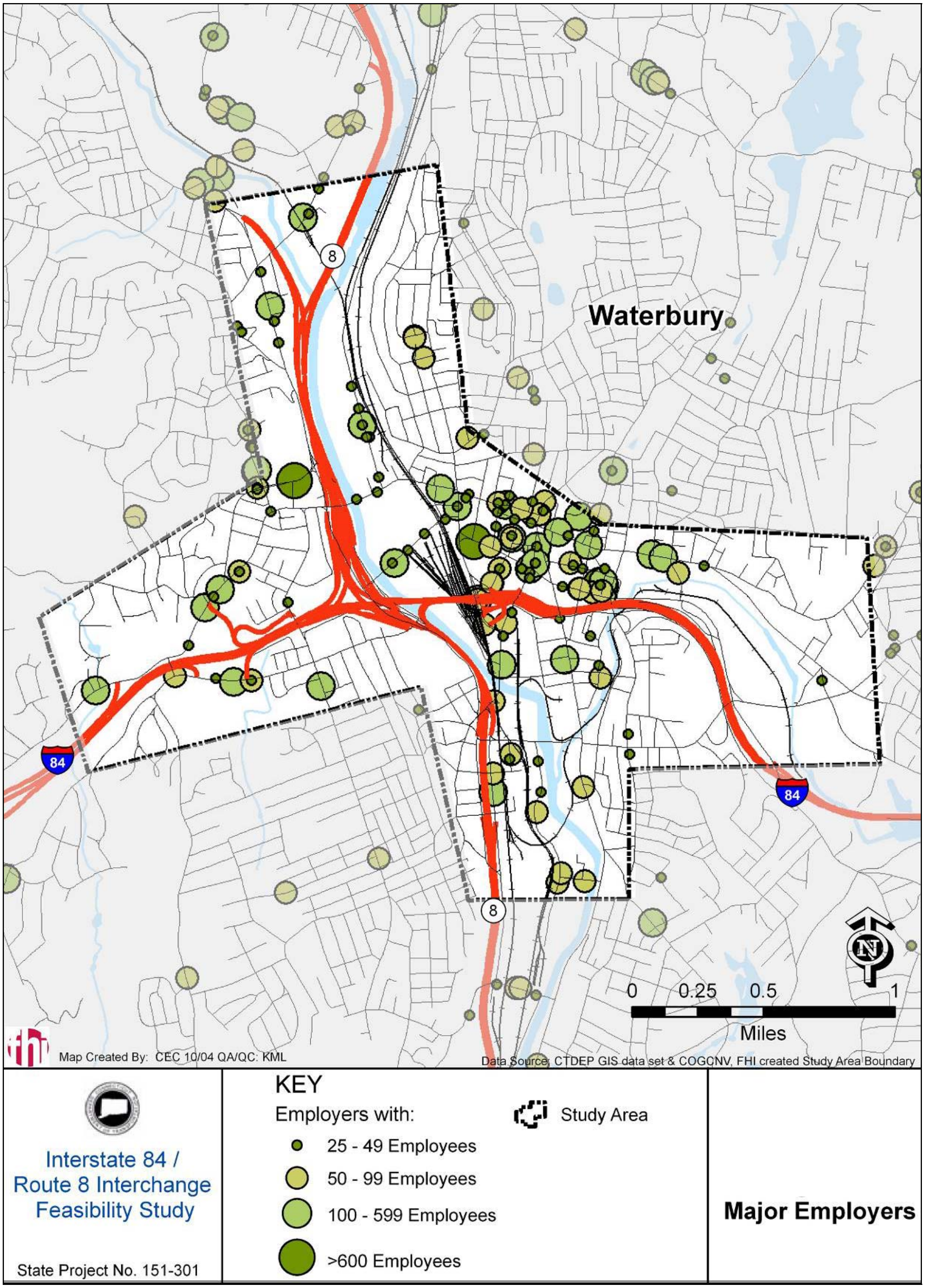


Table 3-1: Major Employers within the Study
Brass Mill Center and Commons
City of Waterbury
Connecticut Light & Power
MacDermid, Inc.
St. Mary's Hospital
Waterbury Hospital
Webster Bank

The City of Waterbury, the Naugatuck Valley Development Corporation (NVDC), and the Greater Waterbury Chamber of Commerce (GWCOC) each play a role in planning for economic development in Waterbury. The "City of Waterbury Strategic Economic Development Plan," (March 2001) prepared for Waterbury Partnership 2000 (a community and economic development, private and public partnership) identified economic development and future land use plans for downtown Waterbury and the Freight Street/West Main Street/Thomaston Avenue area. According to the "City of Waterbury Strategic Economic Development Plan," (the Plan) the land adjacent to the Interstate 84 and Route 8 interchange is among the most valuable in Waterbury, providing flat developable sites in close proximity to highway and freight rail. Challenges include the off-highway road network and suspected brownfield sites.

For the Freight Street/West Main Street/Thomaston Avenue area, the Plan, recommends:

- Extending Thomaston Avenue to Jackson Street, creating a north-south connector and linking the South End with the Thomaston Avenue corridor,
- Pursuing funding for brownfields assessments and remediation,
- Featuring the Naugatuck River as a recreational and scenic resource, and
- Locating large footprint tourist attractions (i.e., baseball stadium, rail museum) in the Thomaston Avenue/Freight Street area.

For downtown Waterbury, the Plan, recommends:

- Targeting West Main Street for new office development and commercial re-development,
- Creating attractive gateways to downtown,
- Creating small, attractive public spaces in the downtown and focus on "place-making," and
- Developing a transit center at the east end of the Green.

One proposal being considered for revitalizing both the downtown and Freight Street area is to locate a Transportation Center at the existing Metro-North station and provide parking on the west side of the railroad tracks with a pedestrian crossing to the historic Union Station building.

As Waterbury Partnership 2000 notes in the Plan, the goals and objectives for economic and community development in Waterbury focus, not only on creating jobs, but also on improving the image of the city. Recently completed projects designed to improve

Waterbury's image are the Palace Theater, the Arts Magnet School, and re-location of the University of Connecticut satellite campus to downtown. Recommendations for a Transportation Center, a baseball stadium, and a rail museum add to these attractions.

National economic trends in the globalization of manufacturing have resulted in a shift in the Central Naugatuck Valley economy. While the industrial base remains strong in Waterbury, diversification is ongoing, with contribution from retail, information technology, and financial and government services. Waterbury, as the central city of the region is still its economic anchor; however, the U.S. Census 2000 indicates a decentralization of employment centers.

3.3 Population and Employment Trends

Population and housing information for this study was obtained primarily from the 1990 and 2000 U.S. Census and COGCNV. Table 3-2 through Table 3-4 depict the population, employment, and housing characteristics and trends in the study area compared to the COGCNV region as a whole. Some of the following tables also include COGCNV's projections of demographic data.

3.3.1 Population

The population data shows a decline in population in the central urban core of Waterbury between 1990 and 2000 and a corresponding growth in population in the outlying suburbs, particularly in Southbury (17.4 percent), Oxford (13.1 percent), and Woodbury (13.1 percent), according to COGCNV. The population of the region as a whole is projected to 298,030 by 2030, an increase of 9.4% from the year 2000]. The study area is projected to remain relatively stable in population through 2030.

The 2000 study area population of 27,792 comprises approximately 10 percent of the region's overall population. Waterbury, as a whole, comprises close to 40 percent of the region's 2000 population (Table 3-2). Close to 60 percent of the population in the study area is workforce age (18-64). The study area has a comparable elderly population (age 65 or older) to Waterbury as a whole (14 percent and 15 percent, respectively). The study area has a slightly lower percentage (at 56.9 percent) of children (age 0–17) than Waterbury as a whole (at 58.5 percent). Elderly populations within the study area are discussed in greater detail in Section 3.3.5, Environmental Justice.

Table 3-2: Population Trends

Geographic Area	1990		2000		2030	
	Population	% of COGCNV Region	Population	% of COGCNV Region	Population	% of COGCNV Region
Study Area	30,528	11.7	21,831	8.0	21,826	7.3
Waterbury	108,961	41.7	107,271	39.3	107,350	36.0
COGCNV Region	261,081	100	272,594	100	298,030	100

Sources: US Census Bureau, Block Group data; ConnDOT's Series 27B Land Use Projection, 2003; COGCNV, *Profile of the Region: 2003*..

Table 3-3 Age and Sex Distribution

	2000					
Geographic Area	Population	% Male	% Female	% School Age (0-17)	% Workforce Age (18-64)	% 65 or Older
Study Area	21,831	47.5	52.5	29.1	56.9	14.0
Waterbury	107,271	47.1	52.9	26.5	58.5	15.0
COGCNV Region	272,594	48.5	51.5	25.8	59.8	14.4

Source: US Census Bureau, Block Group data; ConnDOT's Series 27B Land Use Projection, 2003; COGCNV, *Profile of the Region: 2003*..

3.3.2 Minority Population Distribution

As reported in Table 3-4, the study area as a whole has a substantial minority population at 37 percent, compared with 32.7 percent for Waterbury and 16.2 percent for the Central Naugatuck Valley Region. Minority communities within the study area that could potentially be impacted by the project are discussed in greater detail in Section 3.3.5, Environmental Justice.

Table 3-4 Minority Population

Geographic Area	1990			
	Population	White	Minority	% Minority
Study Area	30,528	22,880	7,648	25.1
Waterbury	108,961	86,681	22,280	20.4
COGCNV Region	261,081	NA	NA	NA
Geographic Area	**2000**			
	Population	White	Minority	% Minority
Study Area	27,792	16,307	10,271	37.0
Waterbury	107,271	72,151	35,120	32.7
COGCNV Region	272,594	228,534	44,060	16.2

Source: US Census Bureau, Block Group data; ConnDOT's Series 27B Land Use Projection, 2003; COGCNV, *Profile of the Region: 2003*. NA = data not available.

According to the 1990 and 2000 U.S. Census data, the minority population has increased from approximately 25 percent of the study area population in 1990 to 37 percent of the study area population in 2000. This trend is also confirmed in Waterbury as a whole, with minorities comprising approximately 20 percent of the Waterbury population in 1990 and approximately 33 percent in 2000.

3.3.3 Housing Characteristics

Table 3-5 summarizes housing characteristics in the study area, Waterbury, and the COGCNV region as a whole. The average household size in the study area (at 2.6 individuals) is comparable with Waterbury as a whole (at 2.5 individuals). The percentage of renter occupied households in the study area is very high (at 68.4 percent), compared with Waterbury (at 52.4) or the region as a whole (32.7 percent).

Between 1990 and 2000, the number of households, persons per household, and vacant and renter-occupied households within the study area and Waterbury as a whole remained essentially constant.

Table 3-5 Housing Characteristics and Trends

	1990			
Geographic Area	**Total Households**	**Persons Per Household**	**Vacant (% Total)**	**Renter Occupied (% Total)**
Study Area	12,188	2.5	11.6	67.0
Waterbury	43,164	2.5	9.4	51.0
COGCNV Region	97,407	NA	NA	NA
	2000			
Town	**Total Households**	**Persons Per Household**	**Vacant (% Total)**	**Renter Occupied (% Total)**
Study Area	12,459	2.6	12.8	68.4
Waterbury	46,827	2.5	9.0	52.4
COGCNV Region	103,155	NA	6.0	32.7

Source: US Census Bureau, Block Group data; ConnDOT's Series 27B Land Use Projection, 2003; COGCNV, *Profile of the Region: 2003*. NA = data not available.

3.3.4 Employment and Income

According to the 2000 U.S. Census, there were 98,606 individuals working in the Central Naugatuck Valley Region. Table 3-6 through Table 3-8 provide characteristics of the labor force and income in the study area and within the COGCNV region as a whole.

As Table 3-6 shows, the unemployment rate in Waterbury is higher than in the Central Naugatuck Valley as a whole. The 2000 per capita income in Waterbury is $17,701 (Table 3-7) which is approximately 20 percent higher than the per capita income for the study area (14,250) as a whole. The percentage of the population below the poverty level is 16 percent for Waterbury and approximately 24 percent for the study area.

Table 3-8 shows that jobs in the retail business account for a significant percentage of the employment in the study area and within Waterbury. Retail is the third highest sector, after education, health and social services, and manufacturing in employment in Waterbury. In the study area, manufacturing is the leading employment sector, with the education, health, and social services second highest, and retail third.

The income and poverty level within the study area is higher (at 23.9 percent) than Waterbury as a whole (at 16 percent). Low-income populations within the study area that could potentially be impacted by the project are discussed in greater detail in Section 3.3.5, Environmental Justice.

Table 3-6 Labor Force

Geographic Area	2002			
	Population	**Labor Force**	**Unemployed**	**% Unemployment**
Study Area	27,792			
Waterbury	107,271	52,993	4,076	7.7
COGCNV Region	272,594	139,156	7,729	5.6

Sources: US Census Bureau, Block Group data; COGCNV, *Profile of the Region: 2003*.

Table 3-7 Income and Poverty Levels

Geographic Area	2000		
	Population Below Poverty Level	**Per Capita Income**	**% of Population Below Poverty Level**
Study Area	21,831	$14,250	23.9
Waterbury	105,016	$17,701	16.0
COGCNV Region	NA	NA	9.0

Source: US Census Bureau, Block Group data; ConnDOT's Series 27B Land Use Projection, 2003; COGCNV, *Profile of the Region: 2003*. NA = data not available.

Table 3-8 Employment — Existing and Projected

Geographic Area	2000		
	Retail	**Non-Retail**	**Total**
Study Area	4,169	16,570	20,739
Waterbury	5,481	40,003	45,484
COGCNV Region	17,870	85,880	103,750
Geographic Area	**2025**		
	Retail	**Non-Retail**	**Total**
Study Area	4,404	17,706	22,111
Waterbury	8,720	37,170	45,890
COGCNV Region	21,130	100,870	122,000

Source:

3.3.5 Environmental Justice

Title VI of the Civil Rights Act of 1964 requires that "no person in the United States shall, on the ground of race, color, or national origin be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal financial assistance." Title VI bars intentional discrimination as well as any disparate impact discrimination (i.e. a neutral policy or practice that has the effect of a disparate impact on protected groups).

In 1994, President Clinton issued Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations.* The Executive Order further amplifies Title VI by providing that "each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental affects of its programs, policies, and activities on minority populations and low-income populations".

Consequently, this section of the feasibility study responds to this mandate by identifying the presence of low income and minority populations within the study area using 2000 U.S. Census data. The purpose is to determine where target environmental justice groups occur relative to the proposed project. There are no legislated standards for defining the number of low income and minority individuals that constitute an environmental justice target area. According to COGCNV's Long Range Regional Transportation Plan: 2004–2030, a target group of environmental justice populations is considered to exist where the percentage of the population that is minority is 50 percent or greater and where the percentage of the population that is low income is 20 percent or greater.

As indicated in Figure 3-3 and 3-4, which show census block groups and potential EJ populations or "target area," the largest EJ populations reside north of I-84 and east of Route 8. There are also EJ populations on the south side of I-84, west of Route 8 in the Brooklyn section of Waterbury and on the south side of I-84, east of Route 8, largely on the east side of South Main Street.

Approximately 54.4 percent of the study area's population, according to the 2000 U.S. Census is minority and 37.4 percent is below the 150 percent poverty level. In Waterbury as a whole, the percent minority is 41.8% and the percent below the 150% poverty level is 26.6 percent. The disparity is greatest between the minority population (at 54.4 percent) and low-income population (37.4 percent) in the study area and the region as a whole (20.6 percent and 14.8 percent, respectively) (Table 3-9). These minority and low-income populations should be included in the project planning process, and the proposed project should be evaluated in terms of how these EJ populations may be impacted.

Table 3-9 Study Area Environmental Justice Populations

Study Area Portion of Town	2000				
	Population	Minority	% Minority	Below 150% Poverty Level	% Below 150% Poverty Level
Study Area	27,792	15,034	54.5%	10,151	37.4%
Waterbury	107,271	44,865	41.8%	27,975	26.6%
COGCNV Region	272,594	54,519	20.6%	NC	14.8%

Source: US Census Bureau, Block Group data; COGCNV, COGCNV, *Profile of the Region: 2003.*
NC=Not calculated.

Figure 3-3: Census Block Groups

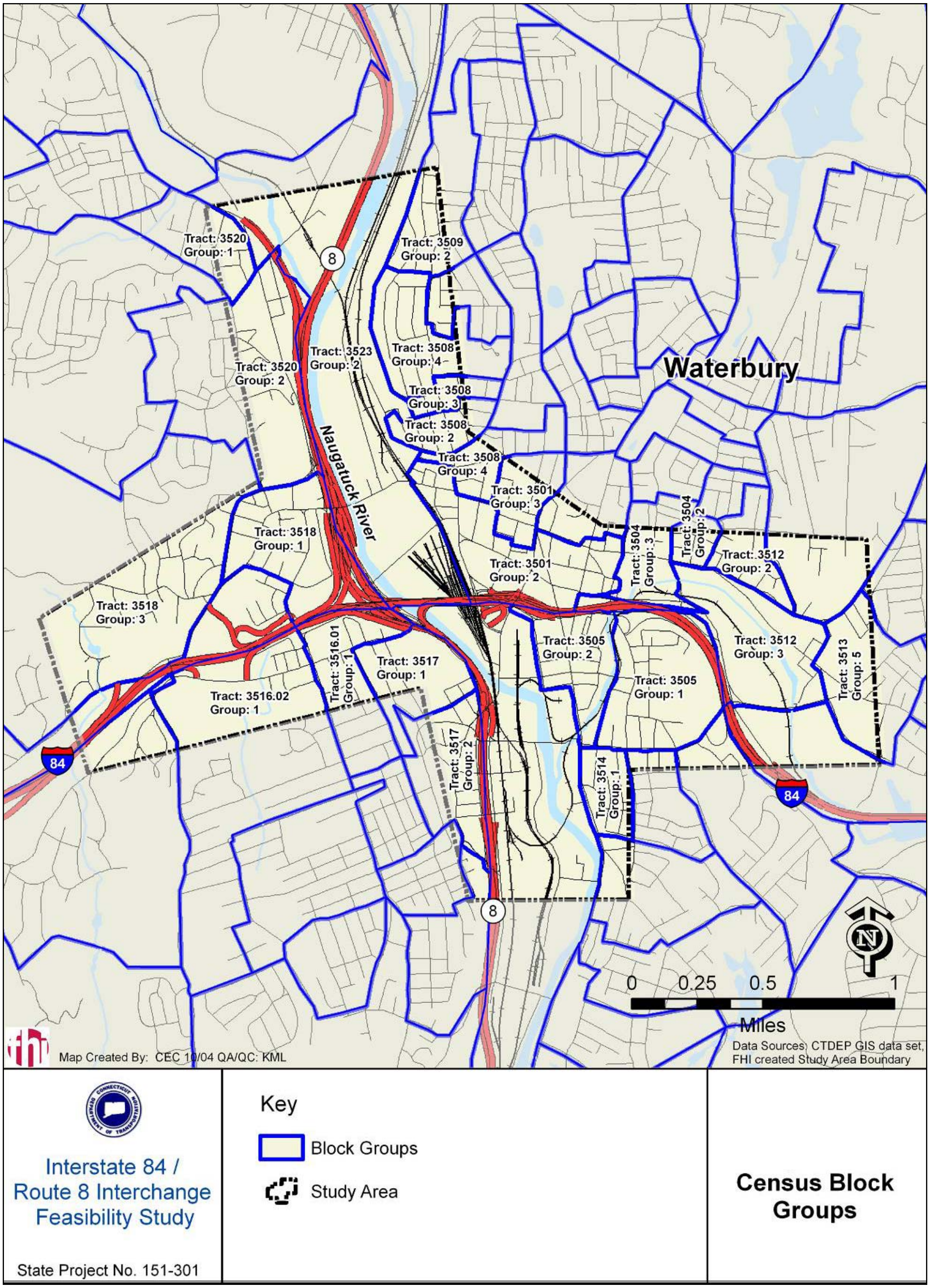
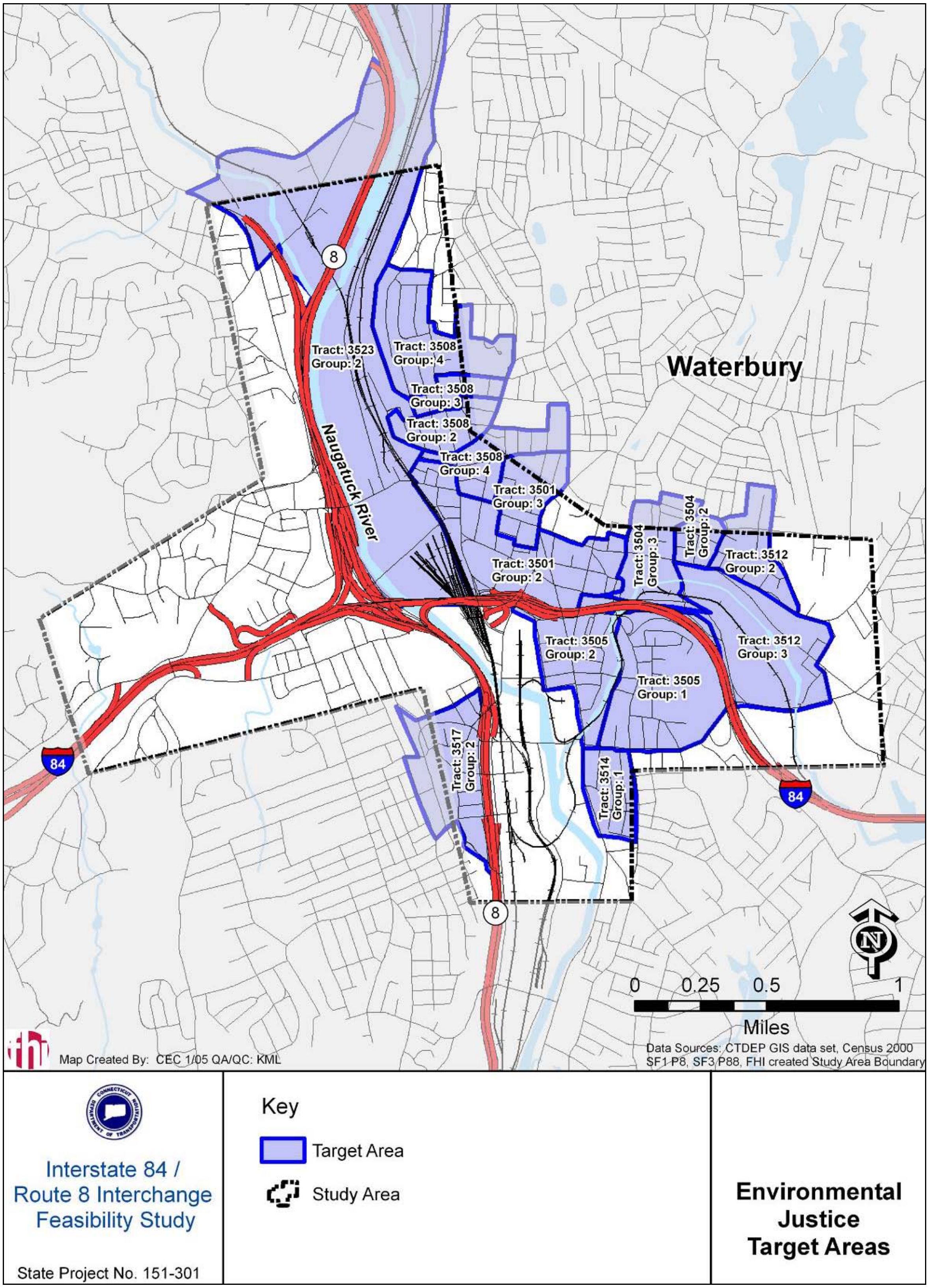


Figure 3-4: Environmental Justice Target Areas



4 Existing and Future Traffic

4.1 Traffic Counts and Classification

Traffic counts within the study area were performed and provided by ConnDOT. The volumes provided were for the A.M. Peak Hour, P.M. Peak Hour and Average Daily Traffic (ADT). Volumes were obtained for existing year (2005) conditions. Traffic counts were taken at mainline sections and ramps for I-84 and Route 8 within the limits of the study area and for adjacent at-grade intersections. Existing ADT is presented in Table 4-1 for I-84 and Route 8 at each end of the study area.

Table 4-1: Existing (2005) Average Daily Traffic

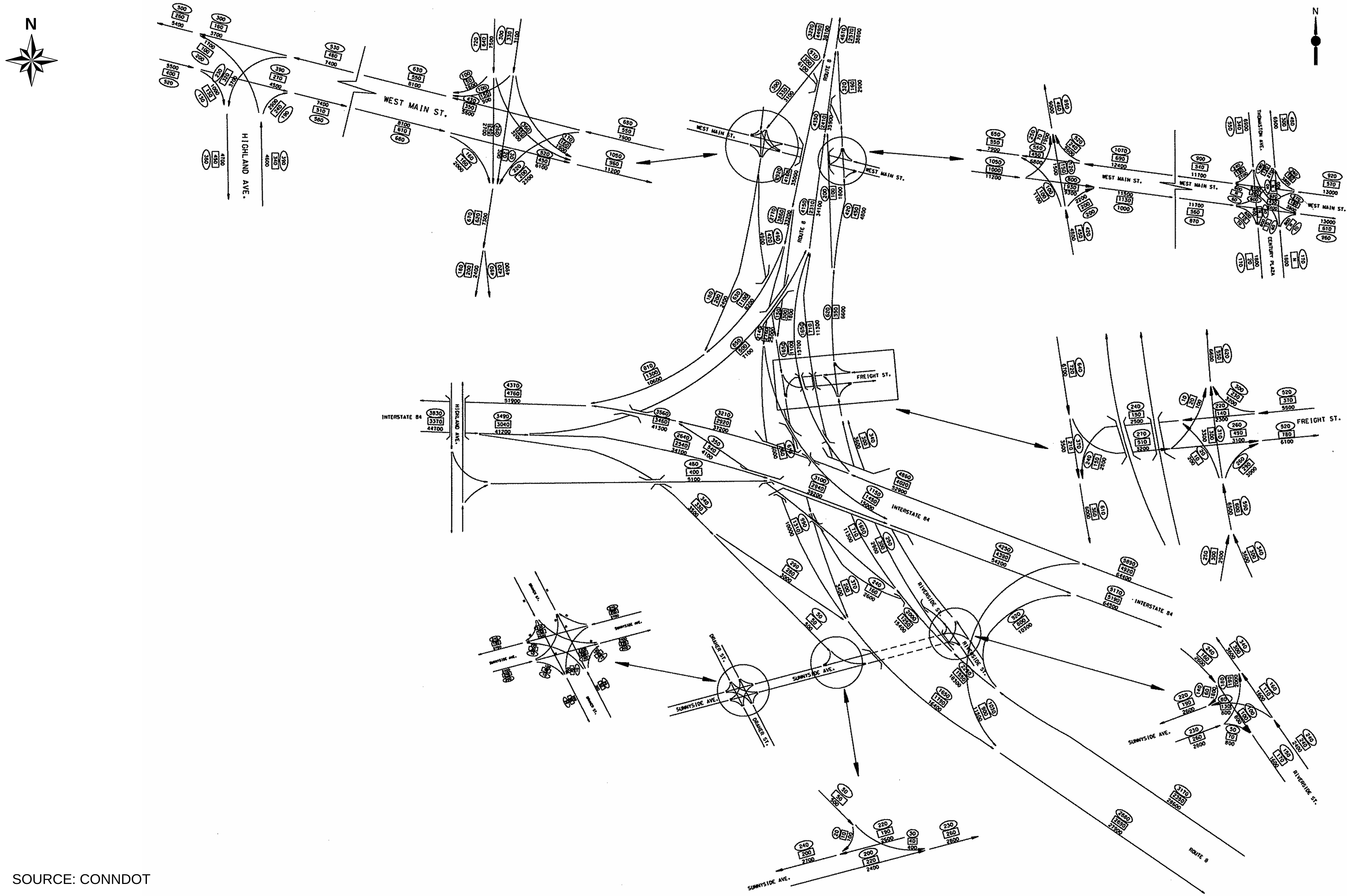
Location	Existing Average Daily Traffic
I-84 West of Interchange 18	82,800
I-84 East of Interchange 23	101,500
Route 8 South of Interchange 30	49,800
Route 8 North of Interchange 35	48,900

Source: ConnDOT

Traffic classification is determined by permanent recorder stations maintained by ConnDOT along the interstate mainline throughout the state. Based on this data, a percentage of truck traffic through the study area was determined. This heavy vehicle percentage is a component of the capacity analysis performed on the freeway segments, ramps and intersections. For highway capacity analysis purposes heavy vehicle is considered to be vehicles with more than four tires. For the freeway segments and ramps, the rate of truck traffic was assumed to be 6%. For at-grade intersections 2% of total traffic was considered to be trucks.

An illustration of the traffic volumes obtained by ConnDOT is shown in Figure 4-1.

Traffic signal plans were also obtained from the City of Waterbury to utilize the timing and phasing of the signals at intersections for the capacity analysis under existing and future year conditions.

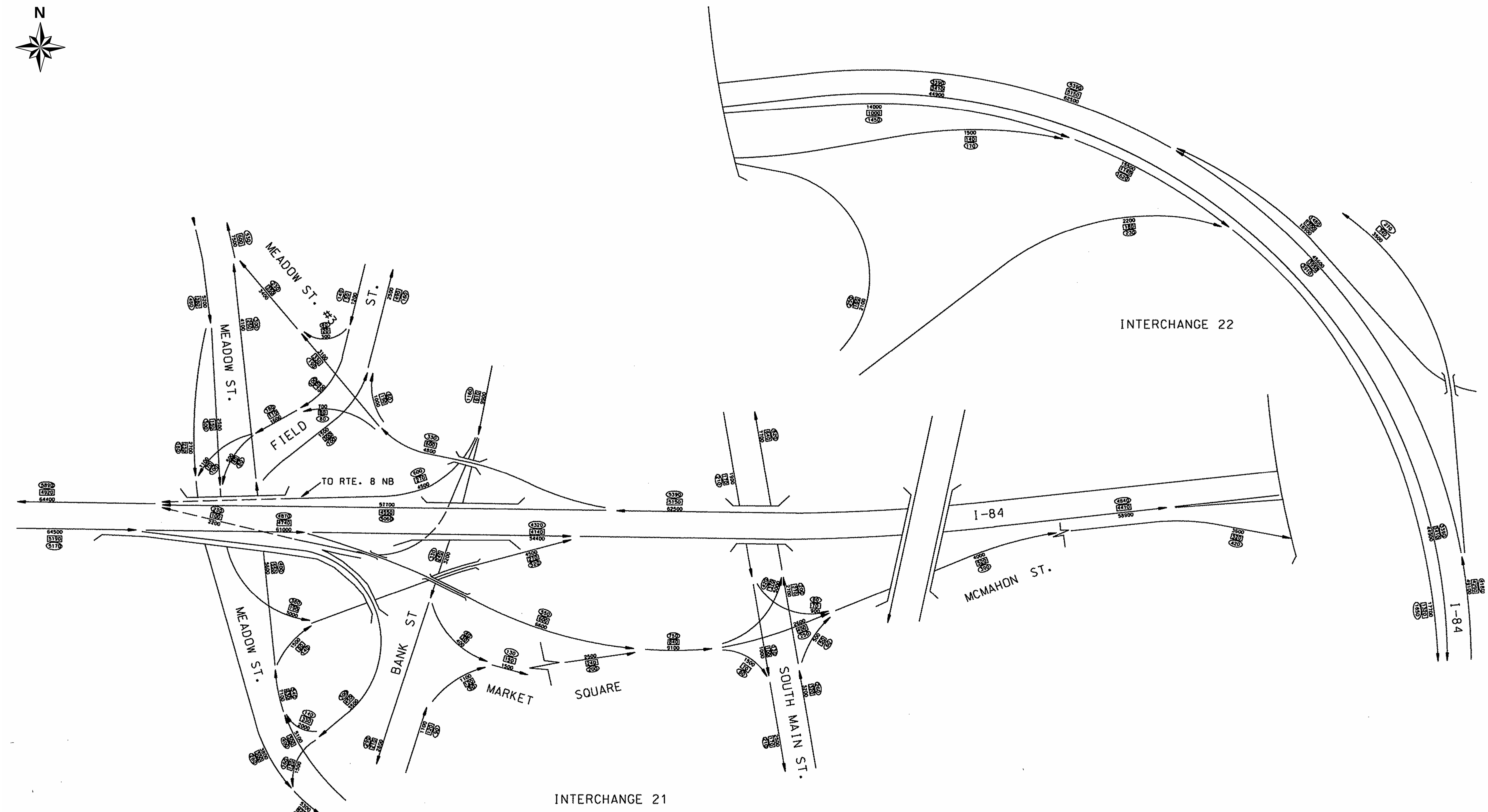


SOURCE: CONNDOT

EXISTING 2005 TRAFFIC COUNT DATA

I-84 / ROUTE 8 INTERCHANGE

ENGINEERS
PLANNERS
ECONOMISTS
Wilbur Smith Associates



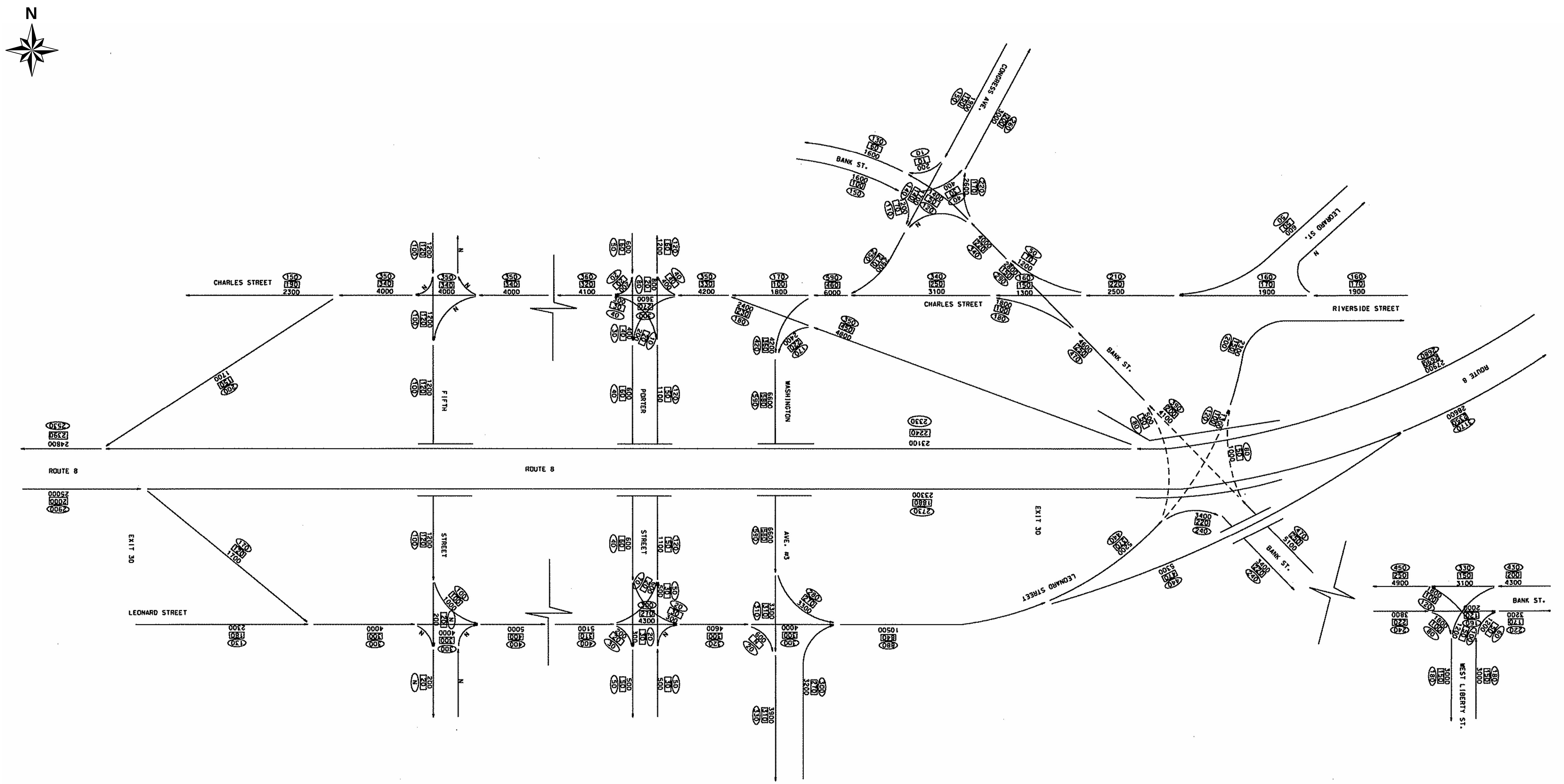
SOURCE: CONNDOT

EXISTING 2005 TRAFFIC COUNT DATA

I-84 EAST OF INTERCHANGE

ENGINEERS
PLANNERS
ECONOMISTS
Wilbur Smith Associates

FIGURE 4-1 (2 OF 4)



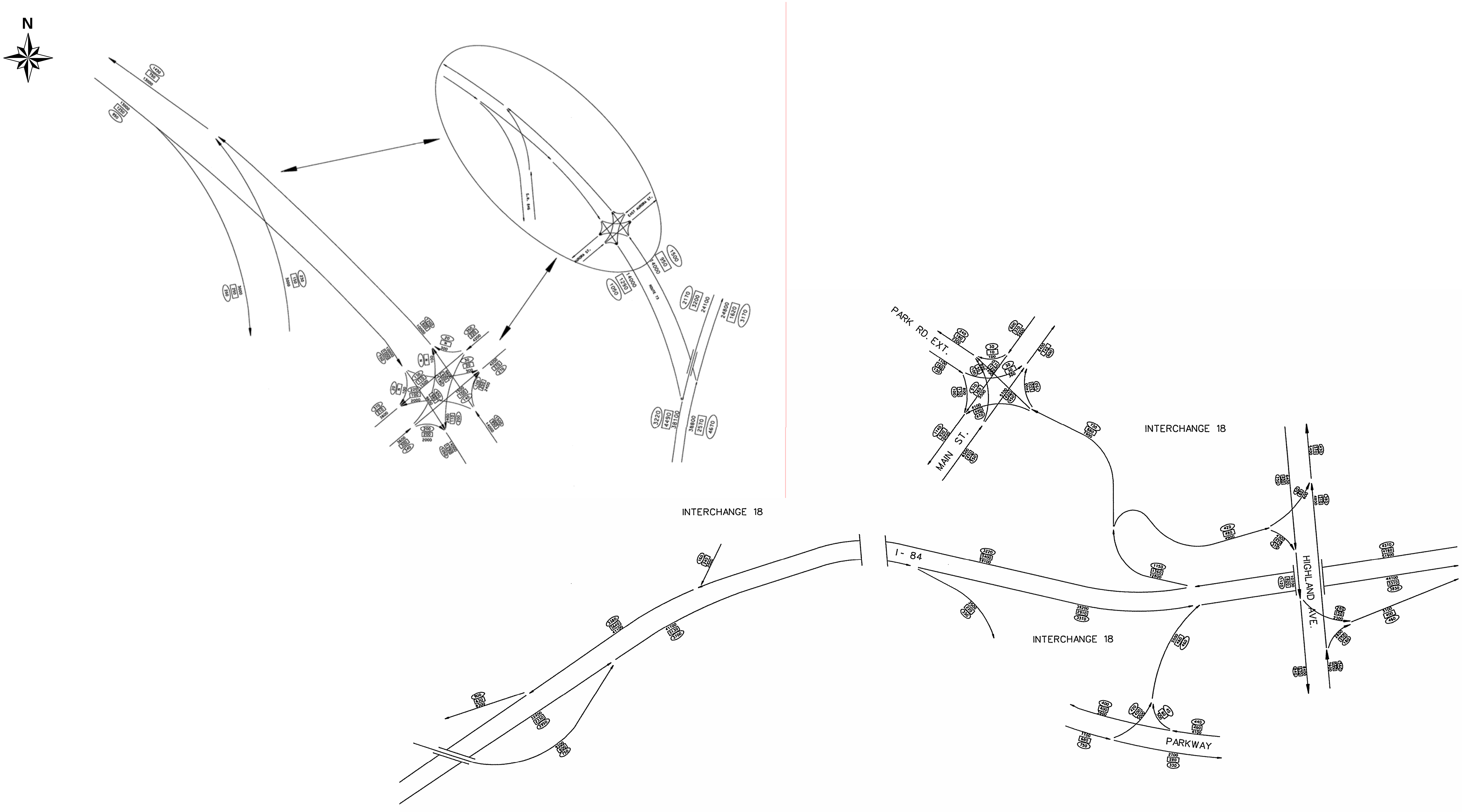
SOURCE: CONNDOT

EXISTING 2005 TRAFFIC COUNT DATA

ROUTE 8 SOUTH OF INTERCHANGE

Wilbur Smith Associates
ENGINEERS
PLANNERS
ECONOMISTS

FIGURE 4-1 (3 OF 4)



SOURCE: CONNDOT

EXISTING 2005 TRAFFIC COUNT DATA

ROUTE 8 NORTH OF INTERCHANGE

I-84 WEST OF INTERCHANGE

Wilbur Smith Associates ENGINEERS PLANNERS ECONOMISTS

FIGURE 4-1 (4 OF 4)

4.2 Speed Analysis

Average speed can be an indicator of roadway congestion. Therefore, the study team conducted a series of speed and delay tests on I-84 and Route 8 within the study area. These speed runs were conducted between 7-9 am and 4-6 pm on October 6, 2004 and October 13, 2004. In all, there were six speed tests for each direction along I-84 and Route 8. The average speeds on I-84 and Route 8 are summarized in Table 4-2, Figure 4-2 and Figure 4-3.

Table 4-2: Average Travel Speeds I-84 and Route 8

Segment	Direction	Posted Speed (mph)	Average Travel Speed (mph)	
			A.M.	P.M.
I-84				
I-84 Int. 18 to Int. 19	EB	50	72	54
	WB	50	56	50
I-84 Int. 19 to Int. 20	EB	50	65	49
	WB	50	56	52
I-84 Int. 20 to Int. 21	EB	50	65	58
	WB	50	69	59
I-84 Int. 21 to Int. 22	EB	55	31	36
	WB	55	56	38
I-84 Int. 22 to Int. 23	EB	55	61	56
	WB	55	-	-
Route 8				
Route 8 Int. 30 to Int. 31	NB	45	58	60
	SB	45	54	57
Route 8 Int. 31 to Int. 32	NB	55	45	49
	SB	55	30	30
Route 8 Int. 32 to Int. 33	NB	55	54	68
	SB	55	60	54
Route 8 Int. 33 to Int. 34	NB	55	51	47
	SB	55	58	68
Route 8 Int. 34 to Int. 35	NB	55	67	68
	SB	55	72	70

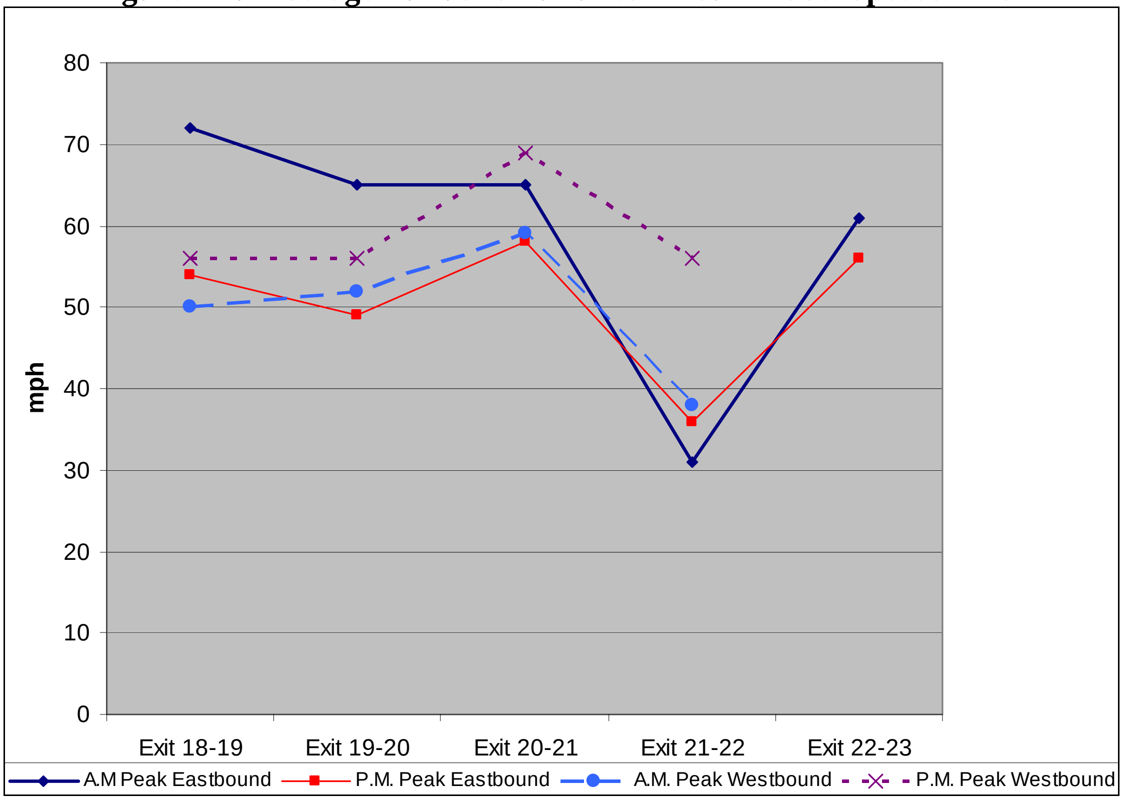
Source: Wilbur Smith Associates Travel Time Runs, October 2004.

4.2.1 Travel Speeds on I-84

Average Travel speeds on I-84 were generally above the posted speed limits of 50 mph and 55 mph suggesting that congestion is not yet a problem along the I-84 corridor within the study area. Average travel speeds on I-84 during the A.M. peak hour were generally above 55 mph with the exception of the segment between interchanges 21-22 in the eastbound direction, where recorded average speeds were 31 mph as shown in Figure 4-2.

The low speed on the segment between Interchange 21 and Interchange 22 of the I-84 mainline is mainly due to difficulties in merging and weaves at this segment. The highest average speed in the A.M. peak hour was 72 mph and was recorded between Interchanges 18-19 in the eastbound direction.

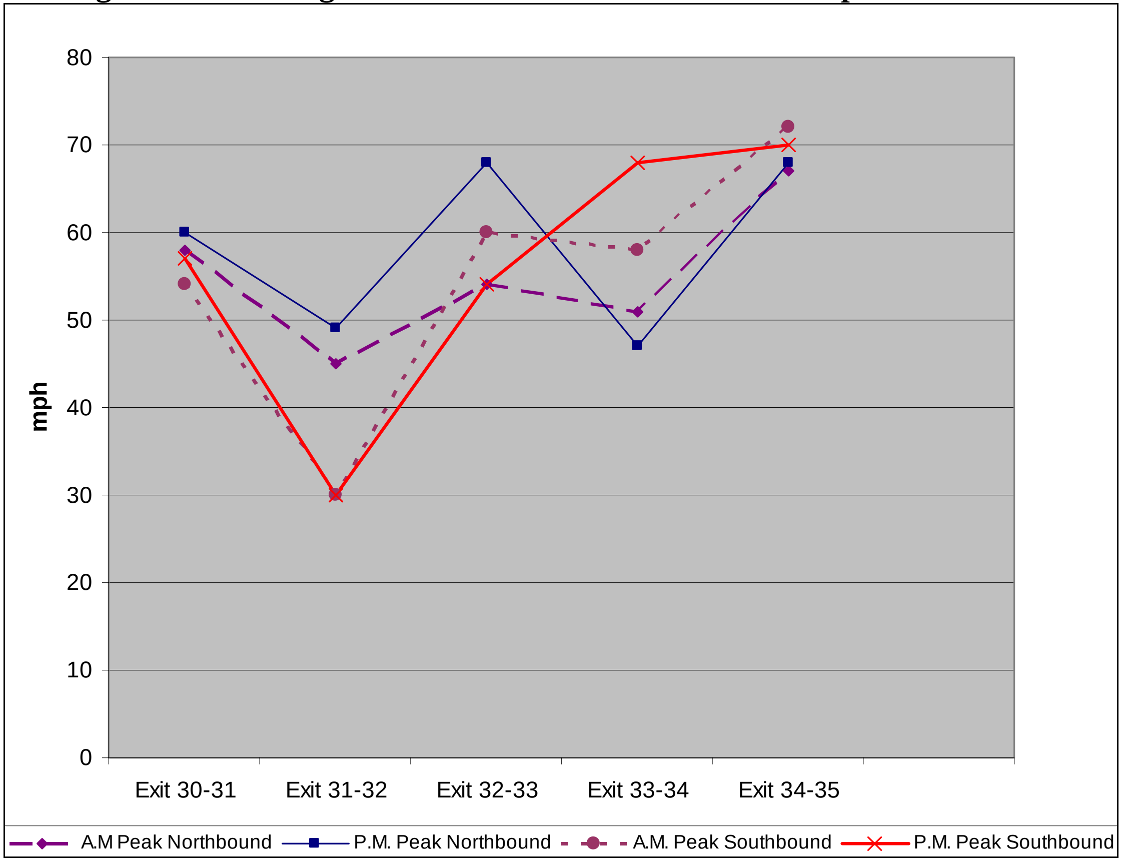
Figure 4-2: Average A.M. and P.M. Peak Hour Travel Speeds – I-84



4.2.2 Travel Speeds on Route 8

Travel speeds on Route 8 were usually above the posted speed limits of 45mph and 55 mph as shown Figure 4-3. The highest speeds were recorded on the segment between interchanges 34-35 where speeds were as high as 72 mph. The segment between Interchange 31 and Interchange 32 in the southbound direction consistently recorded speeds of less than 45 mph. This segment had reduced speeds due to difficult merges and weaves in the area.

Figure 4-3: Average A.M. and P.M. Peak Hour Travel Speeds – Route 8



4.3 Future Growth Assumptions

Future land use and population and employment growth projections dictate the extent of traffic growth throughout a region. These projections are based on a municipality's land use and development plans and examining historical population and employment trends. The City of Waterbury, for example, saw a decline in population from 1990-2000 (see Section 3.3.1), while the population in the surrounding communities grew.

However, with the decline of Waterbury's population and industrial base, there is a shift in land use patterns. Former industrial sites are being re-developed, and special development districts and "technology zones" are being promoted (See Section 3.1).

Travel forecasting efforts such as ConnDOT's Statewide Travel Demand Model reflect population and employment projections and future land use development. These projections are used to predict traffic growth and to show how the transportation network will be impacted by this growth.

While ConnDOT's model addresses the statewide transportation network, the modeling efforts in this study will focus on the immediate I-84/Route 8 Interchange and study area.

This process will use existing and future volumes provided by ConnDOT to simulate existing and future base conditions from a capacity and operational standpoint.

4.4 Future Traffic Volumes

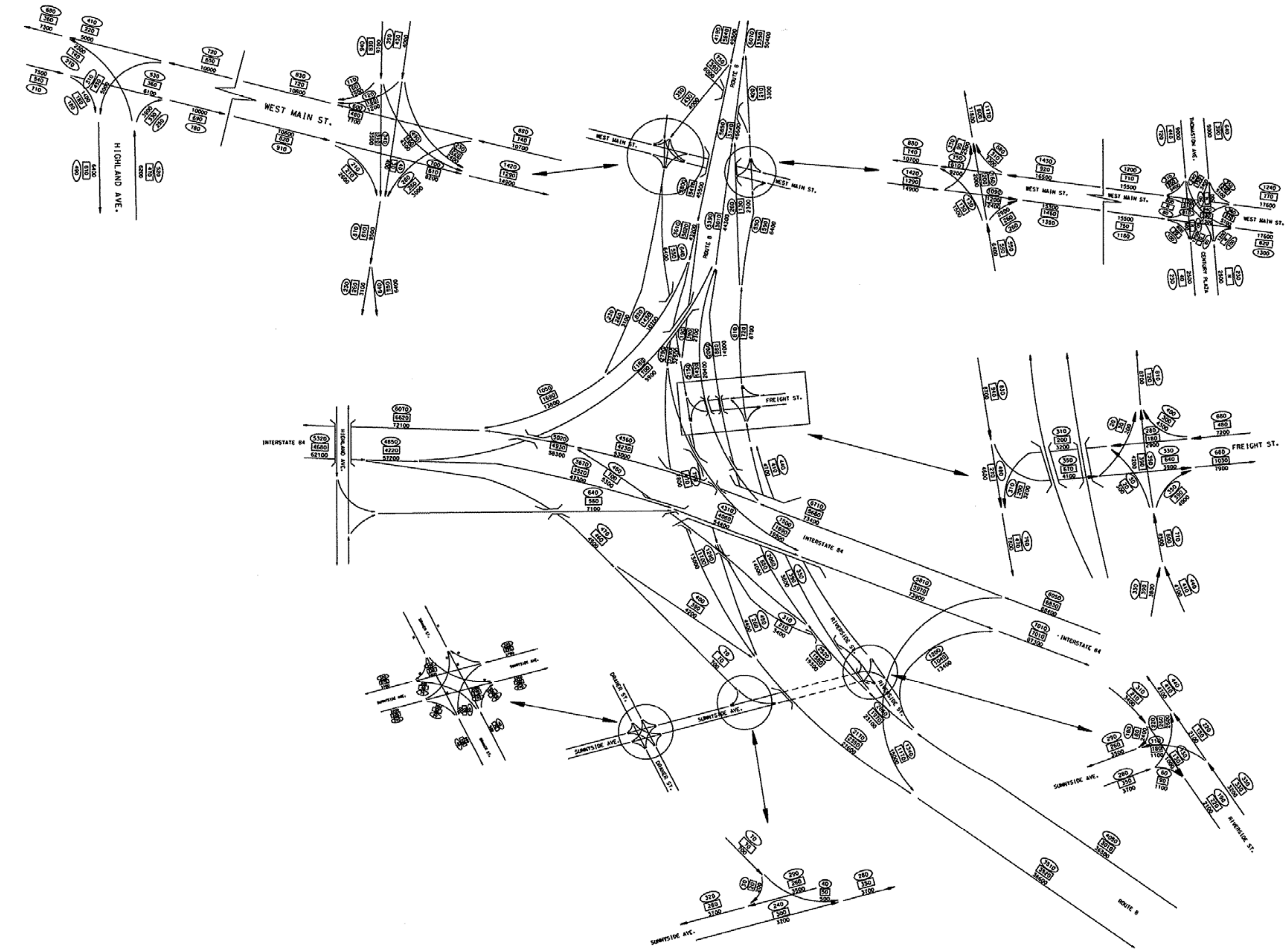
Based on the analysis of historical traffic data and the projected regional growth, future (year 2030) traffic volume forecasts were provided by ConnDOT. These volumes reflect the A.M. and P.M. peak hours as well as the average daily traffic (ADT). To reflect the traffic growth in the study area, ADT is presented in Table 4-3 for I-84 and Route 8 at each end of the study area.

Table 4-3: Future (2030) Traffic Volumes

Location	**Average Daily Traffic**		**Percent Growth**
	Existing (2005)	Future (2030)	
I-84 West of Interchange 18	82,800	115,100	28%
I-84 East of Interchange 23	101,500	127,100	20%
Route 8 South of Interchange 30	49,800	64,400	23%
Route 8 North of Interchange 35	48,900	63,500	23%

Source: ConnDOT

N



SOURCE: CONNDOT

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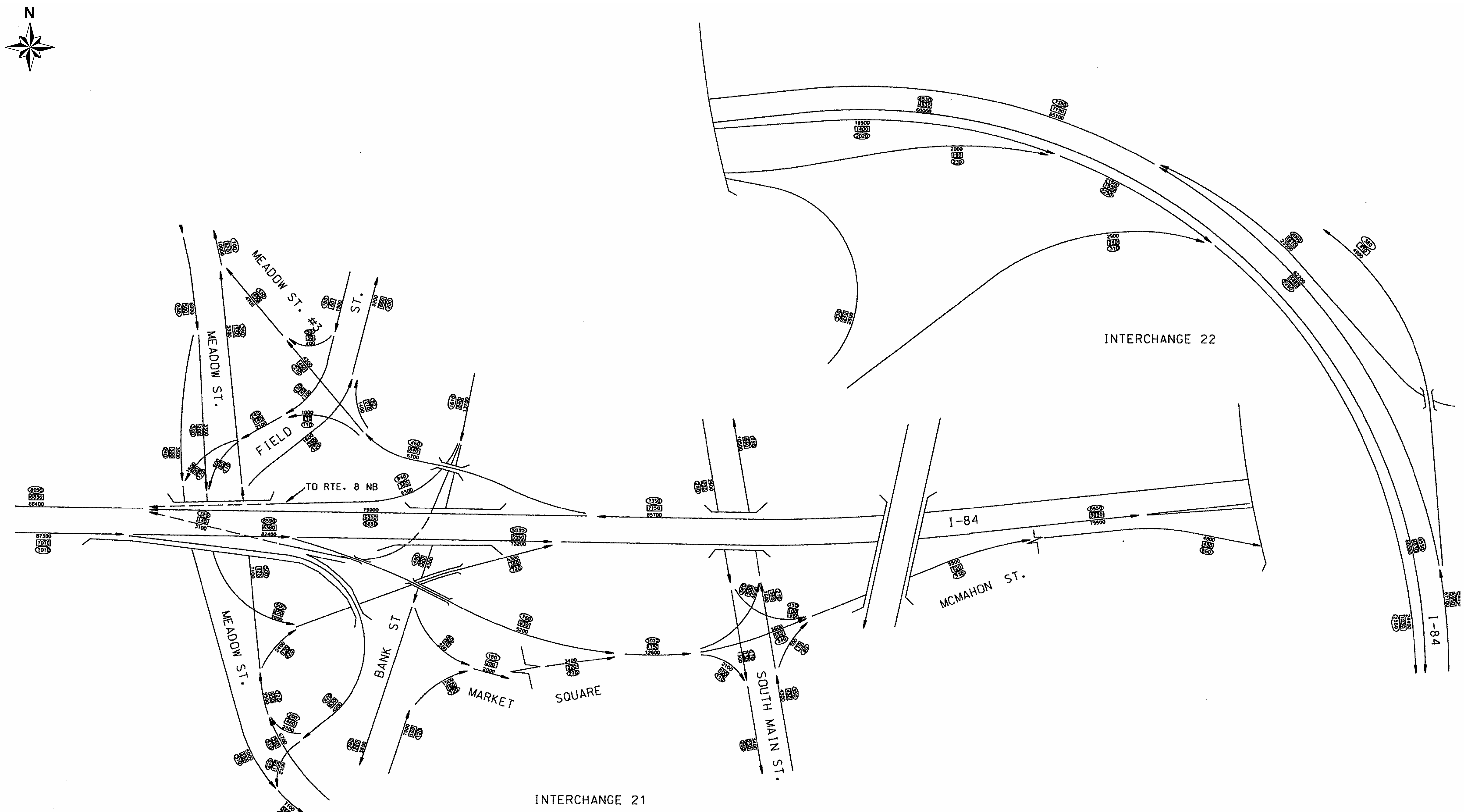
FUTURE 2030 TRAFFIC COUNT DATA

I-84 / ROUTE 8 INTERCHANGE



SOURCE: CONNDOT

FUTURE 2030 TRAFFIC COUNT DATA

I-84 EAST OF INTERCHANGE

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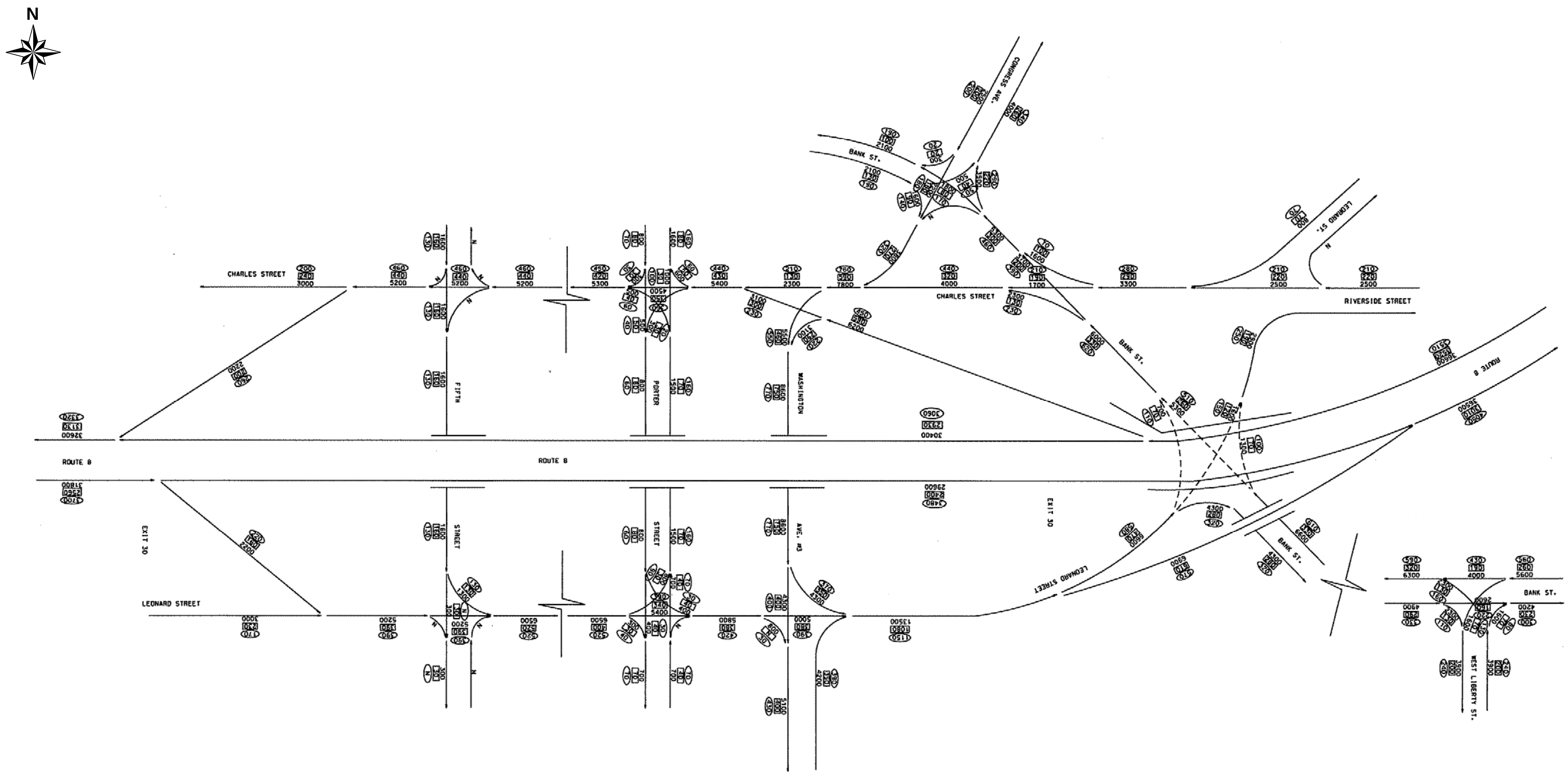

SOURCE: CONNDOT

FUTURE 2030 TRAFFIC COUNT DATA

ROUTE 8 SOUTH OF INTERCHANGE

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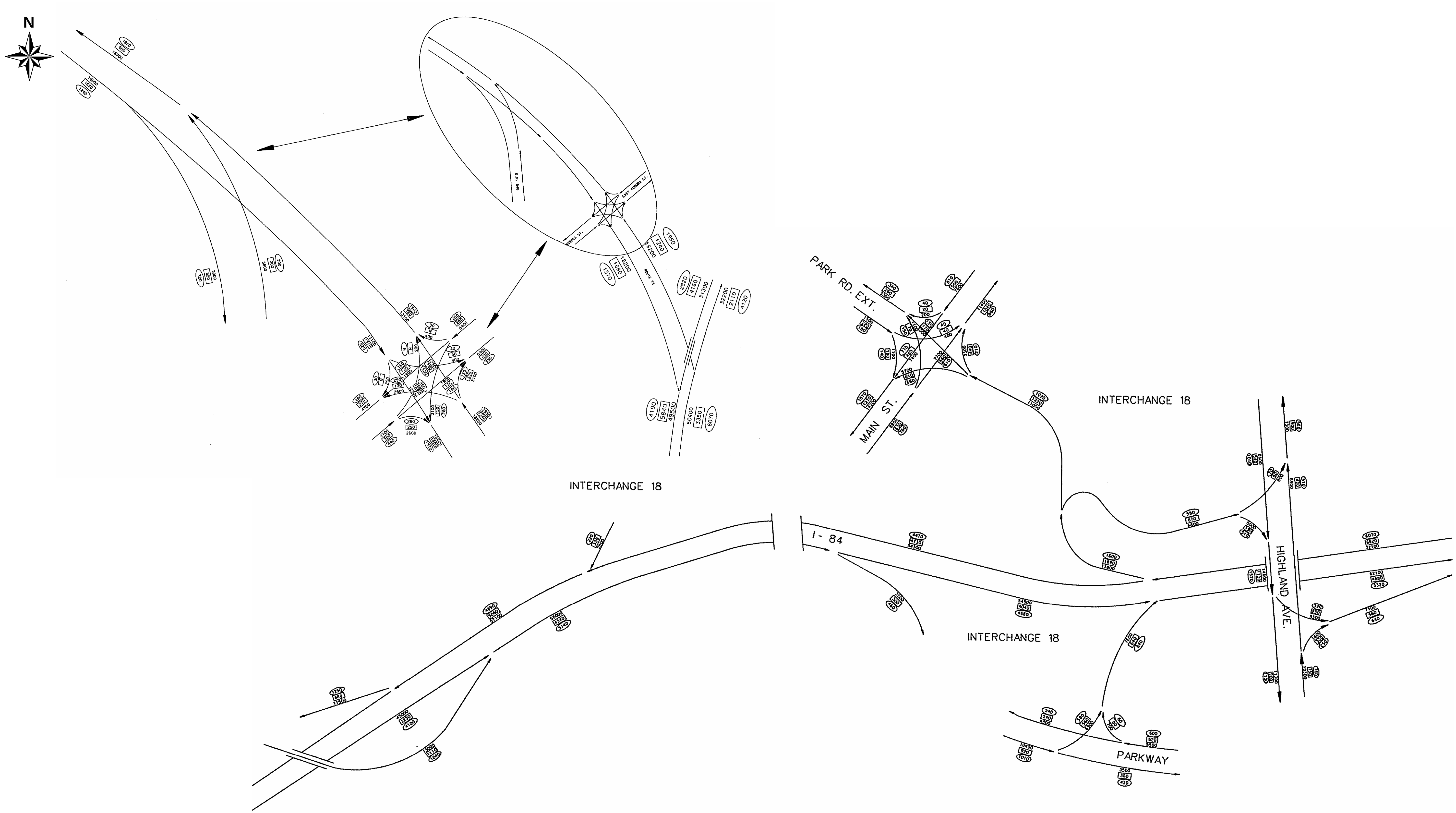
FIGURE 4-4 (3 OF 4)



SOURCE: CONNDOT

FUTURE 2030 TRAFFIC COUNT DATA

ROUTE 8 NORTH OF INTERCHANGE
I-84 WEST OF INTERCHANGE

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FIGURE 4-4 (4 OF 4)

4.5 Planned Improvements

To ensure that planned improvements within the region are well coordinated with this study, reports were gathered and reviewed to help understand the recommendations from other planning efforts.

Two noteworthy improvement projects are planned on I-84 adjacent to the study area. To the west, improvements are planned to Interchange 18. Specifically, the westbound exit ramp at this interchange is currently under design for improving safety and operations by addressing the deceleration length and curve radius.

As part of the Waterbury-Southington widening project already underway, I-84 to the east of Interchange 23 is to be widened to three lanes. While the section from Cheshire to Southington is already under construction, the Waterbury widening section is still in the design process. When this particular project is complete, I-84 will provide at least three through lanes in each direction from Waterbury to the Massachusetts state line.

Earlier needs and deficiencies studies have identified the need for widening I-84 west of the Waterbury area to the New York state line. Major widening improvements in this corridor are still in the planning process, with and Environmental Impact Statement underway. Any major design or construction in this corridor is several years away.

No improvements are currently planned along Route 8 adjacent to this study area.

5 Analysis of Operations and Safety

To evaluate operational performance of a roadway system, a number of different approaches can be used. These approaches have evolved due to the advances in personal computer technology, which has provided the traffic engineer with more powerful tools to help understand the complexities of today's high-volume roadways.

Traditional analytic methodologies advanced by TRB's Highway Capacity Manual (HCM) have been in use for many years, and have been validated by years of research and field testing. Highway Capacity Software (HCS) allows for the quick application of HCM methodologies to user defined traffic conditions and roadway parameters. The HCS makes it possible to analyze a large number of intersections or roadway segments quickly, and uses Level of Service (LOS) to convey the operational performance to the engineer or layperson. While the HCS is a valuable analysis tool for measuring the delay that traffic experiences under given roadway conditions, it is a static methodology that does not consider the influences of other roadway conditions upstream and downstream of the location being analyzed.

To better understand the dynamic nature of traffic flow within and through and roadway system, micro-simulation software applications were developed that take advantage of the power of modern personal computer systems. VISSIM is a micro-simulation tool that is used to understand the dynamic evolution of traffic as it is introduced to a roadway system under real-time conditions. With this software, it is possible for the traffic engineer to see how upstream bottlenecks or downstream queues affect the operation of a particular intersection or roadway segment. VISSIM is highly data intensive and requires considerable time to set up and calibrate.

For this study, both analysis tools are used to test the effects of existing and future traffic on study area roads and intersections. The HCS will give results based on unconstrained roadway conditions. That is, upstream and downstream constraints will not have an impact on the results of the analysis. VISSIM however, will give results that reflect conditions that are present in the entire roadway system. For example, the HCS may demonstrate that two adjacent freeway exit ramps are at a LOS F due to unconstrained traffic volumes supplied by the ConnDOT. VISSIM may report that the upstream exit ramp is a LOS F and the downstream ramp a LOS D if the upstream constraint is metering traffic such that the downstream segment cannot achieve the flow represented in the ConnDOT volume estimate. It is useful to understand the result of both analyses because the HCS method suggests that both ramps are deficient based on the volume of traffic that desires to use the highway, while the VISSIM analysis identifies actual bottlenecks and demonstrates that the desired traffic may not be able to be accommodated due to real constraints in the roadway system.

5.1 Highway Capacity Software (HCS) Analysis

A study of capacity is important in determining the ability of a specific roadway, intersection, or freeway to accommodate traffic under various levels of service. Level of service (LOS) is a qualitative measure describing driver satisfaction with a number of factors that influence the degree of traffic congestion. These factors include speed and travel time, traffic interruption, freedom of maneuverability, safety, driving comfort and convenience, and delay.

In general there are six levels of service describing flow conditions:

- **Level of Service A**, the highest LOS, describes a condition of free flow, with low volumes and high speeds.
- **Level of Service B** represents a stable traffic flow with operating speeds beginning to be restricted somewhat by traffic conditions.
- **Level of Service C**, which is normally utilized for design purposes, describes a stable condition of traffic operation. It entails moderately restricted movements due to higher traffic volumes, but traffic conditions are not objectionable to motorists**.**
- **Level of Service D** reflects a condition of more restrictive movements for motorists and influence of congestion becomes more noticeable. It is generally considered the lower end of acceptable service.
- **Level of Service E** is representative of the actual capacity of the roadway or intersection and involves delay to all motorists due to congestion.
- **Level of Service F**, the lowest LOS, is described as force flow and is characterized by volumes greater than the theoretical roadway capacity. Complete congestion occurs, and in extreme cases, the volume passing a given point drops to zero. This is considered as an unacceptable traffic operating condition.

For this study, level of service analysis was performed for mainline freeway segments, freeway ramp junctions, freeway weaving conditions, and signalized and un-signalized intersections. The analysis was performed for the existing roadway configurations for current and future (2030) traffic volumes. Traffic analyses for this study was based on the 2000 Highway Capacity Manual [2]and conducted using the Highway Capacity Software (HCS).

Table 5-1 highlights the LOS criteria for freeway sections. The level of service criteria for freeway sections is based on maximum density defined in terms of passenger cars per mile per lane (pc/mi/lane).

[2] Highway Capacity Manual 2000, Transportation Research Board, Washington, D.C.

Table 5-1: LOS Criteria for Freeway Sections

Level of Service	Maximum Density (pc/mi/lane)
A	11
B	18
C	26
D	35
E	45
F	Greater than 45

Source: 2000 Highway Capacity Manual

Table 5-2 highlights the LOS criteria for freeway-ramp junctions. The level of service criteria for freeway-ramp junctions is based on maximum density defined in terms of passenger cars per mile per lane.

Table 5-2: LOS Criteria for Freeway-Ramp Junctions

Level of Service	Maximum Density (pc/mi/lane)
A	10
B	20
C	28
D	35
E	Greater than 35

Source: 2000 Highway Capacity Manual

Table 5-3 highlights the LOS criteria for freeway weaving sections. The level of service criteria for freeway weaving sections is based on maximum density defined in terms of passenger cars per mile per lane.

Table 5-3: LOS Criteria for Weaving Areas

Level of Service	Maximum Density (pc/mi/lane)
A	10
B	20
C	28
D	35
E	Less than or equal to 43
F	Greater than 43

Source: 2000 Highway Capacity Manual

Table 5-4 highlights the level of service criteria for signalized intersections. The level of service criteria for signalized and un-signalized intersections is based on control delay per vehicle measured in seconds.

Table 5-4: LOS Criteria for Signalized Intersections

Level of Service	Control Delay Per Vehicle (seconds)
A	≤10
B	>10 and ≤20
C	>20 and ≤35
D	>35 and ≤55
E	>55 and ≤80
F	> 80

Source: 2000 Highway Capacity Manual

Table 5-5 highlights the level of service criteria for un-signalized intersections. The level of service criteria for signalized and un-signalized intersections is based on control delay per vehicle measured in seconds.

Table 5-5: LOS Criteria for Un-signalized Intersections

Level of Service	Control Delay per Vehicle (seconds)
A	≤10
B	>10 and ≤15
C	>15 and ≤25
D	>25 and ≤35
E	>35 and ≤50
F	> 50

Source: 2000 Highway Capacity Manual

5.1.1 Mainline Capacity Analysis

In order to assess the capacity along I-84 and Route 8, a freeway analysis was performed during the existing (2005) and future (2030) years for the weekday morning and evening peak hour conditions. The input to the freeway analysis was the freeway geometry, free-flow speed, number of lanes, and volumes during the weekday morning and evening peak hour conditions.

I-84

Table 5-6 and Table 5-7 present the results of the analysis along I-84 in the eastbound and westbound directions respectively. These results are also shown in Figure 5-1 and Figure 5-2.

Table 5-6: Freeway Analysis Summary – I-84 Eastbound

SECTION ALONG I-84	2005		2030	
	Volume	LOS	Volume	LOS
Between Int. 17 and Int. 18	3130(3700)	D(E)	4340(5140)	F(F)
Between Int. 18 and Int. 19	3370(3830)	C(D)	4680(5320)	D(E)
Between Int. 19 and Int. 20	2940(3100)	D(D)	4080(4310)	F(F)
Between Int. 20 and Int. 21	5190(5170)	D(D)	7010(7010)	E(E)
Between Int. 21 and Int. 22	4140(4320)	D(D)	5550(5830)	E(E)
Between Int. 22 and Int. 23	4410(4840)	D(D)	5930(6550)	F(F)
East of Int. 23*	3410(3390)	C(C)/**E(E)**	4530(4530)	D(D)

Note: X(X) Represents LOS for AM peak hour. PM peak levels of service shown in parenthesis.
* East of Int. 23, freeway transitions from 3 to 2 lanes. LOS in **bold** represents 2-lane segment.

Table 5-7: Freeway Analysis Summary – I-84 Westbound

SECTION ALONG I-84	2005		2030	
	Volume	LOS	Volume	LOS
Between Int. 17 and Int. 18	3640(3380)	E(E)	5060(4690)	F(F)
Between Int. 18 and Int. 19	4760(4370)	C(C)	6620(6070)	D(D)
Between Int. 19 and Int. 20	2920(3210)	C(C)	4230(4560)	D(D)
Between Int. 20 and Int. 21	4920(5890)	C(C)	6830(8050)	D(D)
Between Int. 21 and Int. 22	5150(5390)	E(E)	7150(7350)	F(F)
Between Int. 22 and Int. 23*	4290(4180)	D(D)/***F(F)***	5950(5670)	F(E)
East of Int. 23*	4420(4350)	***F(F)***	6130(5910)	F(F)

Note: X(X) Represents LOS for AM peak hour. PM peak levels of service shown in parenthesis.
* Between Int. 22 & 23, freeway transitions from 3 to 2 lanes. LOS in **bold** represents 2-lane segment.

- **Between Interchanges 17 and 18 –** I-84 between Interchange 17 and Interchange 18 consists of two lanes in each of the eastbound and westbound directions. This segment is 0.6 miles long in the eastbound direction and 0.5 miles long in the westbound direction. Under the future year condition, this segment is anticipated to operate at LOS F during the weekday morning and evening peak hour condition due to an increase in traffic volumes.

- **Between Interchanges 18 and 19 –** I-84 between Interchange 18 and Interchange 19 consists of three lanes in the eastbound direction that is approximately 0.2 miles long. In the future, this segment is anticipated to operate at LOS D and LOS E during the weekday morning and evening peak hour periods respectively. In the westbound direction, this segment has four lanes approaching Interchange 18 and is 0.3 miles long. Immediately west of Interchange 18, the roadway cross section drops to two lanes with a climbing lane 0.6 miles long that begins at Highland Avenue exit ramp and ends just east of the entrance ramp from Chase Parkway. Under the future year condition, this segment is anticipated to operate at LOS D during the weekday morning and evening peak periods in the westbound direction.

- **Between Interchanges 19 and 20 –** I-84 between Interchange 19 and Interchange 20 is a short distance between the on and exit ramps from Route 8. In the eastbound direction, this segment consists of two lanes and is 0.3 miles long, while in the westbound direction it has three lanes and is 0.3 miles in length. Under the future year condition, the segment is anticipated to operate at LOS F in the eastbound direction due to increase in traffic volumes.

- **Between Interchanges 20 and 21 –** I-84 between Interchange 20 and Interchange 21 consists of four lanes in the eastbound and five lanes in the westbound direction. The five lanes consist of three lanes on I-84 and two auxiliary lanes to Route 8 northbound and southbound ramps. The eastbound and westbound sections are 0.2 miles in length. Under the future year condition, this segment is anticipated to operate at LOS E in the eastbound direction due to an increase in traffic volume.

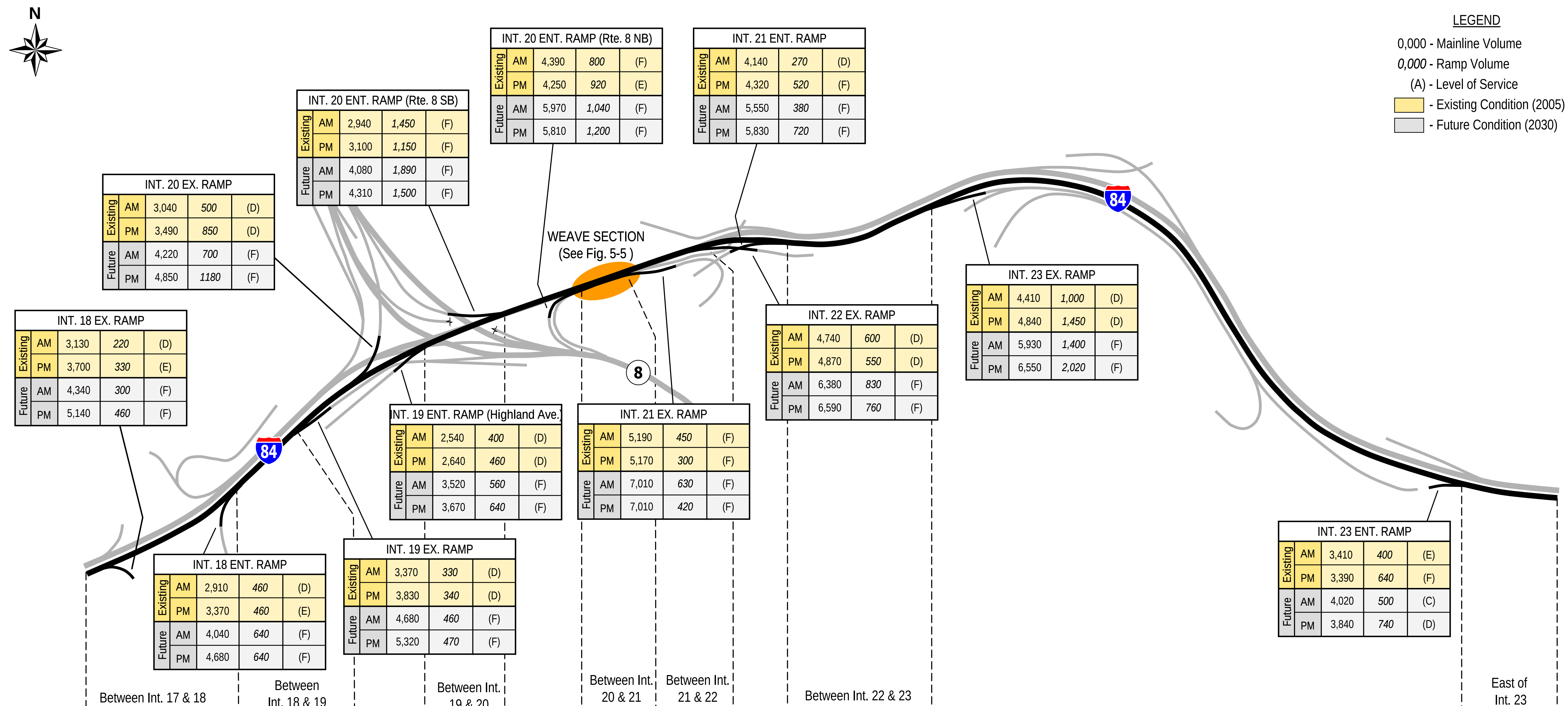
- **Between Interchanges 21 and 22 –** I-84 between Interchange 21 and Interchange 22 consists of three lanes in the eastbound and westbound directions. The eastbound segment is 0.2 miles in length while the westbound segment is 0.5 miles in length. Under the future year condition, this segment is anticipated to operate at LOS E or worse in the westbound direction with an increase in the traffic volume.

- **Between Interchanges 22 and 23 –** I-84 between Interchange 22 and Interchange 23 consists of three lanes in the eastbound direction. In the westbound direction, I-84 changes from two to three travel lanes just west of Interchange 23. The eastbound segment is 1.2 miles long while the westbound segment is 0.7 miles in length. Under the existing conditions, this segment operates at LOS F during the weekday morning and evening peak hour periods at the two-lane section along I-84.

- Under the future year condition, this segment of I-84 will primarily consist of three lanes in each direction due to the proposed widening project currently in design. In addition, the Interchange 24 exit ramp in the eastbound direction will be relocated west of the Interchange 23 entrance ramp. This segment is anticipated to operate at LOS E or worse in the future with three travel lanes in each direction of the mainline.

- **East of Interchange 23 –** I-84 east of Interchange 23 in the eastbound direction has a lane drop, from three to two travel lanes. In the westbound direction, this segment consists of two travel lanes. Under existing conditions, the two lane section in the eastbound direction operates at LOS E during the weekday morning and evening peak hour periods. In the westbound direction, this segment shows a LOS F during the weekday morning and evening peak hour periods.

In the future, with three travel lanes in each direction due to the proposed widening projects, the westbound direction, between Interchange 23 and Interchange 24 is anticipated to operate at LOS F during the weekday morning and evening peak hour conditions.



INT. 18 EX. RAMP

Existing	AM	3,130	*220*	(D)
Existing	PM	3,700	*330*	(E)
Future	AM	4,340	*300*	(F)
Future	PM	5,140	*460*	(F)

INT. 18 ENT. RAMP

Existing	AM	2,910	*460*	(D)
Existing	PM	3,370	*460*	(E)
Future	AM	4,040	*640*	(F)
Future	PM	4,680	*640*	(F)

INT. 19 EX. RAMP

Existing	AM	3,370	*330*	(D)
Existing	PM	3,830	*340*	(D)
Future	AM	4,680	*460*	(F)
Future	PM	5,320	*470*	(F)

INT. 19 ENT. RAMP (Highland Ave.)

Existing	AM	2,540	*400*	(D)
Existing	PM	2,640	*460*	(D)
Future	AM	3,520	*560*	(F)
Future	PM	3,670	*640*	(F)

INT. 20 EX. RAMP

Existing	AM	3,040	*500*	(D)
Existing	PM	3,490	*850*	(D)
Future	AM	4,220	*700*	(F)
Future	PM	4,850	*1180*	(F)

INT. 20 ENT. RAMP (Rte. 8 SB)

Existing	AM	2,940	*1,450*	(F)
Existing	PM	3,100	*1,150*	(F)
Future	AM	4,080	*1,890*	(F)
Future	PM	4,310	*1,500*	(F)

INT. 20 ENT. RAMP (Rte. 8 NB)

Existing	AM	4,390	*800*	(F)
Existing	PM	4,250	*920*	(E)
Future	AM	5,970	*1,040*	(F)
Future	PM	5,810	*1,200*	(F)

INT. 21 EX. RAMP

Existing	AM	5,190	*450*	(F)
Existing	PM	5,170	*300*	(F)
Future	AM	7,010	*630*	(F)
Future	PM	7,010	*420*	(F)

INT. 21 ENT. RAMP

Existing	AM	4,140	*270*	(D)
Existing	PM	4,320	*520*	(F)
Future	AM	5,550	*380*	(F)
Future	PM	5,830	*720*	(F)

INT. 22 EX. RAMP

Existing	AM	4,740	*600*	(D)
Existing	PM	4,870	*550*	(D)
Future	AM	6,380	*830*	(F)
Future	PM	6,590	*760*	(F)

INT. 23 EX. RAMP

Existing	AM	4,410	*1,000*	(D)
Existing	PM	4,840	*1,450*	(D)
Future	AM	5,930	*1,400*	(F)
Future	PM	6,550	*2,020*	(F)

INT. 23 ENT. RAMP

Existing	AM	3,410	*400*	(E)
Existing	PM	3,390	*640*	(F)
Future	AM	4,020	*500*	(C)
Future	PM	3,840	*740*	(D)

		Between Int. 17 & 18	Between Int. 18 & 19		Between Int. 19 & 20		Between Int. 20 & 21	Between Int. 21 & 22		Between Int. 22 & 23		East of Int. 23
Existing	AM	3,130 (D)	3,370 (C)		2,940 (D)		5,190 (D)	4,140 (D)		4,410 (D)		3,410 (C)
Existing	PM	3,700 (E)	3,830 (D)		3,100 (D)		5,170 (D)	4,320 (D)		4,840 (D)		3,390 (C)
Future	AM	4,340 (F)	4,680 (D)		4,080 (F)		7,010 (E)	5,550 (E)		5,930 (F)		4,530 (D)
Future	PM	5,140 (F)	5,320 (E)		4,310 (F)		7,010 (E)	5,830 (E)		6,550 (F)		4,530 (D)

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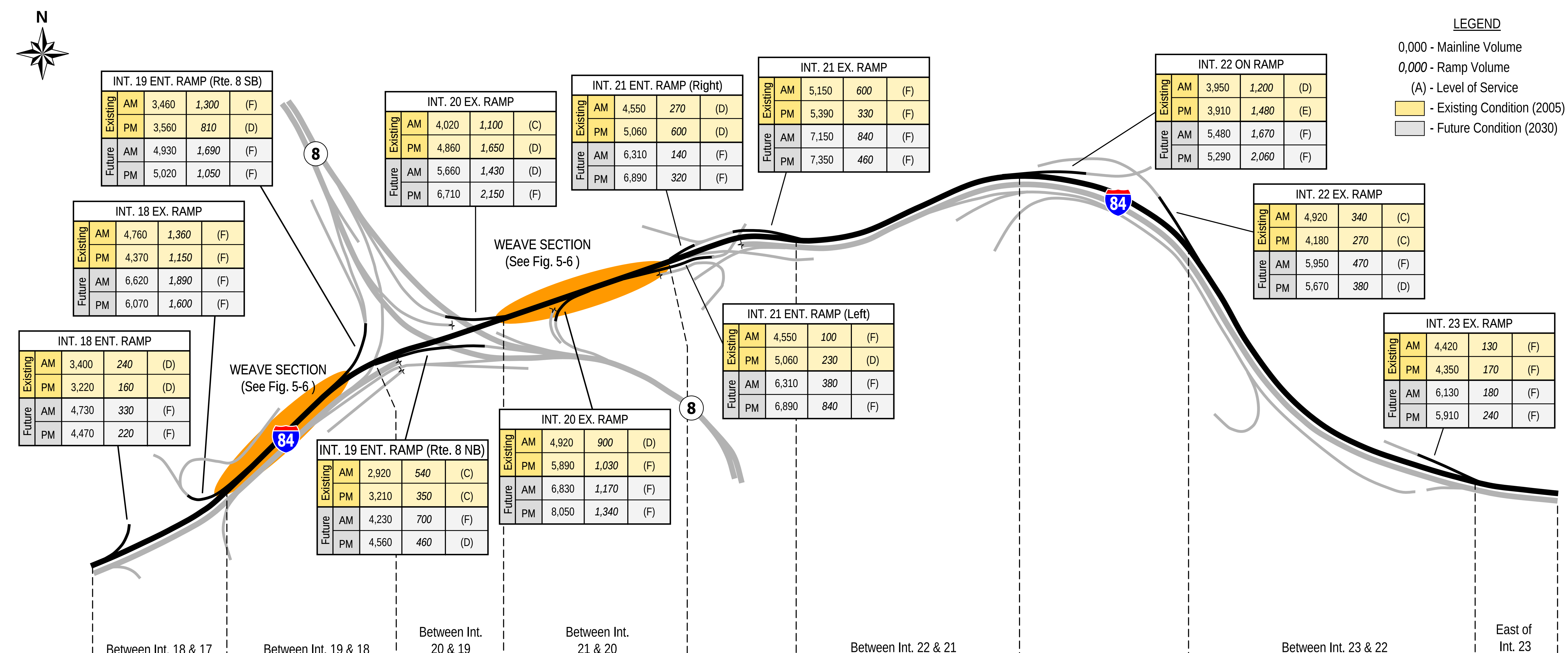
PEAK HOUR VOLUMES AND LEVEL OF SERVICE RESULTS

I-84 EASTBOUND

FIGURE 5-1



INT. 19 ENT. RAMP (Rte. 8 SB)

Existing	AM	3,460	1,300	(F)
	PM	3,560	810	(D)
Future	AM	4,930	1,690	(F)
	PM	5,020	1,050	(F)

INT. 18 EX. RAMP

Existing	AM	4,760	1,360	(F)
	PM	4,370	1,150	(F)
Future	AM	6,620	1,890	(F)
	PM	6,070	1,600	(F)

INT. 18 ENT. RAMP

Existing	AM	3,400	240	(D)
	PM	3,220	160	(D)
Future	AM	4,730	330	(F)
	PM	4,470	220	(F)

INT. 20 EX. RAMP

Existing	AM	4,020	1,100	(C)
	PM	4,860	1,650	(D)
Future	AM	5,660	1,430	(D)
	PM	6,710	2,150	(F)

INT. 19 ENT. RAMP (Rte. 8 NB)

Existing	AM	2,920	540	(C)
	PM	3,210	350	(C)
Future	AM	4,230	700	(F)
	PM	4,560	460	(D)

INT. 21 ENT. RAMP (Right)

Existing	AM	4,550	270	(D)
	PM	5,060	600	(D)
Future	AM	6,310	140	(F)
	PM	6,890	320	(F)

INT. 20 EX. RAMP

Existing	AM	4,920	900	(D)
	PM	5,890	1,030	(F)
Future	AM	6,830	1,170	(F)
	PM	8,050	1,340	(F)

INT. 21 EX. RAMP

Existing	AM	5,150	600	(F)
	PM	5,390	330	(F)
Future	AM	7,150	840	(F)
	PM	7,350	460	(F)

INT. 21 ENT. RAMP (Left)

Existing	AM	4,550	100	(F)
	PM	5,060	230	(D)
Future	AM	6,310	380	(F)
	PM	6,890	840	(F)

INT. 22 ON RAMP

Existing	AM	3,950	1,200	(D)
	PM	3,910	1,480	(E)
Future	AM	5,480	1,670	(F)
	PM	5,290	2,060	(F)

INT. 22 EX. RAMP

Existing	AM	4,920	340	(C)
	PM	4,180	270	(C)
Future	AM	5,950	470	(F)
	PM	5,670	380	(D)

INT. 23 EX. RAMP

Existing	AM	4,420	130	(F)
	PM	4,350	170	(F)
Future	AM	6,130	180	(F)
	PM	5,910	240	(F)

		Between Int. 18 & 17	Between Int. 19 & 18	Between Int. 20 & 19	Between Int. 21 & 20		Between Int. 22 & 21		Between Int. 23 & 22	East of Int. 23
Existing	AM	3,640 (E)	4,760 (C)	2,920 (C)	4,920 (C)		5,150 (E)		4,290 (D)	4,420 (F)
	PM	3,380 (E)	4,370 (C)	3,210 (C)	5,890 (C)		5,390 (E)		4,180 (D)	4,350 (F)
Future	AM	5,060 (F)	6,620 (D)	4,230 (D)	6,830 (D)		7,150 (F)		5,950 (F)	6,130 (F)
	PM	4,690 (F)	6,070 (D)	4,560 (D)	8,050 (D)		7,350 (F)		5,670 (E)	5,910 (F)

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PEAK HOUR VOLUMES AND LEVEL OF SERVICE RESULTS

I-84 WESTBOUND

FIGURE 5- 2

Route 8

Table 5-8 and Table 5-9 present the results of the analysis along Route 8 in the northbound and southbound directions respectively. These results are also shown in Figure 5-3 and Figure 5-4.

Table 5-8: Freeway Analysis Summary – Route 8 Northbound

SECTION ALONG I-84	2005		2030	
	Volume	LOS	Volume	LOS
Between Int. 29 and Int. 30	2000(2900)	C(D)	2560(3700)	D(E)
Between Int. 30 and Int. 31	2350(3170)	C(D)	3010(4050)	D(F)
Between Int. 31 and Int. 32	1550(2250)	B(C)	1970(2850)	C(D)
Between Int. 32 and Int. 33	1250(2000)	B(C)	1580(2520)	B(C)
Between Int. 33 and Int. 34	2310(4150)	B(D)	3010(5390)	C(E)
Between Int. 34 and Int. 35	2570(4670)	B(D)	3350(6070)	C(F)

Note: X(X) Represents LOS for AM peak hour. PM peak levels of service shown in parenthesis.

Table 5-9: Freeway Analysis Summary – Route 8 Southbound

SECTION ALONG I-84	2005		2030	
	Volume	LOS	Volume	LOS
Between Int. 29 and Int. 30	2390(2530)	B(B)	3130(3320)	C(C)
Between Int. 30 and Int. 31	2690(2680)	D(D)	3520(3510)	E(E)
Between Int. 31 and Int. 32	1310(990)	B(A)	1700(1290)	B(B)
Between Int. 32 and Int. 33	2760(2140)	C(B)	3590(2790)	C(C)
Between Int. 33 and Int. 34	4160(2920)	D(C)	5410(3800)	E(C)
Between Int. 34 and Int. 35	4490(3220)	D(C)	5840(4190)	E(D)

Note: X(X) Represents LOS for AM peak hour. PM peak levels of service shown in parenthesis.

- **Between Interchanges 29 and 30** – Route 8 between Interchange 29 and Interchange 30 consists of two lanes in the northbound direction and three lanes in the southbound direction. This segment is 1.5 miles long in the northbound direction and 1.7 miles long in the southbound direction. Under the future year condition, this segment is anticipated to operate at LOS E during the weekday evening peak hour condition in the northbound direction due to an increase in traffic volumes.

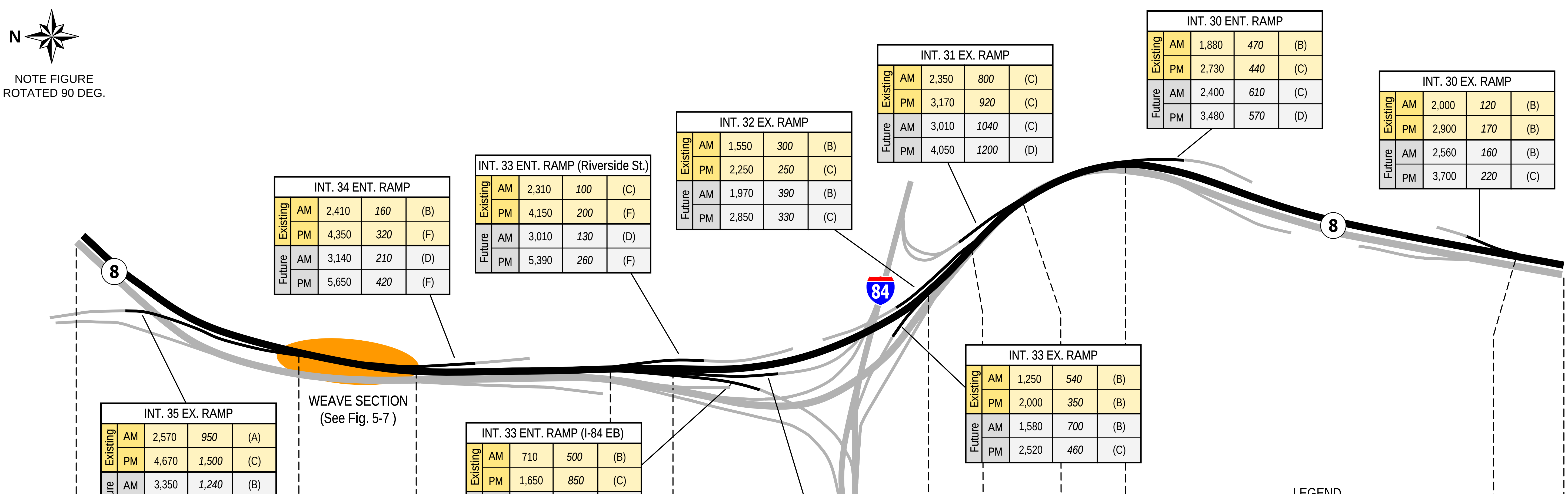
- **Between Interchanges 30 and 31** – Route 8 between Interchange 30 and Interchange 31 consists of two lanes, 0.3 miles long, in both the northbound and southbound directions. Under the future year condition, this segment is anticipated to operate at LOS F and LOS E in the northbound and southbound directions respectively during the weekday evening peak hour condition.

- **Between Interchanges 31 and 32** – The segment along Route 8 between Interchange 31 and Interchange 32 consists of two lanes in the northbound and southbound directions. This segment is 0.1 miles long in the northbound and 0.2 miles long in the southbound direction. Under the future year condition, this segment anticipated to operate at LOS D or better in the northbound and southbound directions.

- **Between Interchanges 32 and 33** – Route 8 between Interchange 32 and Interchange 33 consists of two lanes, 0.1 miles long, in both the northbound and southbound directions. Under the future year condition, this segment is anticipated to operate at LOS C or better in the northbound and southbound directions.

- **Between Interchanges 33 and 34** – Route 8 between Interchange 33 and Interchange 34 consists of three lanes in the northbound and southbound directions. This segment is 0.8 miles long in the northbound direction and 0.5 miles long in the southbound direction. Under the future year condition, this segment is anticipated to operate at LOS E during the weekday evening peak hour in the northbound direction and during the weekday morning peak hour in the southbound direction.

- **Between Interchanges 34 and 35** – Route 8 between Interchange 34 and Interchange 35 consists of three lanes, 0.3 miles long, in both the northbound and southbound directions. Under the future year condition, this segment is anticipated to operate at LOS F during the weekday evening peak hour in the northbound direction and at LOS E during the weekday morning peak hour in the southbound direction.



INT. 35 EX. RAMP

Existing	AM	2,570	*950*	(A)
Existing	PM	4,670	*1,500*	(C)
Future	AM	3,350	*1,240*	(B)
Future	PM	6,070	*1,950*	(F)

INT. 34 ENT. RAMP

Existing	AM	2,410	*160*	(B)
Existing	PM	4,350	*320*	(F)
Future	AM	3,140	*210*	(D)
Future	PM	5,650	*420*	(F)

INT. 33 ENT. RAMP (Riverside St.)

Existing	AM	2,310	*100*	(C)
Existing	PM	4,150	*200*	(F)
Future	AM	3,010	*130*	(D)
Future	PM	5,390	*260*	(F)

INT. 33 ENT. RAMP (I-84 EB)

Existing	AM	710	*500*	(B)
Existing	PM	1,650	*850*	(C)
Future	AM	880	*700*	(B)
Future	PM	2,060	*1,180*	(D)

INT. 32 EX. RAMP

Existing	AM	1,550	*300*	(B)
Existing	PM	2,250	*250*	(C)
Future	AM	1,970	*390*	(B)
Future	PM	2,850	*330*	(C)

INT. 33 ENT. RAMP (I-84 WB)

Existing	AM	710	*1,100*	(B)
Existing	PM	1,650	*1,650*	(D)
Future	AM	880	*1,430*	(C)
Future	PM	2,060	*2,150*	(F)

INT. 31 EX. RAMP

Existing	AM	2,350	*800*	(C)
Existing	PM	3,170	*920*	(C)
Future	AM	3,010	*1040*	(C)
Future	PM	4,050	*1200*	(D)

INT. 33 EX. RAMP

Existing	AM	1,250	*540*	(B)
Existing	PM	2,000	*350*	(B)
Future	AM	1,580	*700*	(B)
Future	PM	2,520	*460*	(C)

INT. 30 ENT. RAMP

Existing	AM	1,880	*470*	(B)
Existing	PM	2,730	*440*	(C)
Future	AM	2,400	*610*	(C)
Future	PM	3,480	*570*	(D)

INT. 30 EX. RAMP

Existing	AM	2,000	*120*	(B)
Existing	PM	2,900	*170*	(B)
Future	AM	2,560	*160*	(B)
Future	PM	3,700	*220*	(C)

		Between Int. 34 & 35	Between Int. 33 & 34	Between Int. 32 & 33	Between Int. 31 & 32	Between Int. 30 & 31	Between Int. 29 & 30
Existing	AM	2,570 (B)	2,310 (B)	1,250 (B)	1,550 (B)	2,350 (C)	2,000 (C)
Existing	PM	4,670 (D)	4,150 (D)	2,000 (C)	2,250 (C)	3,170 (D)	2,900 (D)
Future	AM	3,350 (C)	3,010 (C)	1,580 (B)	1,970 (C)	3,010 (D)	2,560 (D)
Future	PM	6,070 (F)	5,390 (E)	2,520 (C)	2,850 (D)	4,050 (F)	3,700 (E)

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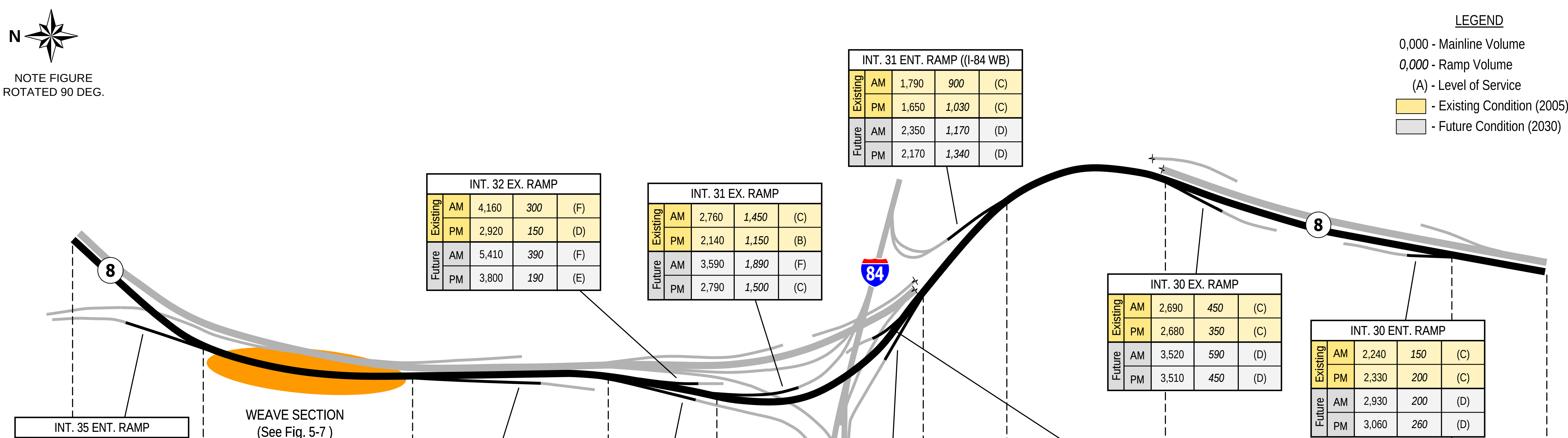
PEAK HOUR VOLUMES AND LEVEL OF SERVICE RESULTS

ROUTE 8 NORTHBOUND

FIGURE 5- 3



INT. 35 ENT. RAMP

Existing	AM	3,200	*1,290*	(F)
Existing	PM	2,170	*1,050*	(C)
Future	AM	4,160	*1,680*	(F)
Future	PM	2,820	*1,370*	(F)

INT. 34 EX. RAMP

Existing	AM	4,490	*330*	(C)
Existing	PM	3,220	*300*	(B)
Future	AM	5,840	*430*	(C)
Future	PM	4,190	*390*	(B)

INT. 32 EX. RAMP

Existing	AM	4,160	*300*	(F)
Existing	PM	2,920	*150*	(D)
Future	AM	5,410	*390*	(F)
Future	PM	3,800	*190*	(E)

INT. 33 EX. RAMP

Existing	AM	4,160	*1,100*	(D)
Existing	PM	2,920	*630*	(C)
Future	AM	5,410	*1,430*	(F)
Future	PM	3,800	*820*	(C)

INT. 31 EX. RAMP

Existing	AM	2,760	*1,450*	(C)
Existing	PM	2,140	*1,150*	(B)
Future	AM	3,590	*1,890*	(F)
Future	PM	2,790	*1,500*	(C)

INT. 31 ENT. RAMP ((I-84 WB)

Existing	AM	1,790	*900*	(C)
Existing	PM	1,650	*1,030*	(C)
Future	AM	2,350	*1,170*	(D)
Future	PM	2,170	*1,340*	(D)

INT. 31 ENT. RAMP (I-84 EB)

Existing	AM	1,310	*280*	(B)
Existing	PM	990	*290*	(B)
Future	AM	1,700	*390*	(C)
Future	PM	1,290	*400*	(B)

INT 31 ENT. RAMP (Riverside St.)

Existing	AM	1,310	*200*	(B)
Existing	PM	990	*370*	(B)
Future	AM	1,700	*260*	(B)
Future	PM	1,290	*480*	(B)

INT. 30 EX. RAMP

Existing	AM	2,690	*450*	(C)
Existing	PM	2,680	*350*	(C)
Future	AM	3,520	*590*	(D)
Future	PM	3,510	*450*	(D)

INT. 30 ENT. RAMP

Existing	AM	2,240	*150*	(C)
Existing	PM	2,330	*200*	(C)
Future	AM	2,930	*200*	(D)
Future	PM	3,060	*260*	(D)

			Between Int. 34 & 35	Between Int. 33 & 34	Between Int. 32 & 33	Between Int. 31 & 32		Between Int. 30 & 31		Between Int. 29 & 30
Existing	AM		4,490 (D)	4,160 (D)	2,760 (C)	1,310 (B)		2,690 (D)		2,390 (B)
Existing	PM		3,220 (C)	2,920 (C)	2,140 (B)	990 (A)		2,680 (D)		2,530 (B)
Future	AM		5,840 (E)	5,410 (E)	3,590 (C)	1,700 (B)		3,520 (E)		3,130 (C)
Future	PM		4,190 (D)	3,800 (C)	2,790 (C)	1,290 (B)		3,510 (E)		3,320 (C)

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PEAK HOUR VOLUMES AND LEVEL OF SERVICE RESULTS
ROUTE 8 SOUTHBOUND

FIGURE 5-4

5.1.2 Weaving Analysis

In order to evaluate traffic operations along the freeway, a weaving analysis is necessary where the freeway consists of entrance ramps followed by exit ramps at close proximity to each other. In this study area, weaving analysis was performed in the Waterbury area where a number of such operations take place along I-84 in the eastbound and westbound directions and along Route 8 in the northbound and southbound directions.

In order to evaluate weaving operations along I-84 and Route 8, freeway and ramp geometry, freeway and ramp speeds, and length of weaving section (distance between on and exit ramps) were used as inputs for the analysis.

The following weaves were identified for evaluation along I-84:

- Route 8 NB Entrance Ramp to Meadow Street Exit Ramp (Eastbound Direction) (upper level);
- Meadow Street Entrance Ramp to Route 8 NB (Westbound Direction) (lower level);
- Meadow Street Entrance Ramp to Route 8 SB (Westbound Direction); and,
- Route 8 Southbound to Highland Avenue Interchange 18 Exit Ramp (Westbound Direction).

The following weaves were identified for evaluation along Route 8:

- West Main Street Entrance Ramp to Watertown Avenue Exit ramp (Northbound Direction);
- Watertown Avenue Entrance Ramp to West Main Street Exit Ramp (Southbound Direction);

The results of the weaving analyses are summarized in Table 5-10and shown in Figure 5-5 through Figure 5-7.

Table 5-10: Weaving Analysis Summary – I-84 and Route 8

SECTION ALONG I-84	2005		2030	
	AM	PM	AM	PM
I-84				
Eastbound Direction				
Route 8 NB to Meadow Street	E	D	F	F
Westbound Direction				
Bank Street to Route 8 NB	C	E	E	F
Bank Street to Route 8 SB	D	D	F	F
Route 8 Southbound to Highland Avenue	E	D	F	F
Route 8				
Northbound Direction				
West Main Street to Watertown Ave.	C	E	D	F
Southbound Direction				
Watertown Avenue to West Main Street	E	C	F	E

- **I-84 between Route 8 NB Entrance Ramp and Meadow Street Exit Ramp –** This weaving section is 950 feet long and has three mainline lanes along I-84 in the eastbound direction. As shown in the table, this weaving section operates at LOS E during the weekday morning peak hour under existing conditions due to heavy traffic volumes along I-84 and the Route 8 entrance ramp. Under the future year condition, this section is anticipated to operate at LOS F during the weekday morning and evening peak hours.

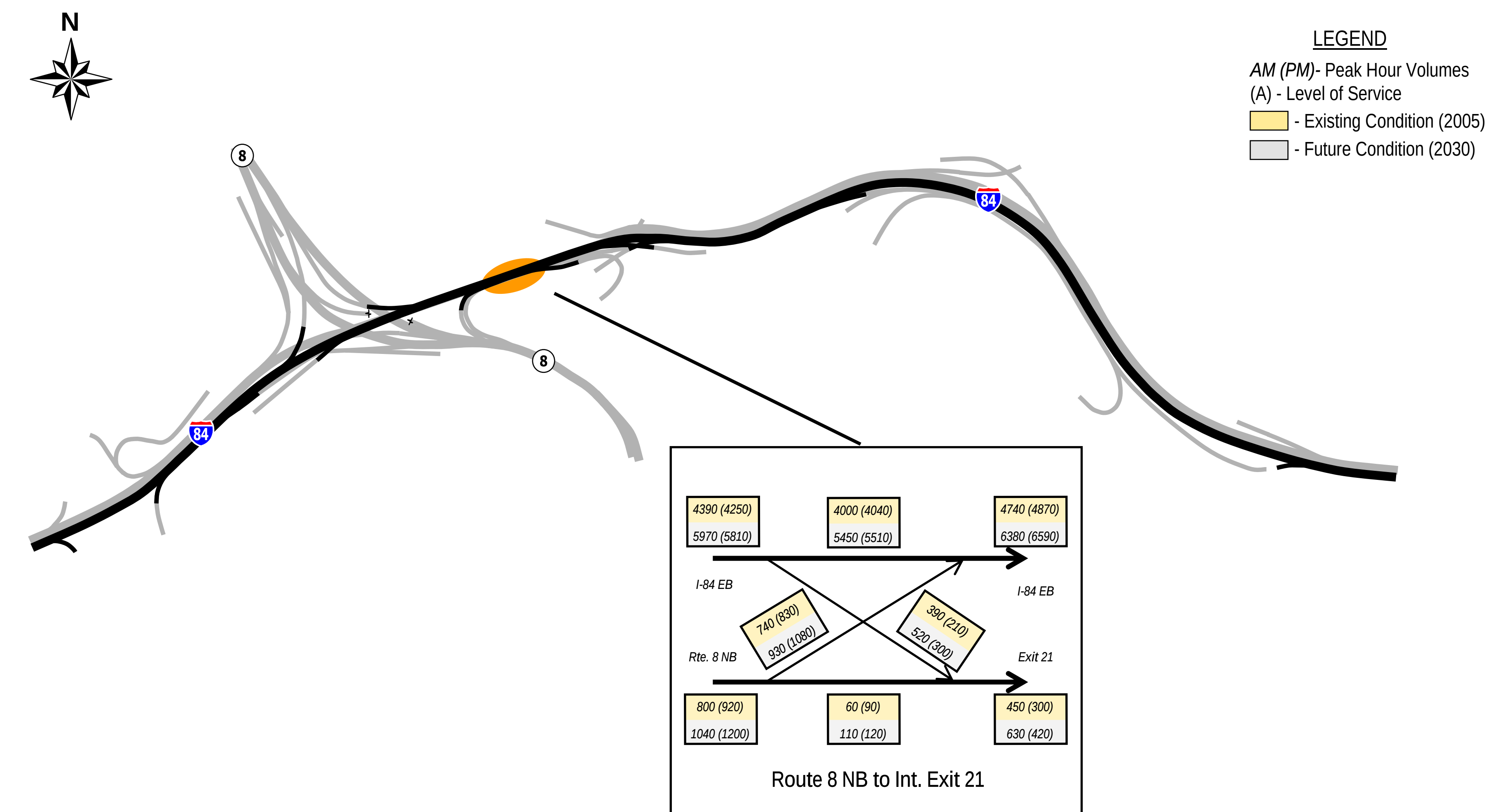
- **I-84 between Meadow Street Entrance Ramp and Route 8 NB Exit Ramp –** This weaving section is 1800 feet long and I-84 has three mainline lanes along I-84 in the westbound direction. Under the future year condition, this section is anticipated to operate at LOS E and LOS F during the weekday morning and evening peak hours respectively.

- **I-84 between Meadow Street Entrance Ramp and Route 8 SB Exit Ramp -** The weaving section between Meadow Street and Route 8 SB is 900 feet long and has three mainline lanes along I-84 in the westbound direction. Under the future year condition, this weaving section is anticipated to operate at LOS F during the weekday morning and evening peak hours.

- **I-84 between Route 8 SB Entrance Ramp and Highland Avenue -** This weaving section between Route 8 SB and Highland Avenue is 1430 feet long and has three mainline lanes along I-84 in the westbound direction. Under the future year condition, this section is anticipated to operate at LOS F during the weekday morning and evening peak hours.

- **Route 8 between West Main Street and Watertown Avenue -** This weaving section between West Main Street and Watertown Avenue is 1490 feet long and has three mainline lanes along Route 8 in the northbound direction. The exit ramp to Watertown Avenue is a left hand exit ramp and therefore, this weaving movement requires a minimum of one lane change. Under the future year condition, this section is anticipated to operate at LOS F during the weekday evening peak hours.

- **Route 8 between Watertown Avenue and West Main Street -** This weaving section between Watertown Avenue and West Main Street is 1490 feet long and has three mainline lanes along Route 8 in the southbound direction. Under the future year condition, this section is anticipated to operate at LOS F during the weekday morning peak hour and at LOS E during the evening peak hours.



Existing		Future	
AM	PM	AM	PM
E	D	F	F

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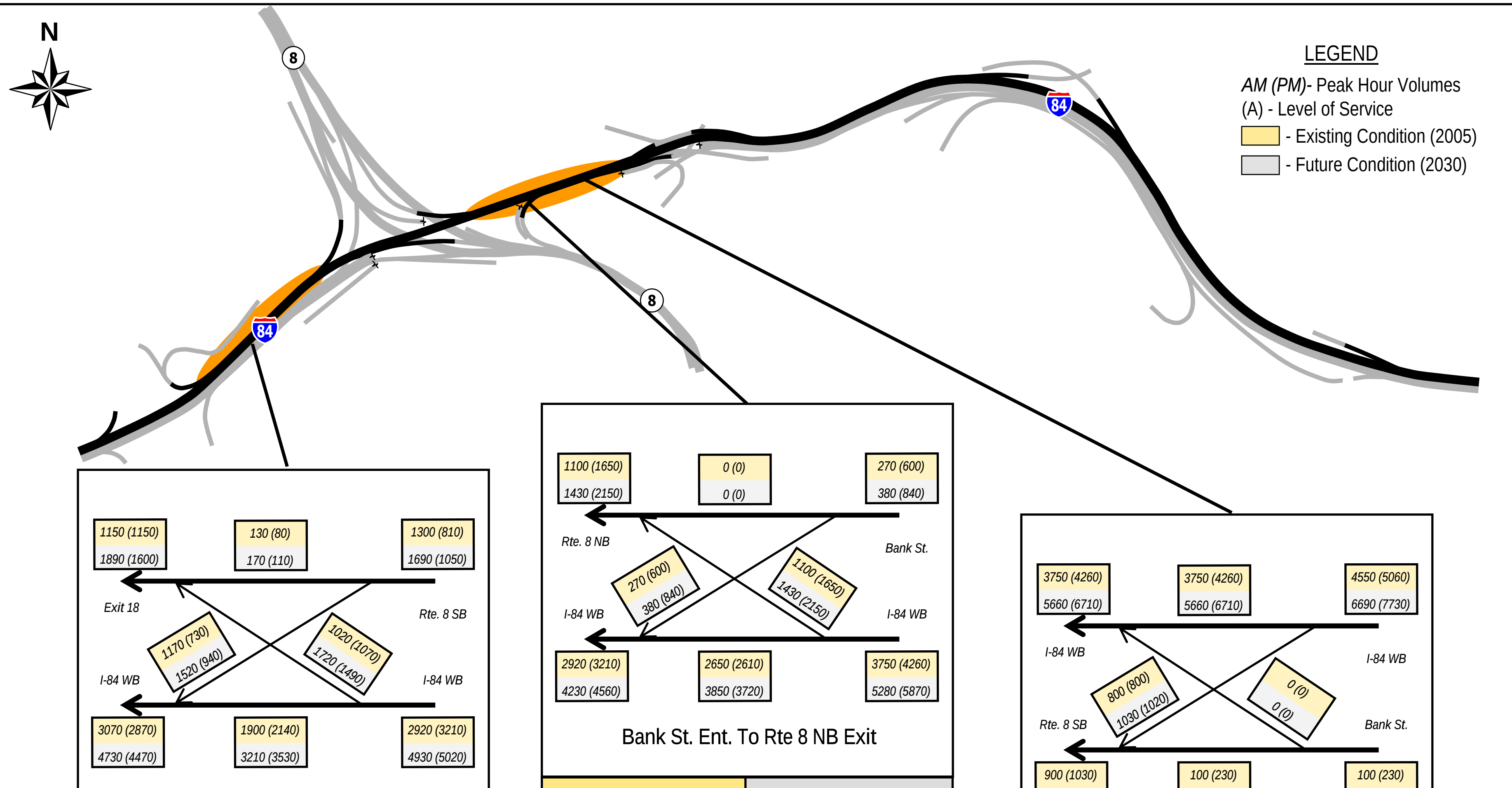
WEAVE ANALYSIS

I-84 EASTBOUND

FIGURE 5-5



Rte 8 SB Ent. to Int. 18 Exit

Existing		Future	
AM	PM	AM	PM
E	D	F	F

Bank St. Ent. To Rte 8 NB Exit

Existing		Future	
AM	PM	AM	PM
C	E	E	F

Bank St. Ent. To Rte. 8 SB Exit

Existing		Future	
AM	PM	AM	PM
D	D	F	F

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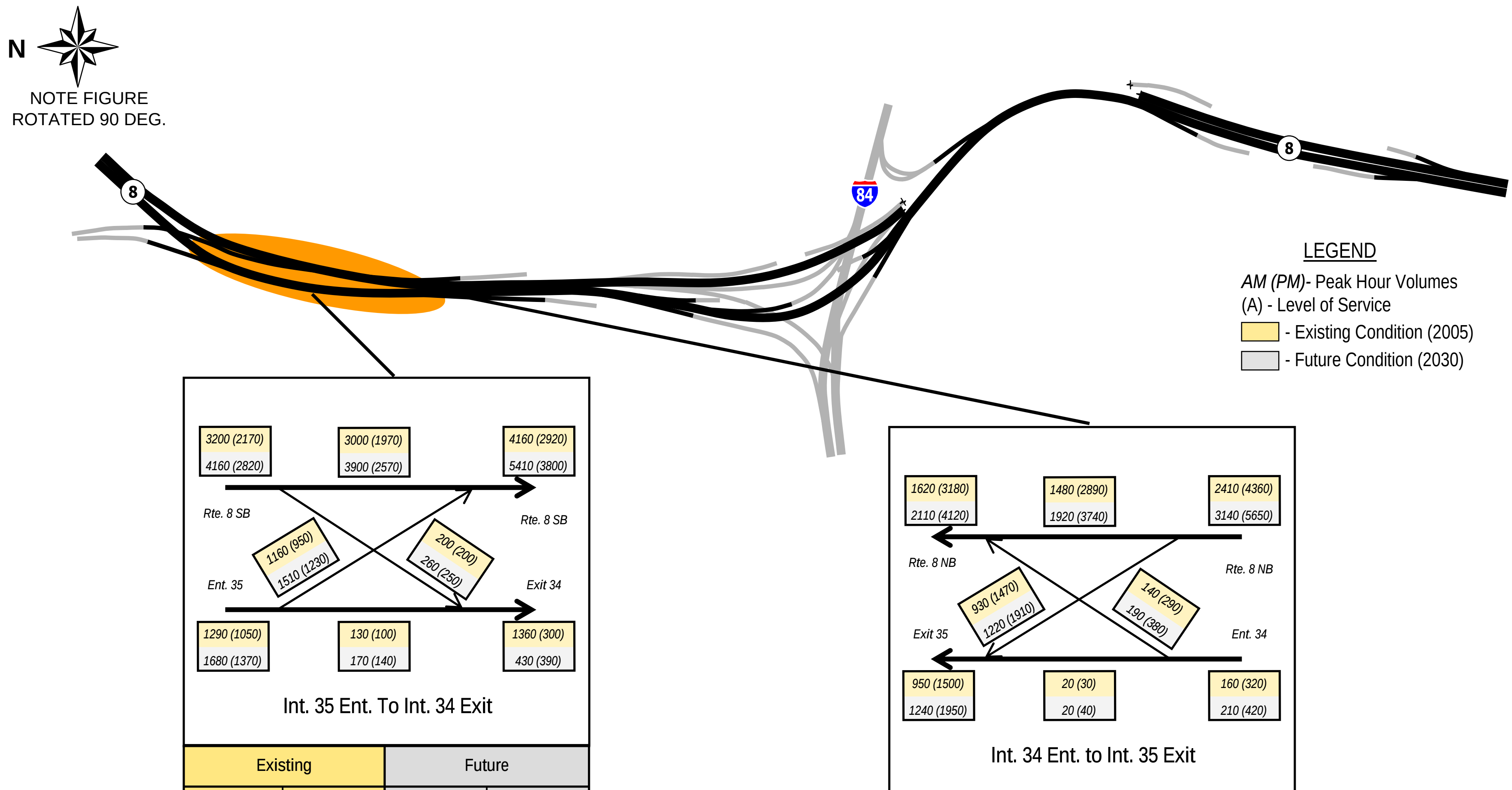
WEAVE ANALYSIS
I-84 WESTBOUND

FIGURE 5-6



Int. 35 Ent. To Int. 34 Exit

Existing		Future	
AM	PM	AM	PM
E	C	F	E

Int. 34 Ent. to Int. 35 Exit

Existing		Future	
AM	PM	AM	PM
C	E	D	F

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WEAVE ANALYSIS
ROUTE 8

FIGURE 5-7

5.1.3 Freeway Ramp analysis

A freeway-ramp junction analysis is performed along I-84 and Route 8 in both directions during the weekday morning and evening peak hour conditions to evaluate traffic operations. The inputs to the analysis are freeway and ramp geometry, speed, and traffic volumes.

I-84

The results of the freeway-ramp analyses along I-84 are presented in Table 5-11 and Table 5-12 in the eastbound and westbound directions respectively. These results are also shown in Figure 5-1 and Figure 5-2.

Table 5-11: Freeway Ramp Analysis Summary – I-84 Eastbound Direction

INTERCHANGE on I-84	2005			2030		
	Mainline Volume	Ramp Volume	LOS	Mainline Volume	Ramp Volume	LOS
Interchange 18						
Exit ramp to Chase Parkway	3130(3700)	220(330)	D(E)	4340(5140)	300(460)	F(F)
Entrance ramp from Chase Parkway	2910(3370)	460(460)	D(E)	4040(4680)	640(640)	F(F)
Interchange 19						
Exit ramp to Sunnyside Ave./Route 8 SB	3370(3830)	330(340)	D(D)	4680(5320)	460(470)	F(F)
Exit ramp to Route 8 NB	3040(3490)	500(850)	D(D)	4220(4850)	700(1180)	F(F)
Entrance ramp from Highland Ave.	2540(2640)	400(460)	D(D)	3520(3670)	560(640)	F(F)
Interchange 20						
Entrance ramp from Route 8 SB	2940(3100)	1450(1150)	F(F)	4080(4310)	1890(1500)	F(F)
Entrance ramp from Route 8 NB	4390(4250)	800(920)	F(E)	5970(5810)	1040(1200)	F(F)
Interchange 21						
Exit ramp to Meadow St.	5190(5170)	450(300)	F(F)	7010(7010)	630(420)	F(F)
Entrance ramp from Meadow St.	4140(4320)	270(520)	D(F)	5550(5830)	380(720)	F(F)
Interchange 22						
Exit ramp to South Main Street	4740(4870)	600(550)	D(D)	6380(6590)	830(760)	F(F)
Interchange 23						
Exit ramp to Frontage Road	4410(4840)	1000(1450)	D(F)	5930(6550)	1400(2020)	F(F)
Entrance ramp from Hamilton Ave.	3410(3390)	400(640)	E(F)	4020(3840)	500(740)	C(D)
Interchange 24						
Exit ramp to Harpers Ferry Road	-	-	-	4530(4530)	510(690)	D(D)

Note: X(X) Represents LOS for AM peak hour. PM peak levels of service shown in parenthesis.

Table 5-12: Freeway Ramp Analysis Summary – I-84 Westbound Direction

INTERCHANGE on I-84	2005			2030		
	Mainline Volume	Ramp Volume	LOS	Mainline Volume	Ramp Volume	LOS
Interchange 18						
Exit ramp to West Main St./Highland Ave.	4760(4370)	1360(1150)	F(F)	6620(6070)	1890(1600)	F(F)
Entrance ramp from Chase Pkwy.	3400(3220)	240(160)	D(D)	4730(4470)	330(220)	F(F)
Interchange 19						
Entrance ramp from Route 8 SB	3460(3560)	1300(810)	F(D)	4930(5020)	1690(1050)	F(F)
Entrance ramp from Route 8 NB	2920(3210)	540(350)	C(C)	4230(4560)	700(460)	F(D)
Interchange 20						
Exit ramp to Route 8 SB	4920(5890)	900(1030)	D(F)	6830(8050)	1170(1340)	F(F)
Exit ramp to Route 8 NB	4020(4860)	1100(1650)	C(D)	5660(6710)	1430(2150)	D(F)
Interchange 21						
Exit ramp to Meadow St.	5150(5390)	600(330)	F(F)	7150(7350)	840(460)	F(F)
Entrance ramp from Bank St. (Left)	4550(5060)	100(230)	F(D)	6310(6890)	380(840)	F(F)
Entrance ramp from Bank St. (Right)	4550(5060)	270(600)	D(D)	6310(6890)	140(320)	F(F)
Interchange 22						
Exit ramp to Union St.	4290(4180)	340(270)	C(C)	5950(5670)	470(380)	F(D)
Entrance ramp from Union St.	3950(3910)	1200(1480)	D(E)	5480(5290)	1670(2060)	F(F)
Interchange 23						
Exit ramp to Hamilton Ave.	4420(4350)	130(170)	F(F)	6130(5910)	180(240)	F(F)

Note: X(X) Represents LOS for AM peak hour. PM peak levels of service shown in parenthesis.

- **Interchange 18 –** This interchange primarily has two mainline lanes and single lane entrance and exit ramps along I-84 in the eastbound and westbound directions. However, in the westbound direction I-84 has three mainline lanes at the Highland Avenue exit ramp junction. Under the future year condition, all freeway ramp junctions are anticipated to operate at LOS F during the weekday morning and evening peak hours in the eastbound direction. In the westbound direction, all freeway ramp junctions are anticipated to operate at LOS F during the weekday morning and evening peak hours and the entrance ramp from Chase Parkway is anticipated to operate at LOS F during the weekday morning and evening peak hour conditions.

- **Interchange 19 –** This interchange in the eastbound direction has two mainline lanes and a left hand exit ramp along I-84 to Route 8 northbound. In the westbound direction, there are three mainline lanes along I-84 and single lane entrance and exit ramps. Under the future year condition, in the eastbound direction, all freeway ramp junctions are anticipated to operate at LOS F during the weekday morning and evening peak hour conditions. In the westbound direction, the entrance ramp from Route 8 southbound is anticipated to operate at LOS F in the future year and the entrance ramp from Route 8 northbound is anticipated to operate at LOS F during the weekday morning peak hour condition.

- **Interchange 20 –** This interchange in the eastbound direction has two mainline lanes just west of the entrance ramp from Route 8 southbound. There is a lane addition along I-84 eastbound just east of the Route 8 southbound merge. In the westbound direction, I-84 has three mainline lanes and two auxiliary lanes to the Route 8 ramps. In the eastbound direction, the entrance ramp from Route 8 southbound and I-84 junction operates at LOS F during the weekday morning and evening peak hour under existing conditions. This is a left hand merge with I-84 and therefore traffic operations at this junction are affected. The junction of I-84 and the entrance ramp from Route 8 northbound operates at LOS E or worse under existing conditions. Under the future year condition, all freeway ramp junctions are anticipated to operate LOS F in the eastbound direction. Under the future year condition, in the westbound direction, the junction of the exit ramp to Route 8 northbound with I-84 operates at LOS D during the weekday morning peak hour condition. All other freeway-ramp junctions operate at LOS F in the future year condition.

- **Interchange 21 –** In the vicinity of this interchange, I-84 has three mainline lanes in the eastbound direction and an auxiliary lane that serves the Meadow Street exit ramp. In the westbound direction, I-84 has three mainline lanes serving this interchange. All ramps to and from I-84 are single lane ramps. The exit ramp to Meadow Street and I-84 eastbound junction operates at LOS F under existing conditions and is anticipated to operate at LOS F under future year conditions. The entrance ramp from Meadow Street is anticipated to operate at LOS F in the future year condition. In the westbound direction, all freeway ramp junctions are anticipated to operate at LOS F in the future.

- **Interchange 22 –** In the eastbound and westbound directions, this interchange has three mainline lanes along I-84. All ramps to and from I-84 are single lane ramps. The entrance ramp from Union Street and I-84 westbound junction operates at LOS E during the weekday evening peak hour under existing conditions. Under the future year condition, all freeway-ramp junctions operate at LOS F during the weekday morning and evening peak hours except the junction of the exit ramp to Union Street with I-84 westbound, which operates at LOS D during the weekday evening peak hour condition.

- **Interchange 23 –** In the eastbound direction, a lane drop from three to two travel lane occurs past the exit ramp to the frontage road. In the westbound direction, a lane addition occurs past the exit ramp to Hamilton Avenue. Under existing conditions, the Hamilton Avenue exit ramp junction with I-84 westbound operates at LOS F due to the availability of two travel lanes in the westbound direction.

- Under the future year condition, three travel lanes will be provided along I-84 in both directions as a result of a previously proposed widening project. Given the increase in traffic volumes, all freeway ramp junctions are anticipated to operate at LOS F in the future year condition in both directions.

- **Interchange 24 –** A future ConnDOT proposal brings the I-84 eastbound Interchange 24 exit ramp prior to the Hamilton Avenue entrance ramp to reduce the amount of traffic on I-84 and to preserve capacity. Under the future year condition, the Interchange 24 exit ramp is anticipated to operate at LOS D during the weekday morning and evening peak hour conditions.

Route 8

The results of the freeway-ramp analyses along Route 8 are presented in Table 5-13 Table 5-14 in the northbound and southbound directions respectively. These results are also shown in Figure 5-3 and Figure 5-4.

- **Interchange 30 –** This interchange primarily has two mainline lanes and single lane entrance and exit ramps along Route 8 in the northbound and southbound directions. Under the future year condition, all freeway ramp junctions are anticipated to operate at LOS D or better during the weekday morning and evening peak hours.

- **Interchange 31 –** This interchange primarily has two mainline lanes and single lane entrance and exit ramps along Route 8 in the northbound and southbound directions. Under the future year condition, the left hand I-84 eastbound exit ramp junction with Route 8 southbound is anticipated to operate at LOS F during the weekday morning peak hour condition. This is due to the heavy traffic volumes exiting at the exit ramp to I-84 eastbound in the future year.

Table 5-13: Freeway Ramp Analysis Summary – Route 8 Northbound Direction

INTERCHANGE on Route 8	2005			2030		
	Mainline Volume	Ramp Volume	LOS	Mainline Volume	Ramp Volume	LOS
Interchange 30						
Exit ramp to Leonard Street	2000(2900)	120(170)	B(B)	2560(3700)	160(220)	B(C)
Entrance ramp from Leonard Street	1880(2730)	470(440)	B(C)	2400(3480)	610(570)	C(D)
Interchange 31						
Exit ramp to I-84 EB	2350(3170)	800(920)	C(C)	3010(4050)	1040(1200)	C(D)
Interchange 32						
Exit ramp to Riverside St.	1550(2250)	300(250)	B(C)	1970(2850)	390(330)	B(C)
Interchange 33						
Exit ramp to I-84 WB	1250(2000)	540(350)	B(B)	1580(2520)	700(460)	B(C)
Entrance ramp from I-84 EB	710(1650)	500(850)	B(C)	880(2060)	700(1180)	B(D)
Entrance ramp from Riverside St.	2310(4150)	100(200)	C(F)	3010(5390)	130(260)	D(F)
Entrance ramp from I-84 WB	710(1650)	1100(1650)	B(D)	880(2060)	1430(2150)	C(F)
Interchange 34						
Entrance ramp from W. Main Street	2410(4350)	160(320)	B(F)	3140(5650)	210(420)	D(F)
Interchange 35						
Exit ramp to Route 73	2570(4670)	950(1500)	A(C)	3350(6070)	1240(1950)	B(F)

Table 5-14: Freeway Ramp Analysis Summary – Route 8 Southbound Direction

INTERCHANGE on I-84	2005			2030		
	Mainline Volume	Ramp Volume	LOS	Mainline Volume	Ramp Volume	LOS
Interchange 30						
Exit ramp to Charles Street	2690(2680)	450(350)	C(C)	3520(3510)	590(450)	D(D)
Entrance ramp from Charles Street	2240(2330)	150(200)	C(C)	2930(3060)	200(260)	D(D)
Interchange 31						
Entrance ramp from I-84 WB	1790(1650)	900(1030)	C(C)	2350(2170)	1170(1340)	D(D)
Entrance ramp from I-84 EB	1310(990)	280(290)	B(B)	1700(1290)	390(400)	C(B)
Entrance ramp from Riverside Street	1310(990)	200(370)	B(B)	1700(1290)	260(480)	B(B)
Exit ramp to I-84 EB	2760(2140)	1450(1150)	C(B)	3590(2790)	1890(1500)	F(C)
Interchange 32						
Exit ramp to Riverside St.	4160(2920)	300(150)	F(D)	5410(3800)	390(190)	F(E)
Interchange 33						
Exit ramp to I-84 WB	4160(2920)	1100(630)	D(C)	5410(3800)	1430(820)	F(C)
Interchange 34						
Exit ramp to W. Main Street	4490(3220)	330(300)	C(B)	5840(4190)	430(390)	C(B)
Interchange 35						
Entrance ramp from Route 73	3200(2170)	1290(1050)	F(C)	4160(2820)	1680(1370)	F(F)

- **Interchange 32 –** This interchange primarily has two mainline lanes along Route 8 in the northbound direction and has three mainline lanes in the southbound direction. Under the future year condition, the left hand Riverside Street exit ramp junction with Route 8 southbound is anticipated to operate at LOS F and LOS E during the weekday morning and evening peak hour conditions respectively.

- **Interchange 33 –** This interchange primarily has two mainline lanes in the northbound direction and three lanes in the southbound direction. In the northbound direction, there are three travel lanes on Route 8 after the merge with the I-84 eastbound entrance ramp. The entrance ramp junctions with Riverside Street and I-84 westbound are anticipated to operate at LOS F during the weekday evening peak hour condition. In the southbound direction, the I-84 westbound exit ramp junction with Route 8 is anticipated to operate at LOS F during the weekday morning peak hour condition in the future year.

- **Interchange 34 –** This interchange primarily has three mainline lanes in the northbound and southbound directions. In the northbound direction, the West Main Street entrance ramp junction with Route 8 Northbound operates at LOS F under existing conditions.

- **Interchange 35 –** This interchange primarily has two mainline lanes and two auxiliary lanes serving the Route 73 exit ramp in the northbound direction and the Route 73 entrance ramp in the southbound direction. In the northbound direction, the Route 73 exit ramp junction with Route 8 is anticipated to operate at LOS F during the weekday evening peak hour condition. In the southbound direction, the Route 73 entrance ramp junction with Route 8 is anticipated to operate at LOS F during the weekday morning and evening peak hour condition.

5.1.4 Intersection Analysis

The level of service (LOS) analysis was performed at study area intersections for the existing configurations along the I-84 and Route 8 corridors during the weekday morning and evening peak hours under current and future year traffic volumes.

Signalized Intersection Analysis

The signal plans used for traffic analyses were provided by ConnDOT and the City of Waterbury. The results of the LOS analysis for signalized intersections along I-84 under existing and future volumes are shown in Table 5-15 and Figure 5-8.

Table 5-15: Capacity Analysis Summary - Signalized Intersections along I-84

INTERSECTION	A.M.		P.M.	
	2005	2030	2005	2030
Interchange 18				
I-84 WB Exit ramp and W. Main St.	E	F	F	F
Interchange 19-20				
Sunnyside St./Riverside St.	B	C	B	B
Freight St./Riverside St. NB	C	C	C	C
Freight St./Riverside St. SB	C	C	C	C
W. Main St./Highland Avenue	C	F	C	F
W. Main St./Riverside St. NB	C	D	E	F
W. Main St./Riverside St. SB	E	F	F	F
Interchange 21				
I-84 EB Entrance ramp/Meadow St.	C	C	B	B
I-84 EB Exit ramp/Meadow St.	B	C	B	B
Field St./Meadow St.	B	C	C	C
I-84 EB Exit ramp/South Main St.	C	C	C	D
Grand Street/Meadow Street	B/E^	D/F^	C/C^	C/D^
Meadow Street/Bank Street	C	C	C	C
Grand Street/Bank Street	C	C	C	E
Union Street/S. Main St.	C	E	F	F
Union Street/S. Elm St.	D/E^	E/F^	D/F^	F/F^
Willow Street/Freight Street	D/D^	E/F^	C/D^	D/F^
Willow Street/Main Street	E/F^	F/F^	F/F^	F/F^
Interchange 22				
Baldwin St./McMahon Street/I-84	B	B	B	B
Baldwin St./Scoville St.	B	B	B	C
I-84 WB Exit ramp/Union St.	C	D	C	D
Union/Brass Mill Entrance (West)	A	A	B	B
Union/Brass Mill Entrance (East)	A	A	A	A
Union Street/Mill Street	B	C	B	C
Interchange 23				
I-84 WB Entrance ramp and Hamilton Ave.	B	D	C	E
I-84 WB Exit ramp and Hamilton Ave.	B	B	B	B
I-84 EB Entrance ramp and Hamilton Ave.	C	C	D	F
Washington Street and Silver/Hamilton	F	F	F	F

^ With pedestrian phase

- **I-84 WB Exit ramp and West Main Street** – The eastbound and westbound directions along West Main Street at this intersection consist of one general purpose lanes, while in the northbound direction from the I-84 westbound exit ramp there is left turn lane and a shared through and right lane. This intersection operates at poor levels of service LOS E or worse during the weekday morning and evening peak hours under existing conditions. Under the future year condition, this intersection is anticipated to operate at LOS F during the weekday morning and evening peak hours.

- **Sunnyside Avenue and Riverside Street –** In the northbound direction along Riverside Street, there are two through lanes while in the southbound direction there is a single through lane and an exclusive right turn lane. In the eastbound direction along Sunnyside Avenue there is a single lane used for left and right turning movements. Under the future year condition, this intersection is anticipated to operate at LOS C and LOS B during the weekday morning and evening peak hours respectively.

- **Freight Street and Riverside Street NB –** In the eastbound and westbound directions, Freight Street has two lanes for all movements. Riverside Street in the northbound direction has a left turn lane, a through lane, and an exclusive right turn lane at this intersection. Under the future year condition, this intersection is anticipated to operate at acceptable levels of service LOS C during the weekday morning and evening peak hour conditions.

- **Freight Street and Riverside Street SB –** In the westbound direction along Freight Street, there are two left turn lanes entering Riverside Street. In the southbound direction, Riverside Street has an exclusive left turn lane, a shared left and through lane, and a through lane. This intersection operates at LOS C during the weekday morning and evening peak hours under existing conditions. Under the future year condition, this intersection is anticipated to operate at LOS C during the weekday morning and evening peak hours.

- **West Main Street and Highland Street –** This intersection has single lane approaches on West Main Street. Highland Avenue has separate turn lanes at the intersection. Under the future year condition, this intersection is anticipated to operate at LOS F during the weekday morning and evening peak hours.

- **West Main Street and Riverside Street NB –** This intersection has an exclusive left turn lane and two through lanes in the eastbound direction on West Main Street. In the westbound direction, there is a through lane and an exclusive right turn lane on West Main Street. The northbound Riverside Street approach consists of two left turn lanes, a through lane, and an exclusive right turn lane at the intersection. Under existing conditions, the intersection operates at LOS C and E during the weekday morning and evening peak hour. Under the future year condition, this intersection is anticipated to operate at LOS D and LOS F during the weekday morning and evening peak hours respectively.

- **West Main Street and Riverside Street SB –** In the eastbound direction along West Main Street there is a through and a shared through and right lane. In the westbound direction along West Main Street, there is an exclusive left turn lane and two through lanes. In the northbound and southbound directions along Riverside Street, there is an exclusive left turn lane and a shared through and right lane. This intersection operates at LOS E and LOS F during the weekday morning and evening peak hours respectively under existing conditions. Riverside Street in the northbound direction operates at LOS F during both peak hour periods. Under the future year condition, this intersection operates at LOS F during the weekday morning and evening peak hour conditions. Riverside Street operates at or over capacity during both peak hour periods.

- **I-84 EB Entrance ramp and Meadow Street –** The eastbound approach along Meadow Street has two left turn lanes onto I-84 eastbound while the westbound direction along Meadow Street has two through lanes. This intersection operates at acceptable levels of service (LOS C or better) during the weekday morning and evening peak hours under existing and future year conditions.

- **I-84 EB Exit ramp and Meadow Street –** The eastbound and westbound approaches along Meadow Street have two through lanes while the exit ramp from I-84 eastbound has exclusive left and right turn lanes. This intersection operates at acceptable levels of service (LOS C or better) during the weekday morning and evening peak hours under existing and future year conditions.

- **Meadow Street and Field Street –** In the northbound direction, Meadow Street has two approach lanes while in the southbound direction it has four approach lanes at this intersection. In the westbound direction along Field Street, there are two left turn lanes and a channelized right turn lane to Meadow Street. This intersection operates at acceptable levels of service (LOS C or better) during the weekday morning and evening peak hours under existing and future year conditions.

- **Market Square Ave./I-84 EB Exit ramp and Main Street –** The I-84 eastbound exit ramp has a left turn lane, a through lane, and a shared through and right turn lane. In the northbound direction along Main Street, there is a single approach lane while in the southbound direction there is an exclusive left turn lane and a shared through and right turn lane. This intersection operates at acceptable levels of service (LOS D or better) during the weekday morning and evening peak hours under existing and future year conditions.

- **Meadow Street and Grand Street –** In the eastbound direction along Grand Street, this intersection has a single approach lane while in the westbound direction along Grand Street there is a shared left and through lane and two exclusive right turn lanes. In the northbound and southbound directions along Meadow Street, there are two approach lanes at this intersection. This intersection operates at LOS B and LOS C during the weekday morning and evening peak hours respectively under existing conditions. Under the future year condition, this intersection operates at LOS D and LOS C during the weekday morning and evening peak hours respectively. If the pedestrian phase is used, the intersection is anticipated to operate at LOS F during the weekday morning peak hour under the future year condition.

- **Meadow Street and Bank Street** – In the eastbound direction along Meadow Street, there are two through lanes and an exclusive right turn lane, while in the westbound direction there is an exclusive left turn lane and a shared through and right lane. In the northbound direction along Bank Street there is an exclusive left turn lane and a shared through and right turn lane. In the southbound direction, there are exclusive left and right turn lanes along with a single through lane at this intersection. This intersection operates at acceptable levels of service (LOS C or better) during the weekday morning and evening peak hours under existing and future year conditions.

- **Grand Street and Bank Street –** In the eastbound direction, along Grand Street there are two approach lanes while in the westbound direction there is an exclusive left turn lane and two through lanes. In the southbound direction along Bank Street, there are two approach lanes at this intersection. Under the future year condition, this intersection operates at LOS C and LOS D during the weekday morning and evening peak hours respectively. With inclusion of the pedestrian phase, the intersection operates at LOS D and LOS F during the weekday morning and evening peak hour conditions respectively. The left turn movement from Grand Street in the westbound direction operates at LOS F with the inclusion of the pedestrian phase during the evening peak hour condition.

- **Union Street and South Main Street –** In the eastbound direction, along Union Street there is an exclusive left turn lane, a through lane, and a shared through and right turn lane. In the westbound direction along Union Street, there is an exclusive left turn lane, a through lane, and an exclusive right turn lane. In the northbound direction on South Main Street there are two approach lanes at this intersection. This intersection operates at LOS C and LOS F during the weekday morning and evening peak hours respectively under existing conditions. Under the future year condition, this intersection is anticipated to operate at LOS E and LOS F during the weekday morning and evening peak hours respectively.

- **Union Street and South Elm Street –** In the eastbound direction along Union Street, there is an exclusive left turn lane and a shared through and right lane. In the westbound direction along Union Street there are two approach lanes. In the northbound direction along South Elm Street, there is a single approach lane while in the southbound direction there is a shared left and through lane and an exclusive right turn lane. This intersection operates at LOS D during the weekday morning and evening peak hours under existing conditions. With inclusion of the pedestrian phase, the level of service deteriorates to LOS E and LOS F during the weekday morning and evening peak hour conditions respectively. Under the future year condition, this intersection operates at LOS F during the weekday morning and evening peak hours with or without the pedestrian phase.

- **Willow Street and Freight Street –** In the eastbound direction along Freight Street, there is an exclusive left turn lane and dual right turn lanes. In the northbound and the southbound directions along Willow Street, there are two approach lanes at this intersection. This intersection operates at LOS D and LOS C during the weekday morning and evening peak hours respectively under existing conditions. Under the future year condition, this intersection operates at LOS E and LOS D during the weekday morning and evening peak hours respectively. With the use of pedestrian phase, the intersection is anticipated to operate at LOS F during the weekday morning and evening peak hours respectively.

- **Willow Street and West Main Street –** In the eastbound direction, Main Street has a through and a through and right shared lane. In the westbound direction, Main Street has an exclusive left turn, a through and a shared through and right turn lane. In the northbound and southbound directions along Willow Street, there is a shared through and left lane and an exclusive right turn lane. This intersection operates at LOS E and LOS F during the weekday morning and evening peak hours respectively under existing conditions. Willow Street operates at LOS F during the evening peak hour condition. With inclusion of the pedestrian phase, the level of service deteriorates to LOS F during the weekday morning and evening peak hour conditions. The pedestrian phase forces Willow Street to operate at LOS F during the morning and evening peak hour conditions. Under the future year condition, this intersection operates at LOS F during the weekday morning and evening peak hour conditions. Willow Street operates at LOS F during the morning and evening peak hours. With inclusion of the pedestrian phase, the intersection operates at LOS F with higher amounts of delay on Willow Street and Main Street.

- **I-84 EB Entrance ramp and Baldwin Street –** In the northbound and southbound directions, Baldwin Street has two approach lanes while in the westbound direction the exit ramp from I-84 eastbound has an exclusive left turn lane and dual right turn lanes at this intersection. This intersection operates at acceptable levels of service (LOS C or better) during the weekday morning and evening peak hours under existing and future year conditions.

- **Mill Street and Baldwin Street –** In the northbound direction, Baldwin Street has a shared left and through lane, a through lane and an exclusive right turn lane. In the southbound direction, there are two approach lanes on Baldwin Street at the intersection. On Mill Street, there is an exclusive left turn lane and a shared through right tune lane. The Scoville Street approach has a single lane approach at the intersection. The intersection operates at acceptable levels of service (LOS C or better) during the weekday morning and evening peak hours under existing and future year conditions.

- **I-84 WB Exit ramp and Hamilton Ave./Union Street** – In the eastbound and westbound directions along Hamilton Avenue and Union Street, there are two approach lanes while the exit ramp from I-84 westbound has exclusive left and right turn lanes at this intersection. This intersection operates at acceptable levels of service (LOS C or better) during the weekday morning and evening peak hours under existing conditions. Under the future year condition, this intersection operates at LOS D during the weekday morning and evening peak hours respectively.

- **Union Street and Brass Mill Mall Entrance (West)** – In the eastbound and westbound directions along Union Street, there are two approach lanes while in the southbound direction from the Brass Mill Mall, there are exclusive left and right turn lanes at this intersection. This intersection operates at acceptable levels of service (LOS C or better) during the weekday morning and evening peak hours under existing and future year conditions.

- **Union Street and Brass Mill Mall Entrance (West)** – In the eastbound and westbound directions along Union Street, there are two approach lanes while in the southbound direction from the Brass Mill Mall, there are two left turn lanes and an exclusive right turn lane at this intersection. This intersection operates at acceptable levels of service (LOS C or better) during the weekday morning and evening peak hours under existing and future year conditions.

- **Union Street and Mill Street** – In the eastbound and westbound directions, Union Street has exclusive turn lanes and a single through lane while from Mill Street there is a shared left and right lane. This intersection operates at acceptable levels of service (LOS C or better) during the weekday morning and evening peak hours under existing and future year conditions.

- **I-84 WB Entrance ramp and Hamilton Avenue** – In the eastbound and westbound directions along Hamilton Avenue there two through lanes while the westbound approach has dual left turn lanes, the eastbound approach has two exclusive right turn lane at this intersection. This intersection operates at acceptable levels of service (LOS C or better) during the weekday morning and evening peak hours under existing conditions. Under the future year condition, this intersection operates at LOS D and LOS E during the weekday morning and evening peak hour conditions.

- **I-84 WB Exit ramp and Hamilton Avenue** – In the eastbound and westbound directions along Hamilton Avenue, there are two approach lanes while the exit ramp from I-84 westbound has exclusive left and right turn lanes at this intersection. This intersection operates at acceptable levels of service (LOS C or better) during the weekday morning and evening peak hours under existing and future year conditions.

- **I-84 EB Entrance ramp and Hamilton Avenue** – In the northbound direction along Hamilton Avenue, there are two approach lanes while in the southbound direction there is an exclusive left turn lane and a through lane. The frontage road from the west has a shared left and through, a through and an exclusive right turn lane at this intersection. Under the future year condition, this intersection operates at LOS C and LOS F during the weekday morning and evening peak hours respectively. During the evening peak hour, eastbound right turn movement operates at LOS F.

- **Washington Street and Silver St./Hamilton Ave.** – In the eastbound and westbound directions on Washington Street and Silver Avenue there are exclusive turn lanes for left and right turn movements and a single through lane along both approaches. The westbound approach has a channelized right turn movement to Silver Street. In the northbound and southbound directions along Hamilton Avenue, there are exclusive left turn lanes on both approaches. In the northbound direction, a through and a shared through and right lane is provided while in the southbound direction a shared through and right lane is provided at this intersection. This intersection operates at LOS F during the weekday morning and evening peak hours under existing conditions. The intersection operates at poor levels of service due to heavy volumes along Washington Street and Hamilton Avenue. Under the future year condition, the level of service at this intersection deteriorates to LOS F during the weekday morning and evening peak hour conditions.

Table 5-16 presents the results of the LOS analysis for signalized intersections along Route 8. These results are also presented in Figure 5-8.

Table 5-16: Capacity Analysis Summary - Signalized Intersections along Route 8

INTERSECTION	A.M.		P.M.	
	2005	2030	2005	2030
Leonard Street and Washington Ave.	B	B	B	B
Charles St./Rte 8 Int. 30 Exit ramp/Washington Ave.	C	D	C	C
Bank Street and West Liberty Street	B	B	B	B
Leonard Street and Bank Street	A	A	A	A
Riverside St. SB/Charles St. and Bank Street	B	B	B	B
Bank Street and Congress Ave.	A	A	A	A
W. Main Street/Thomaston Ave. and Century Plaza	D	F	F	F

- **Leonard Street and Washington Avenue** – The Washington Avenue eastbound approach has two exclusive left turn lanes and a through lane. The Leonard Street northbound approach has two general purpose lanes. This intersection operates at acceptable levels of service (LOS C or better) during the weekday morning and evening peak hours under existing and future year conditions.

- **Charles Street/Route 8 Int. 30 Exit ramp/Congress Avenue –** The Congress Avenue eastbound approach has three general purpose lanes. The Charles Street approach has an exclusive left turn lane and two through lanes. The Int. 30 Exit ramp has an exclusive left turn lane and a through lane. This intersection operates at acceptable levels of service (LOS C or better) during the weekday morning and evening peak hours under existing year conditions. In the future year, this intersection is anticipated to operate at LOS C and LOS D during the weekday morning and evening peak hours respectively.

- **Bank Street and West Liberty Street –** The Bank Street approach has one general purpose lane in each direction the intersection. The West Liberty Street approach has a one lane approach at the intersection. The intersection operates at acceptable levels of service (LOS C or better) during the weekday morning and evening peak hours under existing and future year conditions.

- **Bank Street and Leonard Street –** The Bank Street approach has two general purpose lanes in the westbound direction. The Leonard Street approach has a left turn, a through, and a right turn lane in the northbound direction. This intersection operates at acceptable levels of service (LOS C or better) during the weekday morning and evening peak hours under existing and future year conditions.

- **Bank Street and Riverside St. SB/Charles Street –** The Bank Street approach has a right turn lane in the eastbound direction. In the westbound direction, Bank Street has two left turn lanes and two through lanes at the intersection. In the southbound direction, Riverside Street has an exclusive right turn lane and two through lanes. This intersection operates at acceptable levels of service (LOS C or better) during the weekday morning and evening peak hours under existing and future year conditions.

- **Bank Street and Congress Avenue –** The Bank Street approach has a shared left and through lane and an exclusive right turn lane in the southbound direction. In the northbound direction, Bank Street has a general purpose lane for all movements. In the eastbound direction, Congress Avenue has a single lane approach at the intersection. This intersection operates at acceptable levels of service (LOS C or better) during the weekday morning and evening peak hours under existing and future year conditions.

- **West Main Street/Thomaston Avenue/Century Plaza –** The West Main Street approach in the eastbound direction has two general purpose lanes while in the westbound direction there is an exclusive left turn lane, a through lane, and a shared through and right turn lane. In the northbound and southbound directions, the lane arrangements are similar. There is a shared left and through lane and an exclusive right turn lane on both approaches. Under existing conditions, the intersection operates at LOS D and LOS F respectively during the weekday morning and evening peak hours respectively. Under the future year condition, this intersection operates at LOS F during the weekday morning and evening peak hours.

Unsignalized Intersections

Un-signalized intersection analysis was performed at stop sign controlled intersections in the study area. Roadway geometry and traffic volumes were used as input for the analysis. Table 5-17 summarizes the results of the LOS analyses for un-signalized intersections along I-84. These results are also presented in Figure 5-8.

Table 5-17: Capacity Analysis Summary – Un-signalized Intersections along I-84

	AM		PM	
	2005	2030	2005	2030
Interchange 19-20				
I-84 EB Entrance ramp/Highland Ave.				
Movement Southbound LOS	A	B	B	B
Interchange 21				
I-84 WB Exit ramp/Field St.				
Approach Westbound LOS	F	F	C	D

- **I-EB Entrance ramp and Highland Avenue** - This intersection has single approach lanes on Highland Avenue. There is no STOP sign control at the intersection. This intersection operates at acceptable levels of service (LOS C or better) during the weekday morning and evening peak hours under existing and future year conditions.

- **I-84 WB Exit ramp and Field Street** - This intersection has single approach lanes on Field Street and the exit ramp from I-84 westbound. This intersection operates at LOS F and LOS C during the weekday morning and evening peak hours respectively under existing conditions. The I-84 WB Exit ramp operates at LOS F due to heavy traffic volumes during the morning peak hour condition. Under the future year condition, this intersection operates at LOS F and LOS D during the weekday morning and evening peak hours respectively.

Table 5-18summarizes the results of the LOS analyses for un-signalized intersections along Route 8. these results are also presented in Figure 5-8.

Table 5-18: Capacity Analysis Summary – Un-signalized Intersections along I-84

	AM		PM	
INTERSECTION	2005	2030	2005	2030
Interchange 30				
Fifth St./Charles St				
Approach Eastbound LOS	B	C	B	C
Fifth St./Leonard St.				
Approach Eastbound LOS	B	C	B	B
Approach Westbound LOS	B	B	B	B
Porter St./Charles St.				
Approach Eastbound LOS	B	B	B	C
Approach Westbound LOS	B	B	B	C
Porter St./Leonard St.				
Approach Eastbound LOS	B	B	B	B
Approach Westbound LOS	B	C	B	C
Sunnyside Ave./Draher Ave,	A	B	A	B
Sunnyside Ave. /I-84 EB Exit				
Approach Southbound LOS	B	B	B	B

- **Fifth Street and Charles Street** - This intersection has single approach lanes on Fifth Street and Charles Street. The Fifth Street approach is STOP sign controlled at the intersection. This intersection operates at acceptable levels of service (LOS C or better) during the weekday morning and evening peak hours under existing and future year conditions.

- **Fifth Street and Leonard Street** - This intersection has single approach lanes on Fifth Street and Leonard Street. The Fifth Street approach is STOP sign controlled at the intersection. This intersection operates at acceptable levels of service (LOS C or better) during the weekday morning and evening peak hours under existing and future year conditions.

- **Porter Street and Charles Street** - This intersection has single approach lanes on Porter Street and Charles Street. The Porter Street approach is STOP sign controlled at the intersection. This intersection operates at acceptable levels of service (LOS C or better) during the weekday morning and evening peak hours under existing and future year conditions.

- **Porter Street and Leonard Street** - This intersection has single approach lanes on Porter Street and Leonard Street. The Porter Street approach is STOP sign controlled at the intersection. This intersection operates at acceptable levels of service (LOS C or better) during the weekday morning and evening peak hours under existing and future year conditions.

- **Sunnyside Avenue and Draher Avenue** - This intersection has single approach lanes on Sunnyside Avenue and Draher Avenue. The Draher Avenue approach is STOP sign controlled at the intersection. This intersection operates at acceptable levels of service (LOS C or better) during the weekday morning and evening peak hours under existing and future year conditions.

- **Sunnyside Avenue and Draher Avenue** - This intersection has single approach lanes on Sunnyside Avenue and the I-84 EB Exit ramp. The I-84 EB Exit ramp approach is STOP sign controlled at the intersection. This intersection operates at acceptable levels of service (LOS C or better) during the weekday morning and evening peak hours under existing and future year conditions.

Figure 5-8: Intersection Capacity Analysis Summary (1 of 4)
2005 A.M. Peak Hour

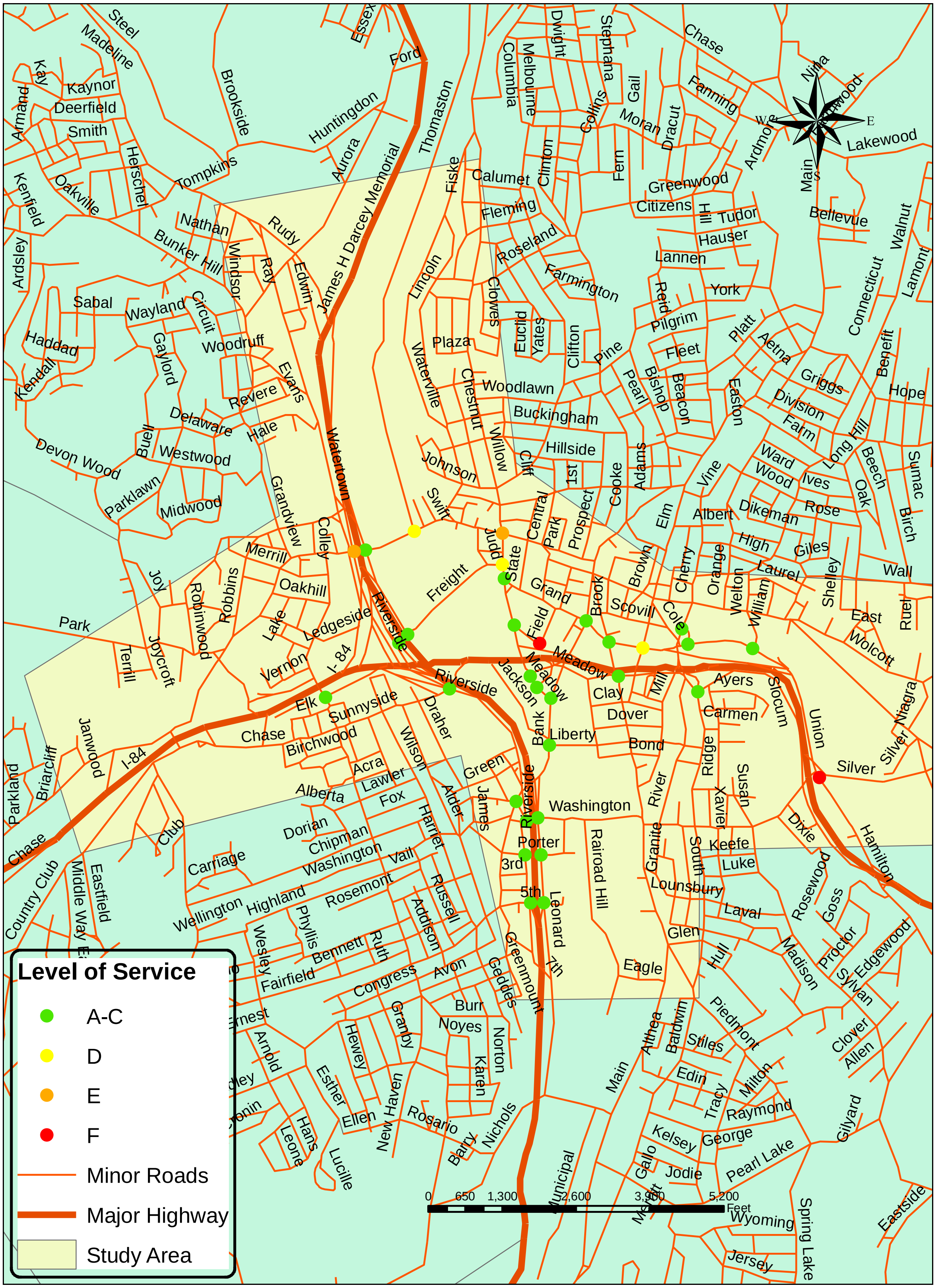


Figure 5-8: Intersection Capacity Analysis Summary (2 of 4)
2030 A.M. Peak Hour

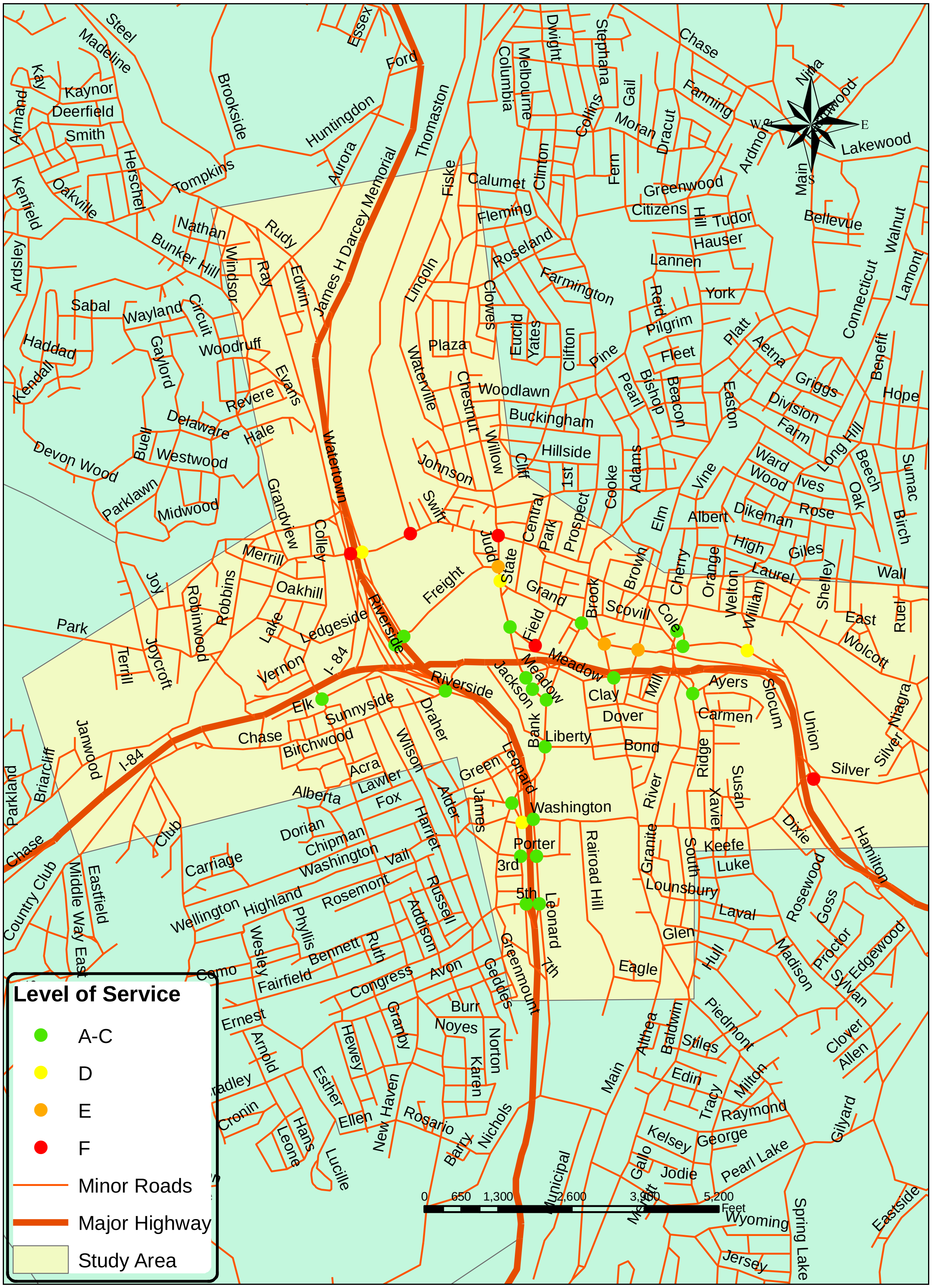


Figure 5-8: Intersection Capacity Analysis Summary (3 of 4)
2005 P.M. Peak Hour

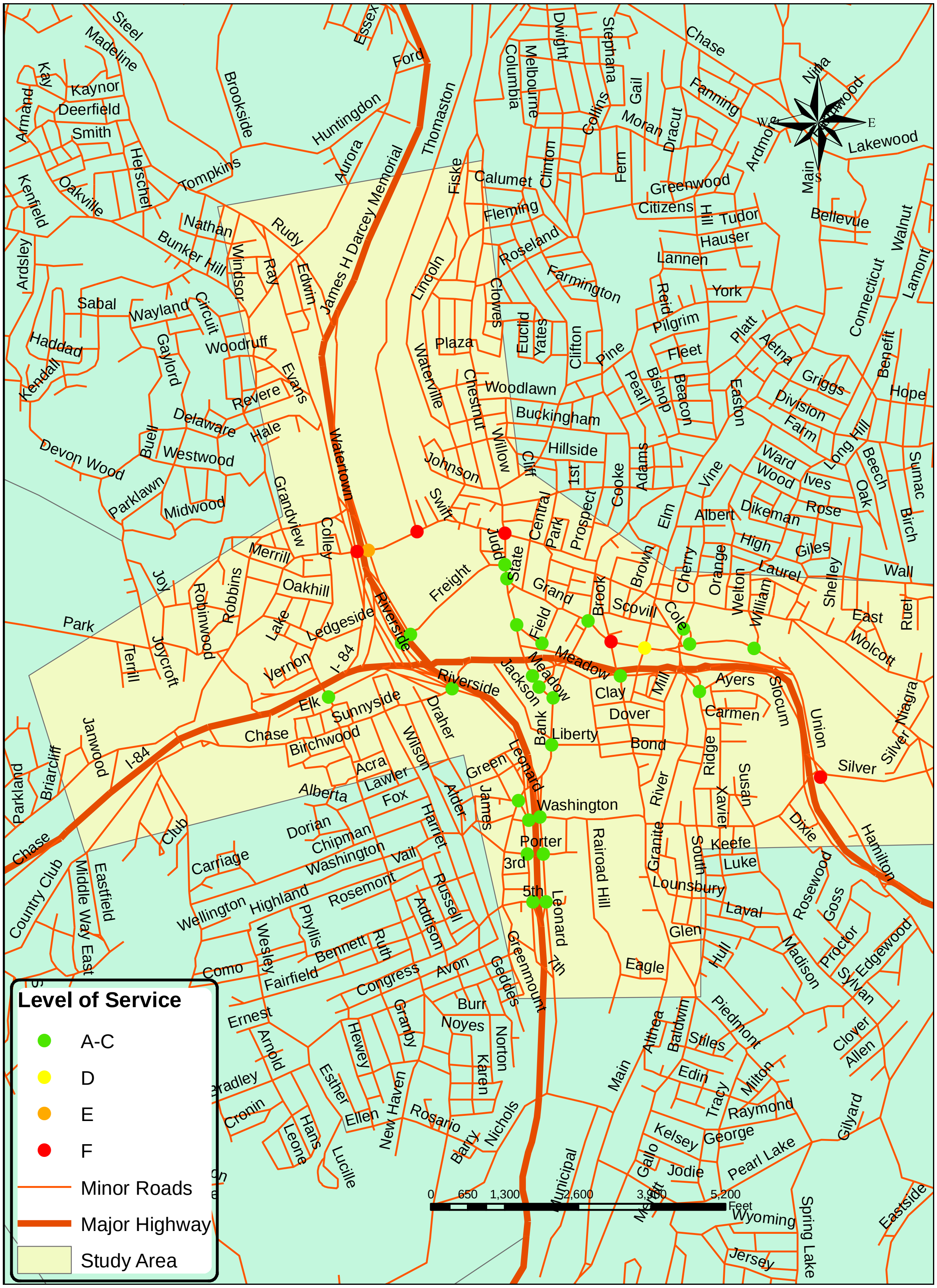
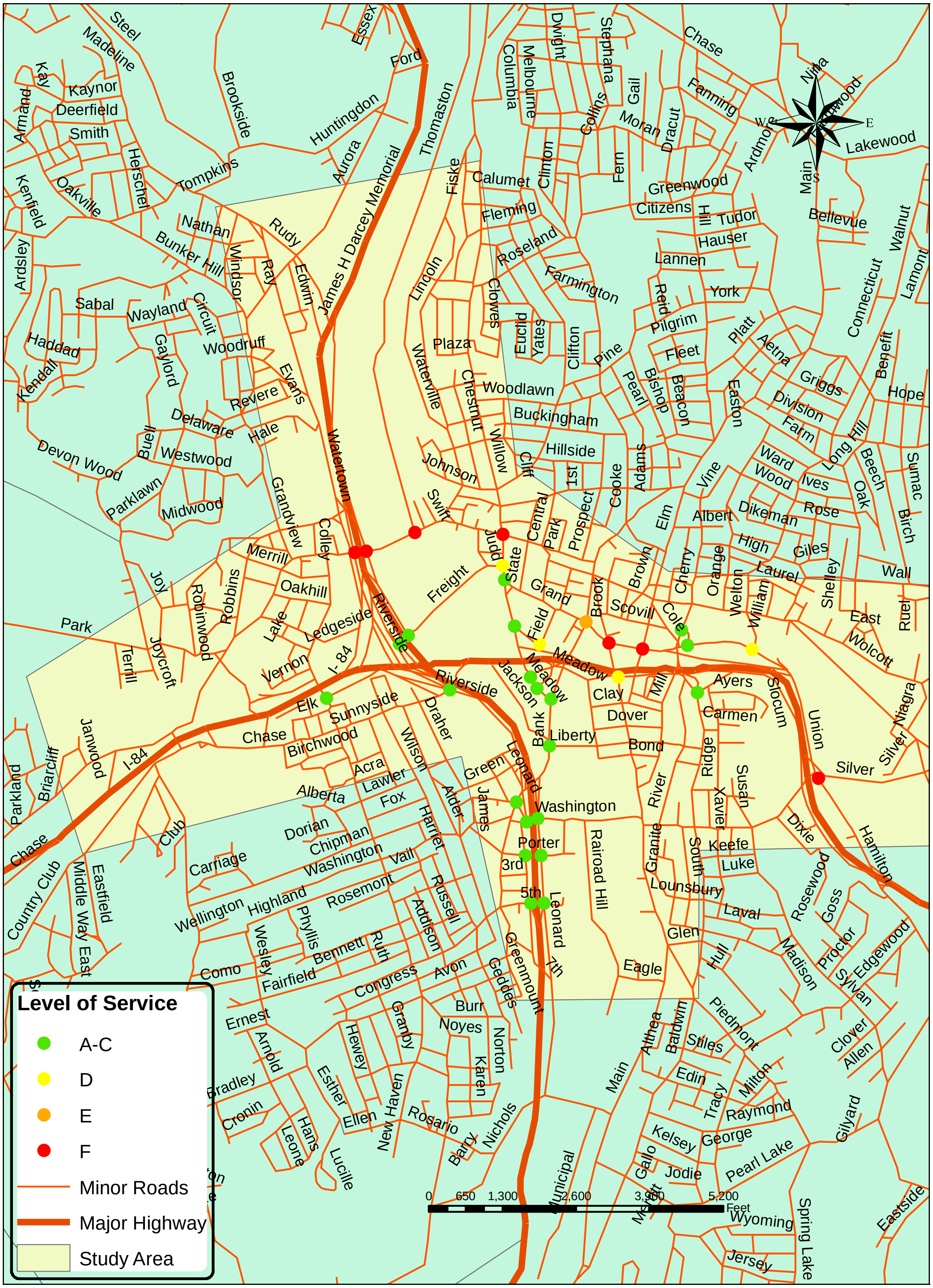


Figure 5-8: Intersection Capacity Analysis Summary (4 of 4)
2030 P.M. Peak Hour



5.2 VISSIM Analysis

A roadway network was developed that included all highway segments, interchange ramps, and major arterial roadways in the study area. The network was superimposed on scaled aerial mapping so that the precise link geometry could be reflected in the model. Figure 5-9 shows the VISSIM network developed for this study. Data inputs to the network file include:

- Lane geometry and configuration;
- Grade and elevation;
- Traffic control information such as signal timing;
- Road functional classification;
- ConnDOT traffic count data; and
- Turn movement distributions from ConnDOT.

Figure 5-9: VISSIM Network

5.2.1 VISSIM Performance Measures

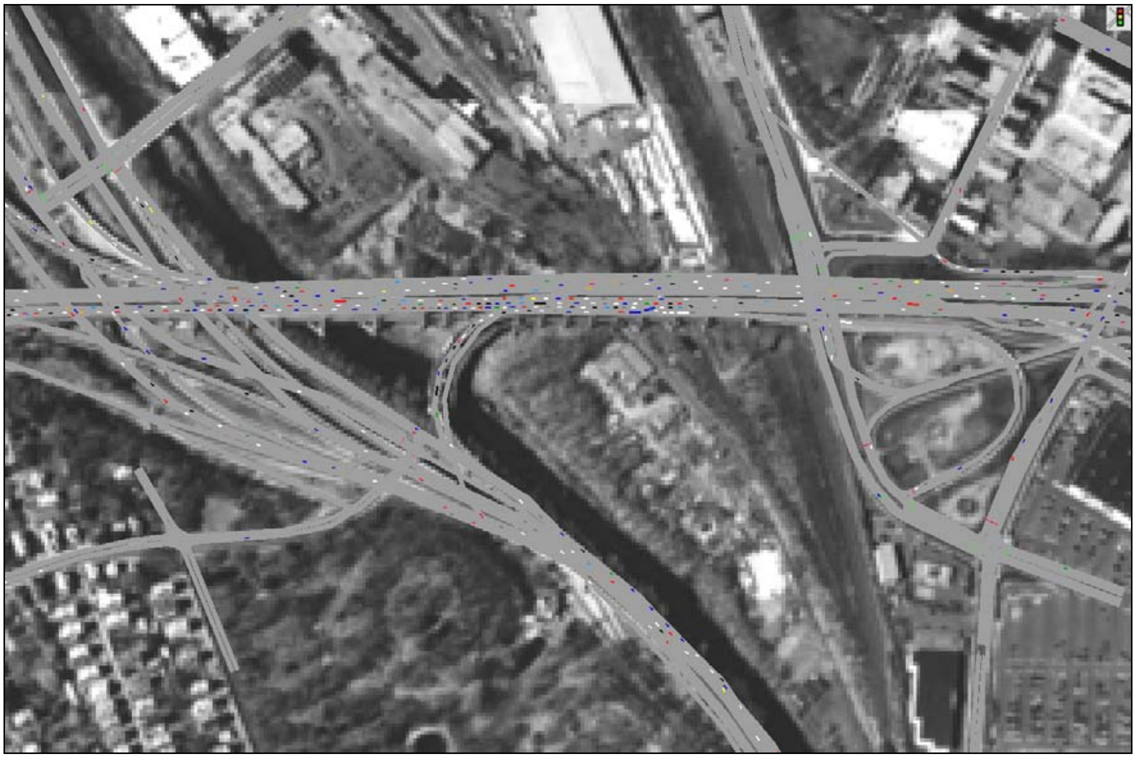
Measuring operational performance of a roadway system is often difficult to achieve in the field, but can be relatively easy with VISSIM provided care is taken when inputting data. Once the model is calibrated to current year 2005 traffic conditions, a variety of performance measures can be exported or derived from the VISSIM output files. The primary performance measures that are generated by VISSIM are as follows:

- Flow – defined as the number of vehicles that pass a given point during a length of time;
- Travel Time – defined as the average length of time for a vehicle to pass between two given points;
- Speed – defined as the average vehicle speed in miles per hour (mph);
- Density – defined as the number of vehicles per mile per lane for a given segment;
- Delay – defined as the additional travel time required to pass between two points when speed is below free flow speed; and
- Queue Length – is the length of vehicle queue that is experienced when congestion occurs at a given location or when traffic is stopped at a traffic control device.

For this study, performance measures are going to be collected for the highway mainlines and associated interchange systems only. The arterial roadway system is included in the model so that vehicles entering and leaving the highway system can be visually tracked and monitored for local intersection congestion. This will be especially important if improvement alternatives are later defined that relocate ramp termini to new locations.

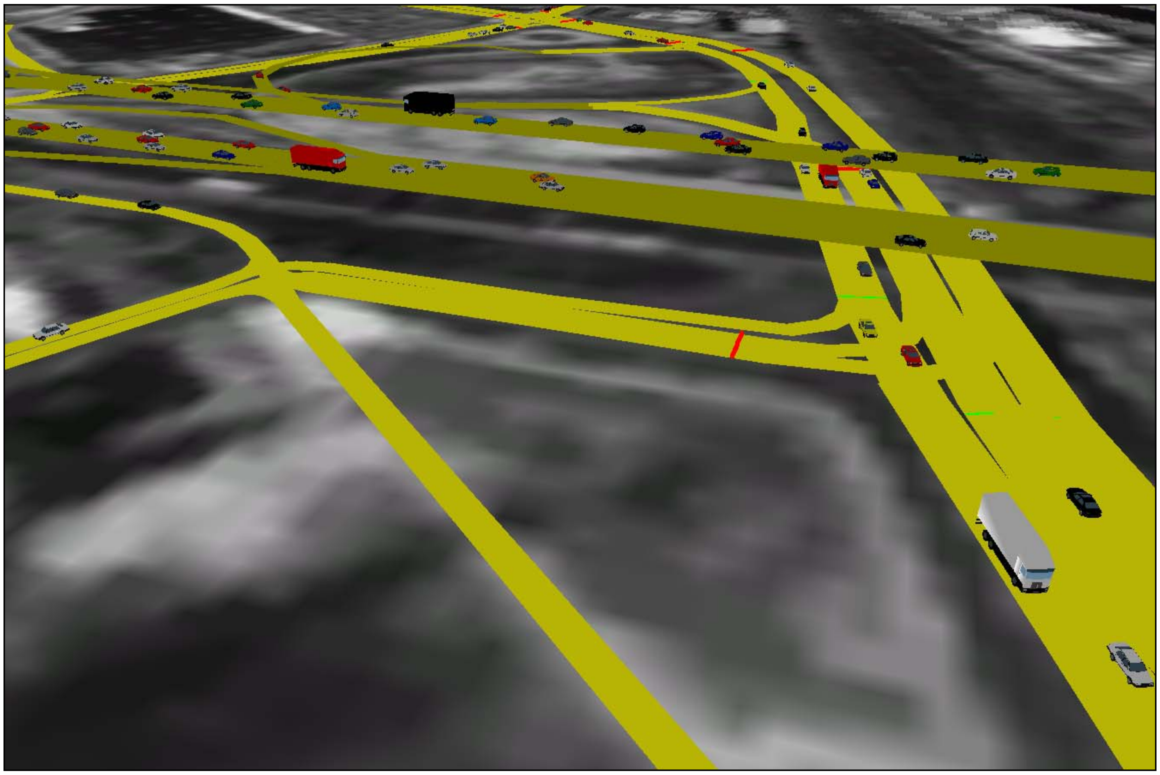
At this stage of the study performance measurement is of primary importance, but VISSIM also has a visualization element that aids in the calibration process and help the user to understand the location, extent and duration of congestion in the network. Figure 5-10demonstrates how VISSIM can be used to visualize the movement of vehicles through the network.

Figure 5-10: Visualization



VISSIM also has 3-dimensional capabilities that allow the user to view the simulation from a variety of angles and perspectives. This feature will be more fully developed as the study progresses and advanced visualization of the interchange and improvement alternatives are required. Figure 5-11shows the 3-D model in its early stages of development.

Figure 5-11: VISSIM 3D Capabilities



5.2.2 Caveats and Assumptions

As stated previously, some of the LOS results from VISSIM may not replicate results found in the HCS analysis for reasons already stated. In addition, vehicle flow may not equate to the traffic volume numbers posted in the HCS analysis, particularly for the future year condition. The difference in these numbers is due the concept of unconstrained versus constrained demand. For the HCS analysis, traffic volumes represent to total amount of traffic that desires to use the roadway over a period of one hour. This volume does not take into consideration the fact that the roadway's actual capacity may prevent all of those vehicles from moving through a particular section over that period of time.

In the VISSIM analysis, traffic flow is measured instead of unconstrained volume. Flow is the actual number of vehicles that can pass through a given section of roadway with a period of time – in this case one hour. In most cases, the future year flow will be less than the unconstrained volume used in the HCS analysis. This is because as volumes exceed capacity, traffic flow is reduced to very low levels - as is speed. Density, in turn, is calculated as the flow divided by the average speed divided by the number of lanes on the segment. This is a major distinction from the HCS analysis because as flow decreases, so does speed. By calculating segment density this way (as opposed to volume/distance/# of lanes), a future year density can be much greater than the existing year density even though the flow is less.

Similarly, the year 2005 speeds calculated are based on traffic volume data collected by the DOT and may not reflect the same conditions experienced in the field and as reported in Table 4.1 in Chapter 4. It is also important to note that VISSIM utilizes a probability distribution of input vehicle speeds that centers around a mean of 55 MPH. This input speed distribution was chosen because the posted speeds on the highways in the study area range from 50 to 55 MPH in most locations. As real world conditions dictate, it is possible to travel at higher rates of speed when congestion is not present. Speeds in excess of highway design speeds present safety issues. For this analysis, we assumed that free flow speed is close to posted speed and therefore did not try to replicate the actual conditions experienced in the field during the days in which the speed analysis was performed.

5.2.3 A.M. Peak Hour Analysis Results

<u>I-84 Eastbound:</u> Figure 5-12 illustrates the VISSIM analysis results for I-84 eastbound. Average speeds for the existing year analysis range from 27 to 41 mph throughout the corridor, with the slowest segment between the entrance ramp from Route 8 NB to the exit ramp at Meadow Street. This is due to the short weave segment at this location. In the future year analysis, speeds drop significantly – ranging from 9 mph on the western end of the corridor to 35 mph on the eastern end. From Interchange 18 to the Meadow Street exit ramp at Interchange 21 speeds are consistently below 20mph, suggesting significant congestion along that segment.

LOS is determined by relating the VISSIM density calculations to the table provided in the Highway Capacity Manual, similar to what was done in the HCS analysis. The HCM LOS definitions are provided in Table 5-19 below.

Table 5-19: LOS Criteria for Freeway Sections

Level of Service	Maximum Density (pc/mi/lane)
A	11
B	18
C	26
D	35
E	45
F	Greater than 45

<u>Source</u>: 2000 Highway Capacity Manual

In the existing year analysis, the segment LOS ranges from D to F for the entire eastbound corridor. The greatest density of traffic (and lowest LOS) occurs at the segment between the entrance ramp from Route 8 NB at Interchange 20 and the South Main Street exit ramp at Interchange 21.This entire segment is at a LOS F due to high volumes, high frequency of interchange ramps, and substandard lane and ramp geometry. In the future year, the entire corridor degrades to poor or failing levels of service. It should be noted that the segment east of Interchange 23 actually improves from a LOS F in year 2005 to LOS E in year 2030 due to the additional travel lane that is currently being constructed along that segment.

I-84 Westbound: Figure 5-13 illustrates the VISSIM analysis results for I-84 westbound. Average speeds for the existing year analysis range from 34 to 47 mph throughout the corridor, with the slowest segment between the entrance ramp from Route 8 NB to the exit ramp at Interchange 18. This is due to the turbulence in flow created by the left hand entrance ramp to I-84 and the closely spaced downstream exit ramp at Interchange 18. In the future year analysis, speeds range from 12 to 46 mph. Overall, speeds are not drastically impacted by the addition future year volume and that is mainly due to the adequate capacity on the highway in the westbound direction. Speeds are significantly impacted west of entrance ramp from Route 8 NB however, due to the same issue previously stated.

In the existing year analysis, the segment LOS ranges from C to F for the entire westbound corridor. The greatest density of traffic (and lowest LOS) occurs from the entrance ramp from Route 8 NB to the exit ramp at Interchange 18. This entire segment is at a LOS F due to high volume and substandard ramp geometry. A LOS F is also recorded between the entrance ramp from Union Street at Interchange 22 to the exit ramp at Meadow Street at Interchange 21 due to the choke point created by the high volume of traffic entering the highway at Interchange 21. In the future year analysis, most of the corridor operates at poor or failing levels of service.

Route 8 Northbound: Figure 5-14 illustrates the VISSIM analysis results for Route 8 northbound. Average speeds for the existing year analysis range from 38 to 52 mph throughout the corridor, with the slowest segment between the entrance ramp from West Main/Riverside to the exit ramp to Route 73(Aurora Street). This is due to the turbulence in flow created by the right-hand entrance ramp to I-84 and the left-hand downstream exit ramp to route 73. In the future year analysis, speeds are not drastically impacted by the addition future year volume and that is mainly due to relatively low traffic volume on Route 8 northbound.

In the existing year analysis, the segment LOS ranges from A to C for the entire northbound corridor. The northbound corridor operates at acceptable levels of service during the A.M. peak hour. For the future year analysis, the corridor LOS degrades slightly between the exit ramp at Interchange 30 and the exit ramp to I-84 eastbound. For this segment, the LOS reduces from LOS B to LOS C over the 25-year forecasting period.

Route 8 Southbound: Figure 5-15 illustrates the VISSIM analysis results for Route 8 southbound. Average speeds for the existing year analysis range from 35 to 46 mph throughout the corridor, with the slowest segment between the right-hand entrance ramp from I-84 eastbound to the left-hand entrance ramp from I-84 westbound. In the future year analysis, speeds significantly decrease between the northern terminus of the Route 8 corridor and the exit ramp to I-84 westbound. Speeds along this segment are below 15 mph and are due to the heavy volume of traffic entering the freeway from Route 73, causing a choke point the backs traffic up to the north and creates forced flow conditions for approximately one half mile south of the merge.

In the existing year analysis, the segment LOS ranges from B to E for the entire southbound corridor. The greatest density of traffic (and lowest LOS) occurs on the segment between the entrance ramp from Route 73 to the exit ramp to I-84 westbound. This entire segment is at a LOS E due to relatively high volumes along this segment. The remainder of the corridor operates at acceptable levels of service. For the future year analysis, much of the corridor LOS remains the same with the exception of the segment previously identifies. This segment drops to LOS F due to the increase in traffic and the high volume merge with Route 73.

5.2.4 P.M. Peak Hour Analysis Results

<u>I-84 Eastbound:</u> Figure 5-16 illustrates the VISSIM analysis results for I-84 eastbound. Average speeds for the existing year analysis range from 30 to 41 mph throughout the corridor, with the slowest segment between the frontage road exit ramp to the entrance ramp at Interchange 23. In the future year analysis, speeds drop significantly – ranging from 7 mph on the western end of the corridor to 33 mph on the eastern end. From Interchange 18 to the South Main Street exit ramp at Interchange 21 speeds are consistently below 20mph, suggesting significant congestion along that segment.

In the existing year analysis, the segment LOS ranges from D to F for the entire eastbound corridor. The greatest density of traffic (and lowest LOS) occurs from the Route 8 SB exit ramp to the Route NB exit ramp at Interchange 19. This segment is at a LOS F due to high volumes, high frequency of interchange ramps, and substandard lane and ramp geometry. In the future year, the entire corridor degrades to poor or failing levels of service. It should be noted that the segment east of Interchange 23 actually improves from a LOS F in year 2005 to LOS E in year 2030 due to the additional travel lane that is currently being constructed along that segment.

<u>I-84 Westbound:</u> Figure 5-17 illustrates the VISSIM analysis results for I-84 westbound. Average speeds for the existing year analysis range from 34 to 48 mph throughout the corridor, with the slowest segment between the entrance ramp from Route 8 NB to the entrance ramp from Route 8 SB at Interchange 19. This is due to the turbulence in flow created by the left hand entrance ramp to I-84 and the closely spaced downstream exit ramp at Interchange 18. In the future year analysis, speeds drop significantly – ranging from 5 to 40 mph. The lowest speeds occur at the segment east of Interchange 23 and the segment between the exit ramp at Interchange 20 and the exit ramp at Interchange 19.

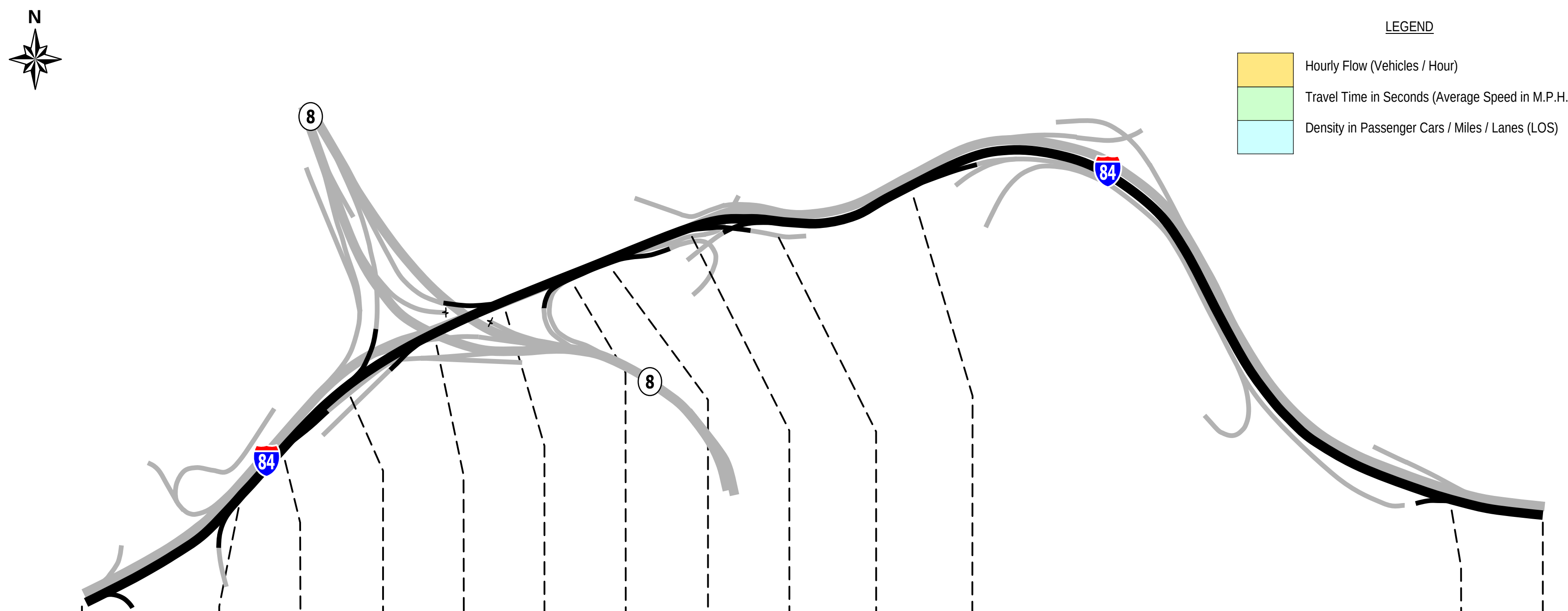
In the existing year analysis, the segment LOS ranges from C to F for the entire westbound corridor. The greatest density of traffic (and lowest LOS) occurs at the segment between the entrance ramp at Interchange 22 and the exit ramp at Interchange 21. This segment is at a LOS F due to high volume and substandard ramp geometry. In the future year analysis, most of the corridor operates at poor or failing levels of service.

Route 8 Northbound: Figure 5-18illustrates the VISSIM analysis results for Route 8 northbound. Average speeds for the existing year analysis range from 29 to 51 mph throughout the corridor, with the slowest segment between the entrance ramp from West Main/Riverside to the exit ramp to Route 73(Aurora Street). This is due to the turbulence in flow created by the right-hand entrance ramp to I-84 and the left-hand downstream exit ramp to route 73. In the future year analysis, speeds are not drastically impacted by the addition future year volume and that is mainly due to relatively low traffic volume on Route 8 northbound.

In the existing year analysis, the segment LOS ranges from C to E for the entire northbound corridor. For the future year analysis, the corridor LOS degrades drastically south of the exit ramp at Interchange 33 from LOS C to LOS F at some segments.

Route 8 Southbound: Figure 5-19 illustrates the VISSIM analysis results for Route 8 southbound. Average speeds for the existing year analysis range from 37 to 50 mph throughout the corridor, with the slowest segment south of the entrance ramp at Interchange 30. In the future year analysis, speeds do not reduce significantly along the entire southbound corridor.

In the existing year analysis, the segment LOS ranges from A to D for the entire southbound corridor. The greatest density of traffic (and lowest LOS) occurs on the south of the exit ramp to I-84 WB at Interchange 31. This entire segment is at a LOS D due to relatively high volumes along this segment. The remainder of the corridor operates at acceptable levels of service. For the future year analysis, the LOS along the corridor does not change substantially with the LOS ranging from B to E.



VISSIM Segment Distance		1530 ft	834 ft	526 ft	605 ft	547 ft	661 ft	509 ft	800 ft	329 ft	1519 ft	5824 ft	1884 ft
Year 2005	Hourly Flow	2860	3300	3010	2570	3030	4470	5260	4800	4210	4460	3460	3820
	Travel Time	24 (45)	17 (35)	11 (34)	12 (36)	11 (33)	13 (34)	15 (24)	16 (34)	6 (36)	32 (33)	120 (33)	35 (37)
	Density	21 (C)	48 (F)	44 (E)	35 (D)	31 (D)	33 (D)	73 (F)	48 (F)	30 (D)	46 (F)	52 (D)	35 (C)
Year 2030	Hourly Flow	3560	4200	3870	3350	3900	4940	5950	5410	4650	4980	3430	3850
	Travel Time	126 (8)	48 (12)	19 (19)	27 (15)	21 (18)	25 (18)	21 (16)	17 (33)	6 (35)	34 (31)	114 (35)	38 (34)
	Density	143 (F)	178 (F)	100 (F)	108 (F)	72 (F)	68 (F)	122 (F)	55 (F)	33 (D)	54 (F)	33 (D)	38 (E)

VISSIM ANALYSIS

I-84 EASTBOUND A.M. PEAK HOUR (7:00-8:00)

ENGINEERS
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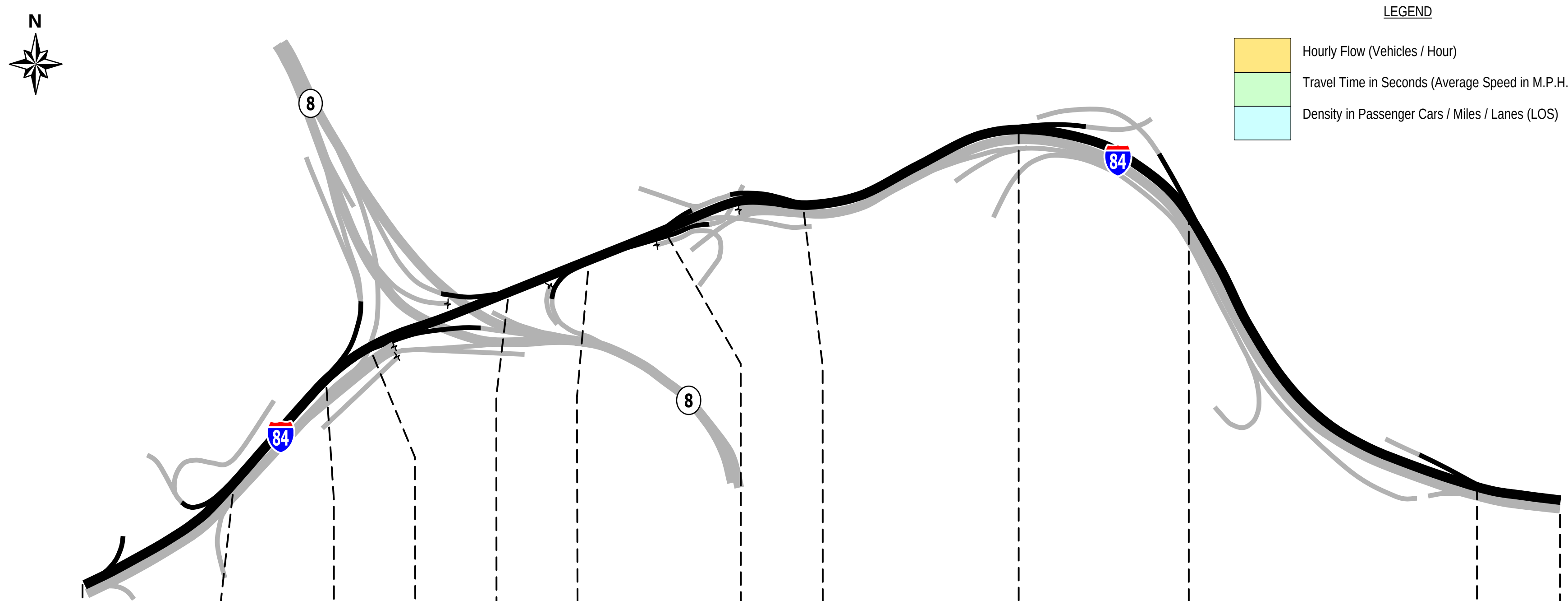
Wilbur Smith Associates

FIGURE 5-12



VISSIM Segment Distance		3464 ft	1354 ft	528 ft	916 ft	866 ft	932 ft	1140 ft	1870 ft	1735 ft	3521 ft	1517 ft
Year 2005	Hourly Flow	3340	4710	3410	2840	3900	4740	4360	4980	3810	4180	4310
	Travel Time (Speed)	62 (38)	27 (35)	9 (40)	15 (42)	16 (37)	17 (38)	19 (42)	32 (40)	20 (59)	66 (36)	43 (24)
	Density (LOS)	22 (C)	34 (D)	28 (D)	17 (B)	21 (C)	31 (D)	35 (D)	42 (E)	21 (C)	38 (E)	89 (F)
Year 2030	Hourly Flow	3500	4890	3950	3330	4490	5460	5080	5870	4750	5220	5390
	Travel Time (Speed)	62 (38)	88 (11)	32 (11)	30 (21)	27 (22)	25 (26)	21 (37)	39 (33)	50 (24)	112 (21)	44 (24)
	Density (LOS)	23 (C)	116 (F)	116 (F)	40 (E)	41 (E)	53 (F)	45 (E)	59 (F)	66 (F)	82 (F)	75 (F)

VISSIM ANALYSIS

I-84 WESTBOUND A.M. PEAK HOUR (7:00-8:00)

Wilbur Smith Associates
ENGINEERS PLANNERS ECONOMISTS

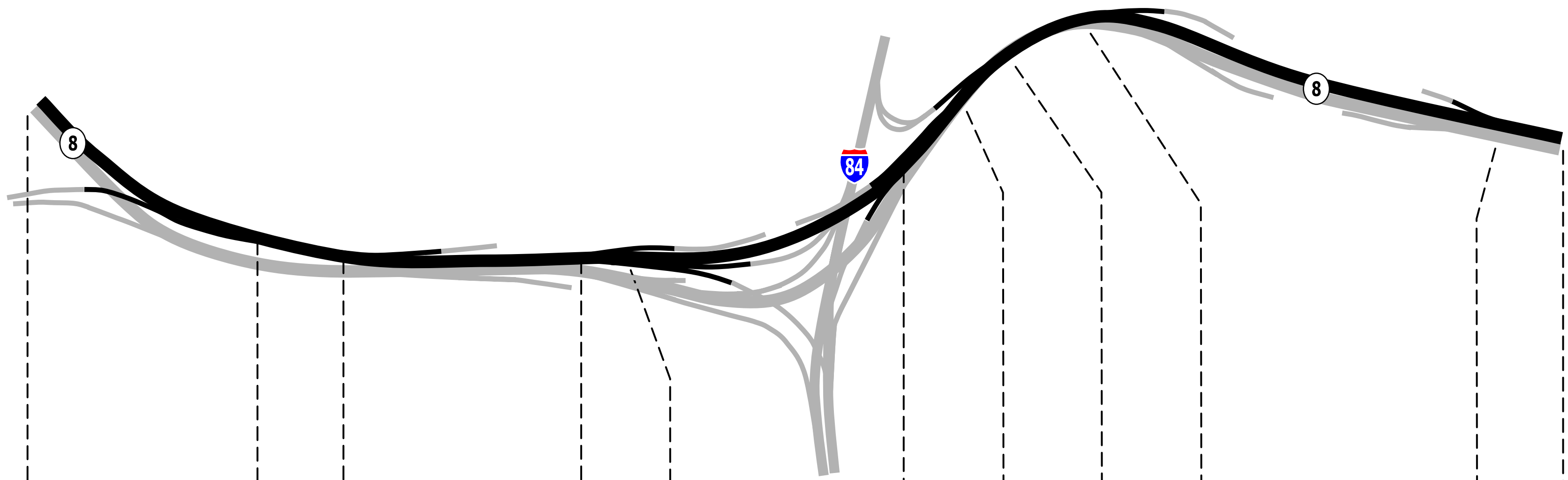
FIGURE 5-13

N

NOTE FIGURE
ROTATED 90 DEG.

LEGEND

- Hourly Flow (Vehicles / Hour) (yellow)
- Travel Time in Seconds (Average Speed in M.P.H.) (green)
- Density in Passenger Cars / Miles / Lanes (LOS) (blue)



VISSIM Segment Distance		1601 ft	1599 ft	1047 ft	611 ft	2099 ft	283 ft	714 ft	874 ft	3464 ft	2796 ft
Year 2005	Hourly Flow	1560	2500	2330	2220	2510	1280	1600	2400	1900	2,010
	Travel Time (Speed)	28 (39)	29 (38)	17 (42)	10 (43)	29 (48)	4 (49)	10 (51)	12 (48)	38 (62)	31 (62)
	Density (LOS)	13 (B)	22 (C)	19 (C)	17 (B)	17 (B)	13 (B)	16 (B)	17 (B)	15 (B)	16 (B)
Year 2030	Hourly Flow	1740	2860	2690	2560	2920	1610	1980	2990	2400	2550
	Travel Time (Speed)	29 (38)	29 (38)	17 (42)	10 (43)	29 (48)	4 (46)	10 (50)	13 (46)	38 (62)	31 (62)
	Density (LOS)	15 (B)	19 (C)	16 (B)	15 (B)	20 (C)	17 (B)	20 (C)	22 (C)	20 (C)	21 (C)

VISSIM ANALYSIS

ROUTE 8 NORTHBOUND A.M. PEAK HOUR (7:00-8:00)

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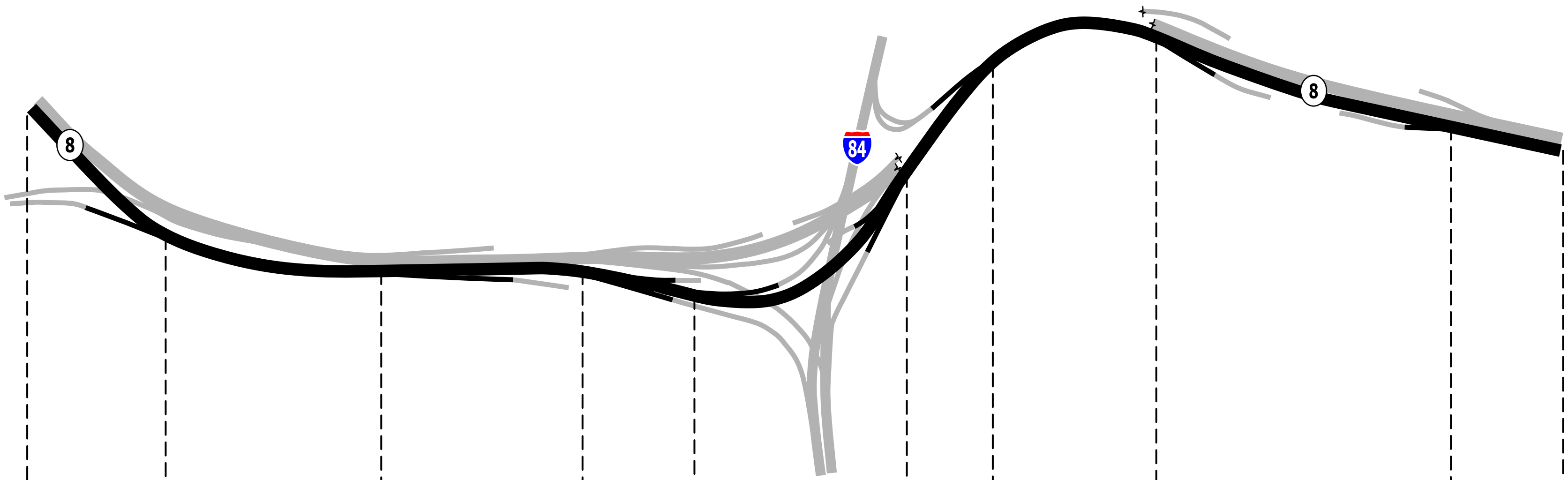
FIGURE 5-14

N

NOTE FIGURE
ROTATED 90 DEG.

LEGEND

- Hourly Flow (Vehicles / Hour)
- Travel Time in Seconds (Average Speed in M.P.H.)
- Density in Passenger Cars / Miles / Lanes (LOS)



VISSIM Segment Distance		1672 ft	2093 ft	1460 ft	810 ft	1343 ft	467 ft	2016 ft	2501 ft	3190 ft
Year 2005	Hourly Flow	3220	4510	4220	2780	1330	1810	2660	2220	2380
	Travel Time (Speed)	19 (60)	33 (43)	24 (41)	14 (39)	20 (45)	9 (34)	34 (40)	41 (41)	54 (40)
	Density (LOS)	27 (D)	35 (D)	34 (D)	24 (C)	15 (B)	27 (D)	33 (D)	27 (D)	30 (D)
Year 2030	Hourly Flow	2660	3410	3040	1980	960	1490	2460	2030	2230
	Travel Time (Speed)	99 (11)	160 (9)	126 (8)	14 (40)	20 (46)	10 (34)	33 (42)	40 (43)	54 (40)
	Density (LOS)	116 (F)	127 (F)	128 (F)	17 (B)	10 (A)	22 (C)	29 (D)	24 (C)	28 (D)

VISSIM ANALYSIS

ROUTE 8 SOUTHBOUND A.M. PEAK HOUR (7:00-8:00)

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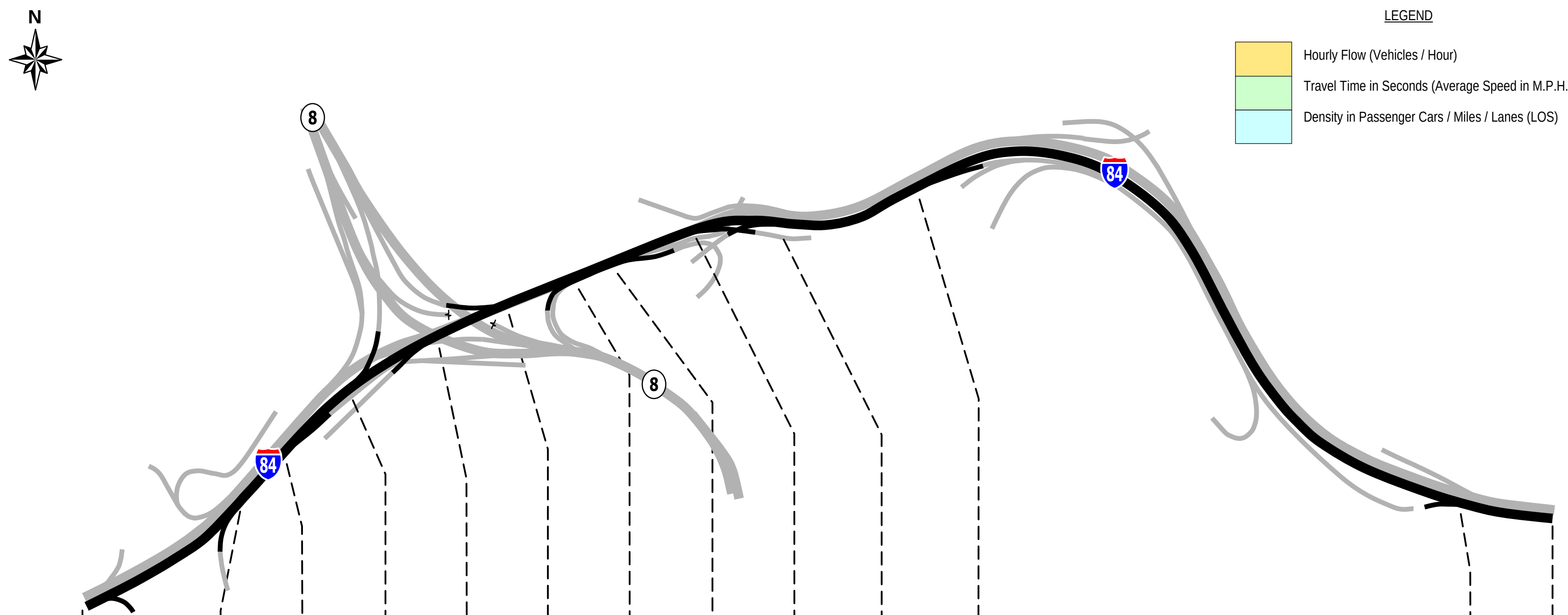
FIGURE 5-15



VISSIM Segment Distance		1,660 ft	940 ft	380 ft	1069 ft	792 ft	606 ft	487 ft	797 ft	898 ft	1120 ft	5,826 ft	1,884 ft
Year 2005	Hourly Flow	3350	3790	3470	2630	3110	4270	5220	4870	4280	4780	3320	3930
	Travel Time	23 (45)	19 (29)	11 (33)	11 (37)	11 (34)	13 (36)	12 (30)	16 (33)	6 (35)	35 (30)	120 (33)	37 (35)
	Density	25 (C)	65 (F)	53 (F)	35 (D)	31 (D)	30 (D)	59 (F)	49 (F)	31 (D)	53 (F)	50 (F)	37 (E)
Year 2030	Hourly Flow	2800	3430	3170	2550	3150	4650	5850	5470	4840	5390	3260	3660
	Travel Time	159(7)	58 (10)	23 (15)	39 (11)	26 (14)	31 (14)	23 (15)	21 (26)	12 (18)	53 (19)	114 (35)	38 (34)
	Density	142 (F)	175 (F)	103 (F)	121 (F)	74 (F)	81 (F)	129 (F)	70 (F)	67 (F)	93 (F)	31 (D)	36 (E)

VISSIM ANALYSIS

I-84 EASTBOUND P.M. PEAK HOUR (5:00-6:00)

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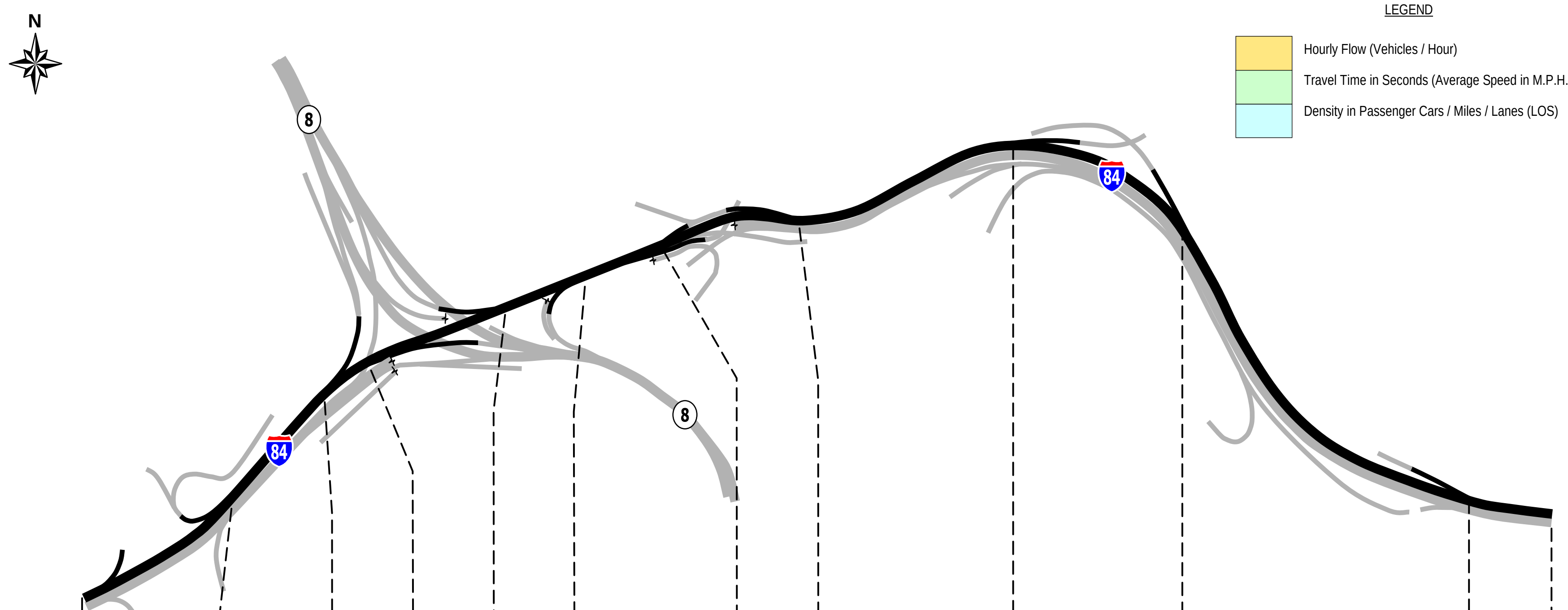
FIGURE 5-16



VISSIM Segment Distance		3464 ft	1354 ft	528 ft	916 ft	866 ft	932 ft	1140 ft	1870 ft	1735 ft	3521 ft	1517 ft
Year 2005	Hourly Flow	3260	4440	3590	3210	4880	5870	5100	5400	3890	4190	4380
	Travel Time	64 (37)	26 (36)	9 (39)	16 (39)	19 (32)	19 (32)	20 (39)	33 (39)	20 (60)	50 (48)	18 (57)
	Density	22 (C)	31 (D)	31 (D)	21 (C)	30 (D)	45 (E)	44 (E)	47 (F)	22 (C)	29 (D)	38 (E)
Year 2030	Hourly Flow	3690	5030	4020	3570	5160	6110	4910	5200	4070	4420	4600
	Travel Time	64 (37)	36 (26)	10 (37)	17 (37)	45 (13)	54 (12)	40 (20)	57 (22)	73 (16)	145 (17)	56 (19)
	Density	25 (C)	49 (E)	36 (E)	24 (C)	78 (F)	129 (F)	84 (F)	77 (F)	84 (F)	89 (F)	83 (F)

VISSIM ANALYSIS

I-84 WESTBOUND P.M. PEAK HOUR (5:00-6:00)

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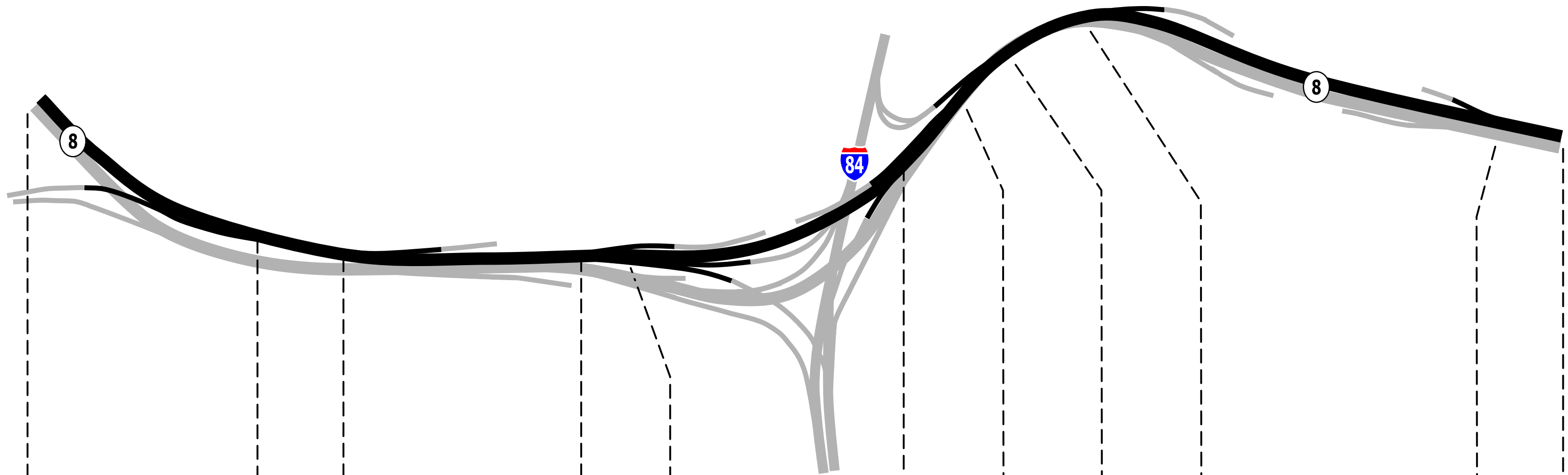
FIGURE 5-17

N

NOTE FIGURE ROTATED 90 DEG.

LEGEND

- Hourly Flow (Vehicles / Hour)
- Travel Time in Seconds (Average Speed in M.P.H.)
- Density in Passenger Cars / Miles / Lanes (LOS)



VISSIM Segment Distance		1601 ft	1599 ft	1047 ft	611 ft	2099 ft	283 ft	714 ft	874 ft	3464 ft	2796 ft
Year 2005	Hourly Flow	3080	4580	4310	4090	4860	1970	2270	3150	2790	2910
	Travel Time (Speed)	32 (34)	36 (30)	20 (37)	11 (39)	30 (44)	4 (50)	9 (53)	12 (51)	38 (62)	31 (62)
	Density (LOS)	30 (D)	38 (E)	29 (D)	26 (C)	37 (E)	20 (C)	21 (C)	21 (C)	22 (C)	23 (C)
Year 2030	Hourly Flow	3340	4940	4500	4240	5640	2460	2770	3980	3480	3700
	Travel Time (Speed)	33 (33)	43 (26)	19 (37)	11 (39)	34 (39)	5 (42)	11 (44)	37 (16)	42 (56)	31 (61)
	Density (LOS)	34 (D)	48 (F)	30 (D)	27 (D)	49 (F)	30 (C)	32 (D)	83 (F)	31 (D)	30 (D)

VISSIM ANALYSIS

ROUTE 8 NORTHBOUND P.M. PEAK HOUR (5:00-6:00)

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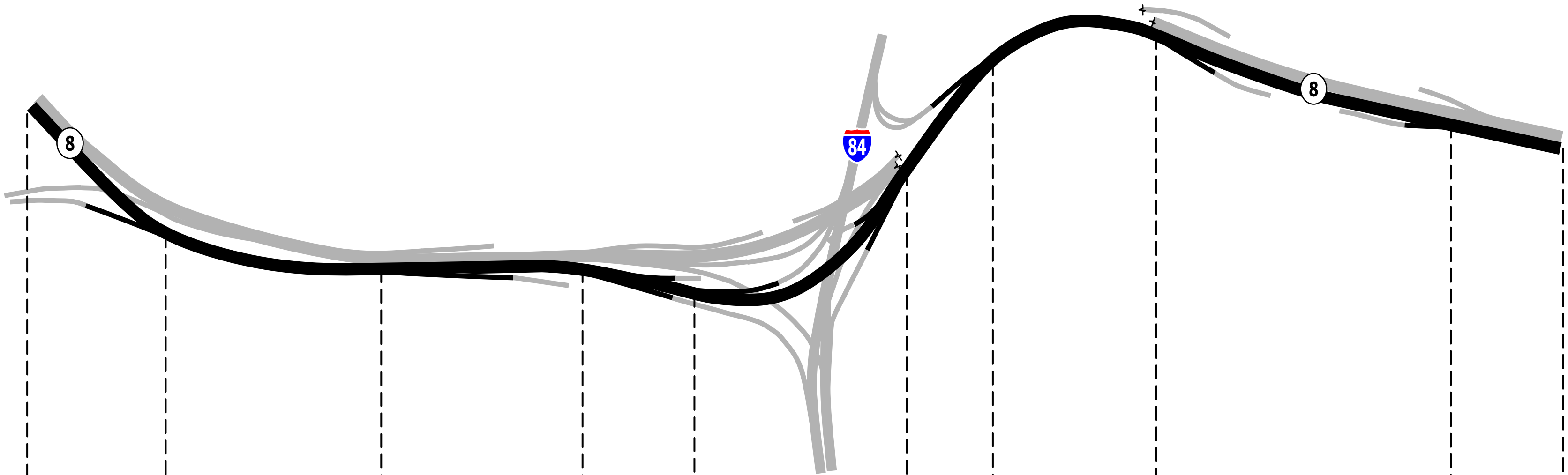
FIGURE 5-18

N

NOTE FIGURE ROTATED 90 DEG.

LEGEND

- Hourly Flow (Vehicles / Hour)
- Travel Time in Seconds (Average Speed in M.P.H.)
- Density in Passenger Cars / Miles / Lanes (LOS)



VISSIM Segment Distance		1672 ft	2093 ft	1460 ft	810 ft	1343 ft	467 ft	2016 ft	2501 ft	3190 ft
Year 2005	Hourly Flow	2200	3250	2960	2160	1010	1690	2690	2320	2520
	Travel Time (Speed)	19 (61)	32 (45)	23 (44)	13 (43)	20 (45)	8 (41)	36 (38)	44 (39)	60 (37)
	Density (LOS)	18 (B)	24 (C)	22 (C)	17 (B)	11 (A)	20 (C)	35 (D)	30 (D)	34 (D)
Year 2030	Hourly Flow	2850	4220	3830	2820	1330	2060	3010	2620	2850
	Travel Time (Speed)	19 (61)	34 (43)	25 (41)	15 (38)	22 (42)	10 (33)	38 (37)	46 (37)	60 (36)
	Density (LOS)	24 (C)	33 (D)	31 (D)	25 (C)	16 (B)	32 (B)	41 (F)	35 (D)	40 (E)

VISSIM ANALYSIS

ROUTE 8 SOUTHBOUND P.M. PEAK HOUR (5:00-6:00)

ENGINEERS PLANNERS ECONOMISTS
Wilbur Smith Associates

FIGURE 5-19

5.2.5 Exit Ramp Queue Lengths

Vehicle queue lengths on exit ramps were obtained from VISSIM to identify deficiencies related to deceleration and stopping sight distance. There were 3 types of deficiencies that were identified. These deficiencies are:

- Queue backup into mainline- This refers to the situation where the queue length on the exit ramp backs up into the highway mainline line thereby interfering with the traffic operation and safety of the mainline.
- Queue backup into deceleration lane- This presents a situation where there is insufficient deceleration length for a vehicle to adequately reduce its speed to negotiate a curve in the exit ramp as a result of queue backup into the deceleration lane. Queues do not backup into the mainline in this case.
- Inadequate stopping sight distance - In this case, queues do not back up into the deceleration lane, however, there is inadequate distance for a vehicle at the end of the deceleration lane to safely come to a stop without colliding with the last vehicle in the queue on the exit ramp.

There were 2 exit ramps with queue length deficiencies in the existing year 2005 as shown in Table 5-20. These exit ramps are:

I-84 westbound exit ramp at Interchange 23- The maximum queue length on this exit ramp is 100 feet while the total ramp length is 915 feet. Even though maximum queues on this exit ramp do not back into the deceleration lane, there is insufficient stopping sight distance from the end of the deceleration lane to the last vehicle in the queue during the P.M. peak hour. The available stopping distance from the end of the deceleration lane to the last vehicle in queue for this exit ramp is 15 feet during the P.M. peak hour. AASHTO recommends a minimum stopping sight distance of 155 feet for a 25mph design speed.

Route 8 southbound exit ramp at Interchange 30- The maximum queue length on this exit ramp is 345 feet, while the total ramp length is 450 feet. Maximum queues on this exit ramp backup into the deceleration lane during the A.M. and P.M. peak hours. There is therefore insufficient deceleration lane length for a vehicle to safely slow down to the design speed of the exit ramp.

There were 6 exit ramps with queue length deficiencies in the future year 2030 as illustrated in Table 5-21. These ramps are:

I-84 westbound exit ramp at Interchange 18- The maximum queue length on this exit ramp is 1,699 feet, while the total ramp length is 1,240 feet. The maximum queue on this exit ramp backs into the highway mainline during the future A.M. peak hour.

I-84 westbound exit ramp at Interchange 22- The maximum queue length on this exit ramp is 1,699 feet, while the total ramp length is 1,500 feet. The maximum queue on this exit ramp backs up into the highway mainline during both future A.M. and P.M. peak hours.

I-84 westbound exit ramp at Interchange 23- The maximum queue length on this exit ramp is 569 feet, while the total ramp length is 915 feet. Maximum queues on this exit ramp backup into the deceleration lane during both future A.M. and P.M. peak hours. There is therefore insufficient deceleration length for a vehicle to safely slow down to the design speed of the exit ramp.

Route 8 northbound exit ramp at Interchange 30- The maximum queue length on this exit ramp is 269 feet, while the total ramp length is 575 feet. Maximum queues on this exit ramp backup into the deceleration lane during the future P.M. peak hour. There is insufficient deceleration length for a vehicle to safely reduce its speed to the design speed of the exit ramp during the future P.M. peak hour.

Route 8 southbound exit ramp at Interchange 30- The maximum queue length on this exit ramp is 267 feet, while the total ramp length is 450 feet. Maximum queues on this exit ramp backup into the deceleration lane during peak hours. There is therefore insufficient deceleration length for a vehicle to safely slow down to the design speed of the exit ramp during both future A.M. and P.M. peak hours.

Route 8 northbound exit ramp at Interchange 31- The maximum queue length on this exit ramp is 1,656 feet, while the total ramp length is 1,080 feet. The maximum queue on this exit ramp backs up into the highway mainline during the both future A.M. and P.M. peak hours.

Table 5-20: Existing Exit Ramp Terminus Queue Lengths

Location	Direction	Ramp Length (feet)	Deceleration Length (feet)	2005 A.M. Peak Average Queue	2005 A.M. Peak Maximum Queue	2005 P.M. Peak Average Queue	2005 P.M. Peak Maximum Queue	Deficiency* A.M. / P.M.
I-84								
Interchange 18								
	WB	1240	390	0	0	0	0	- / -
Interchange 20								
	WB	860	325	0	0	0	0	- / -
Interchange 21								
	EB (to Meadow St)	1400	600	36	330	23	206	- / -
	EB (to S. Main St)	1000	320	0	35	0	21	- / -
	WB	1060	415	8	198	2	80	- / -
Interchange 22								
	WB	1500	250	182	486	46	234	- / -
Interchange 23								
	WB	915	800	5	78	9	100	3 / 3
Route 8								
Interchange 30								
	NB	575	350	0	0	0	0	- / -
	SB	450	630	28	345	25	155	2 / 2
Interchange 31								
	NB	1080	420	0	26	0	0	- / -
Interchange 32								
	NB	960	475	0	0	0	0	- / -
	SB	600	460	0	0	0	0	- / -
Interchange 34								
	SB	1350	660	47	190	48	212	- / -

*Note: 1. Denotes queue backup onto mainline. 2. Denotes queue backup onto deceleration lane.
3. Denotes inadequate stopping sight distance to back of queue. -. Denotes no queue length deficiency.

Table 5-21: Future Exit Ramp Terminus Queue Lengths

Location	Direction	Ramp Length (feet)	Deceleration Length (feet)	2030 A.M. Peak Average Queue	2030 A.M. Peak Maximum Queue	2030 P.M. Peak Average Queue	2030 P.M. Peak Maximum Queue	Deficiency A.M. / P.M.
I-84								
Interchange 18								
	WB	1240	390	1093	1669	0	0	1 / -
Interchange 20								
	WB	860	325	0	0	0	53	- / -
Interchange 21								
	EB (to Meadow St)	1400	600	40	329	19	127	- / -
	EB (to S. Main St)	1000	320	138	534	0	47	- / -
	WB	1060	415	13	299	2	43	- / -
Interchange 22								
	WB	1500	250	902	1669	281	1668	1 / 1
Interchange 23								
	WB	915	800	14	195	157	569	2 / 2
Route 8								
Interchange 30								
	NB	575	350	0	0	9	269	- / 2
	SB	450	630	29	267	32	219	2 / 2
Interchange 31								
	NB	1080	420	4	590	1436	1656	1 / 1
Interchange 32								
	NB	960	475	2	84	0	0	- / -
	SB	600	460	0	0	0	0	- / -
Interchange 34								
	SB	1350	660	47	293	72	286	- / -

*Note: 1. Denotes queue backup onto mainline. 2. Denotes queue backup onto deceleration lane.
3. Denotes inadequate stopping sight distance to back of queue. -. Denotes no queue length deficiency.

5.3 Accident and Safety Analysis

Accident records for I-84 from the most recent three-year period, 2001-2003, were collected from ConnDOT and analyzed. Accident records are listed by date and include information about the location, accident type, light, pavement and weather conditions, vehicles involved, direction of travel, severity of injuries and reason for each collision.

In order to better understand causal patterns, traffic incidents were compiled by light conditions, pavement conditions, accident severity, and accident type. Observations from these analyses are reported in this section. A summary of the findings by segment are shown in Figure 5-20 through Figure 5-23.

5.3.1 Lighting Condition

The light conditions under which accidents occurred (daylight, dark, dusk or dawn) is shown by highway direction in Table 5-22, below. A full account of these accidents by interchange segment is shown in appendix material and in Figure 5-20 through Figure 5-23.

Table 5-22: Accident totals by Highway Direction and Light Condition

Segment	Total No.	Daylight		Dark		Dusk/Dawn		Unknown	
		No.	%	No.	%	No.	%	No.	%
EB I-84	593	410	69%	157	26%	26	4%	0	0%
WB I-84	644	414	64%	199	31%	27	4%	4	1%
NB Route 8	134	75	56%	49	37%	9	7%	1	1%
SB Route 8	120	95	79%	21	18%	4	3%	0	0%
GRAND TOTAL	**1491**	**994**	**67%**	**426**	**29%**	**66**	**4%**	**5**	**0%**

Based on Average Daily Traffic (ADT) on I-84, about 70% of this traffic drives during daylight hours. It would be expected that accidents would be distributed proportionally to driving time, unless lighting conditions are a major factor. The number of accidents occurring during daylight hours for the study area, as well as for I-84 and Route 8 when considered individually was 67%, slightly below the expected 70%.

While eastbound and westbound portions of I-84 showed slight variation (69% vs. 64%), the two directions of Route 8 show a strong correlation between direction and lighting condition. Only 56% of northbound accidents occurred during the daylight, compared to 79% of southbound accidents, suggesting the lighting situations on the two parts of the highway may be a factor.

Many of the segments deviated within ±10% of the 70%, which is statistically insignificant. Exceptions which may bear further investigation are listed in Table 5-23, below.

Table 5-23: Highway Segments - Lighting Condition Observations

	Over 80% during daylight	Over 40% during non-daylight
I-84 EB	• Int. 20 (to Rte. 8 NB) Exit Ramp • Int. 19 (Rte. 8 SB) Exit Ramp	• Int. 18 • Between Int. 21 and Int.22 Exit Ramps • Between Int. 22 Exit Ramp and Meadow St. entrance ramp
I-84 WB	• WB Access for SB Rte 8 • Between SB 8 and NB 8 Exits	• West of Highland Ave • WB Exit to NB Rte 8 • WB Access from Bank St • All 4 segments between Meadow St. Exit and Union St. Access • Between Rte 69 and Union St
Rte 8 NB	• Int. 30 exit ramp • Int. 35 exit ramp	• Between Int. 30 exit and entrance ramps • Between interchange 30 entrance- and interchange 31 exit ramp • Int. 31 exit ramp • Between interchange 31 and 32 exit ramps • Between interchange 32 and 34 entrance ramps • Between interchange 34 entrance- and interchange 35 exit ramps
Rte 8 SB	• Between interchange 30 exit and entrance ramps • Between interchange 33 entrance- and interchange 30 exit ramps • Between interchange 34 and 33 exit ramps • Three segments north of interchange 34 entrance ramp	• Int. 30 exit ramp • Exit 33/W. Main exit ramp

Again the imbalance between directions on Route 8 is evident, with non-daylight accidents being more of an issue in the northbound direction and daylight accidents more of an issue in the southbound direction. On Route 8, segments with daylight accident rates falling between 60% and 80% are the exception rather than the rule. However, it must be noted that considerably fewer accidents occurred on Route 8 than on I-84.

5.3.2 Pavement Conditions

The pavement conditions upon which accidents occurred (dry, wet, snowy or icy) are shown in Table 5-24 below. A full account of all segments is in appendix material and in Figure 5-20 through Figure 5-23.

Table 5-24: Accident Totals by Highway Direction and Pavement Condition

Segment	Total No.	Dry		Wet		Snow/Ice/Sand		Unknown	
		No.	%	No.	%	No.	%	No.	%
I-84 EB	593	354	60%	203	34%	35	6%	1	0%
I-84 WB	644	379	59%	232	36%	29	5%	4	1%
Route 8 NB	134	75	56%	49	37%	9	7%	1	1%
Route 8 SB	120	85	71%	27	23%	8	7%	0	0%
GRAND TOTAL	**1491**	**901**	**60%**	**503**	**34%**	**82**	**5%**	**5**	**0%**

According to the National Weather Service, three percent of the days in Connecticut are snowy or icy and 30 percent are rainy. By drawing a correlation to weather conditions, preventative measures can be taken to help reduce accidents in slippery conditions. Throughout the study area, the proportion of accidents occurring in wet conditions or icy/snowy conditions were slightly higher than this would predict; 34% for wet conditions and 5% for snowy or icy. Thus, weather appears to be a potential factor in the accident rate within the study area.

Again, the two directions of I-84 are relatively balanced, while the two directions of Route 8 show substantial imbalance, especially in terms of wet vs. dry conditions. A substantially small proportion of accidents on Route 8 SB occurred during wet conditions.

Table 5-25 below shows specific interchange segments where accident rates during wet or snowy/icy conditions were higher than expected.

Table 5-25: Highway Segments - Pavement Condition Observations

	Over 40% during wet conditions	Over 10% during snowy or icy conditions
I-84 EB	• Int. 18 (SR 845) Entrance Ramp • Between Int. 18 entrance- and Int. 19 exit ramp • Int. 19 (Rte. 8 SB) Exit Ramp • Int. 20 (Rte. 8 NB) Exit Ramp • Entrance Ramp from Rte. 8 NB • Int. 21 (Meadow St.) Exit Ramp	• Int. 18 (SR 845) Entrance Ramp • Int. 19 (Rte. 8 SB) Exit Ramp • Int. 20 (Rte. 8 NB) Exit Ramp • Entrance Ramp from Rte. 8 SB • Between Int. 22 exit and Meadow St. entrance ramp
I-84 WB	• WB Exit to SB Rte 8 • Between Meadow & Bank St Access	• WB Access for SB Rte 8 • Between Union Exit and Access • Between Rte 69 and Union St
Rte 8 NB	• Int. 31 exit ramp • Between interchange 31 and 32 exit ramps	• Between interchange 30 entrance- and interchange 31 exit ramps • Between interchange 31 and 32 exit ramps • Between interchange 33 entrance- and exit ramps
Rte 8 SB	• Exit 33/I-84 exit ramp • North of Exit 35 entrance ramp	• Between interchange 33 entrance- and interchange 30 exit ramps

As indicated in Table 4, along I-84 eastbound, there were a number of locations where more than 40% of the accidents occurred due to wet or snow/icy conditions. In the westbound direction,

5.3.3 Accident Severity

While accident conditions can show problem areas in terms of lighting or pavement, accident severity is important in designating dangerous locations along a corridor. Table 5-26 shows accident totals by direction relative to severity along I-84 and Route 8.

Table 5-26: Accident Totals by Highway Direction and Severity

Segment	Total No.	Property Damage Only		Injury		Fatality	
		No.	%	No.	%	No.	%
I-84 EB	594	475	80%	119	20%	0	0%
I-84 WB	644	494	77%	149	23%	1	0%
I-84 TOTAL	*1237*	*969*	*78%*	*267*	*22%*	*1*	*0%*
Route 8 NB	134	98	73%	35	26%	1	1%
Route 8 SB	120	97	81%	22	18%	1	1%
ROUTE 8 TOTAL	*254*	*195*	*77%*	*57*	*22%*	*2*	*1%*
GRAND TOTAL	**1491**	**1164**	**78%**	**324**	**22%**	**3**	**0%**

The percentage of injury accidents for the corridor as a whole was 22%. Again, there is a greater imbalance between Route 8 Northbound and Southbound than between I-84 Eastbound and Westbound. Segments with injury rates of over 30% are listed in Table 5-27 below. A full account of injury rates by segment is shown in appendix material and in Figure 5-20 through Figure 5-23.

Table 5-27: Highway Segments – Injury Rate Observations

	Segment	Injury rate
I-84 EB	• Between Int. 20 exit and Highland Ave. entrance ramps	50 % (3 of 6)
I-84 WB	• Between Highland Ave and SB Rte 8 Access • WB Exit to NB Rte 8 • Between Meadow & Bank St Access • Exit to Union St.	30% (10 of 33) 31% (8 of 26) 32% (9 of 28) 40% (8 of 20)
Rte 8 NB	• Between interchange 31 and 32 exit ramps • Four segments between interchange 31 and 34 entrance ramps	57% (4 of 7) 54% (7 of 13)
Rte 8 SB	• Int. 32 exit ramp	50% (3 of 6)

Three fatal accidents occurred within the study area. Interestingly, none of the three fatality accidents occurred in the high-injury segments listed in the table above. The fatality accidents are described in detail below:

- The first fatality occurred on May 1st, 2002, when a motorcycle southbound on Route 8 struck a highway sign in the gore area. The motorcyclist, who was under the influence, was killed.

- A fatality occurred on May 17th, 2003, when a passenger car, which was going too fast for conditions, struck a beam rail, then ran off the road to the right and struck a bridge rail. One person was killed and one significantly injured.
- A third fatality occurred on January 4th, 2003, when the driver of a tandem rig was unable to cope with dark and snowy conditions, lost control of the vehicle, and struck a second truck that was stopped on the side of the road with mechanical difficulties. A person entering the stopped vehicle—presumably the driver—was killed in the side-swipe collision.

5.3.4 Accident Type

The best method for determining improvements to a high accident location is by analyzing the occurrence of various accident types. Table 7 shows the percentage of accidents by accident type for I-84. Table 5-28 shows accident type for all segments.

The category "Other" includes pedestrian, head-on, backing, jack-knife, angle, turning and overturn accidents that individually make up less than 1% of the accidents along a segment. Fixed object collisions are cars that hit the guide-rails, jersey barriers or other objects on the side of the road. A moving object collision is an accident involving a moving object that is not an automobile, truck, pedestrian or bicycle. It often refers to collisions with animals.

Table 5-28: Accident Totals by Highway Direction and Type

Segment	Total	Fixed Object		Moving Object		Rear End		Side-swipe		Other	
		No.	%	No.	%	No.	%	No.	%	No.	%
I-84 EB	593	168	28%	14	2%	232	39%	156	26%	23	4%
I-84 WB	644	201	31%	26	4%	203	32%	178	28%	36	6%
I-84 TOTAL	1237	369	30%	40	3%	435	35%	334	27%	59	5%
Route 8 NB	134	71	53%	9	7%	26	19%	26	19%	2	1%
Route 8 SB	120	41	34%	12	10%	20	17%	44	37%	3	3%
ROUTE 8 TOTAL	254	112	44%	21	8%	46	18%	70	28%	5	2%
GRAND TOTAL	**1491**	**481**	**32%**	**61**	**4%**	**481**	**32%**	**404**	**27%**	**64**	**4%**

The types of collisions occurring most often along the corridor as a whole include fixed object (32%), rear end (32%) and sideswipe (27%). Particular differences among highway directions are noted:

- Route 8 Northbound had a very high rate of fixed object collisions, 53%, compared to 34% southbound and 30% on I-84.
- Both directions of Route 8 show a higher rate of moving object collisions than on I-84.
- The rear-end accident rates on I-84 are considerably higher than on Route 8. Both road's rear-ending rates are balanced between directions.
- Side-swipe collision rates were nearly identical for both roads overall. However, Route 8 Southbound had a high (37%) rate, counterbalanced by a low rate (19%) in the northbound direction.

Several segments had a high percentage of a particular type of accident. Table 5-29, below, shows all segments with accident rates in one category more than 10 percentage points above the study-area average.

Table 5-29: Highway Segments – Accident Type Observations

	SEGMENT	Pct in category
	FIXED OBJECT	
I-84 EB	• Int. 20 (Rte. 8 NB) Exit Ramp • Entrance Ramp from Rte. 8 NB	48% (11 of 23) 74% (26 of 35)
I-84 WB	• WB Exit to SB Rte 8	68% (71 of 105)
Rte 8 NB	• Between interchange 30 exit and entrance ramps • Between interchange 30 entrance- and interchange 31 exit ramps • Int. 31 exit ramp • Between interchange 33 entrance- and exit ramps, incl. entrance ramp • Between interchange 34 entrance- and interchange 35 exit ramps	62% (13 of 21) 60% (12 of 20) 76% (13 of 17) 50% (4 of 8) 47% (8 of 17)
Rte 8 SB	• Int. 30 exit ramp • Four segments from Int. 31 exit ramp to Int. 33/I-84 exit ramp	55% (6 of 11) 73% (11 of 15)
	REAR END	
I-84 EB	• Between Int. 18 Exit and Entrance Ramps • Bet. Rt.8 NB entrance- and interchange 21 exit ramps, incl. exit ramp • Int. 22 (Baldwin St.) Exit Ramp • Bet Meadow St. entrance- & interchange 23 exit ramp, incl. exit ramp	44% (15 of 34) 56% (29 of 52) 72% (13 of 18) 51% (68 of 133)
I-84 WB	• Exit to Highland Ave • Between SB 8 and NB 8 Exits • Access for Union St. • Exit to Rte 69	46% (30 of 65) 59% (22 of 37) 47% (24 of 51) 43% (10 of 23)
Rte 8 NB	• Int. 30 exit ramp • Between interchange 31 and 32 exit ramps • Between interchange 32 and 34 entrance ramps, incl. interchange 34 ramp	67% (6 of 9) 57% (4 of 7) 67% (5 of 8)
Rte 8 SB	• none	--

Table 5-29 (continued)

SIDE-SWIPE		
I-84 EB	• Int. 19 (Rte. 8 SB) Exit Ramp • Bet. interchange 20 exit & Highland. Ave. entrance ramp, incl. entrance ramp • Between Int. 22 exit and Meadow St. entrance ramps • Entrance Ramp from Int. 23 (Rte. 69)	55% (6 of 11) 50% (10 of 20) 50% (8 of 16) 40% (48 of 121)
I-84 WB	• Three segments from Highland Ave exit ramp to SB Rte 8 entrance ramp • Between Bank St & Rte 8 SB • Between Rte 69 and Union St	58% (41 of 71) 52% (14 of 27) 41% (14 of 34)
Rte 8 NB	• none	--
Rte 8 SB	• Between interchange 30 exit and entrance ramps • Bet. interchange 33 entrance- and interchange 30 exit ramps, incl. entrance ramp • Entrance Ramps for Interchanges 31 & 32 • Bet. interchange 35 entrance- and interchange 34 exit ramps, incl. entrance ramp	36% (4 of 11) 67% (16 of 24) 56% (5 of 9) 56% (10 of 18)

5.3.5 Trucks

Truck Related Accidents - In addition to these measures of accident analysis, the percentage of accidents involving trucks was of particular concern on this corridor. Table 5-30gives the percentage of accidents involving trucks on I-84 by highway direction. Figure 5-20 through Figure 5-23 show the truck accident rates for all segments of the study area.

Table 5-30: Percentage of Accidents involving Trucks

Segment	Total No.	Truck(s) Involved	
		No.	%
I-84 EB	593	202	34%
I-84 WB	644	197	31%
I-84 TOTAL	1237	399	32%
Route 8 NB	134	34	25%
Route 8 SB	120	26	22%
ROUTE 8 TOTAL	254	60	24%
GRAND TOTAL	**1491**	**459**	**31%**

The percentage of accidents involving trucks on I-84 is 31% for the study area as a whole. This is significantly higher than the percentage of all vehicles that are trucks (approximately 8%).

The truck involvement rate is substantially higher on I-84 (32%) than on Route 8 (24%). Each road is balanced in terms of the truck involvement rate in opposing directions. The truck involvement rate by segment is given in Table 15. Most segments are within a few percentage points of their respective road average. The segment with the highest truck involvement rate is I-84 westbound, between the northbound exit ramp to Route 8 and the entrance ramp from Route 8 southbound, where 17 of 27 accidents (63%) involved trucks.

5.3.6 Contributing Factors

The top five typical contributing factors or causes for the accidents included:

1. Driving too fast for conditions (27%)
2. Driver following too close (25%)
3. Driver changed lanes improperly (22%)
4. Driver unable to cope with conditions and lost control (8%)
5. Foreign object in the road (5%)

The remaining 13% of the accidents were attributed to other factors such as driver falling asleep, slippery conditions, driver under the influence of alcohol or drugs, vehicle mechanical failure, and improper passing maneuver. A full account of contributing factors, by highway segment, is shown in appendix material.

Separating contributing factors into “Driver Error” and “Roadway Conditions” shows that the vast majority of accidents are attributed to driver error, as shown below in Table 5-31. Therefore, efforts to address safety in this study area will need to address the way drivers react to the roadway, not just address the roadway itself.

Table 5-31: Category of Contributing Factors

Factor Category	Number	Pct.
Driver Error	1377	92%
Road Condition	88	6%
Other	26	2%
Total	1491	100%

5.3.7 Summary

Several comments about the interchange of I-84 and Route 8 in Waterbury can be made after a review of the accident data from 2001 to 2003:

- Overall, lighting conditions do not appear to produce a bias in accident rates. However, a higher-than-expected proportion of accidents on Route 8 northbound occurred during non-daylight hours, while a lower-than-expected proportion occurred during non-daylight hours on Route 8 southbound.

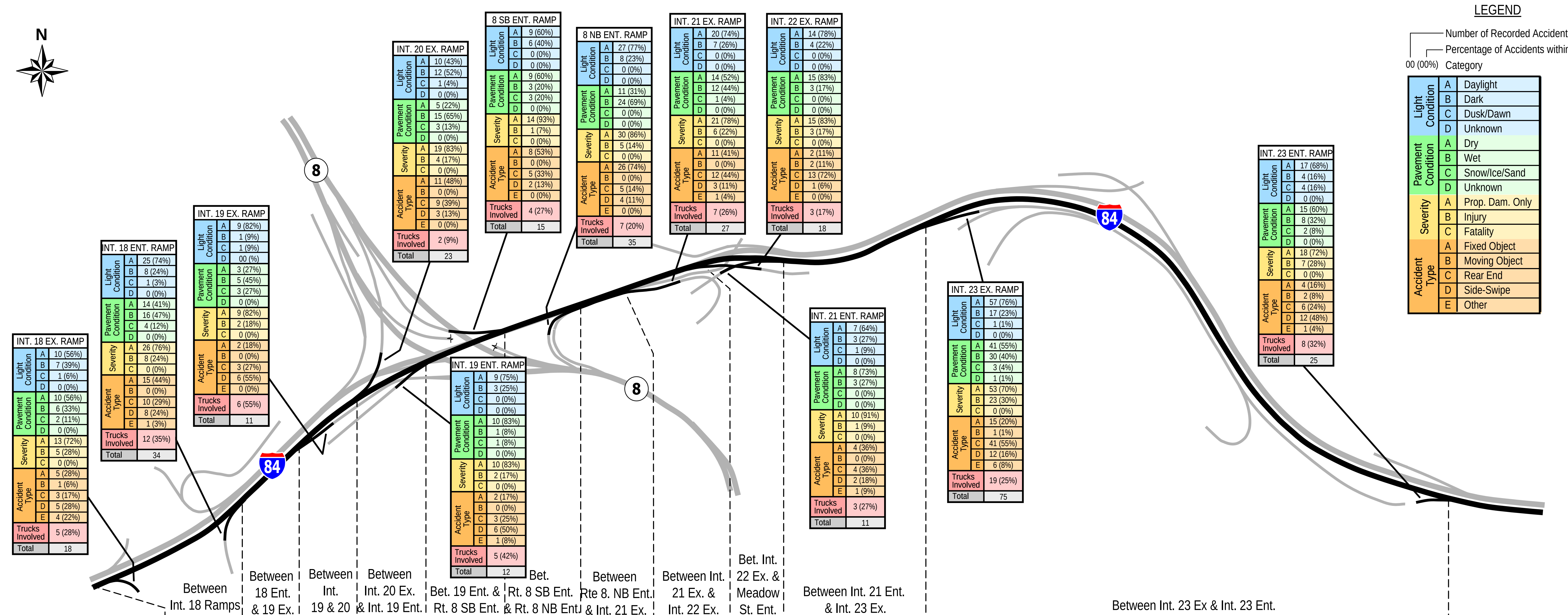
- Weather may be a potential factor in the accident rate within the study area, as accident rates are slightly higher than would be expected during both wet and snowy or icy conditions. Route 8 southbound is an exception, as the accident rate is lower than expected during such conditions.

- The percentage of accidents involving injuries was 22% for the study area as a whole. There was a greater imbalance between opposing directions of Route 8 (26% northbound, 18% southbound) than between I-84 eastbound and westbound. Three fatalities occurred during the period observed, two on Route 8 and one on I-84.

- The most common types of accident were Fixed Object (32%), Rear-end (32%) Side-swipe (27%) and Moving Object (4%). Route 8 had a higher rate of Fixed and Moving Object collisions than I-84, while the opposite was true for Rear-end and Side-swipe collisions.

- The rate of truck involvement in accidents (31% overall, 32% on I-84 and 24% on Route 8) was very high relative to the percentage of vehicles that are trucks (about 8%).

- The leading contributing factors of accidents were drivers driving too fast for conditions (27%), following too close (25%), changing lanes improperly (22%), or being unable to cope with conditions and losing control (8%). The vast majority of collisions — 92% — were attributed to one form or another of driver error.



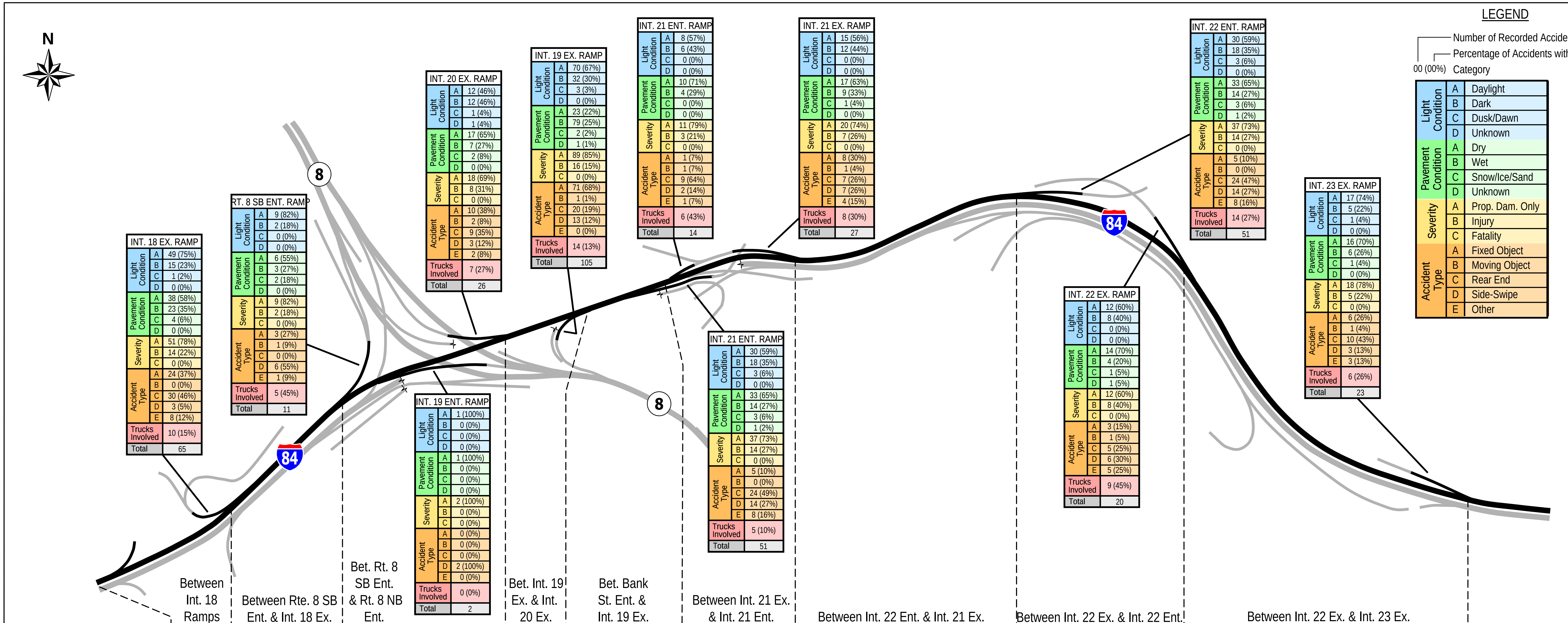
			Between Int. 18 Ramps	Between 18 Ent. & 19 Ex.	Between Int. 19 & 20	Between Int. 20 Ex. & Int. 19 Ent.	Bet. 19 Ent. & Rt. 8 SB Ent.	Bet. Rt. 8 SB Ent. & Rt. 8 NB Ent	Between Rte 8. NB Ent. & Int. 21 Ex.	Between Int. 21 Ex. & Int. 22 Ex.	Bet. Int. 22 Ex. & Meadow St. Ent.	Between Int. 21 Ent. & Int. 23 Ex.	Between Int. 23 Ex & Int. 23 Ent.
Light Condition	A	Daylight	23 (68%)	17 (61%)	1 (100%)	6 (75%)	3 (100%)	4 (67%)	18 (72%)	7 (58%)	9 (56%)	40 (69%)	68 (70%)
	B	Dark	10 (29%)	10 (36%)	0 (0%)	2 (25%)	0 (0%)	2 (33%)	7 (28%)	4 (33%)	4 (25%)	14 (24%)	23 (22%)
	C	Dusk/Dawn	1 (3%)	1 (4%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (8%)	3 (19%)	4 (7%)	5 (8%)
	D	Unknown	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Pavement Condition	A	Dry	22 (65%)	14 (50%)	1 (100%)	7 (88%)	2 (67%)	3 (50%)	21 (84%)	10 (83%)	12 (75%)	40 (69%)	66 (67%)
	B	Wet	11 (32%)	14 (50%)	0 (0%)	1 (13%)	1 (33%)	3 (50%)	4 (16%)	2 (17%)	2 (13%)	18 (31%)	20 (23%)
	C	Snow/Ice/Sand	1 (3%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2 (13%)	0 (0%)	10 (10%)
	D	Unknown	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Severity	A	Prop. Dam. Only	30 (88%)	14 (50%)	1 (100%)	6 (75%)	3 (100%)	3 (50%)	19 (76%)	10 (83%)	13 (80%)	46 (79%)	83 (86%)
	B	Injury	4 (12%)	14 (50%)	0 (0%)	2 (25%)	0 (0%)	3 (50%)	6 (24%)	2 (17%)	3 (19%)	12 (21%)	13 (14%)
	C	Fatality	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Accident Type	A	Fixed Object	12 (35%)	10 (36%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (25%)	1 (6%)	14 (24%)	22 (23%)
	B	Moving Object	0 (0%)	1 (4%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (6%)	1 (2%)	5 (5%)
	C	Rear End	15 (44%)	10 (36%)	1 (100%)	4 (50%)	2 (67%)	3 (50%)	17 (68%)	3 (25%)	6 (38%)	27 (47%)	29 (30%)
	D	Side-Swipe	5 (15%)	6 (21%)	0 (0%)	4 (50%)	1 (33%)	3 (50%)	8 (32%)	6 (50%)	8 (50%)	15 (26%)	36 (38%)
	E	Other	2 (6%)	1 (4%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (2%)	4 (4%)
Trucks Involved			11 (32%)	8 (29%)	0 (0%)	5 (63%)	2 (67%)	5 (83%)	10 (40%)	6 (50%)	7 (44%)	18 (31%)	48 (50%)
Total			34	28	1	8	3	6	25	12	16	58	96

ACCIDENT AND SAFETY ANALYSIS

I-84 EASTBOUND

ENGINEERS
PLANNERS
ECONOMISTS
Wilbur Smith Associates

FIGURE 5-20



Category		INT. 18 EX. RAMP	RT. 8 SB ENT. RAMP	INT. 20 EX. RAMP	INT. 19 EX. RAMP	INT. 19 ENT. RAMP	INT. 21 ENT. RAMP	INT. 21 ENT. RAMP	INT. 21 EX. RAMP	INT. 22 EX. RAMP	INT. 22 ENT. RAMP	INT. 23 EX. RAMP
Light Condition	A	49 (75%)	9 (82%)	12 (46%)	70 (67%)	1 (100%)	8 (57%)	30 (59%)	15 (56%)	12 (60%)	30 (59%)	17 (74%)
	B	15 (23%)	2 (18%)	12 (46%)	32 (30%)	0 (0%)	6 (43%)	18 (35%)	12 (44%)	8 (40%)	18 (35%)	5 (22%)
	C	1 (2%)	0 (0%)	1 (4%)	3 (3%)	0 (0%)	0 (0%)	3 (6%)	0 (0%)	0 (0%)	3 (6%)	1 (4%)
	D	0 (0%)	0 (0%)	1 (4%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Pavement Condition	A	38 (58%)	6 (55%)	17 (65%)	23 (22%)	1 (100%)	10 (71%)	33 (65%)	17 (63%)	14 (70%)	33 (65%)	16 (70%)
	B	23 (35%)	3 (27%)	7 (27%)	79 (25%)	0 (0%)	4 (29%)	14 (27%)	9 (33%)	4 (20%)	14 (27%)	6 (26%)
	C	4 (6%)	2 (18%)	2 (8%)	2 (2%)	0 (0%)	0 (0%)	3 (6%)	1 (4%)	1 (5%)	3 (6%)	1 (4%)
	D	0 (0%)	0 (0%)	0 (0%)	1 (1%)	0 (0%)	0 (0%)	1 (2%)	0 (0%)	1 (5%)	1 (2%)	0 (0%)
Severity	A	51 (78%)	9 (82%)	18 (69%)	89 (85%)	2 (100%)	11 (79%)	37 (73%)	20 (74%)	12 (60%)	37 (73%)	18 (78%)
	B	14 (22%)	2 (18%)	8 (31%)	16 (15%)	0 (0%)	3 (21%)	14 (27%)	7 (26%)	8 (40%)	14 (27%)	5 (22%)
	C	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Accident Type	A	24 (37%)	3 (27%)	10 (38%)	71 (68%)	0 (0%)	1 (7%)	5 (10%)	8 (30%)	3 (15%)	5 (10%)	6 (26%)
	B	0 (0%)	1 (9%)	2 (8%)	1 (1%)	0 (0%)	1 (7%)	0 (0%)	1 (4%)	1 (5%)	0 (0%)	1 (4%)
	C	30 (46%)	0 (0%)	9 (35%)	20 (19%)	0 (0%)	9 (64%)	24 (49%)	7 (26%)	5 (25%)	24 (47%)	10 (43%)
	D	3 (5%)	6 (55%)	3 (12%)	13 (12%)	2 (100%)	2 (14%)	14 (27%)	7 (26%)	6 (30%)	14 (27%)	3 (13%)
	E	8 (12%)	1 (9%)	2 (8%)	0 (0%)	0 (0%)	1 (7%)	8 (16%)	4 (15%)	5 (25%)	8 (16%)	3 (13%)
Trucks Involved		10 (15%)	5 (45%)	7 (27%)	14 (13%)	0 (0%)	6 (43%)	5 (10%)	8 (30%)	9 (45%)	14 (27%)	6 (26%)
Total		65	11	26	105	2	14	51	27	20	51	23

LEGEND

Light Condition	A	Daylight
	B	Dark
	C	Dusk/Dawn
	D	Unknown
Pavement Condition	A	Dry
	B	Wet
	C	Snow/Ice/Sand
	D	Unknown
Severity	A	Prop. Dam. Only
	B	Injury
	C	Fatality
Accident Type	A	Fixed Object
	B	Moving Object
	C	Rear End
	D	Side-Swipe
	E	Other

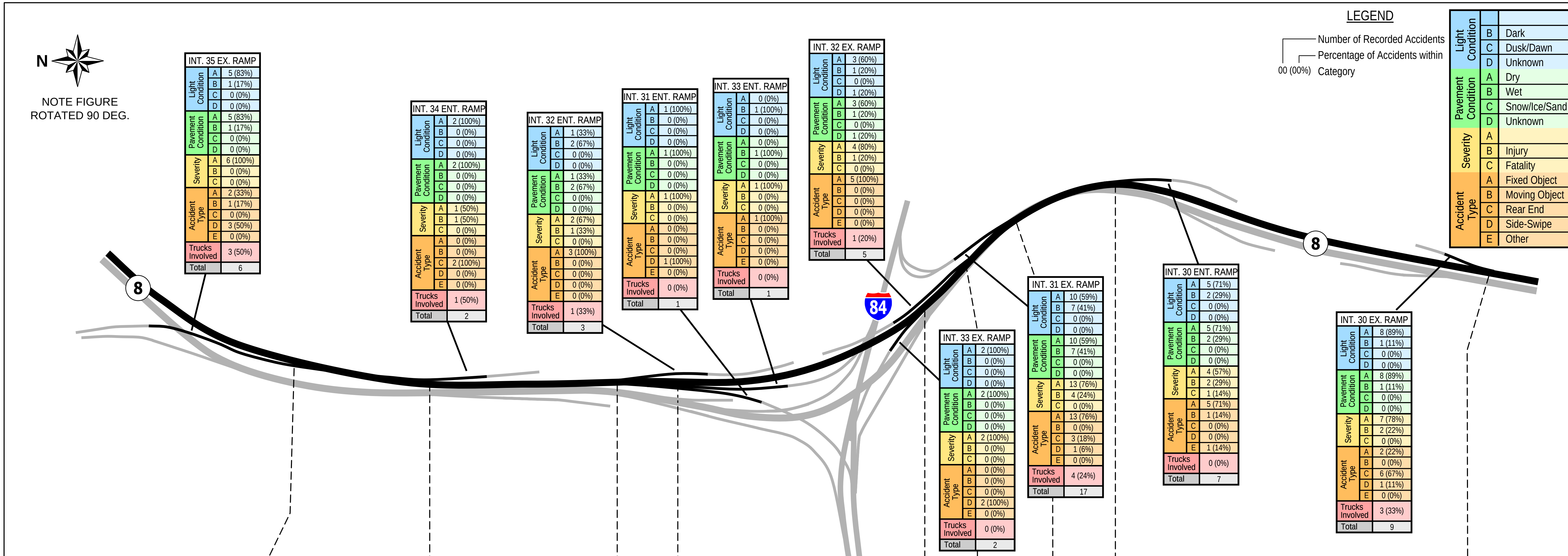
			Between Int. 18 Ramps	Between Rte. 8 SB Ent. & Int. 18 Ex.	Bet. Rt. 8 SB Ent. & Rt. 8 NB Ent.	Bet. Int. 19 Ex. & Int. 20 Ex.	Bet. Bank St. Ent. & Int. 19 Ex.	Between Int. 21 Ex. & Int. 21 Ent.	Between Int. 22 Ent. & Int. 21 Ex.	Between Int. 22 Ex. & Int. 22 Ent.	Between Int. 22 Ex. & Int. 23 Ex.
Light Condition	A	Daylight	11 (55%)	25 (76%)	21 (78%)	30 (81%)	17 (63%)	17 (61%)	43 (57%)	11 (55%)	17 (50%)
	B	Dark	8 (40%)	4 (12%)	5 (19%)	5 (14%)	6 (22%)	9 (32%)	28 (37%)	9 (45%)	15 (44%)
	C	Dusk/Dawn	1 (5%)	4 (12%)	1 (4%)	2 (5%)	3 (11%)	1 (4%)	4 (5%)	0 (0%)	2 (6%)
	D	Unknown	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (4%)	1 (4%)	1 (1%)	0 (0%)	0 (0%)
Pavement Condition	A	Dry	14 (70%)	21 (64%)	22 (81%)	26 (70%)	21 (78%)	15 (54%)	48 (63%)	11 (55%)	27 (79%)
	B	Wet	5 (25%)	10 (30%)	5 (19%)	11 (30%)	6 (22%)	12 (43%)	25 (33%)	5 (25%)	4 (12%)
	C	Snow/Ice/Sand	1 (5%)	2 (6%)	0 (0%)	0 (0%)	0 (0%)	1 (4%)	2 (3%)	4 (20%)	3 (9%)
	D	Unknown	00 (%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (1%)	0 (0%)	0 (0%)
Severity	A	Prop. Dam. Only	16 (80%)	23 (70%)	24 (89%)	27 (73%)	23 (85%)	19 (68%)	57 (75%)	15 (75%)	25 (74%)
	B	Injury	4 (20%)	10 (30%)	3 (11%)	10 (27%)	4 (15%)	9 (32%)	19 (25%)	5 (25%)	8 (24%)
	C	Fatality	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (3%)
Accident Type	A	Fixed Object	00 (%)	3 (9%)	3 (11%)	4 (11%)	5 (19%)	11 (39%)	21 (28%)	5 (25%)	6 (18%)
	B	Moving Object	00 (%)	2 (6%)	2 (7%)	1 (3%)	1 (4%)	1 (4%)	5 (7%)	1 (5%)	5 (15%)
	C	Rear End	00 (%)	11 (33%)	4 (15%)	22 (59%)	7 (26%)	7 (25%)	23 (30%)	6 (30%)	8 (24%)
	D	Side-Swipe	00 (%)	17 (52%)	18 (67%)	9 (24%)	14 (52%)	9 (32%)	25 (33%)	8 (40%)	14 (41%)
	E	Other	00 (%)	0 (0%)	0 (0%)	1 (3%)	0 (0%)	0 (0%)	2 (3%)	0 (0%)	1 (3%)
Trucks Involved			7 (35%)	16 (48%)	17 (63%)	11 (30%)	8 (30%)	8 (29%)	27 (36%)	7 (35%)	17 (50%)
Total			20	33	27	37	27	28	76	20	34

ACCIDENT AND SAFETY ANALYSIS

I-84 WESTBOUND

Wilbur Smith Associates
ENGINEERS PLANNERS ECONOMISTS

FIGURE 5-21



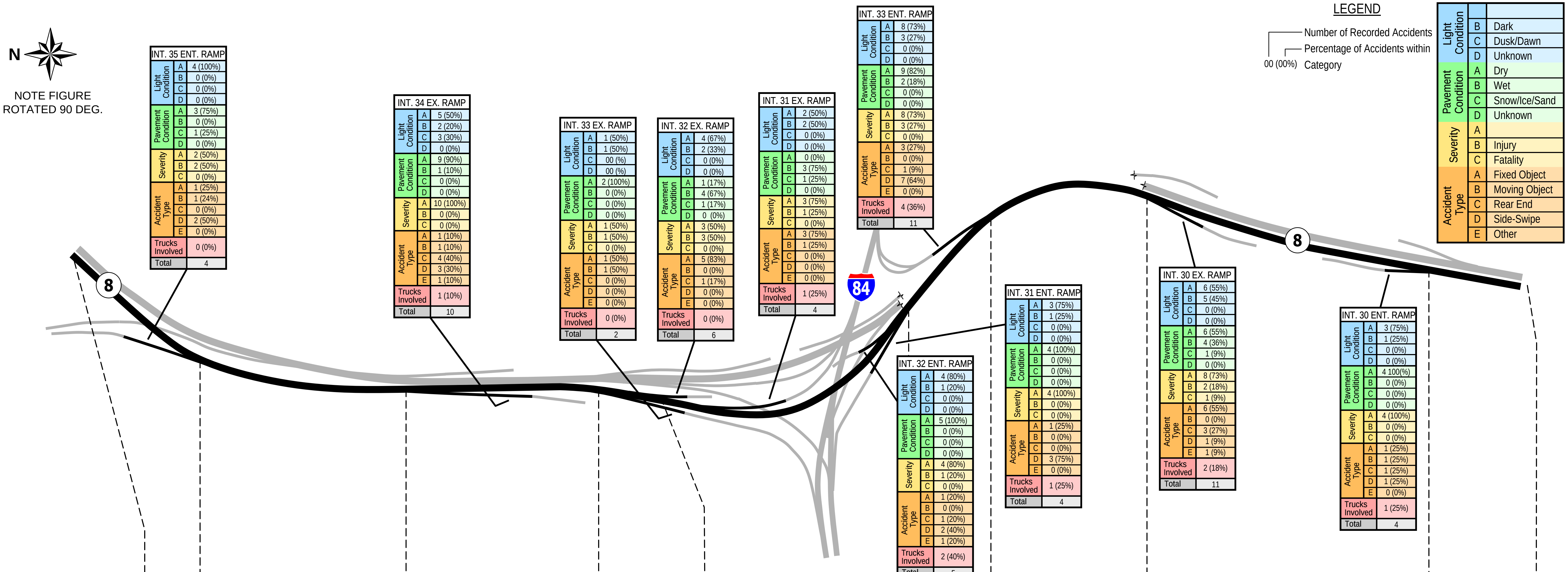
			Between Int. 34 Ent. & Int. 35 Ex.	Between Int. 32 Ent. & Int. 34 Ent.	Between Int. 31 Ent . & Int. 32 Ent.	Between Int. 33 Ex. & Int. 33 Ent.	Bet. Int. 32 Ex. & Int. 33 Ex.	Between Int. 31 Ex. & Int. 32 Ex.	Between Int. 30 Ent. &Int. 31 Ex.	Between Int. 30 Ex. & Int. 30 Ent.
Light Condition	A	Daylight	8 (47%)	3 (50%)	2 (100%)	5 (71%)	1 (100%)	4 (57%)	7 (35%)	8 (38%)
	B	Dark	6 (35%)	3 (50%)	0 (0%)	1 (14%)	0 (0%)	3 (43%)	11 (55%)	10 (48%)
	C	Dusk/Dawn	3 (18%)	0 (0%)	0 (0%)	1 (14%)	0 (0%)	0 (0%)	2 (10%)	3 (14%)
	D	Unknown	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Pavement Condition	A	Dry	8 (47%)	3 (50%)	2 (100%)	5 (71%)	1 (100%)	4 (57%)	7 (35%)	8 (38%)
	B	Wet	6 (35%)	3 (50%)	0 (0%)	1 (14%)	0 (0%)	3 (43%)	11 (55%)	10 (48%)
	C	Snow/Ice/Sand	3 (18%)	0 (0%)	0 (0%)	1 (14%)	0 (0%)	0 (0%)	2 (10%)	3 (14%)
	D	Unknown	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Severity	A	Prop. Dam. Only	14 (82%)	2 (33%)	1 (50%)	5 (71%)	1 (100%)	3 (43%)	16 (80%)	15 (71%)
	B	Injury	3 (18%)	4 (67%)	1 (50%)	2 (29%)	0 (0%)	4 (57%)	4 (20%)	6 (29%)
	C	Fatality	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Accident Type	A	Fixed Object	8 (47%)	1 (17%)	0 (0%)	3 (43%)	1 (100%)	2 (29%)	12 (60%)	13 (62%)
	B	Moving Object	3 (18%)	1 (17%)	0 (0%)	2 (29%)	0 (0%)	0 (0%)	0 (0%)	1 (5%)
	C	Rear End	1 (6%)	3 (50%)	1 (50%)	1 (14%)	0 (0%)	4 (57%)	3 (15%)	2 (10%)
	D	Side-Swipe	5 (29%)	1 (17%)	1 (50%)	1 (14%)	0 (0%)	1 (14%)	5 (25%)	4 (19%)
	E	Other	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (5%)
Trucks Involved			3 (18%)	1 (17%)	1 (50%)	2 (29%)	1 (100%)	3 (43%)	6 (30%)	4 (19%)
Total			17	6	2	7	1	7	20	21

ACCIDENT AND SAFETY ANALYSIS

ROUTE 8 NORTHBOUND

ENGINEERS PLANNERS ECONOMISTS
Wilbur Smith Associates

FIGURE 5-22



			North of Int. 35 Ent.	Between Int. 34 Ex. & Int. 35 Ent.	Between Int. 33 Ex. & Int.34 Ex.	Between Int. 33 Ex. & Int. 32 Ex.	Between Int. 31 Ex. & Int. 31 Ent.	Bet. Int. 32 Ent. & Int. 33 Ent.	Between Int. 33 Ent. & Int. 30 Ex.	Between Int. 30 off & Int. 30 Ent.	South of Int. 30 Ent.
Light Condition	A	Daylight	2 (100%)	13 (93%)	10 (100%)	1 (50%)	1 (100%)	3 (75%)	12 (92%)	11 (100%)	1 (100%)
	B	Dark	0 (0%)	1 (7%)	0 (0%)	1 (50%)	0 (0%)	1 (25%)	0 (0%)	0 (0%)	0 (0%)
	C	Dusk/Dawn	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (8%)	0 (0%)	0 (0%)
	D	Unknown	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Pavement Condition	A	Dry	1 (50%)	8 (57%)	6 (60%)	1 (50%)	1 (100%)	3 (75%)	11 (85%)	9 (82%)	1 (100%)
	B	Wet	1 (50%)	6 (43%)	3 (30%)	0 (0%)	0 (0%)	1 (25%)	2 (15%)	0 (0%)	0 (0%)
	C	Snow/Ice/Sand	0 (0%)	0 (0%)	1 (10%)	1 (50%)	0 (0%)	0 (0%)	0 (0%)	2 (18%)	0 (0%)
	D	Unknown	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Severity	A	Prop. Dam. Only	2 (100%)	11 (79%)	10 (100%)	2 (100%)	0 (0%)	1 (25%)	12 (92%)	10 (91%)	1 (100%)
	B	Injury	0 (0%)	3 (21%)	0 (0%)	0 (0%)	1 (100%)	3 (75%)	1 (8%)	1 (9%)	0 (0%)
	C	Fatality	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Accident Type	A	Fixed Object	1 (50%)	4 (29%)	2 (20%)	1 (50%)	1 (100%)	1 (25%)	2 (15%)	4 (36%)	1 (100%)
	B	Moving Object	1 (50%)	1 (7%)	2 (20%)	0 (0%)	0 (0%)	0 (0%)	1 (8%)	2 (18%)	0 (0%)
	C	Rear End	0 (0%)	1 (7%)	3 (30%)	0 (0%)	0 (0%)	3 (75%)	1 (8%)	1 (9%)	0 (0%)
	D	Side-Swipe	0 (0%)	8 (57%)	3 (30%)	1 (50%)	0 (0%)	0 (0%)	9 (69%)	4 (36%)	0 (0%)
	E	Other	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Trucks Involved			1 (50%)	0 (0%)	3 (30%)	1 (50%)	0 (0%)	2 (50%)	7 (54%)	0 (0%)	0 (0%)
Total			2	14	10	2	1	4	13	11	1

ACCIDENT AND SAFETY ANALYSIS

ROUTE 8 SOUTHBOUND

Wilbur Smith Associates
ENGINEERS
PLANNERS
ECONOMISTS

FIGURE 5-23

6 Conditions, Resources and Constraints

6.1 Roadway Conditions

The Interstate 84 (I-84)and Route 8 interchange, which was constructed in the mid-sixties, is the only double decked interchange in the State of Connecticut. This stacked interchange stands at approximately 90 feet from the ground to the top most deck. I-84 runs above Route 8 in the east-west direction, while Route 8 runs in the north- south direction. I-84 is double decked as it crosses Route 8 with the eastbound deck running over the westbound deck. Route 8 is double decked south of I-84 with the northbound deck running over the southbound deck. I-84 typically has 3 travel lanes within the study area although there are some sections with 2 travel lanes. Likewise Route 8 primarily has 2 travel lanes within the study area with a few locations registering 3 travel lanes. Figure 6-1 through Figure 6-11 illustrate the typical sections along the highway mainline. Ramps within the study area are mainly located on the right side of the travel way, however there are some left hand ramps particularly in the vicinity where I-84 and Route 8 cross each other.

From the time of construction of the I-84 and Route 8 interchange in the early to mid-sixties, the traffic volume has increased dramatically. I-84 for instance was designed to carry an Average Daily Traffic (ADT) of approximately 35,000 vehicles, and has since exceeded 100,000 vehicles in some locations. This increase in traffic places a burden on the existing infrastructure and contributes to safety issues. Additionally, the changes in the practice of highway design have caused several interchanges to become sub-standard by today's criteria.

The purpose of this analysis was to identify and assess any geometric deficiencies within the study area. This included an assessment of ramp and mainline geometry, ramp acceleration and deceleration lengths, interchange spacing, lane continuity and configuration, lane and shoulder widths, superelevation rates, sight distance and roadside safety features and clear zones. The following section is a report on the findings on geometric deficiencies along I-84 and Route 8 within the study area. These deficiencies are illustrated in Figure 6-12 through Figure 6-26.

6.1.1 Ramp and Mainline Geometry

Ramps and the highway mainline within the study area were assessed to determine whether existing geometry meets current design standards. The geometric parameters that were assessed were curve radii, roadway grade and superelevation rate. Table 6-1 through Table 6-4 give a summary of the geometric assessment of ramps within the study area.

Curve Radii

The first step in curve radii assessment was to obtain the design speed for both ramps and highway mainline in the study area. For the highway mainline, the minimum allowable design of 50 mph for highways, as specified by AASHTO was used. A ramp design speed of 25 mph was then obtained based on the highway design speed using methodology from "A policy on Geometric Design of Highways and Streets" by the American Association of State Highway and Transportation Officials (AASHTO) - 2001 Edition. The ramp design speed of 25 mph represents the lower range corresponding minimum radius for a 50 mph mainline speed.

A minimum ramp curve radius of 185 feet was then derived from Exhibit 3-14 of AASHTO (2001) based on the ramp design speed of 25 mph and a superelevation (e) rate of 6%. Any ramp with a curve radius smaller than 185 feet was considered to be deficient. There was only one ramp that was deficient in terms of curve radii. This ramp is the Interchange 18 westbound exit ramp on I-84, which has a curve radius of 180 feet.

Ramp Grades

Ramp grades were also evaluated based on current AASHTO standards. In this analysis, a recommended range of ramp grade was obtained based on curve design speed, using methodology from AASHTO (2001). AASHTO standards stipulate that ramps with design speeds of 15-25 mph should be limited to grades of 6-8%, while ramps with design speeds of 25-30 mph should be limited to 5-7%. A grade range of 4-6% should be used for ramps with design speed of 40 mph while a range of 3-5% should be used for ramps with design speed of 45-50 mph. Based on the ramp design speed of 25 mph used in this analysis, a maximum grade range of 5-7% was used for all ramps in the study area. Any ramp with a grade greater than the recommended AASHTO range of 5-7% was considered to be deficient.

As the tables below show, there were 3 ramps that did not the meet the specified AASHTO grade standards. Two of the deficient ramps were located on I-84, while one was located on Route 8. The deficient ramps on I-84 are:

- Interchange 21 westbound exit ramp which has a downhill grade of 8%
- Interchange 19 eastbound entrance ramp which has a downhill grade of 8%

The deficient ramp on Route 8 is the Interchange 31 southbound entrance ramp which has a downhill grade of 8%.

Table 6-1: I-84 Exit Ramp Geometry Assessment

Location	Direction	Grade	Maximum Recommended Grade[2]	Curve Radius *(ft)*	Minimum Curve Radius[3]	Curve Design Speed[1] *(mph)*	Ramp Posted Speed	Comments
I-84								
Interchange 18								
	WB	+3%	5-7%	180	185	25	25	Tight radius
Interchange 19								
	EB Left	-3%	5-7%	1400	185	25	35	Posted speed exceeds design speed
	EB Right	-3%	5-7%	850	185	25	35	Posted speed exceeds design speed
Interchange 20								
	WB	-3%	5-7%	250	185	25	-	
Interchange 21								
	EB Meadow	-4%	5-7%	160	185	25	25	
	EB S. Main	-6%	5-7%	1535	185	25	25	
	WB	-8%	5-7%	1000	185	25	-	Steep grade
Interchange 22								
	WB	-3%	5-7%	840	185	25	25	
Interchange 23								
	EB	+3%	5-7%	2085	185	25	45	Posted speed exceeds design speed

(1) AASHTO Exhibit 10-56, p 830

(2) AASHTO 2001, p 833

(3) Based on 25 mph Design Speed

Table 6-2: Route 8 Exit Ramp Geometry Assessment

Location **Route 8**	Direction	Grade	Maximum Recommended Grade[2]	Curve Radius *(ft)*	Minimum Curve Radius[3]	Curve Design Speed[1] *(mph)*	Ramp Posted Speed	Comments
Interchange 30								
	SB	-4%	5-7%	1380	185	25	-	
Interchange 31								
	NB	+4%	5-7%	250	185	25	25	
	SB	+2%	5-7%	950	185	25	-	
Interchange 32								
	NB	-4%	5-7%	1840	185	25	-	
	SB	-4%	5-7%	1100	185	25	30	Posted speed exceeds design speed
Interchange 33								
	NB	+4%	5-7%	2600	185	25	35	
	SB	+2%	5-7%	600	185	25	-	
Interchange 34								
	SB	-4%	5-7%	52750	185	25	35	Posted speed exceeds design speed
Interchange 35								
	NB	+1%	5-7%	2200	185	25	-	

(1) AASHTO Exhibit 10-56, p 830

(2) AASHTO 2001, p 833

(3) Based on 25 mph Design Speed

(+) % Upgrade

(-) % Down grade

Table 6-3: I-84 Entrance Ramp Geometry Assessment

Location I-84	Direction	Grade	Maximum Recommended Grade[2]	Curve Radius *(ft)*	Minimum Curve Radius *(ft)*	Curve Design Speed[1] *(mph)*	Comments
Interchange 18							
	EB	-1%	5-7%	400	185	25	
	WB	-	5-7%	900	185	25	
Interchange 19							
	EB	-8%	5-7%	2240	185	25	Steep grade
	WB Right	+2%	5-7%	600	185	25	
	WB Left	+4%	5-7%	2600	185	25	
Interchange 20							
	EB Right	+4%	5-7%	250	185	25	
	EB Left	+2%	5-7%	950	185	25	
Interchange 21							
	WB Left	+5%	5-7%	350	185	25	
	WB Right	+5%	5-7%	1180	185	25	
Interchange 22							
	EB	+2%	5-7%	550	185	25	
	WB	+3%	5-7%	5770	185	25	

(1) AASHTO Exhibit 10-56, p 830

(2) AASHTO 2001, p 833

(3) Based on 25 mph Design Speed

(+) % Upgrade

(-) % Down grade

Table 6-4: Route 8 Entrance Ramp Geometry Assessment

Location Route 8	Direction	Grade	Maximum Recommended Grade[2]	Curve Radius *(ft)*	Minimum Curve Radius *(ft)*	Curve Design Speed[1] *(mph)*	Comments
Interchange 30							
	NB	+5%	5-7%	1780	185	25	
Interchange 31							
	SB (84 EB)	-8%	5-7%	850	185	25	Steep grade
	SB (84 WB)	-4%	5-7%	250	185	25	
	SB (Riverside)	+2%	5-7%	1900	185	25	
Interchange 33							
	NB (84 WB)	-6%	5-7%	1170	185	25	
	NB (84 EB)	-3%	5-7%	1400	185	25	
	NB (Riverside)	+5%	5-7%	18400	185	25	
Interchange 34							
	NB	+3%	5-7%	9829	185	25	
Interchange 35							
	SB	-2%	5-7%	14950	185	25	

(1) AASHTO Exhibit 10-56, p 830

(2) AASHTO 2001, p 833

(3) Based on 25 mph Design Speed

(+) % Upgrade

(-) % Down grade

Mainline Grades

Similarly, grades on the highway mainline were evaluated. Table 6-5 and Table 6-6 highlight results of the mainline evaluation. AASHTO standards recommend that a maximum grade of 5% should be used for a highway design speed of 50 mph in an area with rolling terrain. Mainline grades were measured to determine whether grades met the 5% maximum grade standard. There were no observed geometric deficiencies in terms of grades along both the I-84 and Route 8 corridor as shown by Table 6-5 and Table 6-6.

Table 6-5: I-84 Mainline Geometry Assessment

From	To	Segment Length *(ft)*	Grade	Maximum Recommended Grade[1]	Curve Design Speed *(mph)*	Mainline Posted Speed *(mph)*
Eastbound						
Interchange 18 Exit Ramp	Interchange 18 Entrance Ramp	*1660*	+3%	5%	50	50
Interchange 18 Entrance Ramp	Interchange 19 Exit Ramp (R)	*940*	+3%	5%	50	50
Interchange 19 Exit Ramp (R)	Interchange 19 Exit Ramp (L)	380	-2%	5%	50	50
Interchange 19 Exit Ramp (L)	Interchange 19 Entrance Ramp	*1069*	-3%	5%	50	50
Interchange 19 Entrance Ramp	Interchange 20 Entrance Ramp (L)	*792*	-2%	5%	50	50
Interchange 20 Entrance Ramp (L)	Interchange 20 Entrance Ramp	*606*	-2%	5%	50	50
Interchange 20 Entrance Ramp	Interchange 21 Exit Ramp (Meadow St.)	*487*	-1%	5%	50	50
Interchange 21 Exit Ramp (Meadow St.)	Interchange 21 Exit Ramp (S. Main St.)	*797*	-2%	5%	50	55
Interchange 21 Exit Ramp (S. Main St.)	Interchange 22 Entrance Ramp	*898*	-3%	5%	50	55
Interchange 22 Entrance Ramp	Interchange 23 Exit Ramp	*1120*	+3%	5%	50	55
Westbound						
Interchange 22 Entrance Ramp	Interchange 21 Exit Ramp	*2660*	-4%	5%	50	55
Interchange 21 Exit Ramp	Interchange 21 Entrance Ramp (R)	*1240*	+1%	5%	50	55
Interchange 21 Entrance Ramp (R)	Interchange 20 Entrance Ramp (L)	*158*	+1%	5%	50	55
Interchange 21 Entrance Ramp (L)	Interchange 20 Exit Ramp	*898*	+1%	5%	50	55
Interchange 20 Exit Ramp	Interchange 19 Exit Ramp	*793*	+1%	5%	50	50
Interchange 19 Exit Ramp	Interchange 19 Entrance Ramp (L)	*1300*	+4%	5%	50	50
Interchange 19 Entrance Ramp (L)	Interchange 19 Entrance Ramp (R)	*625*	+4%	5%	50	50
Interchange 19 Entrance Ramp (R)	Interchange 18 Exit Ramp	*1540*	-2%	5%	50	50
Interchange 18 Exit Ramp	Interchange 18 Entrance Ramp	*3204*	+1%	5%	50	50

(1) AASHTO 2001, Exhibit 8-1, p 510

(+) % Upgrade (-) % Down grade

Table 6-6: Route 8 Mainline Geometry Assessment

From	To	Segment Length *(ft)*	Grade	Maximum Recommended Grade[1]	Curve Design Speed *(mph)*	Mainline Posted Speed *(mph)*
Northbound						
Interchange 30 Entrance ramp	Interchange 31 Exit ramp	*1392*	+3%	5%	50	45
Interchange 31 Exit ramp	Interchange 32 Exit ramp	*475*	+2%	5%	50	55
Interchange 32 Exit ramp	Interchange 33 Exit ramp (L)	*253*	+1%	5%	50	55
Interchange 33 Exit ramp (L)	Interchange 33 Entrance ramp (84 WB)	1500	+1%	5%	50	55
Interchange 33 Entrance ramp (84 WB)	Interchange 33 Entrance ramp (84 EB)	*354*	+1%	5%	50	55
Interchange 33 Entrance ramp (84 EB)	Interchange 33 Entrance ramp (Riverside)	*507*	+1%	5%	50	55
Interchange 33 Entrance ramp (Riverside)	Interchange 34 Entrance ramp	*1192*	-2%	5%	50	55
Interchange 34 Entrance ramp	Interchange 35 Exit ramp	*1600*	-2%	5%	50	55
Southbound						
Interchange 35 Entrance ramp	Interchange 34 Exit ramp	*1560*	+2%	5%	50	55
Interchange 34 Exit ramp	Interchange 33 Exit ramp	*1627*	+2%	5%	50	55
Interchange 33 Exit ramp	Interchange 32 Exit ramp	377	+2%	5%	50	55
Interchange 32 Exit ramp	Interchange 31 Exit ramp	311	+2%	5%	50	55
Interchange 31 Exit ramp	Interchange 31 Entrance ramp (84 EB)	*1953*	-3%	5%	50	55
Interchange 31 Entrance ramp (84 EB)	Interchange 31 Entrance ramp (Riverside)	*106*	-3%	5%	50	55
Interchange 31 Entrance ramp (Riverside)	Interchange 31 Entrance ramp (84 WB)	*615*	-1%	5%	50	55
Interchange 31 Entrance ramp (84 WB)	Interchange 30 Exit ramp	*1656*	+1%	5%	50	55

(1) AASHTO 2001, Exhibit 8-1, p 510

(+) % Upgrade

(-) % Down grade

Superelevation Rates

Superelevation rates entrance ramps and the highway mainline was also assessed based on the AASHTO recommended maximum standard of 6%. There were two ramps with a superelevation rate of 8%. These ramps are Interchange 31 exit ramp which connects Route 8 northbound to I-84 and Interchange 20 exit ramp which connects I-84 westbound to Route 8. There were no observed superelevation rate deficiencies along the highway mainline.

6.1.2 Acceleration and Deceleration Lengths

Differential speeds on highways, which is usually caused by vehicles entering and exiting a highway, disrupts traffic flow and sometimes presents traffic safety issues. Acceleration and deceleration lanes are used to minimize such differential speeds on highways. Acceleration lanes enable drivers' to build up enough speed to safely enter mainline traffic flow without disruptions to traffic flow. Likewise, deceleration lanes enable drivers to substantially reduce their speeds to negotiate a curve in the exit ramp or stop safely at the end of a ramp.

As part of the geometric condition evaluation of the ramps and mainlines in the study area, acceleration and deceleration lanes were evaluated to verify that the recommended minimum acceleration and deceleration lane distances were satisfied. The first step in this task was to obtain the minimum AASHTO recommended acceleration and deceleration lengths based entrance ramp and corresponding mainline design speeds. AASHTO guidelines stipulate a minimum acceleration length of 550 feet and minimum deceleration length of 335 feet for a ramp design speed of 25 mph and a highway design speed of 50 mph. Any ramp with acceleration or deceleration lengths less than the minimum AASHTO standards was considered to be deficient. Table 6-7and Table 6-8 give a summary of the findings on acceleration and deceleration lengths on I-84, while Table 6-9 and Table 6-10 give a summary of acceleration and deceleration lengths on Route 8.

Entrance Ramp Acceleration Lengths on I-84

There were 4 entrance ramps along the I-84 corridor with acceleration length deficiencies. These ramps are:

- **Interchange 20 Eastbound Entrance Ramp (Right Ramp) –** This entrance ramp is a right hand ramp which connects Route 8 northbound to I-84 eastbound. The minimum acceleration length on this ramp as specified by AASHTO is 550 feet; however the measured acceleration length is only 480 feet.

- **Interchange 21 Westbound Entrance Ramp (Left Ramp) –** This entrance ramp is a left hand ramp. The measured acceleration length on this ramp is 280 feet. The minimum acceleration length as recommended by AASHTO is 550 feet.

- **Interchange 21 Westbound Entrance Ramp (Right Ramp)** –The measured acceleration length on this ramp is 410 feet. The minimum acceleration length as recommended by AASHTO is 550 feet.

- **Interchange 22 Eastbound Entrance Ramp -** The measured acceleration length on this ramp is 450 feet. The minimum acceleration length as recommended by AASHTO is 550 feet.

- **Interchange 22 Westbound Entrance Ramp -** The measured acceleration length on this ramp is 350 feet. The minimum acceleration length as recommended by AASHTO is 550 feet.

Exit Ramp Deceleration Lengths on I-84

There were 3 exit ramps along the I-84 corridor with deceleration length deficiencies as listed in Table 1.7. These exit ramps are:

- **Interchange 20 Westbound Exit ramp** - The minimum deceleration length for this ramp as specified by AASHTO is 335 feet. The measured deceleration length is 325 feet.
- **Interchange 21 Eastbound Exit ramp (to South Main Street) –** This exit ramp connects to South Main Street. The minimum deceleration length for this ramp as specified by AASHTO is 335 feet. The measured deceleration length is 320 feet.
- **Interchange 22 Westbound Exit ramp** - The minimum deceleration length for this ramp as specified by AASHTO is 335 feet. The measured deceleration length is 250 feet.

Table 6-7: I-84 Entrance Ramp Acceleration Lengths

Location	Direction	Curve Design Speed[2] *(mph)*	Mainline Design Speed *(mph)*	Acceleration Length (*ft*)	AASHTO Min. Acceleration Length[1,3] *(ft)*	Comments
I-84						
Interchange 18						
	EB	*25*	*50*	*840*	*550*	
	WB	*25*	*50*	`	*550*	
Interchange 19						
	EB	*25*	*50*	*450*	*550*	
	WB (Right)	*25*	*50*	*1200*	*550*	
	WB (Left)	*25*	*50*	*850*	*550*	
Interchange 20						
	EB (Right)	*25*	*50*	*480*	*550*	inadequate acceleration length
	EB (Left)	*25*	*50*	*N/A*	*550*	
Interchange 21						
	WB (Left)	*25*	*50*	*280*	*550*	inadequate acceleration length
	WB (Right)	*25*	*50*	*410*	*550*	inadequate acceleration length
Interchange 22						
	EB	*25*	*50*	*450*	*550*	inadequate acceleration length
	WB	*25*	*50*	*350*	*550*	inadequate acceleration length

(1) Design speed of 50 mph for mainline and 25 mph for ramps
(2) AASHTO 2001, Exhibit 10-56, p 830
(3) AASHTO 2001, Exhibit 10-70, p 851

Table 6-8: I-84 Exit Ramp Deceleration Lengths

Location	Direction	Curve Design Speed[2] *(mph)*	Mainline Design Speed *(mph)*	Deceleration Length *(ft)*	AASHTO Min. Deceleration Length[1, 3] *(ft)*	Comments
I-84						
Interchange 18						
	EB	*25*	*50*	*380*	*335*	
	WB	*25*	*50*	*390*	*335*	
Interchange 19						
	EB (Left)	*25*	*50*	*380*	*335*	
	EB (Right)	*25*	*50*	*720*	*335*	
Interchange 20						
	WB	*25*	*50*	*325*	*335*	inadequate deceleration length
Interchange 21						
	EB (Meadow)	*25*	*50*	*600*	*335*	
	EB (S. Main)	*25*	*50*	*320*	*335*	inadequate deceleration length
	WB	*25*	*50*	*415*	*335*	
Interchange 22						
	WB	*25*	*50*	*250*	*335*	inadequate deceleration length
Interchange 23						
	EB	*25*	*50*	*800*	*335*	

(1) Design speed of 50 mph for mainline and 25 mph for ramps
(2) AASHTO 2001, Exhibit 10-56, p 830
(3) AASHTO 2001, Exhibit 10-73, p 855

Entrance Ramp Acceleration Lengths on Route 8

There was one entrance ramp along the Route 8 corridor within the study area with an acceleration length deficiency as shown in Table 1.8. The deficient ramp is the Interchange 31 southbound entrance ramp from Riverside Street which has an acceleration length of 300 feet.

Exit Ramp Deceleration Lengths on Route 8

There were no observed deficiencies with regard to deceleration lengths on Route 8.

Table 6-9: Route 8 Entrance Ramp Acceleration Lengths

Location	Direction	Curve Radius	Curve Design Speed[2]	Mainline Design Speed	Acceleration Length	AASHTO Min. Acceleration Length[1,3]	Comments
Route 8		*(ft)*	*(mph)*	*(mph)*	*(ft)*	*(ft)*	
Interchange 30							
	NB	*1780*	*25*	*50*	*600*	*550*	
Interchange 31							
	SB (84 EB)	*850*	*25*	*50*	*900*	*550*	
	SB (84 WB)	*250*	*25*	*50*	*N/A*	*550*	
	SB (Riverside)	*1900*	*25*	*50*	*300*	*550*	inadequate acceleration length
Interchange 33							
	NB (84 WB)	*1170*	*25*	*50*	*N/A*	*550*	
	NB (84 EB)	*1400*	*25*	*50*	*700*	*550*	
	NB (Riverside)	*18400*	*25*	*50*	*800*	*550*	
Interchange 34							
	NB	*9829*	*25*	*50*	*850*	*550*	
Interchange 35							
	SB	*14950*	*25*	*50*	*N/A*	*550*	

(1) Design speed of 50 mph for mainline and 25 mph for ramps

(2) AASHTO 2001, Exhibit 10-56, p 830

(3) AASHTO 2001, Exhibit 10-70, p 851

Table 6-10: Route 8 Exit Ramp Deceleration Lengths

Location	Direction	Curve Radius	Curve Design Speed[2]	Mainline Design Speed	Deceleration Length	AASHTO Min. Deceleration Length[1,3]
Route 8		*(ft)*	*(mph)*	*(mph)*	*(ft)*	*(ft)*
Interchange 30						
	SB	*1380*	*25*	*50*	*630*	*335*
Interchange 31						
	NB	*250*	*25*	*50*	*420*	*335*
	SB	*950*	*25*	*50*	*460*	*335*
Interchange 32						
	NB	*1840*	*25*	*50*	*475*	*335*
	SB	*11000*	*25*	*50*	*460*	*335*
Interchange 33						
	NB	*2600*	*25*	*50*	*420*	*335*
	SB	*600*	*25*	*50*	*1000*	*335*
Interchange 34						
	SB	*52750*	*25*	*50*	*660*	*335*
Interchange 35						
	NB	*2200*	*25*	*50*	*670*	*335*

(1) Design speed of 50 mph for mainline and 25 mph for ramps

(2) AASHTO 2001, Exhibit 10-56, p 830

(3) AASHTO 2001, Exhibit 10-73, p 855

6.1.3 Interchange Spacing

In addition to evaluating the geometry of the ramps in the study area, an analysis was conducted to ascertain whether the minimum ramp spacing between successive ramp terminals, as specified by current design standards are satisfied. Successive ramp terminals are defined as the presence of two or more ramps (entrance or exit) in close succession either upstream or downstream an urban freeway. A reasonable distance between successive ramps is important to provide enough room for maneuvering and signage placement.

AASHTO standards recognize four different designated ramp combinations, namely entrance ramp-entrance ramp, entrance ramp-exit ramp, exit ramp-entrance ramp and exit ramp-exit ramp. An entrance ramp-entrance ramp combination is a ramp combination in which an entrance ramp is followed by an entrance ramp. Likewise, an exit ramp- exit ramp combination is a combination in which an exit ramp is followed by another exit ramp. In an entrance ramp- exit ramp combination, an entrance ramp is directly followed by an exit ramp, while in an exit ramp entrance ramp combination; an exit ramp is directly followed by an entrance ramp.

Minimum interchange spacings were obtained for the four different designated ramp combinations, using methodology from AASHTO (2004). AASHTO standards recommend a minimum interchange spacing of 500 feet for an exit ramp-entrance ramp combination, 1000 feet for exit ramp-exit ramp or entrance ramp- entrance ramp combination and 2000 feet for an entrance ramp-exit ramp combination. The existing interchange spacings were then compared to the AASTHTO standards to ascertain whether the set standards were met. Table 6-11 and Table 6-12 summarize the findings of the interchange spacing analysis.

Along the I-84 mainline in the eastbound direction, there were 7 segments with interchange spacing deficiencies as listed in Table 6-11. These segments are:

- **Interchange 18 Entrance Ramp to Interchange 19 Exit Ramp (Right Ramp) -** The interchange spacing for this segment is 940 feet. The minimum AASHTO standard for this ramp combination is 2000 feet.

- **Interchange 19 Exit Ramp (on Right) to Interchange 19 Exit Ramp (on Left) -** The interchange spacing for this segment is 380 feet. The minimum AASHTO standard for this ramp combination is 1000 feet.

- **Interchange 19 Entrance Ramp to Interchange 20 Entrance Ramp (Left Ramp)** - The interchange spacing for this segment is 792 feet. The minimum AASHTO standard for this ramp combination is 1000 feet.

- **Interchange 20 Entrance Ramp (Left Ramp) to Interchange 20 Entrance Ramp (Route 8 NB)** - The interchange spacing for this segment is 606 feet. The minimum AASHTO standard for this ramp combination is 1000 feet.

- **Interchange 20 Entrance Ramp (Route 8 NB) to Interchange 21 Exit Ramp (Meadow St)** - The interchange spacing for this segment is 487 feet. The minimum AASHTO standard for this ramp combination is 2000 feet.

- **Interchange 21 Exit Ramp (Meadow St) to Interchange 21 Exit Ramp (South Main St)** - The interchange spacing for this segment is 797 feet. The minimum AASHTO standard for this ramp combination is 1000 feet.

- **Interchange 22 Entrance Ramp to Interchange 23 Exit Ramp** - The interchange spacing for this segment is 1120 feet. The minimum AASHTO standard for this ramp combination is 2000 feet.

In the westbound direction along I-84, there were 4 different successive ramps sections with spacing deficiencies as listed in Table 6-12. These segments are:

- I**nterchange 21 Entrance Ramp (from Right) to Interchange 21 Entrance Ramp (Left Ramp)** - The interchange spacing for this segment is 158 feet. The minimum AASHTO standard for this ramp combination is 1000 feet.

- **Interchange 21 Entrance Ramp (from Left) to Interchange 20 Exit Ramp** - The interchange spacing for this segment is 898 feet. The minimum AASHTO standard for this ramp combination is 2000 feet.

- **Interchange 20 Exit Ramp to Interchange 19 Exit Ramp** - The interchange spacing for this segment is 793 feet. The minimum AASHTO standard for this ramp combination is 1000 feet.

- **Interchange 19 Entrance Ramp (from Left) to Interchange 19 Entrance Ramp (Right Ramp)** - The interchange spacing for this segment is 625 feet. The minimum AASHTO standard for this ramp combination is 1000 feet.

Table 6-11: I-84 Interchange Spacing

Location I-84	Downstream Distance to Next Ramp *(ft)*	Downstream Ramp	AASHTO Designated Ramp Combination	AASHTO Min. Recommended Distance *(ft)*	Comments
Eastbound					
Interchange 17 Entrance Ramp	*3300*	Interchange 18 Exit Ramp	En-Ex	*2000*	
Interchange 18 Exit Ramp	*1660*	Interchange 18 Entrance Ramp	Ex-En	*500*	
Interchange 18 Entrance Ramp	*940*	Interchange 19 Exit Ramp (R)	En-Ex	*2000*	insufficient ramp spacing
Interchange 19 Exit Ramp (R)	380	Interchange 19 Exit Ramp (L)	Ex-Ex	*1000*	insufficient ramp spacing
Interchange 19 Exit Ramp (L)	*1069*	Interchange 19 Entrance Ramp	Ex-En	*500*	
Interchange 19 Entrance Ramp	*792*	Interchange 20 Entrance Ramp (L)	En-En	*1000*	insufficient ramp spacing
Interchange 20 Entrance Ramp (L)	*606*	Interchange 20 Entrance Ramp (Rte 8 NB)	En-En	*1000*	insufficient ramp spacing
Interchange 20 Entrance Ramp (Rte 8 NB)	*487*	Interchange 21 Exit Ramp (Meadow St.)	En-Ex	*2000*	insufficient ramp spacing
Interchange 21 Exit Ramp (Meadow St.)	*797*	Interchange 21 Exit Ramp (S. Main St.)	Ex-Ex	*1000*	insufficient ramp spacing
Interchange 21 Exit Ramp (S. Main St.)	*898*	Interchange 22 Entrance Ramp	Ex-En	*500*	
Interchange 22 Entrance Ramp	*1120*	Interchange 23 Exit Ramp	En-Ex	*2000*	insufficient ramp spacing
Westbound					
Interchange 22 Entrance Ramp	*2660*	Interchange 21 Exit Ramp	En-Ex	*2000*	
Interchange 21 Exit Ramp	*1240*	Interchange 21 Entrance Ramp (R)	Ex-En	*500*	
Interchange 21 Entrance Ramp (R)	*158*	Interchange 21 Entrance Ramp (L)	En-En	*1000*	insufficient ramp spacing
Interchange 21 Entrance Ramp (L)	*898*	Interchange 20 Exit Ramp	En-Ex	*2000*	insufficient ramp spacing
Interchange 20 Exit Ramp	*793*	Interchange 19 Exit Ramp	Ex-Ex	*1000*	insufficient ramp spacing
Interchange 19 Exit Ramp	*1300*	Interchange 19 Entrance Ramp (L)	Ex-En	*500*	
Interchange 19 Entrance Ramp (L)	*625*	Interchange 19 Entrance Ramp (R)	En-En	*1000*	insufficient ramp spacing
Interchange 19 Entrance Ramp (R)	*1540*	Interchange 18 Exit Ramp	En-Ex	*2000*	
Interchange 18 Exit Ramp	*3204*	Interchange 18 Entrance Ramp	Ex-En	*500*	
Interchange 18 Entrance Ramp	*2900*	Interchange 17 Exit Ramp	En-Ex	*2000*	

(R) Denotes Right Hand Interchange Ramp

(L) Denotes Left Hand Interchange Ramp

Along the Route 8 mainline, there were 6 different successive ramps sections with spacing deficiencies in the northbound direction as listed in Table 6-12. These ramps are:

- **Interchange 30 Entrance Ramp to Interchange 31 Exit Ramp** - The interchange spacing for this segment is 1392 feet. The minimum AASHTO standard for this ramp combination is 2000 feet.
- **Interchange 31 Exit Ramp to Interchange 32 Exit Ramp** - The interchange spacing for this segment is 475 feet. The minimum AASHTO standard for this ramp combination is 1000 feet.
- **Interchange 32 Exit Ramp to Interchange 33 Exit Ramp (Left Ramp)** - The interchange spacing for this segment is 253 feet. The minimum AASHTO standard for this ramp combination is 1000 feet.
- **Interchange 33 Entrance Ramp (84 WB) to Interchange 33 Entrance Ramp (84 EB)** - The interchange spacing for this segment is 353 feet. The minimum AASHTO standard for this ramp combination is 1000 feet.
- **Interchange 33 Entrance Ramp (84 EB) to Interchange 33 Entrance Ramp (Riverside St)** - The interchange spacing for this segment is 507 feet. The minimum AASHTO standard for this ramp combination is 1000 feet.
- **Interchange 34 Entrance Ramp to Interchange 35 Exit Ramp** - The interchange spacing for this segment is 1600 feet. The minimum AASHTO standard for this ramp combination is 2000 feet.

In the southbound direction, there were 5 different successive ramps with spacing. These segments are:

- **Interchange 35 Entrance Ramp to Interchange 34 Exit Ramp** - The interchange spacing for this segment is 1560 feet. The minimum AASHTO standard for this ramp combination is 2000 feet.
- **Interchange 33 Exit Ramp to Interchange 32 Exit Ramp** - The interchange spacing for this segment is 377 feet. The minimum AASHTO standard for this ramp combination is 1000 feet.
- **Interchange 32 Exit Ramp to Interchange 31 Exit Ramp** - The interchange spacing for this segment is 311 feet. The minimum AASHTO standard for this ramp combination is 1000 feet.
- **Interchange 31 Entrance Ramp (from I-84 EB) to Interchange 31 Entrance Ramp (from Riverside St)** - The interchange spacing for this segment is 106 feet. The minimum AASHTO standard for this ramp combination is 1000 feet.

- **Interchange 31 Entrance Ramp (from Riverside St) to Interchange 31 Entrance Ramp (from I-84 WB**) - The interchange spacing for this segment is 615 feet. The minimum AASHTO standard for this ramp combination is 1000 feet.

Table 6-12: Route 8 Interchange Spacing

Location Route 8	Downstream Distance to Next Ramp *(ft)*	Downstream Ramp	AASHTO Designated Ramp Combination	AASHTO Min. Recommended Distance *(ft)*	Comments
Northbound					
Interchange 30 Exit Ramp	*3450*	Interchange 30 Entrance Ramp	Ex-En	*500*	
Interchange 30 Entrance Ramp	*1392*	Interchange 31 Exit Ramp	En-Ex	*2000*	insufficient ramp spacing
Interchange 31 Exit Ramp	*475*	Interchange 32 Exit Ramp	Ex-Ex	*1000*	insufficient ramp spacing
Interchange 32 Exit Ramp	*253*	Interchange 33 Exit Ramp (L)	Ex-Ex	*1000*	insufficient ramp spacing
Interchange 33 Exit Ramp (L)	1500	Interchange 33 Entrance Ramp (84 WB)	Ex-En	*500*	
Interchange 33 Entrance Ramp (84 WB)	*354*	Interchange 33 Entrance Ramp (84 EB)	En-En	*1000*	insufficient ramp spacing
Interchange 33 Entrance Ramp (84 EB)	*507*	Interchange 33 Entrance Ramp (Riverside)	En-En	*1000*	insufficient ramp spacing
Interchange 33 Entrance Ramp (Riverside)	*1192*	Interchange 34 Entrance Ramp	En-En	*1000*	
Interchange 34 Entrance Ramp	*1600*	Interchange 35 Exit Ramp	En-Ex	*2000*	insufficient ramp spacing
Southbound					
Interchange 35 Entrance Ramp	*1560*	Interchange 34 Exit Ramp	En-Ex	*2000*	insufficient ramp spacing
Interchange 34 Exit Ramp	*1627*	Interchange 33 Exit Ramp	Ex-Ex	*1000*	
Interchange 33 Exit Ramp	377	Interchange 32 Exit Ramp	Ex-Ex	*1000*	insufficient ramp spacing
Interchange 32 Exit Ramp	311	Interchange 31 Exit Ramp	Ex-Ex	*1000*	insufficient ramp spacing
Interchange 31 Exit Ramp	*1953*	Interchange 31 Entrance Ramp (84 EB)	Ex-En	*500*	
Interchange 31 Entrance Ramp (84 EB)	*106*	Interchange 31 Entrance Ramp (Riverside)	En-En	*1000*	insufficient ramp spacing
Interchange 31 Entrance Ramp (Riverside)	*615*	Interchange 31 Entrance Ramp (84 WB)	En-En	*1000*	insufficient ramp spacing
Interchange 31 Entrance Ramp (84 WB)	*1656*	Interchange 30 Exit Ramp	En-Ex	2000	

(L) Denotes Left Hand Interchange Ramp

6.1.4 Lane Continuity and Configuration

Lane continuity and configuration are important geometric parameters that affect traffic flow. Lane continuity refers to the provision of a path throughout the length of a roadway. Sudden lane discontinuities generate unnecessary weaving and maneuvering by drivers, which ultimately disrupts traffic flow and in some cases lead to accidents.

Lane configuration on the other hand refers to the location, direction and dimension of roadway lanes, sidewalks and other design features. The location of ramps along a highway is an important configuration issue. Exit ramps located on the left side of a highway generate weaving and maneuvering problems particularly in instances where there is insufficient advance warning for drivers to maneuver to the left lane to take an exit ramp.

In this study, sections along the I-84 and Route 8 mainline within the study area with lane configuration and continuity problems were identified. Table 6-13 and Table 6-14 give a summary of the findings on lane continuity and configuration for I-84 and Route 8 respectively.

Lane Discontinuity along I-84

In the eastbound direction along I-84, there are two sections with lane discontinuities.

- **Interchange 19 Exit Ramp (to Route 8 SB) –** This exit ramp is located on the right side of the travel way. Upstream this ramp, there are 3 lanes comprising 2 travel lanes and one auxiliary lane. The auxiliary lane is dropped at this interchange leaving 2 travel lanes downstream the exit ramp.

- **Interchange 21 Exit Ramp (to Meadow St.) -** Upstream this exit ramp, there are 4 lanes comprising 3 travel lanes and one right auxiliary lane. The auxiliary lane is dropped at this ramp leaving 3 travel lanes downstream the ramp.

In the westbound direction, there are three sections along I-84 where lanes are discontinued. These sections are:

- **Interchange 20 Exit Ramp**-Upstream this exit ramp, there are 5 lanes comprising 3 travel lanes and 2 auxiliary lanes located on each side of the roadway. At this exit ramp, the left auxiliary lane is dropped leaving 3 travel lanes and the right auxiliary lane downstream the ramp.

- **Interchange 19 Exit Ramp**-Upstream this exit ramp, there are 4 lanes comprising 3 travel lanes and a right auxiliary lane. At this exit ramp, the auxiliary lane is dropped leaving 3 travel lanes downstream the ramp.

- **Interchange 18 Exit Ramp**-Upstream this exit ramp, there are 4 lanes comprising 3 travel lanes and a right auxiliary lane. At this exit ramp, the auxiliary lane is dropped leaving 3 travel lanes downstream the ramp.

Table 6-13: I-84 Lane Configuration and Continuity

Location I-84	Number of Lanes (Upstream)	Number of Lanes (Downstream)	Comments
Eastbound			
Interchange 18 Entrance ramp	2	3	
Interchange 19 Exit ramp (R)	3	2	Lane discontinued
Interchange 19 Exit ramp (L)	2	2	
Interchange 19 Entrance ramp	2	2	
Interchange 20 Entrance ramp (L)	2	3	
Interchange 20 Entrance ramp (Rte 8 NB)	3	4	
Interchange 21 Exit ramp (Meadow St.)	4	3	Lane discontinued
Interchange 21 Exit ramp (S. Main St.)	3	3	
Interchange 22 Entrance ramp	3	4	
Westbound			
Interchange 22 Entrance ramp	3	3	
Interchange 21 Exit ramp	3	3	
Interchange 21 Entrance ramp (R)	3	4	
Interchange 21 Entrance ramp (L)	4	5	
Interchange 20 Exit ramp	5	4	Lane discontinued
Interchange 19 Exit ramp	4	3	Lane discontinued
Interchange 19 Entrance ramp (L)	3	4	
Interchange 19 Entrance ramp (R)	4	4	
Interchange 18 Exit ramp	4	3	Lane discontinued
Interchange 18 Entrance ramp	3	-	

(R) Denotes Right Hand Interchange Ramp
(L) Denotes Left Hand Interchange Ramp

Lane Discontinuity along Route 8

In the northbound direction along Route 8, there is one location with a lane discontinuity. This location is:

Interchange 31 Exit Ramp – Upstream this exit ramp, there are 3 lanes comprising, 2 travel lanes and an auxiliary lane. The auxiliary lane is dropped at this ramp leaving the 2 travel lanes downstream.

In the southbound direction along Route 8, there are also two sections with lane discontinuities. These sections are:

- **Interchange 34 Exit Ramp -** Upstream this ramp, there are 4 lanes comprising 3 travel lanes and an auxiliary lane. The auxiliary lane is dropped at this ramp leaving 3 travel lanes downstream the ramp.

- **Interchange 32 Exit Ramp (Left Ramp) -** The number of travel lanes drop from 3 to 2 lanes at this exit ramp.

Table 6-14: Route 8 Lane Configuration and Continuity

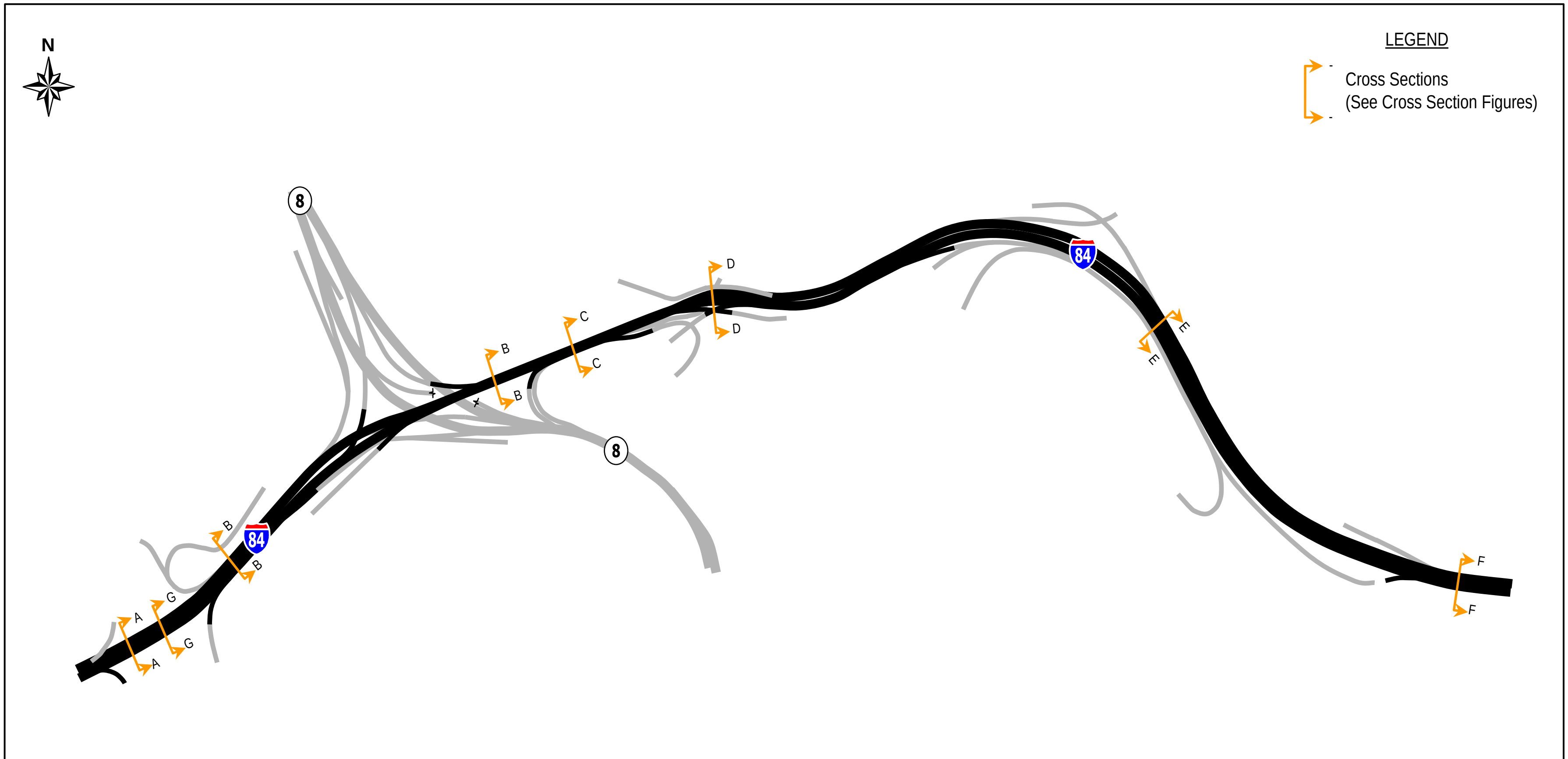
Location	Number of Lanes (Upstream)	Number of Lanes (Downstream)	Comments
Route 8			
Northbound			
Interchange 30 Exit ramp	2	2	
Interchange 30 Entrance ramp	2	3	
Interchange 31 Exit ramp	3	2	Lane discontinued
Interchange 32 Exit ramp	2	2	
Interchange 33 Exit ramp (L)	2	2	
Interchange 33 Entrance ramp (84 WB)	2	3	
Interchange 33 Entrance ramp (84 EB)	3	4	
Interchange 33 Entrance ramp (Riverside)	3	4	
Interchange 34 Entrance ramp	3	4	
Southbound			
Interchange 35 Entrance ramp	2	3	
Interchange 34 Exit ramp	4	3	Lane discontinued
Interchange 33 Exit ramp	3	3	
Interchange 32 Exit ramp (L)	3	2	Lane discontinued
Interchange 31 Exit ramp (L)	2	2	
Interchange 31 Entrance ramp (84 EB)	2	2	
Interchange 31 Entrance ramp (Riverside)	2	2	
Interchange 31 Entrance ramp (84 WB)	2	2	
Interchange 30 Exit ramp	2	2	

(L) Denotes Left Hand Interchange Ramp

Left Hand Ramps

In the eastbound direction along the I-84 mainline, there are two ramps located on the left side of the mainline. These ramps are the Interchange 19 exit ramp and Interchange 20 entrance ramp. The nearest upstream entrance ramp to the Interchange 19 exit ramp is the Interchange 18 entrance ramp which is 1220 feet away (AASHTO minimum = 2000’). In the westbound direction along I-84, there are also two left ramps. These ramps are Interchange 19 and Interchange 21 entrance ramps.

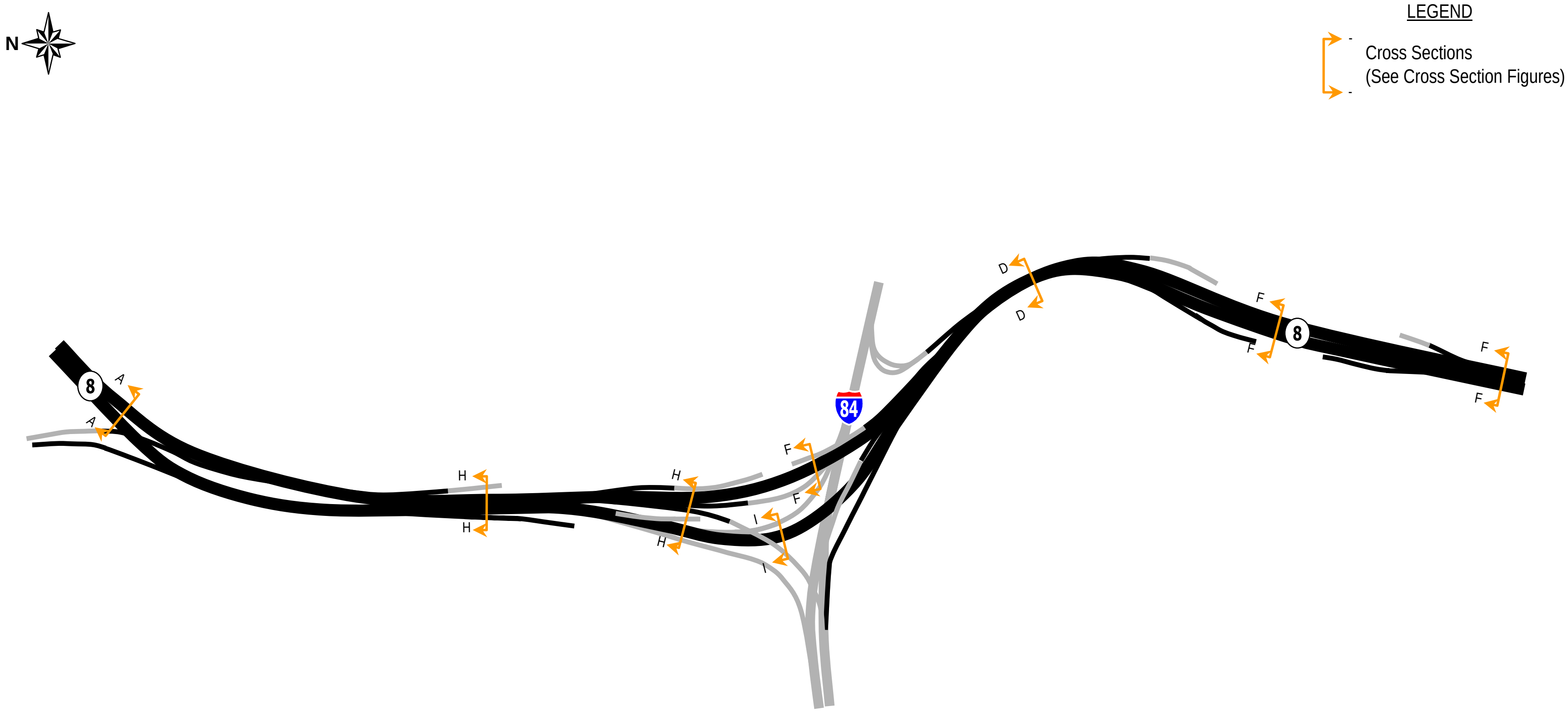
Along the Route 8 mainline in the northbound direction, there are three left ramps. These are the Interchange 33 exit ramp and the Interchange 33 entrance ramps from I-84 eastbound and I-84 westbound. In the southbound direction along Route 8, there two left ramps namely, the Interchange 31 and 32 exit ramps.



INTERSTATE 84

CROSS SECTION OVERVIEW

FIGURE 6-1



ROUTE 8
CROSS SECTION OVERVIEW

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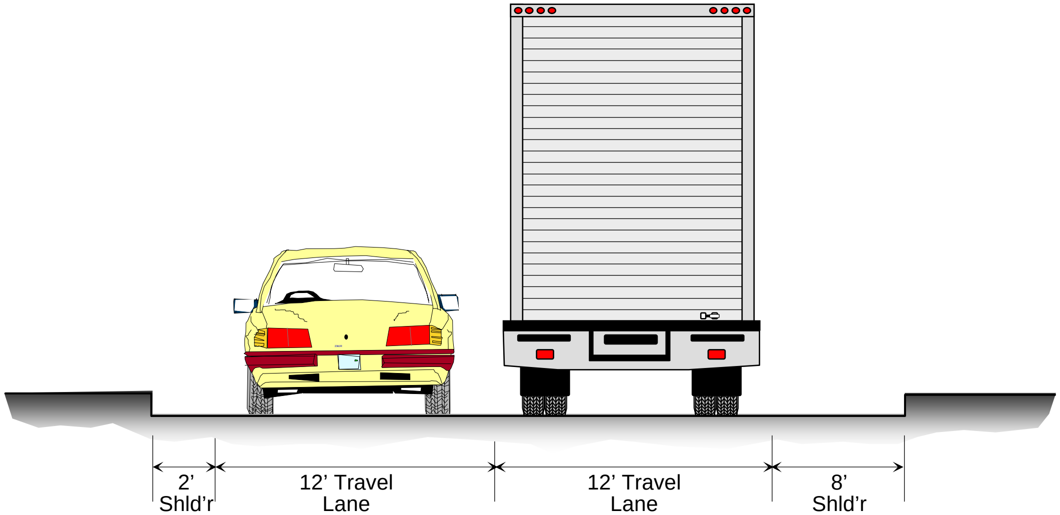
ECONOMISTS

FIGURE 6-2



INTERSTATE 84 EASTBOUND BETWEEN INTERCHANGES 17 & 19

ROUTE 8 NORTHBOUND BETWEEN INTERCHANGES 35 & 36

TYPICAL TWO LANE CROSS SECTION

SECTION A-A

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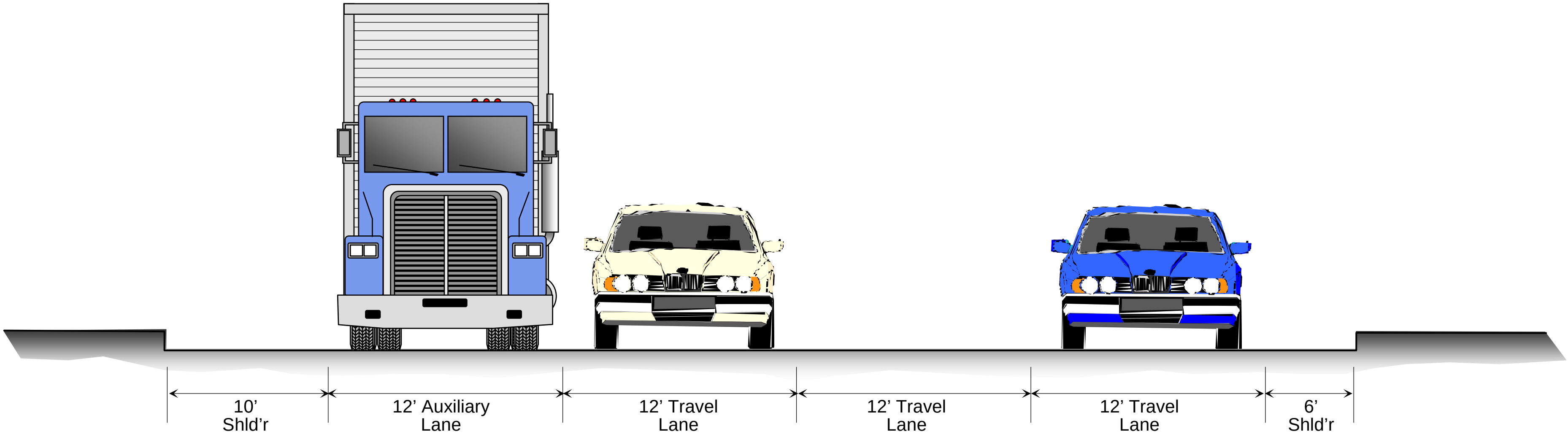
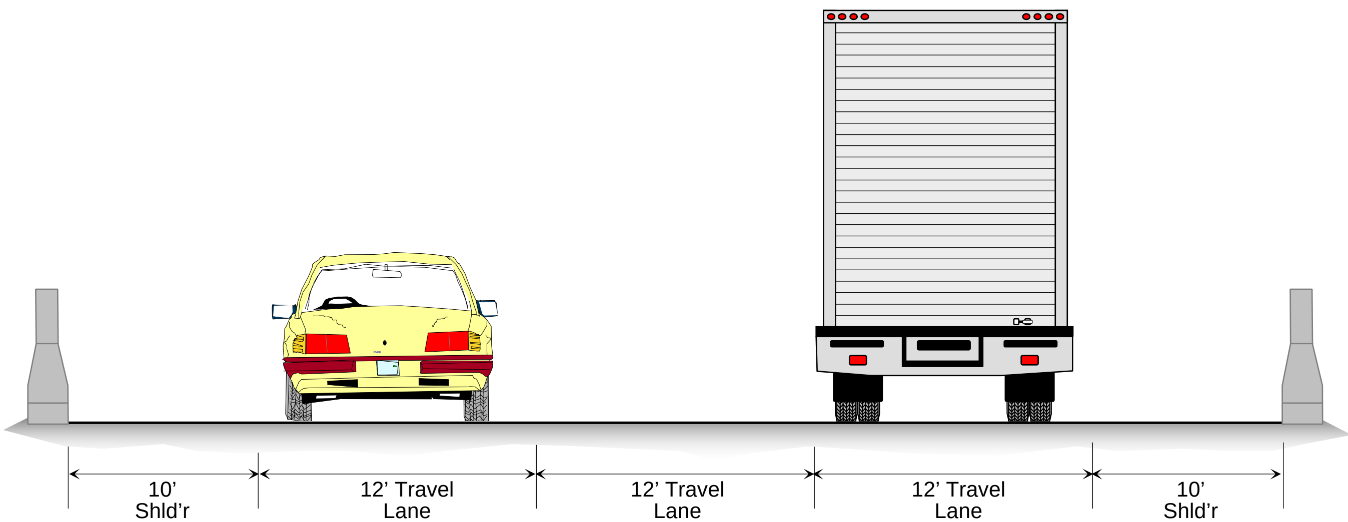
FIGURE 6-3



INTERSTATE 84 WESTBOUND BETWEEN INTERCHANGES 18 & 19

INTERSTATE 84 WESTBOUND BETWEEN INTERCHANGES 20 & 21



INTERSTATE 84 EASTBOUND BETWEEN INTERCHANGES 20 & 21

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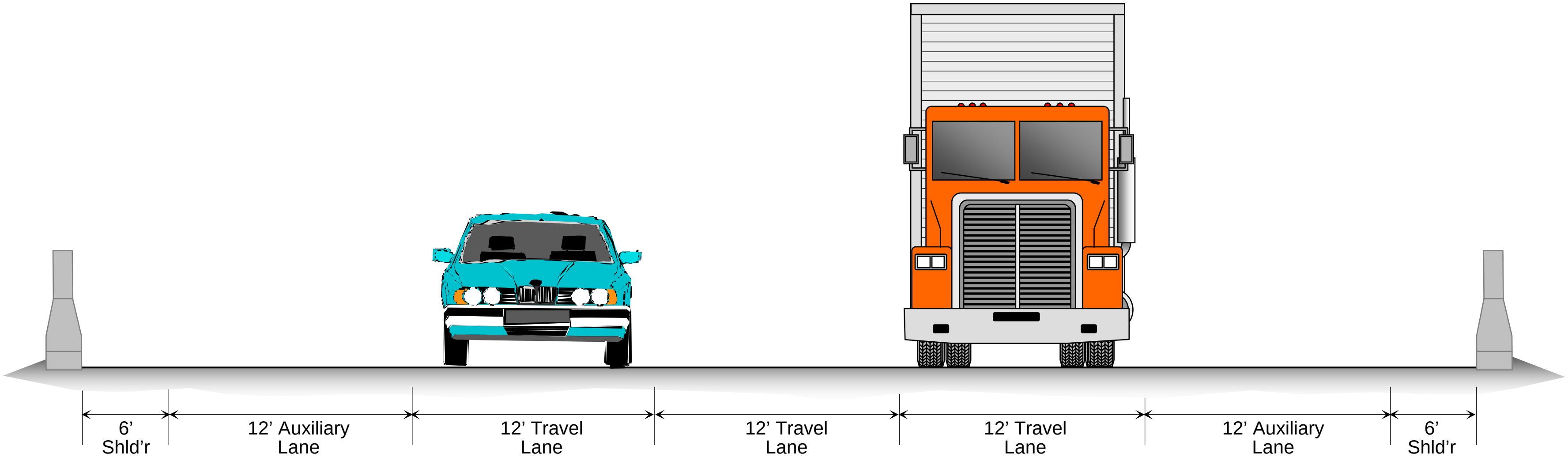
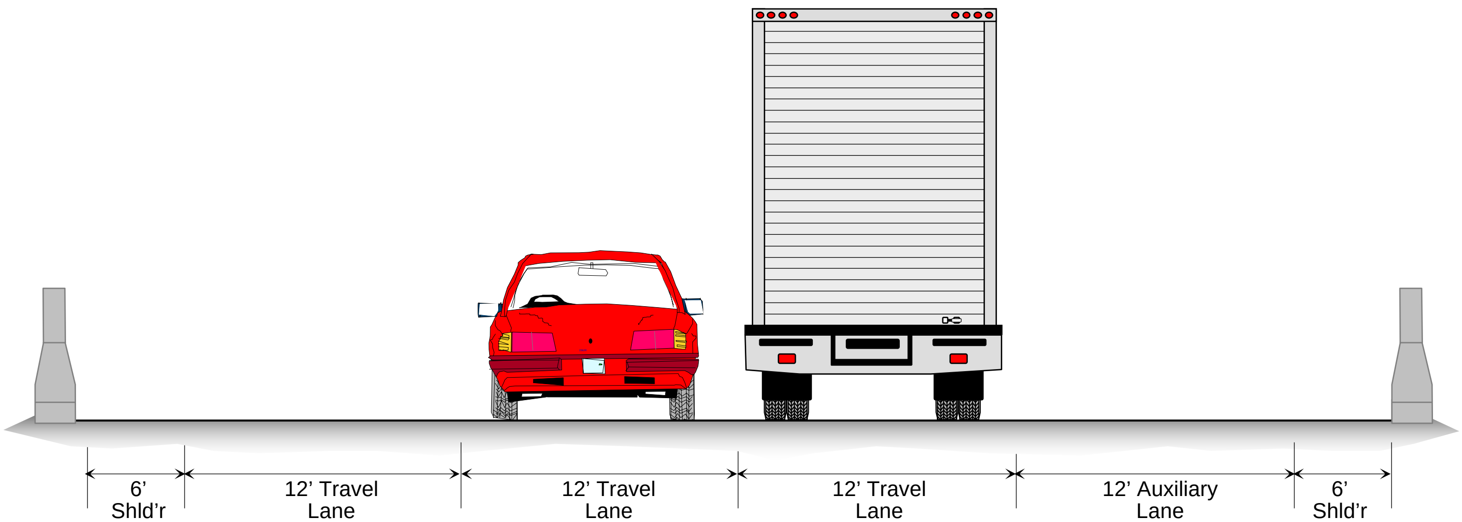
TYPICAL THREE LANE CROSS SECTION (WITH AUXILIARY LANE)

SECTION B-B

FIGURE 6-4



INTERSTATE 84 WESTBOUND BETWEEN INTERCHANGES 20 & 21



INTERSTATE 84 EASTBOUND BETWEEN INTERCHANGES 20 & 21

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ECONOMISTS
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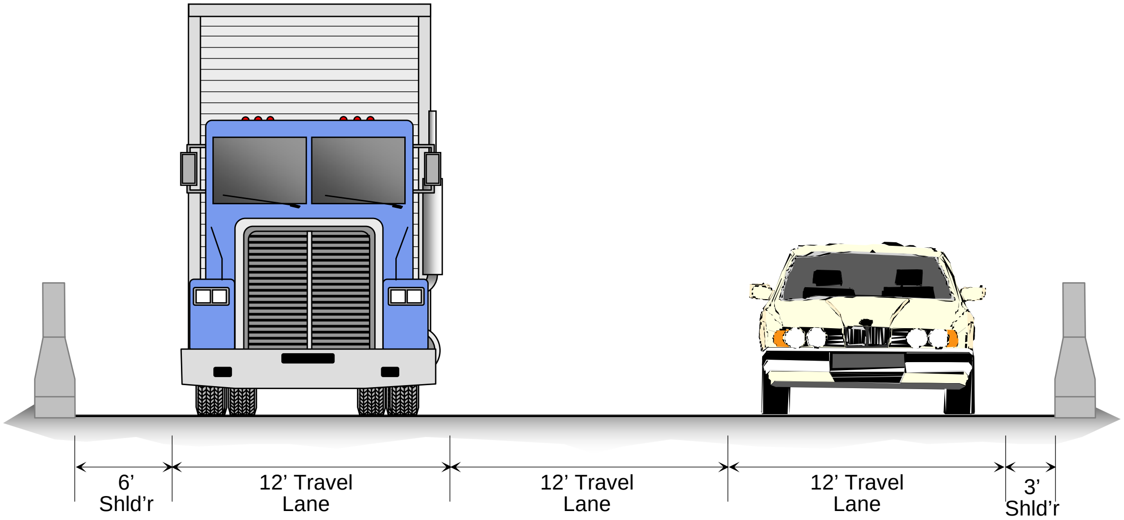
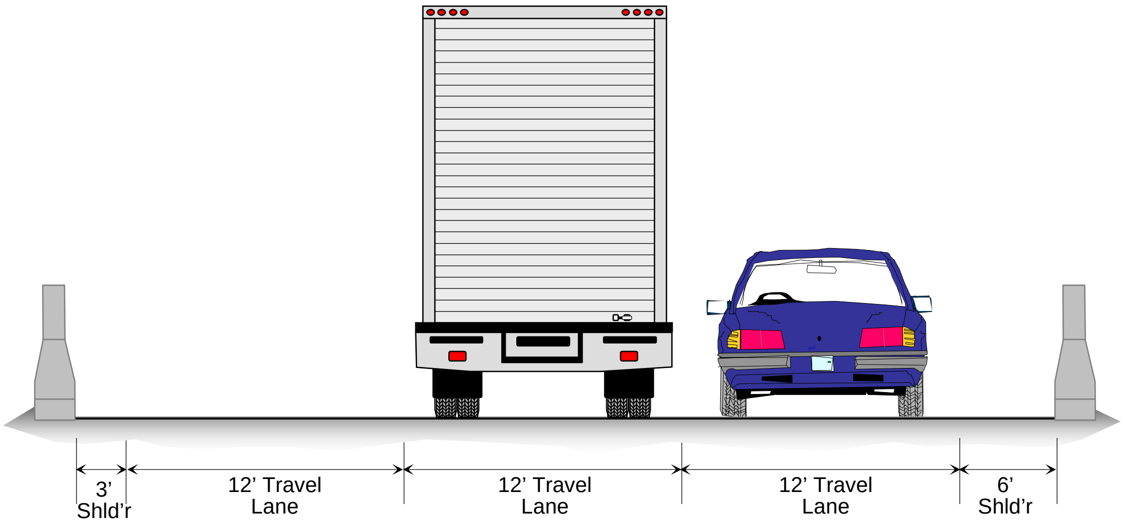
TYPICAL THREE LANE CROSS SECTION (WITH AUXILIARY LANE)
SECTION C-C

FIGURE 6-5



INTERSTATE 84 WESTBOUND BETWEEN INTERCHANGES 21 & 22



INTERSTATE 84 EASTBOUND BETWEEN INTERCHANGES 21 & 22

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ECONOMISTS
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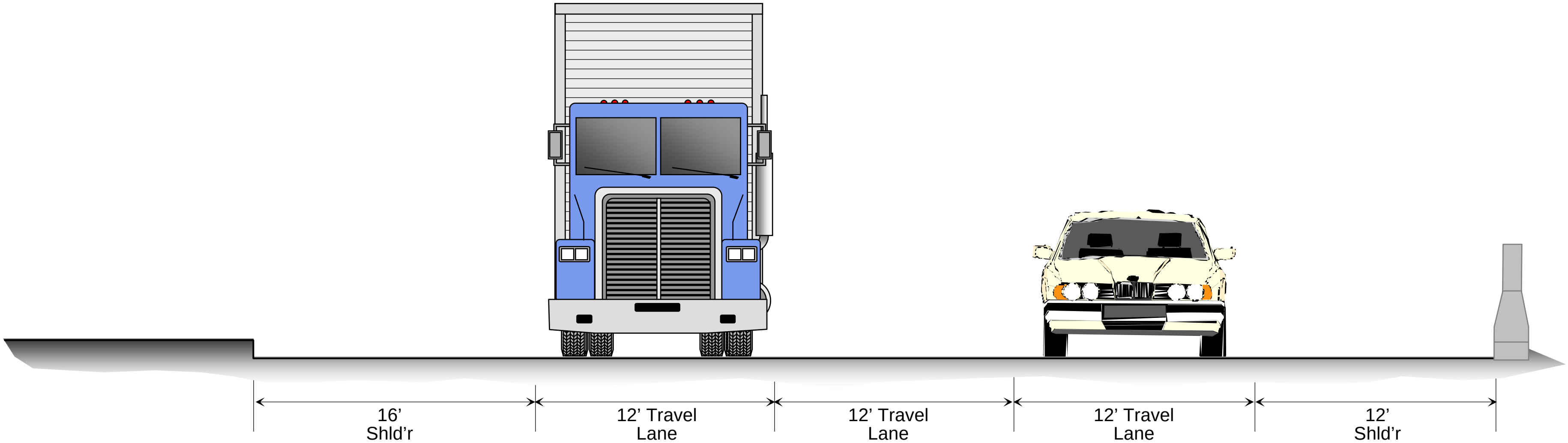
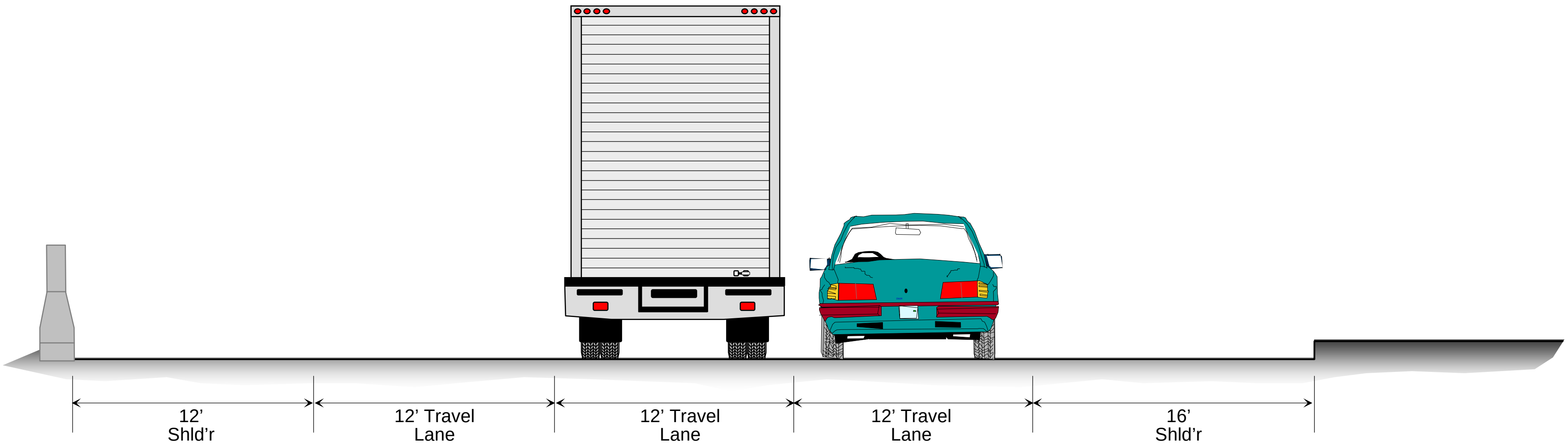
TYPICAL THREE LANE CROSS SECTION

SECTION D-D

FIGURE 6-6



INTERSTATE 84 WESTBOUND WEST OF HAMILTON AVENUE



INTERSTATE 84 EASTBOUND WEST OF HAMILTON AVENUE

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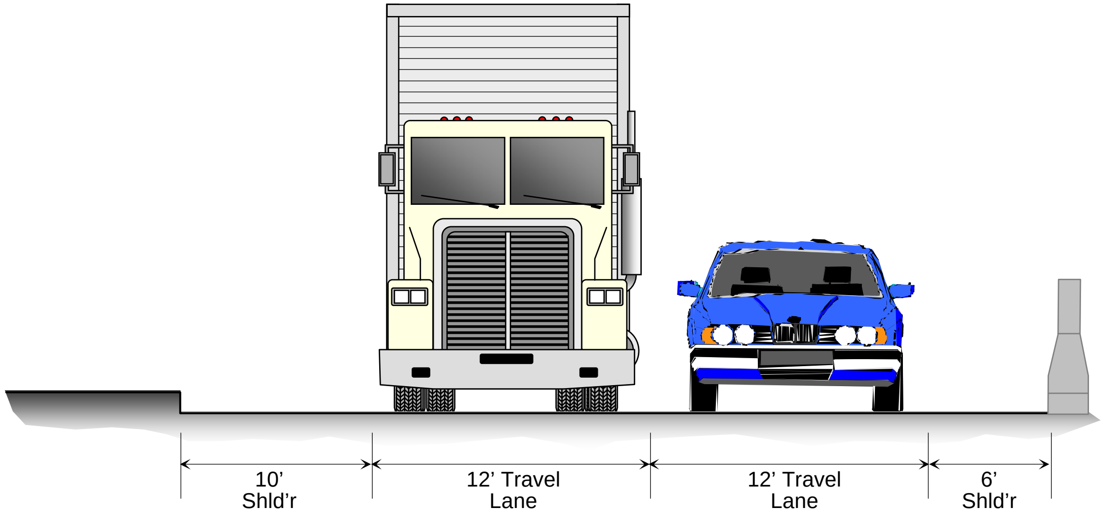
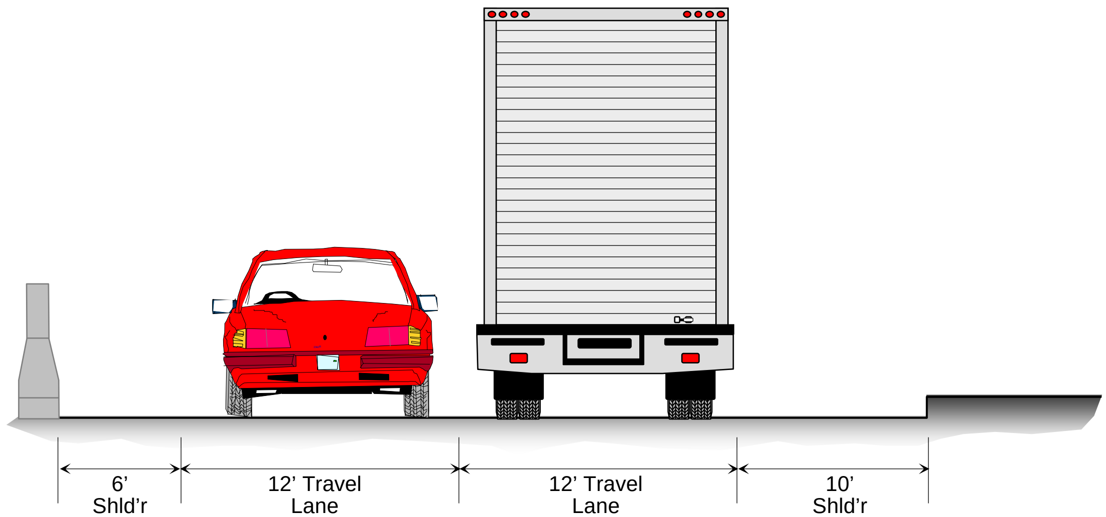
TYPICAL THREE LANE CROSS SECTION
SECTION E-E

FIGURE 6-7



INTERSTATE 84 WESTBOUND BETWEEN INTERCHANGES 23 & 24
ROUTE 8 SOUTHBOUND BETWEEN INTERCHANGES 29 & 30



INTERSTATE 84 EASTBOUND BETWEEN INTERCHANGES 23 & 24
ROUTE 8 NORTHBOUND BETWEEN INTERCHANGES 32 & 33
ROUTE 8 NORTHBOUND BETWEEN INTERCHANGES 29 & 30

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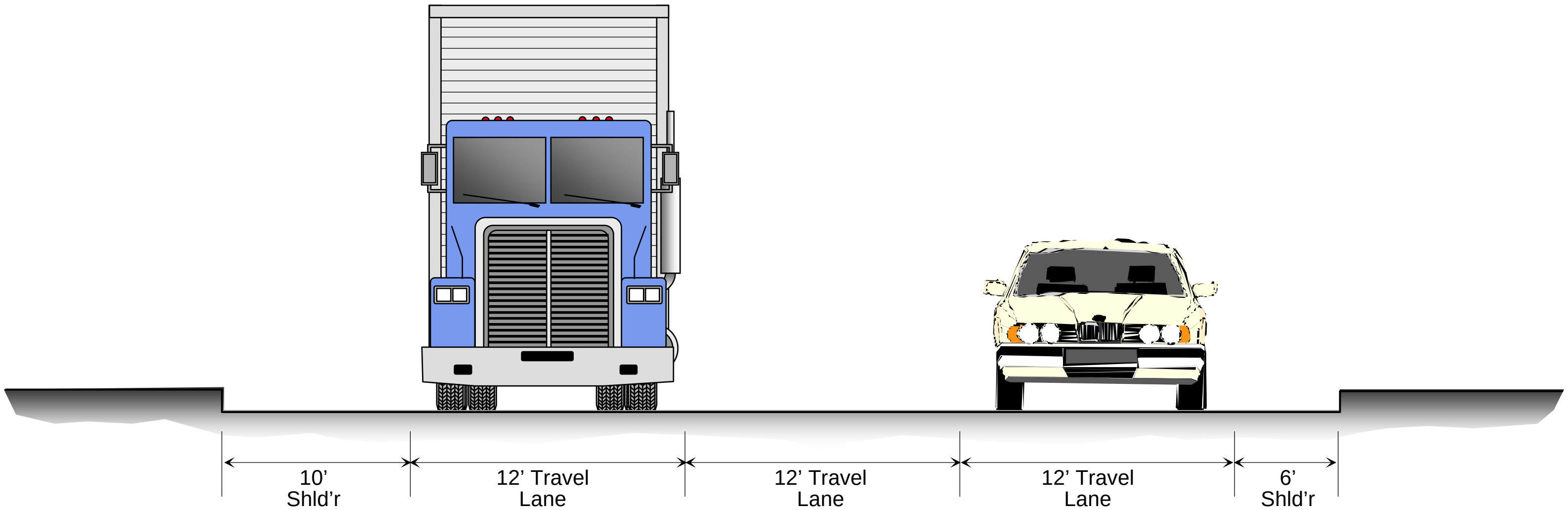
TYPICAL TWO LANE CROSS SECTION
SECTION F-F

FIGURE 6-8



INTERSTATE 84 WESTBOUND AT INTERCHANGE 18

TYPICAL THREE LANE CROSS SECTION
SECTION G-G

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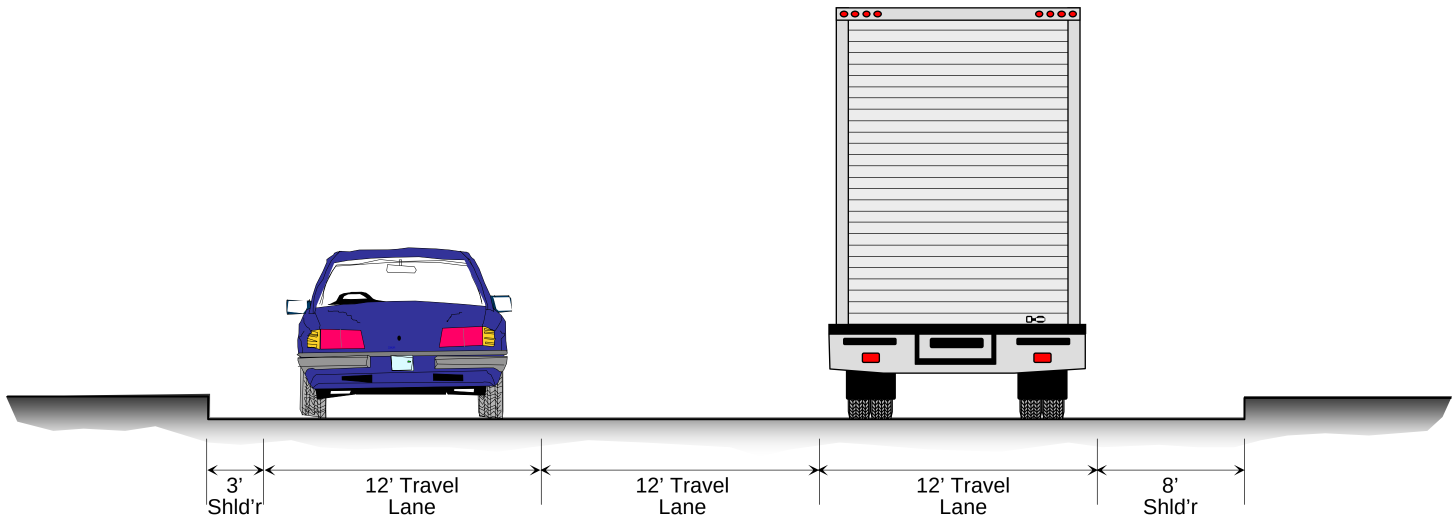
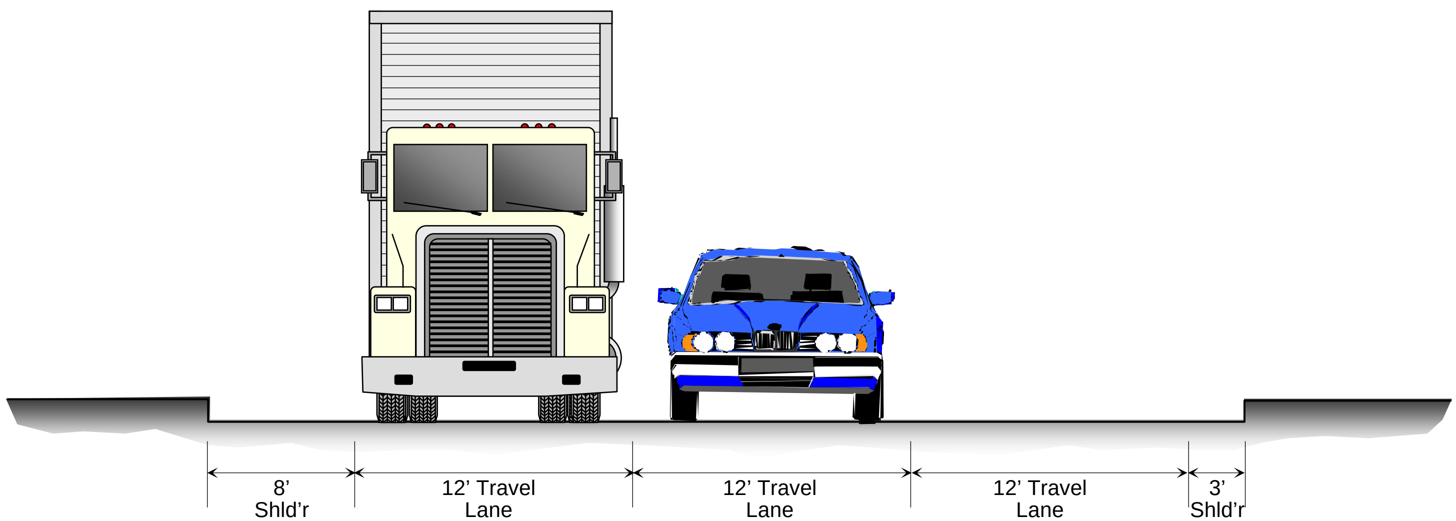
FIGURE 6-9



ROUTE 8 NORTHBOUND BETWEEN INTERCHANGES 34 & 35



ROUTE 8 SOUTHBOUND BETWEEN INTERCHANGES 33 & 34

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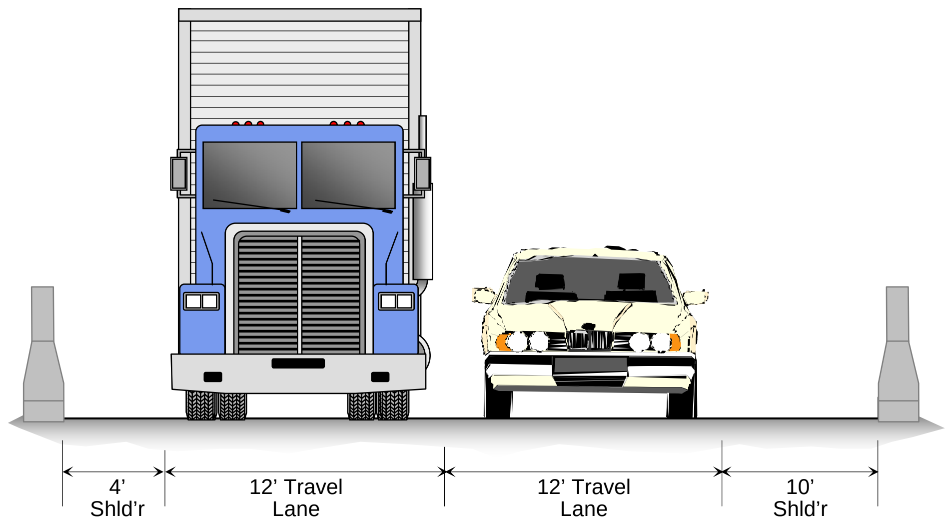
TYPICAL THREE LANE CROSS SECTION
SECTION H-H

FIGURE 6-10



ROUTE 8 SOUTHBOUND BETWEEN INTERCHANGES 31 & 33

TYPICAL TWO LANE CROSS SECTION
SECTION I-I

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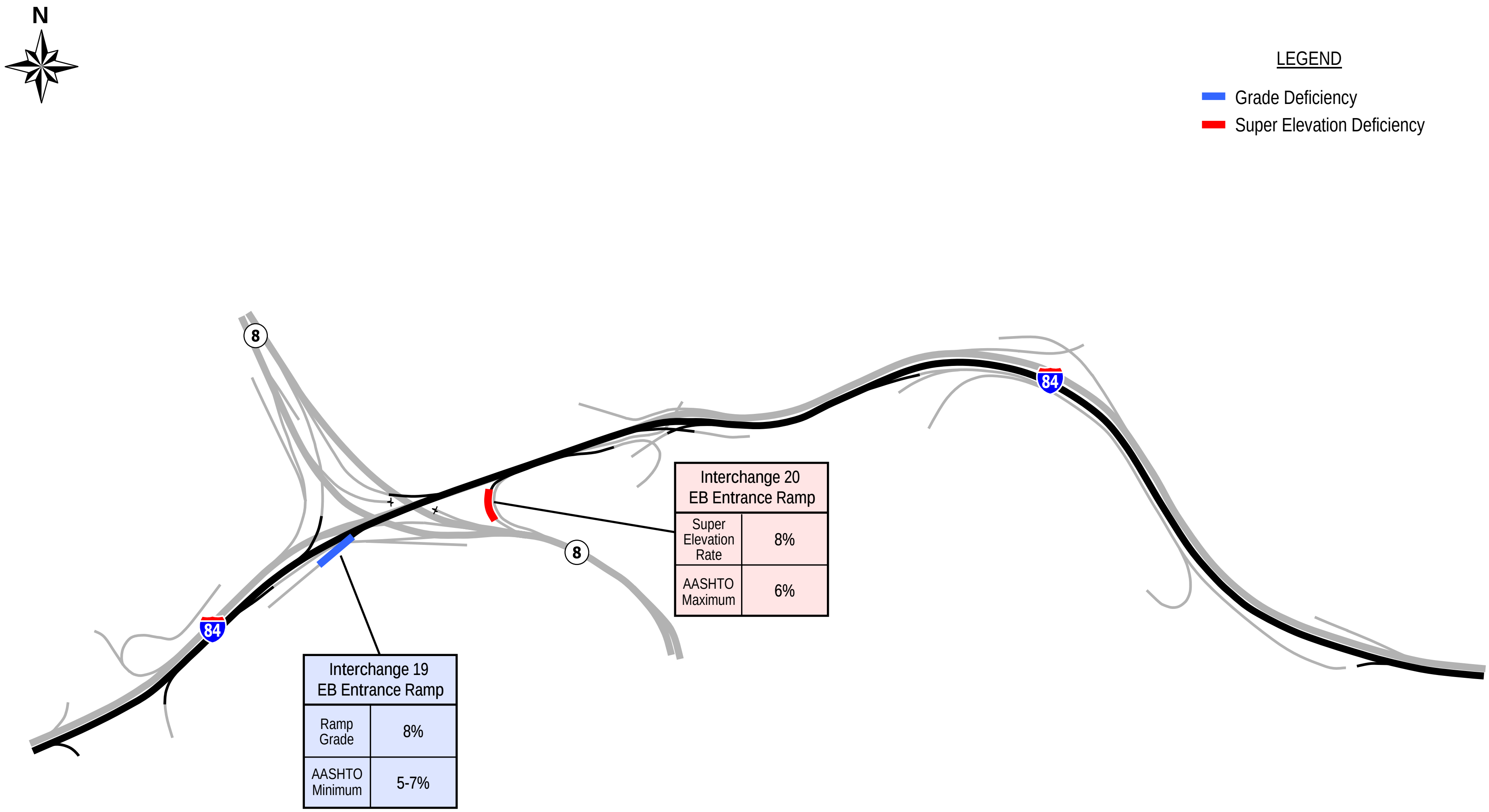
FIGURE 6-11



RAMP AND MAINLINE GEOMETRY DEFICIENCIES
I-84 EASTBOUND

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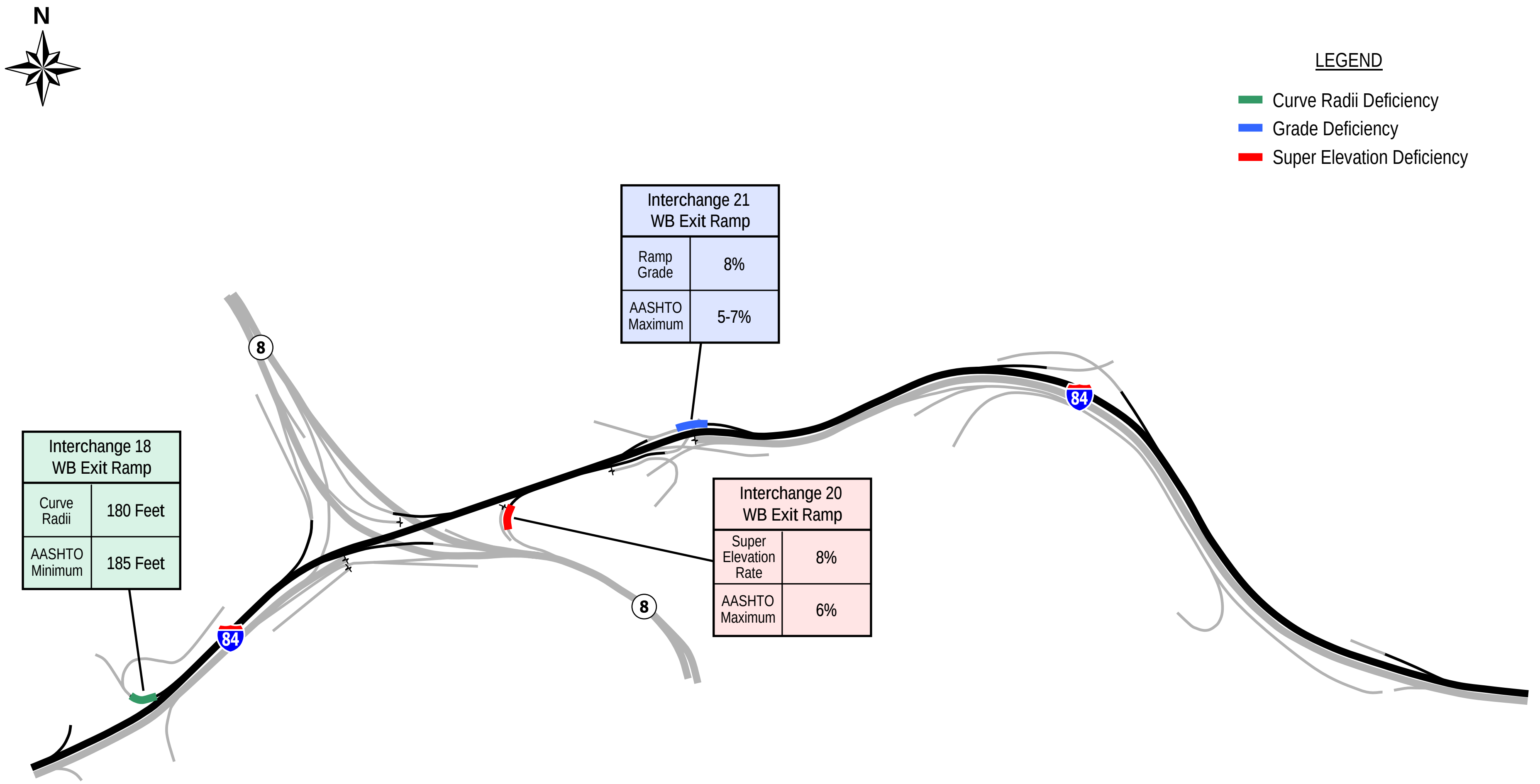
FIGURE 6-12



RAMP AND MAINLINE GEOMETRY DEFICIENCIES
I-84 WESTBOUND

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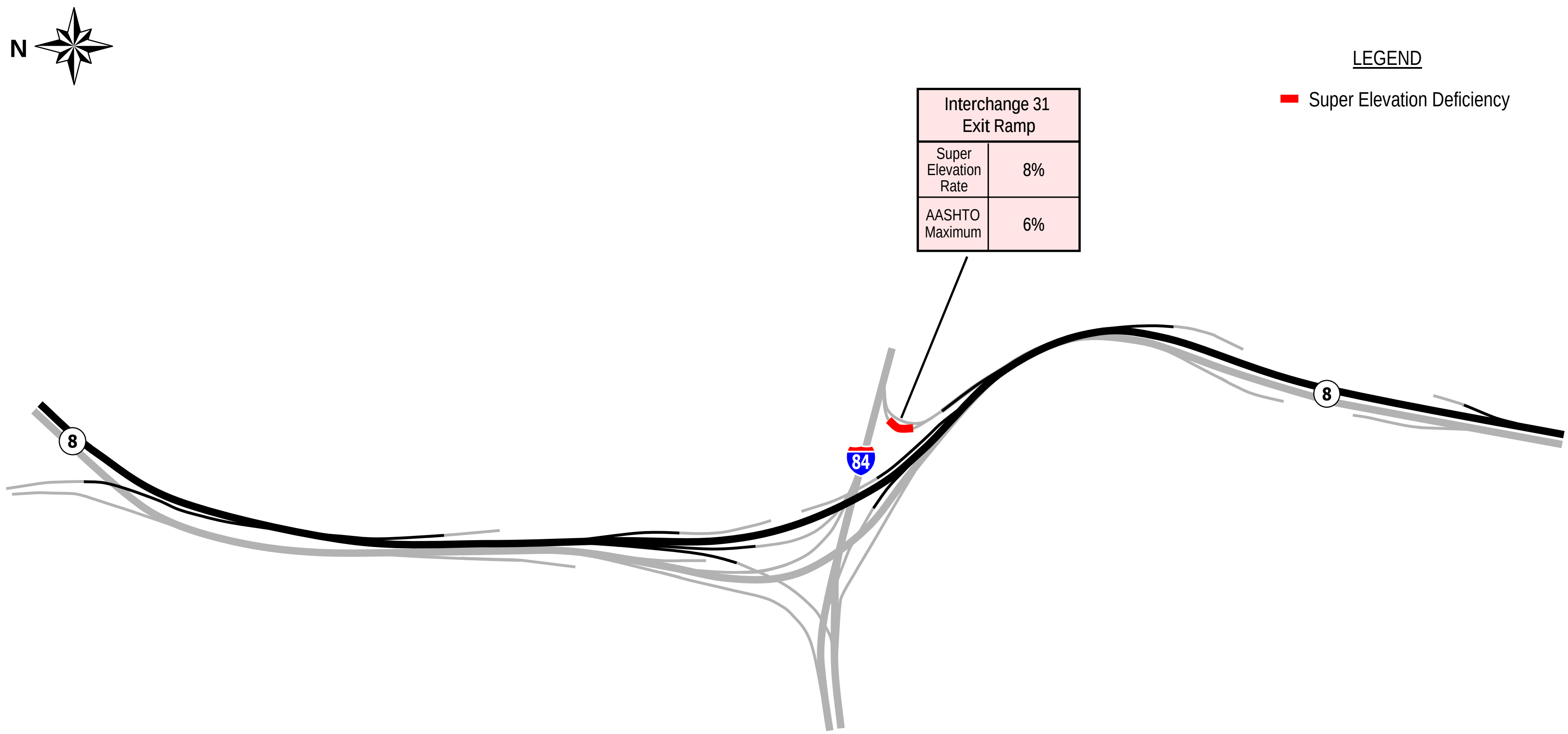
ECONOMISTS

FIGURE 6-13



RAMP AND MAINLINE GEOMETRY DEFICIENCIES

ROUTE 8 NORTHBOUND

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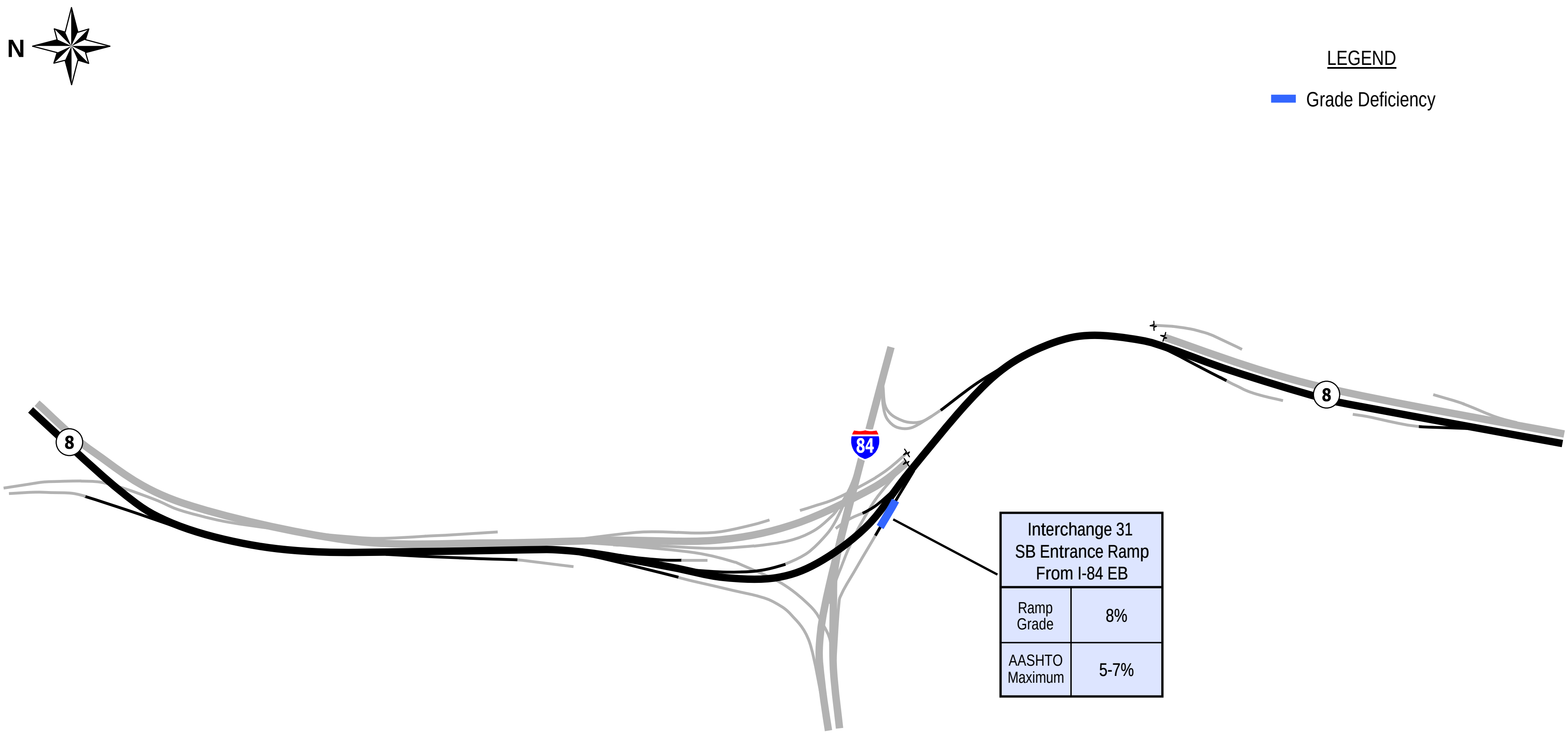
FIGURE 6-14



RAMP AND MAINLINE GEOMETRY DEFICIENCIES

ROUTE 8 SOUTHBOUND

ENGINEERS
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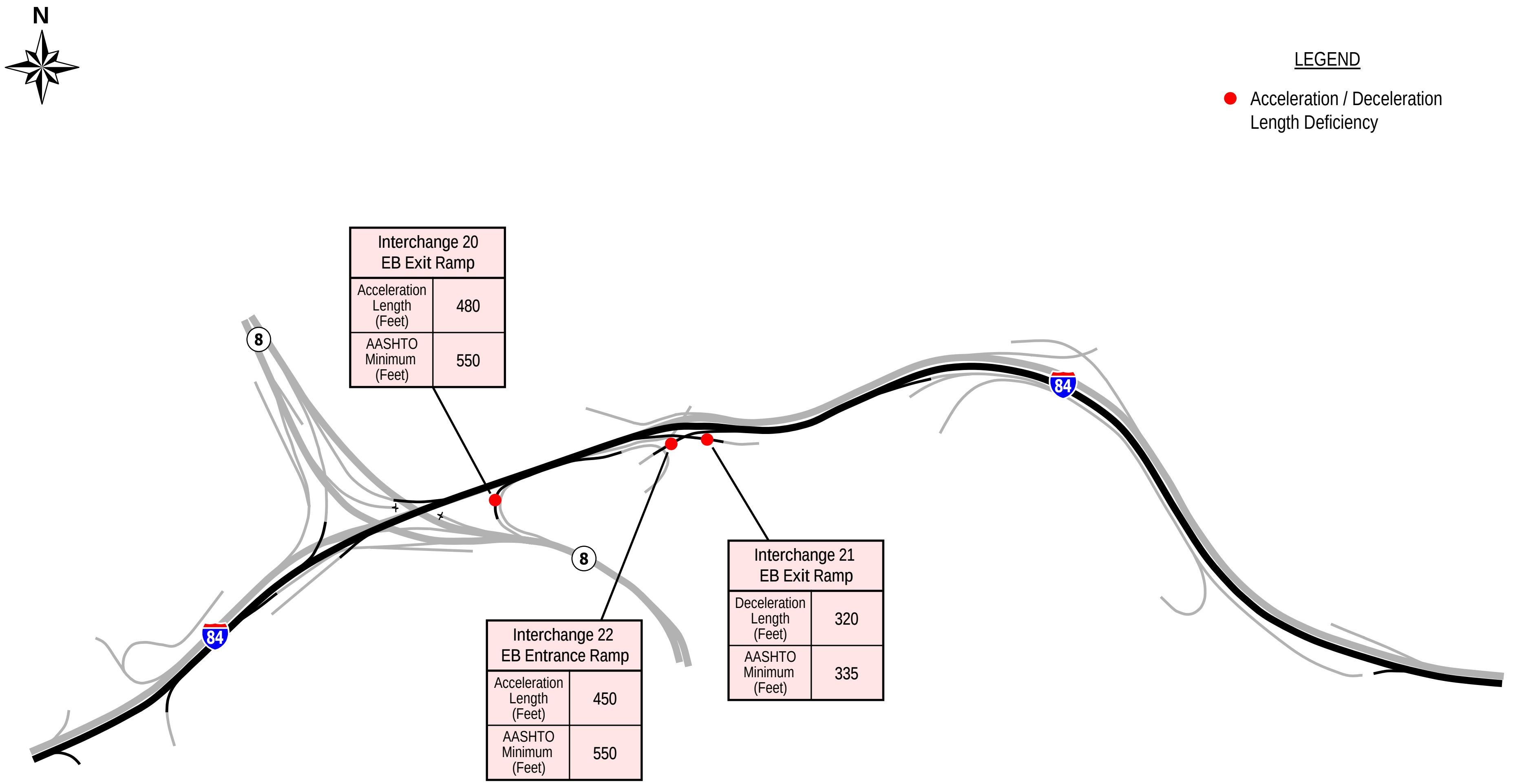
FIGURE 6-15



ACCELERATION AND DECELERATION LENGTH DEFICIENCIES
I-84 EASTBOUND

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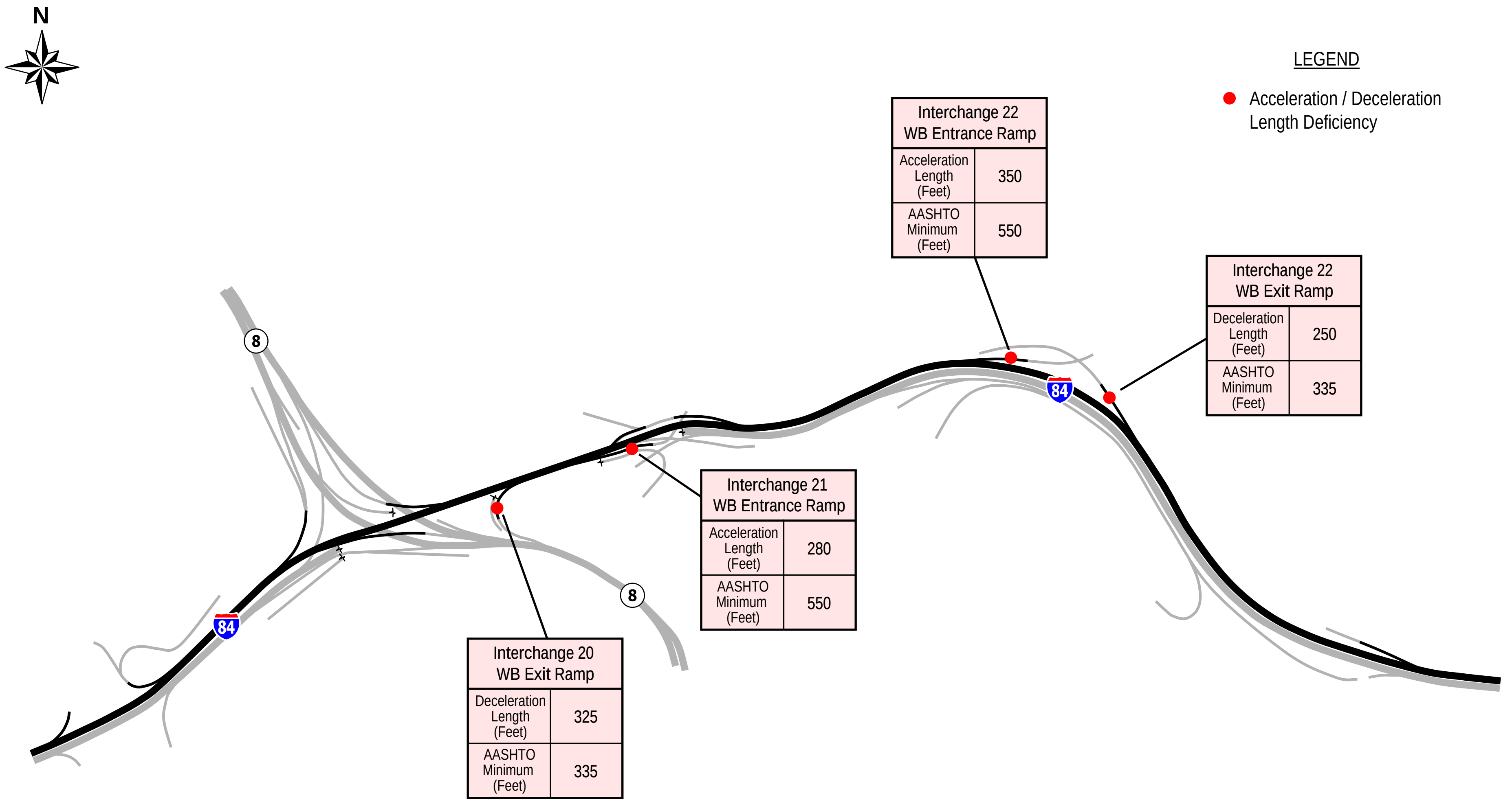
ENGINEERS PLANNERS ECONOMISTS

FIGURE 6-16



ACCELERATION AND DECELERATION LENGTH DEFICIENCIES
I-84 WESTBOUND

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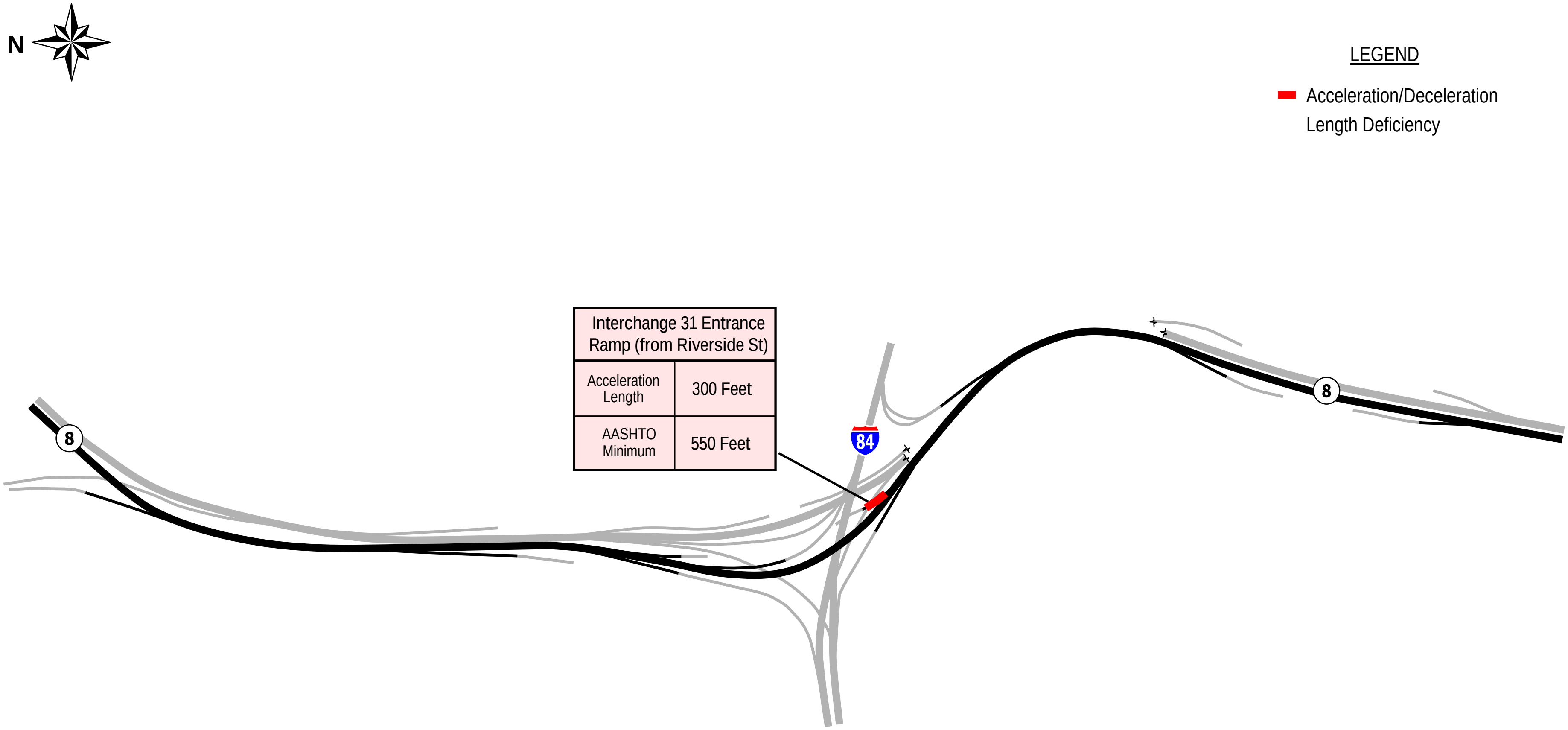
FIGURE 6-17



ACCELERATION AND DECELERATION LENGTH DEFICIENCIES
ROUTE 8 SOUTHBOUND

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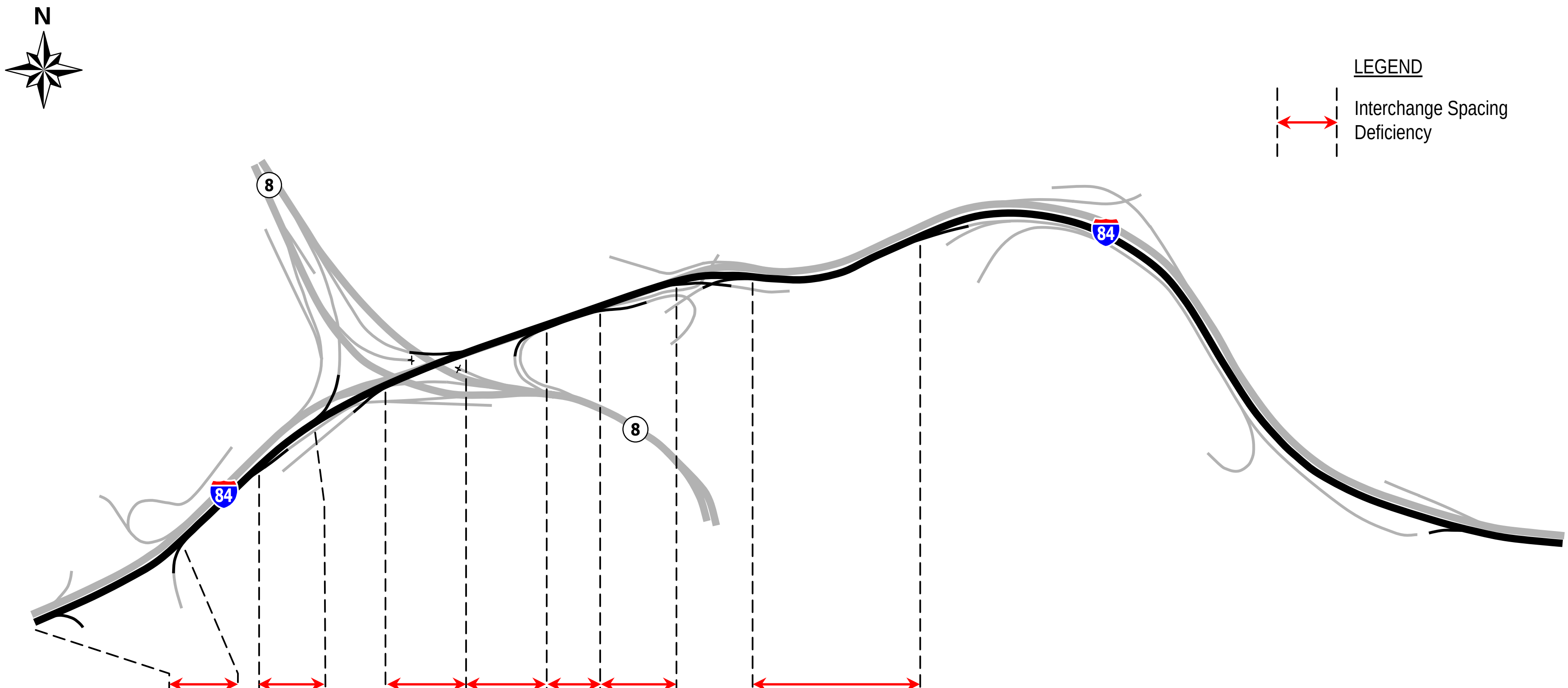
FIGURE 6-18



Interchange Spacing (Feet)	940		380		792	606	487	797		1120
AASHTO Minimum (Feet)	2000		1000		1000	1000	2000	1000		2000

INTERCHANGE SPACING DEFICIENCIES
I-84 EASTBOUND

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ECONOMISTS
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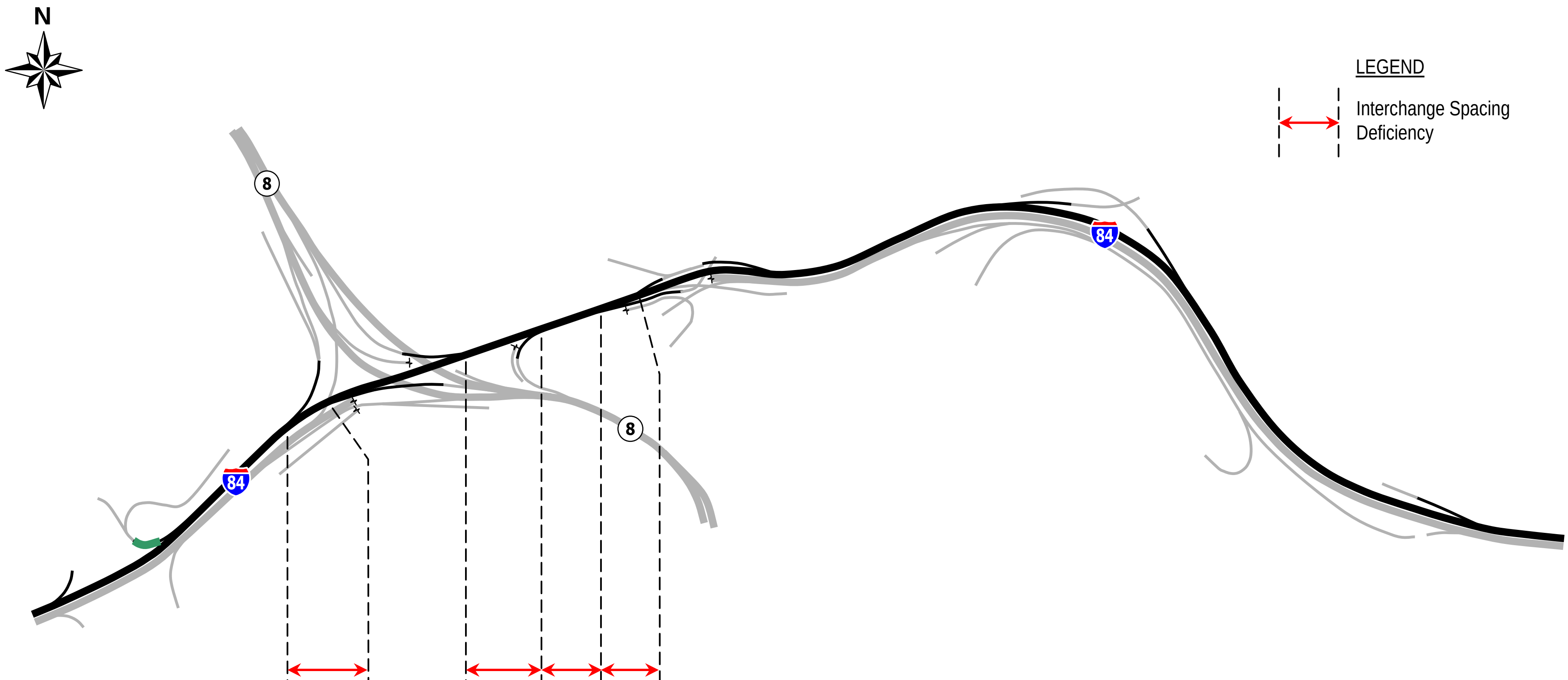
FIGURE 6-19



Interchange Spacing (Feet)		625		793	898	158
AASHTO Minimum (Feet)		1000		1000	2000	1000

INTERCHANGE SPACING DEFICIENCIES
I-84 WESTBOUND

ENGINEERS PLANNERS ECONOMISTS
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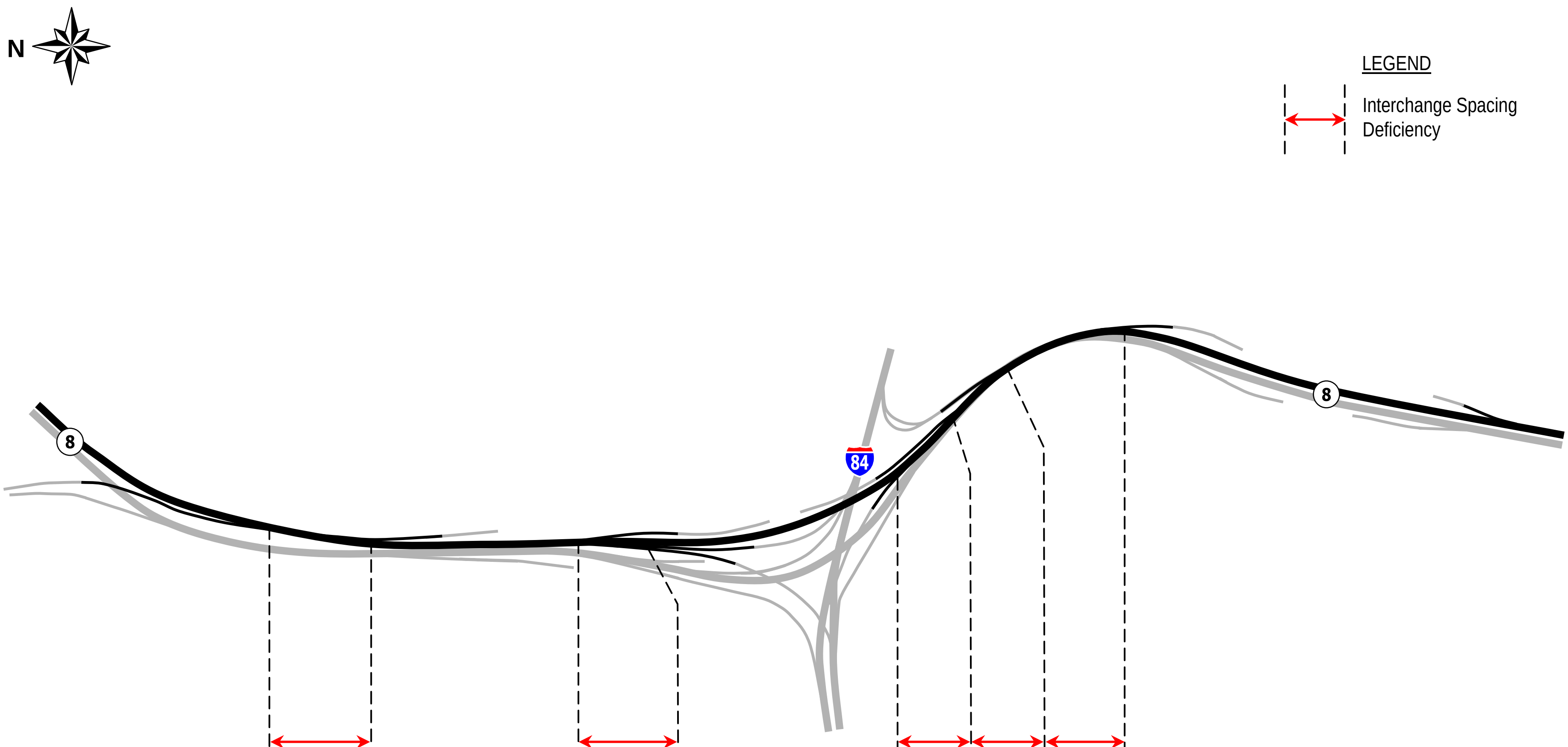
FIGURE 6-20



Interchange Spacing (Feet)	1600		507		253	475	1392
AASHTO Minimum (Feet)	2000		1000		1000	1000	2000

INTERCHANGE SPACING DEFICIENCIES
ROUTE 8 NORTHBOUND

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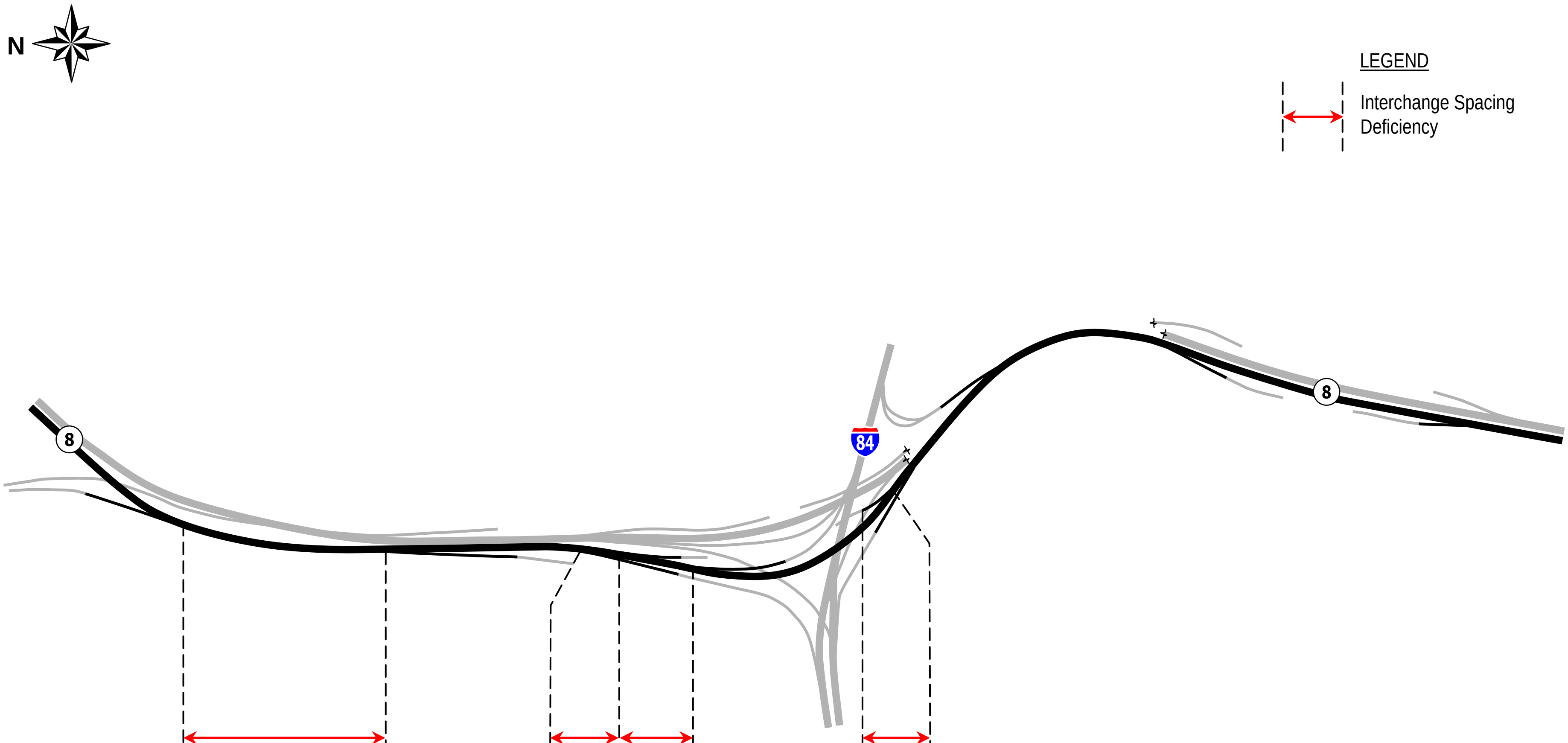
FIGURE 6-21



Interchange Spacing (Feet)	1560		377	311		615
AASHTO Minimum (Feet)	2000		1000	1000		1000

INTERCHANGE SPACING DEFICIENCIES
ROUTE 8 SOUTHBOUND

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ECONOMISTS
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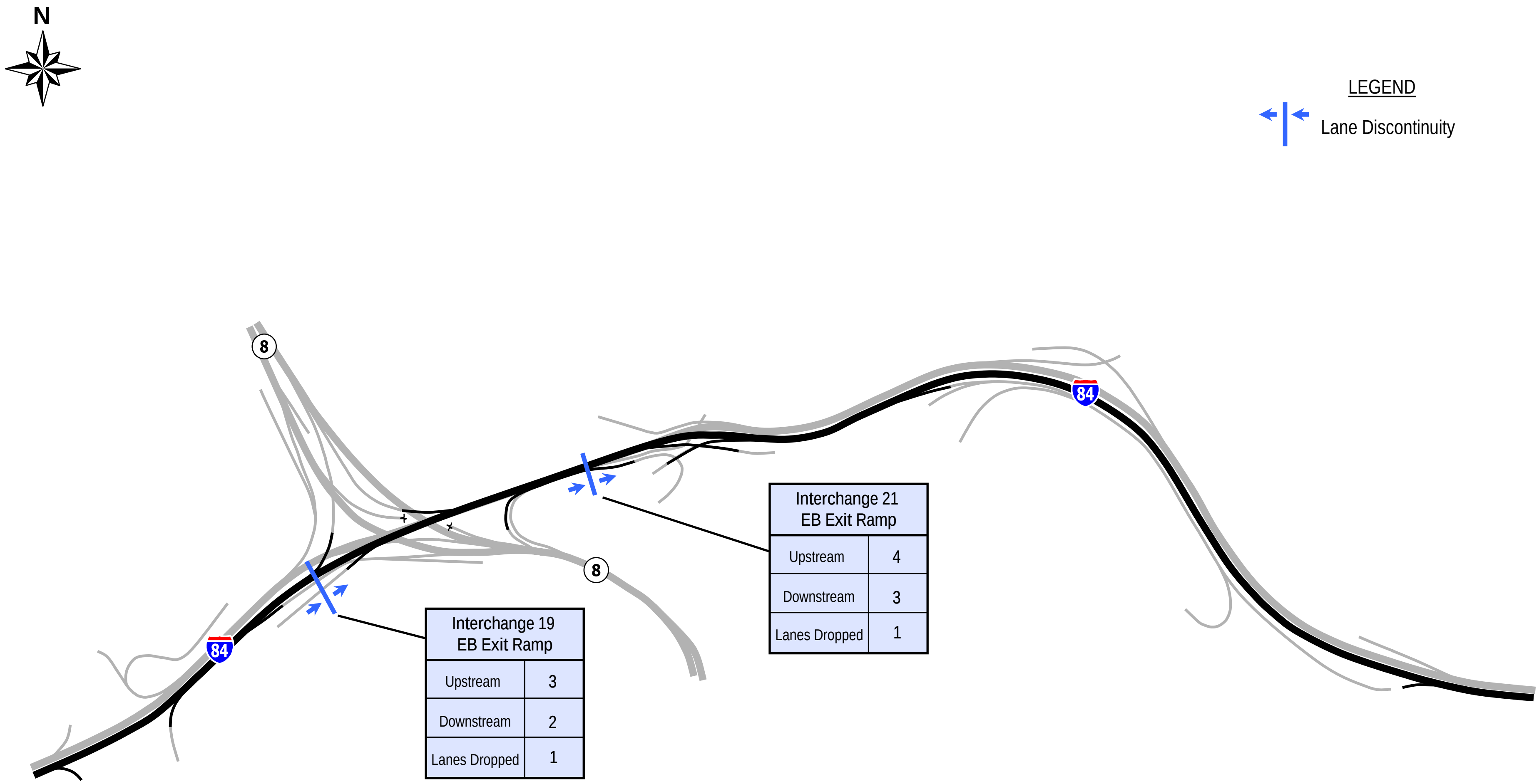
FIGURE 6-22



Interchange 19 EB Exit Ramp	
Upstream	3
Downstream	2
Lanes Dropped	1

Interchange 21 EB Exit Ramp	
Upstream	4
Downstream	3
Lanes Dropped	1

LANE CONTINUITY DEFICIENCIES
I-84 EASTBOUND

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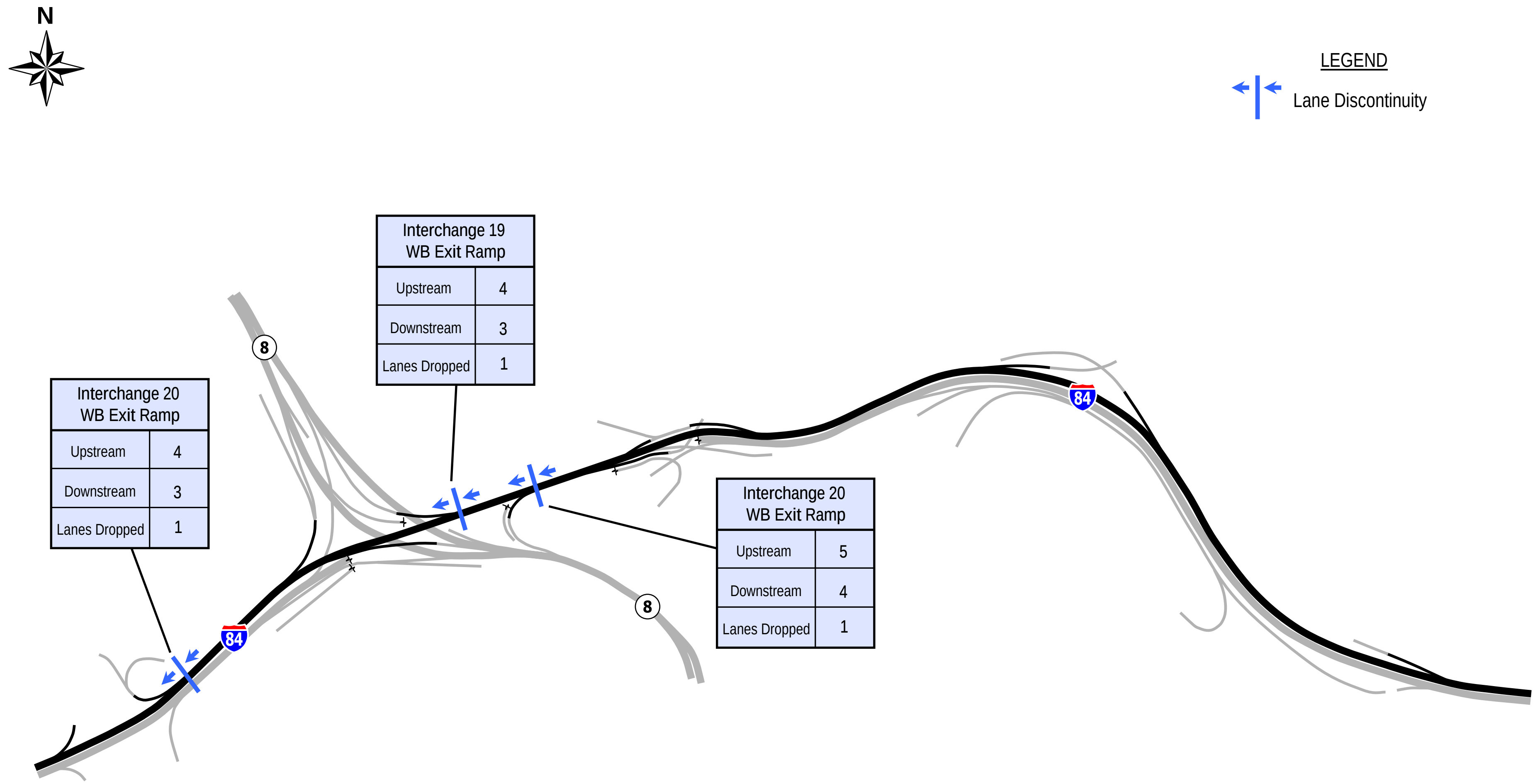
FIGURE 6-23



LANE CONTINUITY DEFICIENCIES

I-84 WESTBOUND

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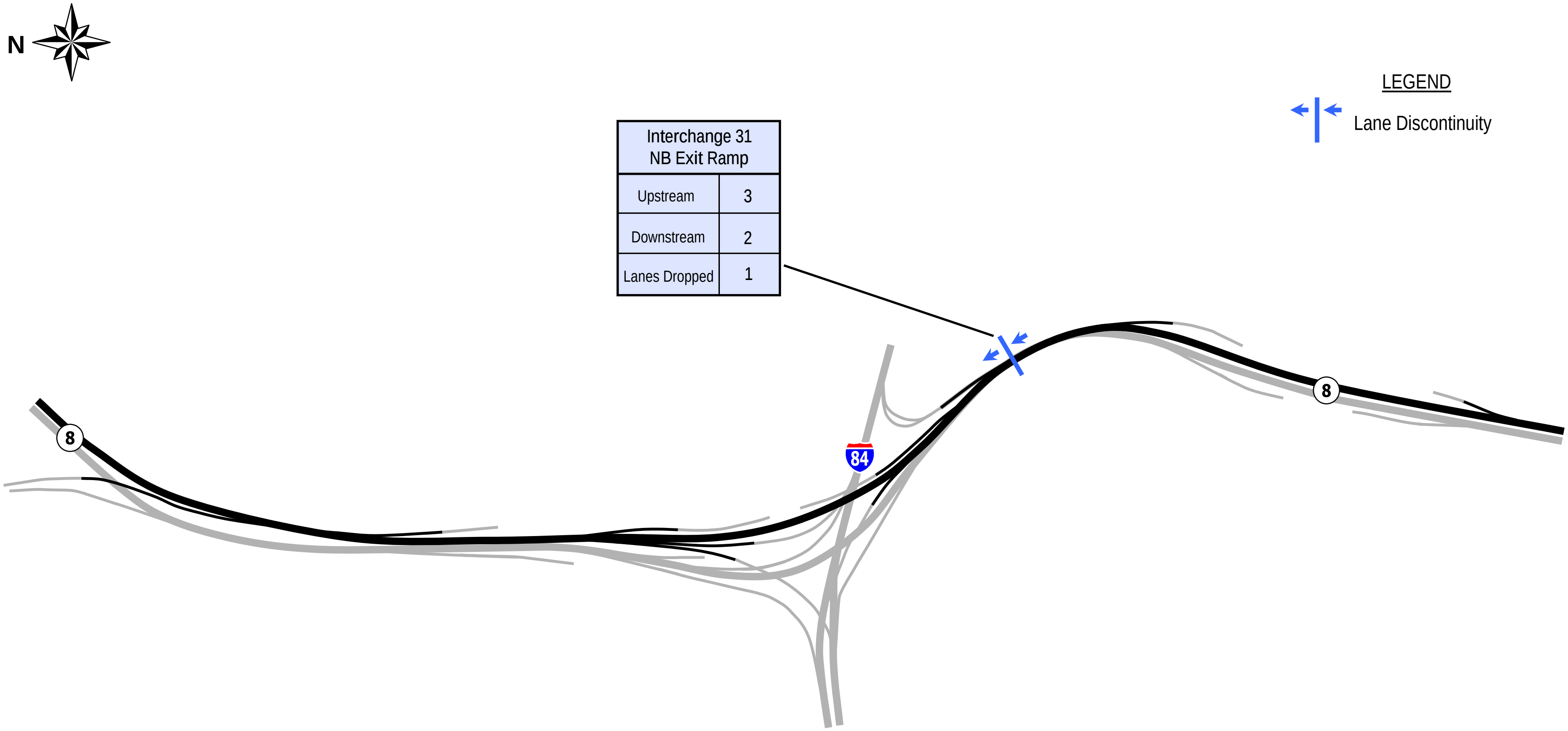
FIGURE 6-24



LANE CONTINUITY DEFICIENCIES
ROUTE 8 NORTHBOUND

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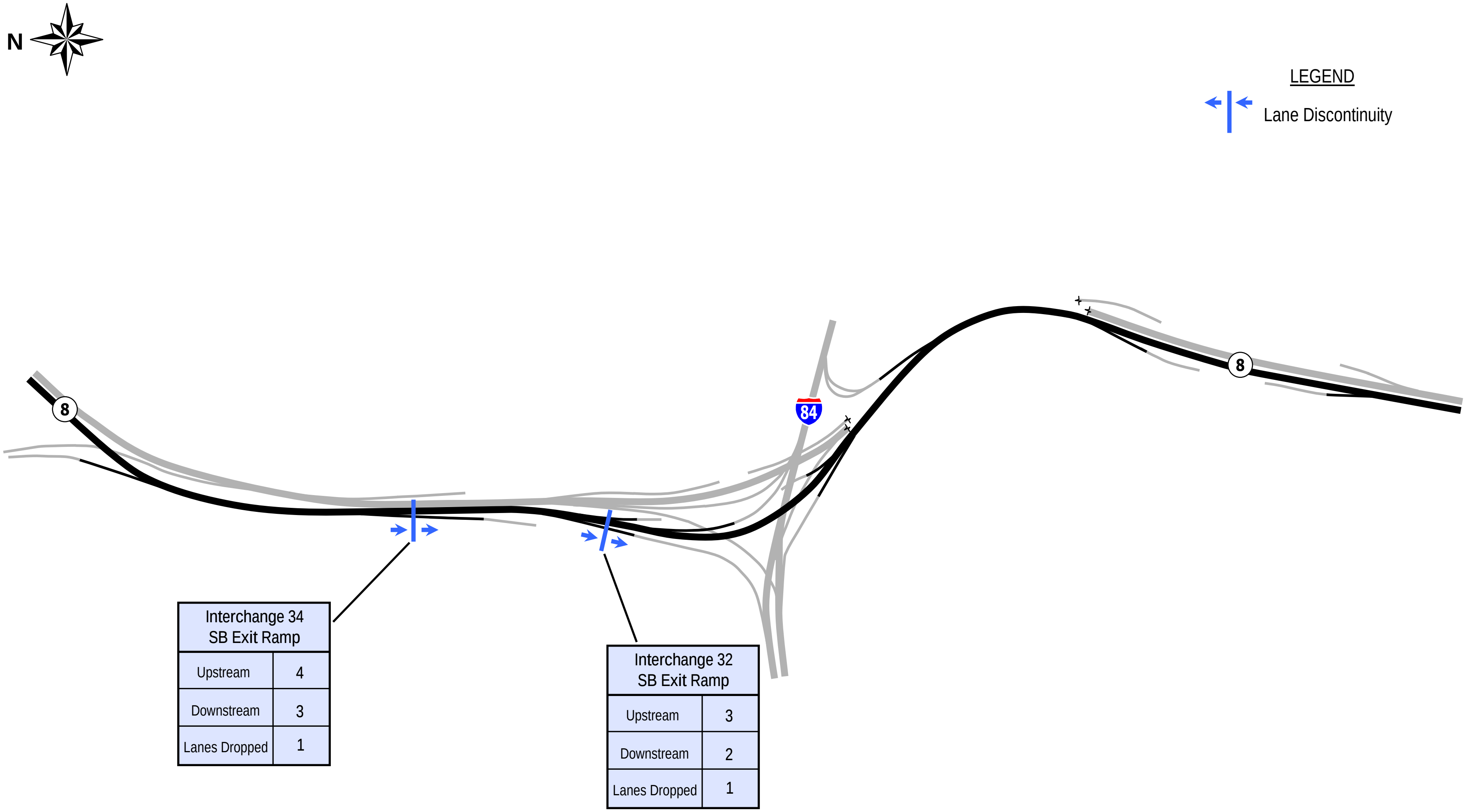
FIGURE 6-25



Interchange 34 SB Exit Ramp	
Upstream	4
Downstream	3
Lanes Dropped	1

Interchange 32 SB Exit Ramp	
Upstream	3
Downstream	2
Lanes Dropped	1

LANE CONTINUITY DEFICIENCIES
ROUTE 8 SOUTHBOUND

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FIGURE 6-26

6.1.5 Shoulder Widths

An examination of shoulder width was performed to gauge the existence of minimum shoulder requirements on the highway mainline and ramps. Aerial photographs and digital design plans were consulted to aid in identifying locations that violated the minimum shoulder width standards as specified by AASHTO.

AASHTO standards indicate that a minimum right shoulder width on highway mainlines should be at least 12 feet. For a one way ramp, a shoulder width of 2 to 4 feet is desirable for left shoulders, while a width of 8 to 10 feet is recommended for right shoulders. The findings in this task reveal that there were no deficiencies with regard to ramp shoulder widths in the study area. There were some mainline locations however, that had shoulder width violations. The section that follows highlights these locations.

Shoulder Widths on I-84

In the eastbound direction along I-84 there are 3 locations where shoulder widths violate specified AASHTO standards. These locations are:

- **Interchange 19 Exit Ramp to Interchange 19 Entrance Ramp –** The shoulder width at this section of highway is about 3-5 feet.

- **Interchange 20 Entrance Ramp (from Route 8 NB) to Interchange 21 Exit Ramp (to Meadow St**) **–** The shoulder width at this section of highway mainline is about 3 feet.

- **Interchange 22 Exit Ramp to Interchange 23 Exit Ramp –** The shoulder width at this section of highway ranges from about 3-5 feet.

In the westbound direction along I-84, there are 2 locations with shoulder width violations. These locations are:

- **Interchange 22 Entrance Ramp to Interchange 19 Exit Ramp –** The shoulder width at this location ranges from 6-8 feet.

- **Interchange 18 Exit Ramp to 18 Entrance Ramp –** The shoulder width at this section is about 3 feet.

Shoulder Widths on Route 8

In the northbound direction along Route 8 there are 2 sections where shoulder widths violate specified AASHTO standards. These locations are:

- **Interchange 30 Entrance Ramp to Interchange 31 Exit Ramp –** The shoulder width at this section of mainline is about 3 feet.

- **Interchange 32 Exit Ramp to Interchange 31 Entrance Ramp –** A shoulder width of about 3 feet runs from the interchange 32 exit ramp for about 720 feet downstream and increases to 12 feet before the interchange 31 entrance ramp.

In the southbound directions there is 1 section where shoulder widths do not meet the specified standards. This section is:

Interchange 31 Entrance Ramp to Interchange 30 Exit Ramp – The shoulder width at this section is about 3-5 feet.

6.1.6 Signage Deficiencies

Roadway signs form an integral part of the geometric design of roads. These signs enhance the overall traffic operation and safety on highways because they inform, warn and control driver behavior.

There are three general types of road signs recognized by AASHTO. These signs are regulatory signs, warning signs and guide signs. Regulatory signs are used to indicate the rules for traffic movement; warning signs are used to inform drivers of potential risk or danger on the roadway, while guide signs are used to direct drivers along a roadway.

A field reconnaissance was undertaken to examine the current state of signage on and around I-84 and Route 8 within the study area. The task involved field verification, photo documentation and sign classification that was based on the following categories:

- Absence of signs
- Location of signs
- Legibility/Condition of signs and
- Clarity of signs

Figure 6-27 shows the locations within the study area with signage deficiencies. The major signage deficiency within the study area is the absence of directional signs to guide motorists to both I-84 and Route 8. Locations with such deficiencies are:

City Green – There is inadequate signage directing drivers from the City Green to Interstate 84.

St Mary's Hospital –There is no clear signage guide motorists from the hospital to I-84.

Baldwin Street/Mill Street – There are no signs at the Baldwin Street/Mill Street intersection to direct traffic traveling south on Baldwin Street to I-84.

Grand Street/Bank Street- There are no signs on the Grand Street approach eastbound to direct traffic to both I-84 and Route 8.

Hamilton Street/ Silver Lane – This intersection needs an I-84 westbound directional sign on the Hamilton Street approach northbound. Also, there are no signs to direct drivers traveling west on Washington Street to I-84.

Riverside Street/West Main Street – An I-84 westbound directional sign is needed at the northbound approach on Riverside Street.

West Main Street/ Chase Parkway – This intersection needs I-84 directional signs on the eastbound approach from West Main Street.

Chase Parkway/Country Club Road - This intersection needs I-84 directional signs

Sunnyside Avenue/ Highland Avenue – An I-84 westbound directional sign is needed on all approaches to this intersection.

Sunnyside Avenue/Riverside Street – There is no sign directing motorists to Route 8

There are other signage deficiencies that require minor maintenance with a few requiring full replacement. Some signs require painting as these signs have either faded or peeled off due to exposure. These signs include:

- I-84 directional sign located at the intersection of Bank Street/Congress Street,
- I-84 directional sign located at the intersection of I-84 EB entrance ramp/ Baldwin Street
- I-84 and Route 8 directional signs located at the intersection of Grand Street/Leavenworth Street.

Some signs are also obscured by vegetation or roadway infrastructure and are thus not clearly visible to motorists. These are I-84 directional signs located the following intersections:

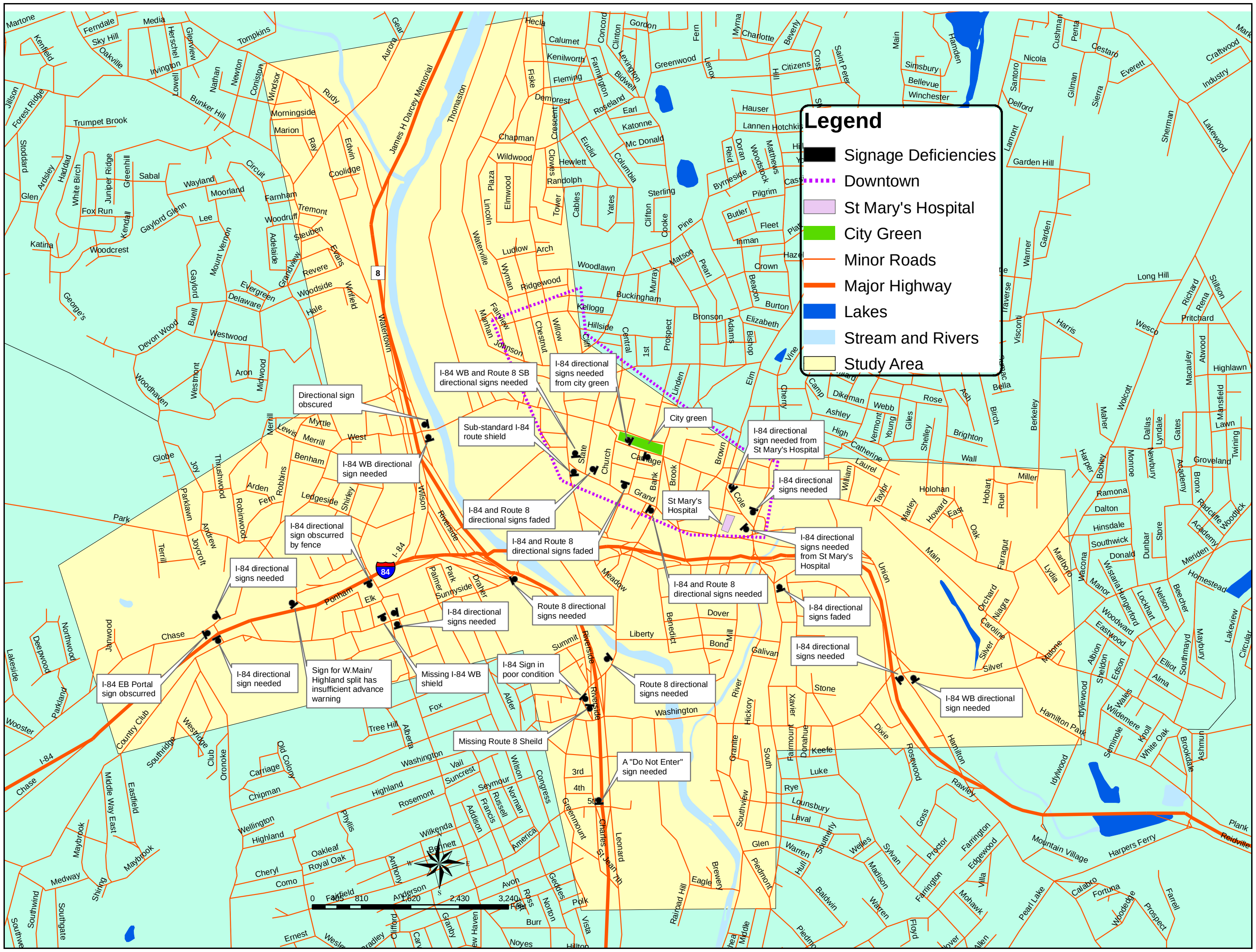
- Chase Parkway/West Main Street
- Highland Street/I-84 EB entrance ramp
- West Main Street/Riverside Street NB.

Three highway directional signs have either missing or sub-standard route shields and should be replaced. Of the three signs, two have missing route shields while one has a sub-standard route shield. The two signs with missing shields include:
The I-84 westbound sign located at the intersection of Highland Avenue/Sunnyside Avenue

The Route 8 sign located at the intersection of Riverside Street /Congress Avenue.

The sub-standard directional sign is an I-84 sign located at the intersection of Meadow Street/ Grand Street.

Figure 6-27: Signage Deficiencies



6.2 Structural Conditions Review

6.2.1 General Description of Bridges

There are 42 bridges within the study area with a span greater than twenty feet . These bridges have concrete decks with steel superstructures supported on concrete substructure units. Almost all of the bridges have a bituminous concrete overlay with membrane. All but one of the bridges was constructed in 1965 to 1967. Thirty one of the bridges have undergone rehabilitation. 29 have been painted since 1990. 7 of the longest bridges have been seismically retrofitted. All but two of the bridges have inventory load ratings greater than the interstate load limit of 36 tons (HS20 Load). Bridge 01715 is rated for 35 tons and Bridge 04318 is rated for 26 tons.

Table 6-15 lists general information about each bridge. Figure 6-28 shows the locations of the various bridges.

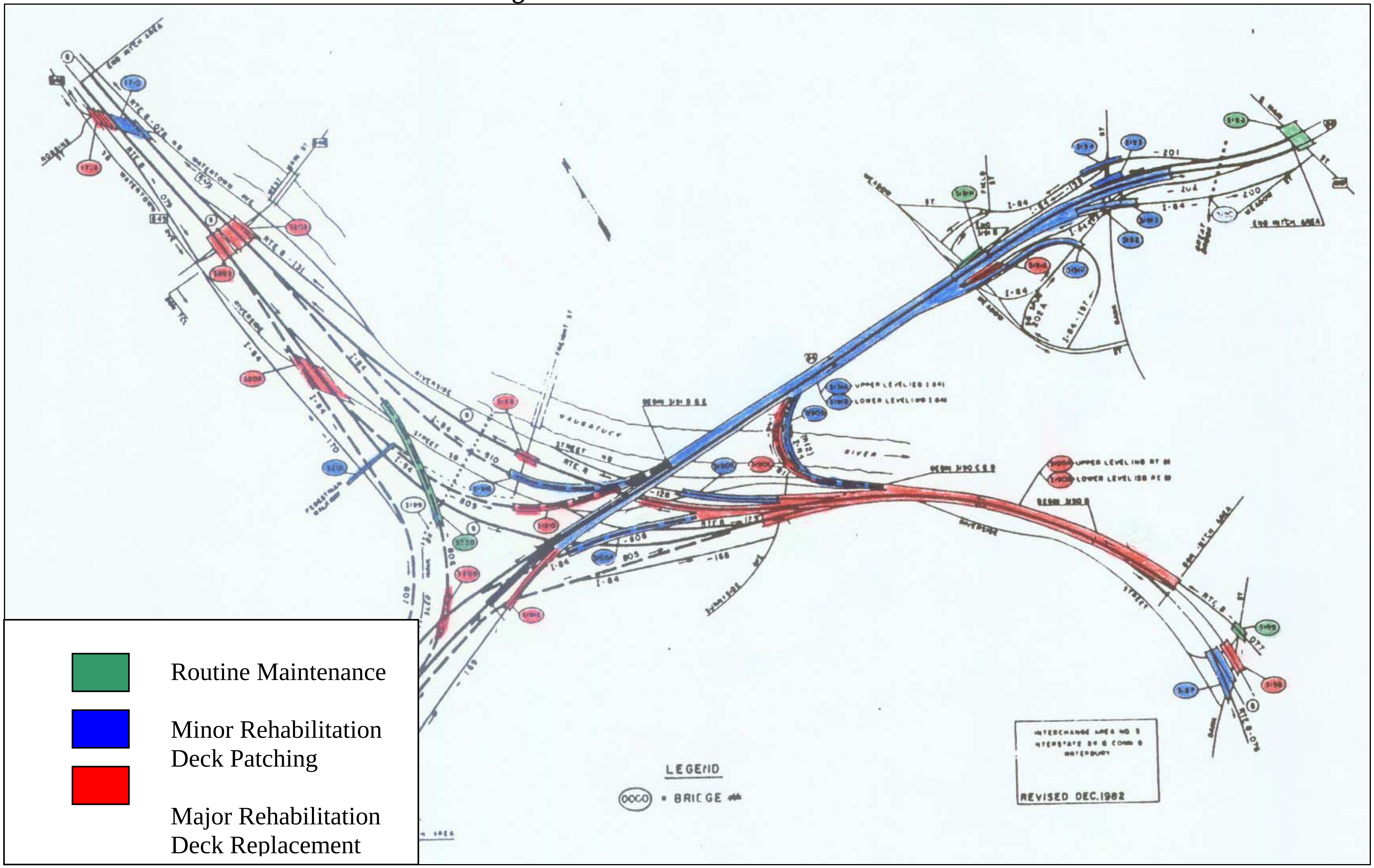
Table 6-15: Bridge Data

DESCRIPTION				CONSTRUCTION / REHAB DATES						GEOMETRY					RATING
BR. NO.	CARRIES	OVER	STRUCTURE TYPE	BUILT	REHAB	REHAB DESCRIPTION	PAINTED	SEISMIC	SPANS	OVERALL LENGTH (FT)	CURB TO CURB (FT)	LANES ON BRIDGE	DECK AREA (SF)	UNDER CLEARANCE	INVENTORY RATING (TONS)
1714	RTE 8 RAMP 079	SR 846 NB	ROLLED BEAM	1965	1996	DECK PATCH	---	---	1	94	28	1	2,914	14'-3"	52
1715	RTE 8	SR 846 SB	ROLLED BEAM	1965	1996	DECK PATCH	---	---	1	96	110	6	11,759	14'-7"	35
1716	RTE 8 SB	ROUTE 73 WB	ROLLED BEAM	1965	1990	NEW DECK	1990	---	3	261	40	2	11,405	16'-0"	61
3183A	RTE 8 NB	FIFTH STREET	GIRDER	1965	1995	DECK PATCH	1995	---	1	94	38	2	4,089	17'-9"	58
3183B	RTE 8 SB	FIFTH STREET	GIRDER	1965	1995	DECK PATCH	1995	---	1	94	38	2	4,089	14'-8"	58
3184A	RTE 8 NB	PORTER STREET	ROLLED BEAM	1965	1995	DECK PATCH	1995	---	1	95	38	2	4,132	17'-5"	56
3184B	RTE 8 SB	PORTER STREET	ROLLED BEAM	1965	1995	DECK PATCH	1995	---	1	95	38	2	4,132	14'-6"	65
3185	RTE 8 NB	WASHINGTON AVENUE	ROLLED BEAM	1965	1990	NEW DECK	1991	---	1	73	40	2	3,183	14'-1"	42
3186	RTE 8 SB	WASHINGTON AVENUE	ROLLED BEAM	1965	1990	NEW DECK	1991	---	1	77	40	2	3,357	14'-9"	60
3187	RTE 8 SB	BANK ST & SO. LEONARD ST	ROLLED BEAM	1965	1995	DECK PATCH	1996	---	3	199	55	3	15,393	14'-4"	45
3188	RTE 8 NB	BANK ST & SO. LEONARD ST	GIRDER	1966	1994	DECK PATCH	1995	---	2	165	38	2	7,210	16'-8"	55
3189	RTE 8 RAMP 077	BANK STREET	ROLLED BEAM	1965	1993	NEW DECK	1993	---	1	106	24	1	2,915	14'-0"	60

3190A	RTE 8 NB	RTE 8 SB, RIVERSIDE STREET	GIRDER/FLBM	1966	---	---	---	1996	36	2,634	30	2	130,165	15'-3"	??
3190B	RTE 8 SB	RIVERSIDE ST & SUNNYSIDE AVE	GIRDER/FLBM	1966	1991	DECK PATCH	1991	1996	21	1,589	30	2	75,312	14'-4"	35
3190C	I-84 TR 811	I-84 TR 812 & NAUGATUCK RIVER	GIRDER	1966	1991	???	1996	1996	9	877	22	1	24,118	17'-2"	51
3190D	I-84 TR 812	RIVERSIDE ST, NAUGATUCK RIVER	GIRDER	1966	1991	???	1996	1996	9	778	22	1	21,395	14'-2"	53
3190E	RTE 8 RAMP 128	RIVERSIDE STREET SOUTHBOUND	ROLLED BEAMS	1966	1990	NEW DECK	1990	---	7	495	23	1	13,613	15'-6"	60
3190F	I-84 TR 808	ROUTE 8 SOUTHBOUND & RAMP 129	ROLLED BEAMS	1966	1991	???	1991	---	10	652	22	?	17,930	16'-9"	47
3191A	I-84 EB	I-84 WB, RTE 8, NAUGATUCK RIVER	GIRDER/FLBM	1967	---	---	---	1994	46	3,766	30	2	221,699	16'-10"	34
3191B	I-84 WB	RTE 8, NAUGATUCK RIVER	GIRDER/FLBM	1967	1991	???	---	1994	30	2,461	42	?	???	17'-0"	37
3191C	I-84 RAMP 169	I-84 TR 805 & 808	GIRDER	1966	---	---	---	---	4	408	22	1	11,220	17'-5"	58
3191D	I-84 TR 809	RTE 8 NB, RIVERSIDE STREET	ROLLED BEAM	1966	---	---	---	1994	10	781	30	1	27,726	18'-8"	54
3191E	I-84 TR 810	ROUTE 8 NB & RAMP 128	ROLLED BEAM	1967	1990	NEW DECK	1990	---	8	630	30	1	22,365	18'-7"	51
3191F	I-84 RAMP 197	RAMP 202 MEADOW STREET	ROLLED BEAM	1967	1990	???	---	---	11	672	22	1	14,778	15'-6"	63
3191G	I-84 RAMP 199	MEADOW STREET	ROLLED BEAM	1965	???	???	1991	---	3	228	22	1	6,316	35'-0"	59
3191H	I-84 RAMP 198	NO NOTABLE FEATURE	ROLLED BEAM	1967	???	???	1992	---	1	70	21	1	1,890	N/A	54
3191I	I-84 RAMP 200	I-84 RAMPS 199 & 202	GIRDER	1966	???	???	---	---	3	296	30	1	10,508	16'-2"	69
3192	I-84 RAMP 202	BANK STREET	GIRDER	1965	???	???	1991	---	1	81	29	1	2,729	14'-4"	66
3193	I-84 WB	BANK STREET & RAMP 198	ROLLED BEAM	1965	1990	???	1991	---	2	133	42	3	6,344	14'-4"	54

3194	I-84 RAMP 201	I-84 RAMP 198	GIRDER	1965	---	---	1991	---	3	195	22	1	5,401	14'-3"	49
3196	I-84	SR 847 SOUTH MAIN STREET	ROLLED BEAM	1965	---	---	1997	---	1	64	122	8	8,480	14'-7"	43
3197	SOUTH ELM STREET	I-84 & MCMAHON STREET	ROLLED BEAM	1965	---	---	1997	---	3	201	28	2	8,543	17'-0"	62
3198	RTE 8 NB	FREIGHT STREET	ROLLED BEAM	1966	1996	PATCH DECK	1991	---	3	138	38	2	6,030	14'-2'	44
3200	I-84 TR 806	I-84 TR 808, 809, RIVERSIDE ST	GIRDER	1965	1989	NEW DECK	1996	---	6	703	24	1	19,332	14'-6"	51
3201	PEDESTRIAN WALK	ROUTE 8 SOUTHBOUND	TWO GIRDER	1965	---	---	2002	---	4	362	----	----	4,101	16'-0"	N/A
3203A	RTE 8 NB	SR 849 WEST MAIN ST NO 1	GIRDER	1965	1996	PATCH DECK	---	---	1	134	64	3	9,058	18'-1"	89
3203B	RTE 8 SB	SR 849 WEST MAIN ST NO 1	ROLLED BEAM	1965	1996	PATCH DECK	---	---	1	134	61	4	8,589	14'-7"	82
3203C	RTE 8 RAMP 131	WEST MAIN STREET NO 1	GIRDER	1965	1996	PATCH DECK	---	---	1	134	28	1	4,234	19'-7"	93
3205	RTE 8 SOUTHBOUND	RIVERSIDE STREET	THRU GIRDER	1965	1996	PATCH DECK	1991	---	1	117	78	4	9,063	14'-3"	37
3207	HIGHLAND AVENUE	I-84	GIRDER	1966	---	---	1996	---	3	288	38	2	15,120	40'-0"	59
3209	I-84 TR 806	I-84 WB	THRU GIRDER	1965	---	---	1997	---	1	141	26	1	5,781	16'-1"	42
4318	BALDWIN STREET NO 1	I-84 SR 830 & I-84 RAMPS	STEEL BOX	1978	---	---	---	---	3	545	52	4	37,333	16'-5"	26

Figure 6-28: Locations of Structures



6.2.2 Existing Condition of Bridges

The Connecticut Department of Transportation inspects each of the bridges every two years. The bridge inspection reports for the bridges within the study were reviewed and the results are summarized in Appendix A.

As part of the inspection, condition assessments are made to each of the major components for the bridge using the scale shown below:

9 Excellent Condition – No maintenance or rehabilitation concerns
8 Very Good Condition – No maintenance or rehabilitation concerns
7 Good Condition – Potential exists for minor maintenance
6 Satisfactory Condition – Potential exists for major maintenance
5 Fair Condition – Potential exists for minor rehabilitation
4 Poor Condition – Potential exists for major rehabilitation
3 Serious Condition – Rehabilitation or repair required immediately
2 Critical Condition – Need for immediate repairs or rehabilitation is urgent
1 "Immanent" Failure Condition – Bridge is closed to traffic
0 Out of Service – Beyond corrective action

During the course of the inspection a visual survey is made of the underside of the deck noting any defects. From this visual survey, a percent deterioration for the deck is then determined, by dividing the area with defects by the total deck area. This percentage in conjunction with the numerical condition rating and repair history of the deck can then be used to make an initial determination as to the required deck repairs and/or replacement.

Table 6-16 summarizes the condition ratings and lists the percent deck deterioration for each bridge.

As noted in the following table the majority of the bridges are in satisfactory condition indicating a current potential for major maintenance. Over time additional deterioration is expected and prior to 2030 it is expected that the majority of the bridges will be potential candidates for rehabilitation.

The table shown below summarizes the ratings by number of bridges.

		Deck		Superstructure		Substructure	
Rating		No.	%	No.	%	No.	%
4	Poor	0	0%	1	2%	1	2%
5	Fair	8	19%	3	7%	6	14%
6	Satisfactory	30	71%	23	55%	19	45%
7	Good	3	7%	12	29%	16	38%
8	Very Good	1	2%	3	7%	0	0%
	Totals	42	100%	42	100%	42	100%

Table 6-16: Bridge Condition Assessment to 2030

BRIDGE DESCRIPTION			EXISTING CONDITION (2002-2003)					POTENTIAL REPAIRS TO YEAR 2030									
BR. NO.	CARRIES	OVER	% DECK DETERIORATION	DECK	SUPERSTRUCTURE	SUBSTRUCTURE	COMMENTS	ROUTINE MAINTENANCE	DECK PATCHING	DECK REPLACEMENT	SUBSTRUCTURE PATCHING	COMPLETE PAINTING	SPOT PAINTING	BEARING REPLACEMENT	REPAIR IMPACT DAMAGE TO BEAMS	SAFETYWALK RETROFIT	SEISMIC RETROFIT
1714	RTE 8 RAMP 079	SR 846 NB	18%	5	7	7	LARGE SPALLS WITH REBAR UNDERSIDE OF DECK, SOME WITH EPOXY PAINT			X	X	X					
1715	RTE 8	SR 846 SB	5%	6	5	7			X		X	X		X			
1716	RTE 8 SB	ROUTE 73 WB	1%	7	6	6		X					X				
3183A	RTE 8 NB	FIFTH STREET	4%	6	8	7		X					X			X	
3183B	RTE 8 SB	FIFTH STREET	19%	6	8	7				X	X		X				
3184A	RTE 8 NB	PORTER STREET	14%	6	7	7				X	X		X				
3184B	RTE 8 SB	PORTER STREET	11%	6	8	7				X	X		X				
3185	RTE 8 NB	WASHINGTON AVENUE	8%	6	7	6		X					X				
3186	RTE 8 SB	WASHINGTON AVENUE	10%	6	7	6		X					X				
3187	RTE 8 SB	BANK ST & SO. LEONARD ST	5%	6	6	6			X		X		X				

3188	RTE 8 NB	BANK ST & SO. LEONARD ST	14%	6	6	7				X	X		X				
3189	RTE 8 RAMP 077	BANK STREET	0%	8	6	7	SECTION LOSS TO BEAMS PRIOR TO PAINTING	X					X				
3190A	RTE 8 NB	RTE 8 SB, RIVERSIDE STREET	17%	5	6	6	FAILED MEMBRANE CAUSING RUST ON FASCIA GIRDERS. STEEL CRACKS IN SUPERSTRUCTURE.			X		X					
3190B	RTE 8 SB	RIVERSIDE ST & SUNNYSIDE AVE	14%	6	6	6	FAILED MEMBRANE CAUSING RUST ON FASCIA GIRDERS. STEEL CRACKS IN SUPERSTRUCTURE.			X	X		X				
3190C	I-84 TR 811	I-84 TR 812 & NAUGATUCK RIVER	18%	5	6	6	FAILED MEMBRANE CAUSING RUST ON FASCIA GIRDERS.			X	X		X				
3190D	I-84 TR 812	RIVERSIDE ST, NAUGATUCK RIVER	7%	6	6	5	FAILED MEMBRANE CAUSING RUST ON FASCIA GIRDER.		X		X		X				
3190E	RTE 8 RAMP 128	RIVERSIDE STREET SOUTHBOUND	9%	7	6	6			X		X		X				X
3190F	I-84 TR 808	ROUTE 8 SOUTHBOUND & RAMP 129	8%	6	6	5	LARGE SPALLS WITH REBAR ON SUBSTRUCTURE.		X		X		X				X
3191A	I-84 EB	I-84 WB, RTE 8, NAUGATUCK RIVER	7%	7	4	4	NUMEROUS CRACKS IN STEEL SUPERSTRUCTURE. LARGE SPALLS W/ REBAR ON PIERS.		X		X	X				X	
3191B	I-84 WB	RTE 8, NAUGATUCK RIVER	9%	6	7	5	NUMEROUS CRACKS IN STEEL SUPERSTRUCTURE. LARGE SPALLS W/ REBAR ON PIERS.		X		X	X				X	
3191C	I-84 RAMP 169	I-84 TR 805 & 808	19%	6	7	5				X	X	X				X	X
3191D	I-84 TR 809	RTE 8 NB, RIVERSIDE STREET	9%	5	6	6				X	X	X				X	
3191E	I-84 TR 810	ROUTE 8 NB & RAMP 128	9%	6	6	6			X		X		X			X	X
3191F	I-84 RAMP 197	RAMP 202 MEADOW STREET	7%	6	6	5			X		X	X				X	X
3191G	I-84 RAMP 199	MEADOW STREET	1%	5	6	6	40% OF SPAN 3 DECK HAS FULL DEPTH PATCHES			X	X		X			X	
3191H	I-84 RAMP 198	NO NOTABLE FEATURE	1%	6	6	7		X			X		X			X	
3191I	I-84 RAMP 200	I-84 RAMPS 199 & 202	8%	5	6	6			X		X	X				X	

3192	I-84 RAMP 202	BANK STREET	2%	6	7	7			X		X		X			X	
3193	I-84 WB	BANK STREET & RAMP 198	8%	6	6	6			X		X		X			X	
3194	I-84 RAMP 201	I-84 RAMP 198	14%	6	6	7			X		X		X			X	
3196	I-84	SR 847 SOUTH MAIN STREET	2%	6	5	6		X			X		X		X		
3197	SOUTH ELM STREET	I-84 & MCMAHON STREET	16%	6	7	6			X		X		X				
3198	RTE 8 NB	FREIGHT STREET	17%	5	6	6				X	X		X				
3200	I-84 TR 806	I-84 TR 808, 809, RIVERSIDE ST	1%	6	5	5		X			X		X				
3201	PEDESTRIAN WALK	ROUTE 8 SOUTHBOUND	2%	6	7	7			X		X		X				X
3203A	RTE 8 NB	SR 849 WEST MAIN ST NO 1	5%	6	6	6				X	X	X					
3203B	RTE 8 SB	SR 849 WEST MAIN ST NO 1	1%	6	6	7				X	X	X					
3203C	RTE 8 RAMP 131	WEST MAIN STREET NO 1	5%	6	6	7				X	X	X					
3205	RTE 8 SOUTHBOUND	RIVERSIDE STREET	34%	6	7	6				X	X		X				
3207	HIGHLAND AVENUE	I-84	3%	6	7	7			X		X		X				
3209	I-84 TR 806	I-84 WB	10%	6	7	6				X	X		X				
4318	BALDWIN STREET NO 1	I-84 SR 830 & I-84 RAMPS	22%	5	6	7				X	X	X					

6.2.3 Condition Assessment to 2030

Based on the 2002-2003 bridge inspection reports and previous rehabilitation projects, an estimate was made of the required work to maintain the existing bridges until the year 2030. This work assumes the bridges will maintain their existing geometry and improvements will not be made to improve the functionality (traffic capacity) of the bridge. Table 2 lists these potentially required repairs.

These potential repairs can be grouped into three primary categories.

Category	# of Bridges	% of Bridges
Routine Maintenance	8	19%
Minor Rehablitation - Deck Patching	16	38%
Major Rehablitation - Deck Replacement	18	43%
Totals	42	100%

Figure 6-28 shows a graphical distribution of these three categories.

Below is a short explanation of each of the repair items.

REPAIR TYPE	DISCUSSION
Routine Maintenance	**Criteria** Bridges in this category are expected to remain serviceable until the year 2030 without rehabilitation. Maintenance required under this option is typically done by ConnDOT personnel or contracted out under District supervision.
	Description This work includes such items as: Joint repairs in kind. Substructure patching of specific areas Overlay replacement and new membrane
Deck Patching Minor Rehabilitation	**Criteria** Bridges in this category have deck deterioration to the extent that a rehabilitation project will likely be required prior to the year 2030.
	Description Work includes: Remove existing overlay Patch deck as required Install new membrane and overlay Repair/replacement of joints

Deck Replacement Major Rehabilitation	**Criteria** Bridges in this category will likely require the deck to be replaced prior to the year 2030.
	Description Remove existing deck and replace with new cast-in-place concrete deck, membrane and overlay. Deck will be made composite with superstructure. Adding reinforcing plates to the steel superstructure to repair localized deterioration is included in this item. All bridge and approach railings will be upgraded to the current design standards. Rehabilitation work on the approaches will be done only to the extent required to transition to the bridge.
Substructure Patching	**Criteria** Almost all of the bridges in the study have areas of substructure deterioration to one degree or the other that will need to be addressed as part of routine maintenance or during a rehabilitation project. For structures not expected to require rehabilitation, it is assumed that smaller areas of substructure repair will be part of normal maintenance, and therefore substructure repair is not specifically called out for the bridge. Substructure units requiring more significant amounts of repair are called out for patching. Substructure repairs will likely be a part of any rehabilitation project (Deck Patching or Replacement), and are therefore indicated as a separate repair item.
	Description Remove deteriorated concrete, repair reinforcing bars as required and patch area with concrete.
Complete Painting	**Criteria** This item is indicated as a repair if overall painting is required to maintain the structural integrity of the bridge. For purposes of this study it is assumed that bridges which have not been painted since 1990 will require painting.
	Description Erect enclosure, blast clean and paint existing steel. This item includes any minor steel repairs required to reinforce local areas.
Spot Painting	**Criteria** This item is indicated as a repair if localized painting is required to maintain the structural integrity of the bridge. Spot painting would typically be done where drainage from (or through) the deck has caused localized rusting; for example at deck joints. For purposes of this study it is assumed that all bridges which are not receiving a complete painting will require at least spot painting.

	Description Clean existing steel in localized areas and spot paint.
Bearing Replacement	**Criteria** This item is indicated as a repair if the existing bearings are deteriorated to the extent that they no longer allow the structure to move freely with changes in temperature. It is also indicated as a repair item if the existing bearings are significantly misaligned.
	Description Jack existing superstructure and replace bearings.
Repair Impact Damage to Beams	**Criteria** This item is indicated as a repair if significant impact damage has occurred resulting in misalignment and bending of members.
	Description Heat straighten main beams and replace secondary members as required. Spot paint as required.
Safetywalk Retrofit	**Criteria** Various bridges still have safetywalks at the base of the parapets. This item is indicated as a repair item if safetywalks are present and deck replacement is not anticipated.
	Description Remove or retrofit safetywalks using one CDOT standard methods.
Seismic Retrofit	**Criteria** For purposes of this study it is assumed that all bridges with greater than three spans, which have not been seismically retrofitted will require retrofitting.
	Description Secure structure in such a way that it will not loose bearing support during a seismic event.

6.3 Cultural Resources

6.3.1 Visual and Aesthetic Resources

Visual and aesthetic resources in the study area include ridgelines, parks, historic sites and/or neighborhoods, and streetscapes. In particular, the *Waterbury-Republican American* newspaper company is housed in historic Union Station, a building whose landmark tower is visible from I-84, Route 8, and much of Waterbury. The Waterbury Green, on West Main Street, inclusive of its monuments and sculptures, is also a visual and aesthetic resource, as is Saint Anne's Church on East Clay Street in Waterbury. Another feature unique to Waterbury is "Holy Land," characterized by a large cross positioned on a ridgeline, visible from several miles. The Naugatuck River, winding its way from north to south through Waterbury, bisecting the city, is an aesthetic natural resource in the region.

Waterbury Green. View from West Main Street.

Holy Land Cross on ridgeline in the distance. View looking east from South Elm Street

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Saint Anne's Church. View from East Clay Street, looking south.

Historic Union Station. View looking north on Meadow Street

Naugatuck River. View looking south.

6.3.2 Historic Resources

Section 106 of the National Historic Preservation Act of 1966 (16 U.S.C. 470f) states that any Federally funded project must "take into account the effect of the undertaking on any district, site, building, structure, or object that is included in or eligible for inclusion in the National Register." The first step in evaluating potential impacts to historic resources is to establish an Area of Potential Effect (APE) for the project. For this Feasibility Study, an APE of 500 feet been defined. The size of the APE was selected because it was determined that any proposed interchange improvement plan would not incur potential impacts, including visual impacts, beyond 500 feet on ether side of the existing roadways and interchanges. This proposed APE has not been reviewed by the State Historic Preservation Office (SHPO). During the further analysis of cultural resources that would take place during the NEPA phase (Environmental Impact Statement) for this project, the size of the APE would be formally approved by the SHPO at that time.

With the APE defined, potential historic and archaeological resources within the APE were identified through consultation with the SHPO, review of available maps provided by local planning departments and historical societies, and searches of the State Register of Historic Places, the Historic American Engineering Record, and of the National Register Information System Database. In addition to this research, a visit to portions of the study area in Connecticut was conducted on November 11, 2004 by Fitzgerald & Halliday, Inc. (FHI). The area located within the 500 foot buffer was reviewed during the reconnaissance. The document research and reconnaissance revealed that a number of historic resources fall within and/or abut the proposed APE. These historic resources are listed in Table 6-17.

Six previously listed National Register resources fall within the 500 foot APE and are listed in the table below.

Table 6-17: Historic Resources

Name	Location	Description	National Register
Downtown Waterbury Historic District	Bounded by Main, Meadow and Elm Streets	106 buildings of various styles dating from 1850-1950	Listed on the National Register of Historic Places
Hamilton Park	Bounded by Silver and East Main Streets, Idylwood Avenue, Plank Road, the Mad River and I-84	Historic Park designed by George Dunkelburger in the Colonial Revival Design	Listed on the National Register of Historic Places
Riverside Cemetery	496 Riverside Street	Cemetery with Gothic-style, stone gatehouse and iron fence surrounding the grounds.	Listed on the National Register and as a National Historic Site.
Bank Street Historic District	207-231 Bank Street	Four Victorian and Colonial Revival-style buildings dating from 1875-1924	Listed on the National Register
Waterbury Municipal Center Complex (Cass Gilbert Historic District)	195, 235, 236 Grand Street and 7, 35, 43 Field Street	Six Classical Revival-style buildings dating from 1900-1925 designed by Cass Gilbert.	Listed on the National Register

Field reconnaissance revealed that several neighborhoods have a notable number of properties that appear to be eligible for the National Register. Further research will be conducted to determine their eligibility once the project progresses to the next development stage.

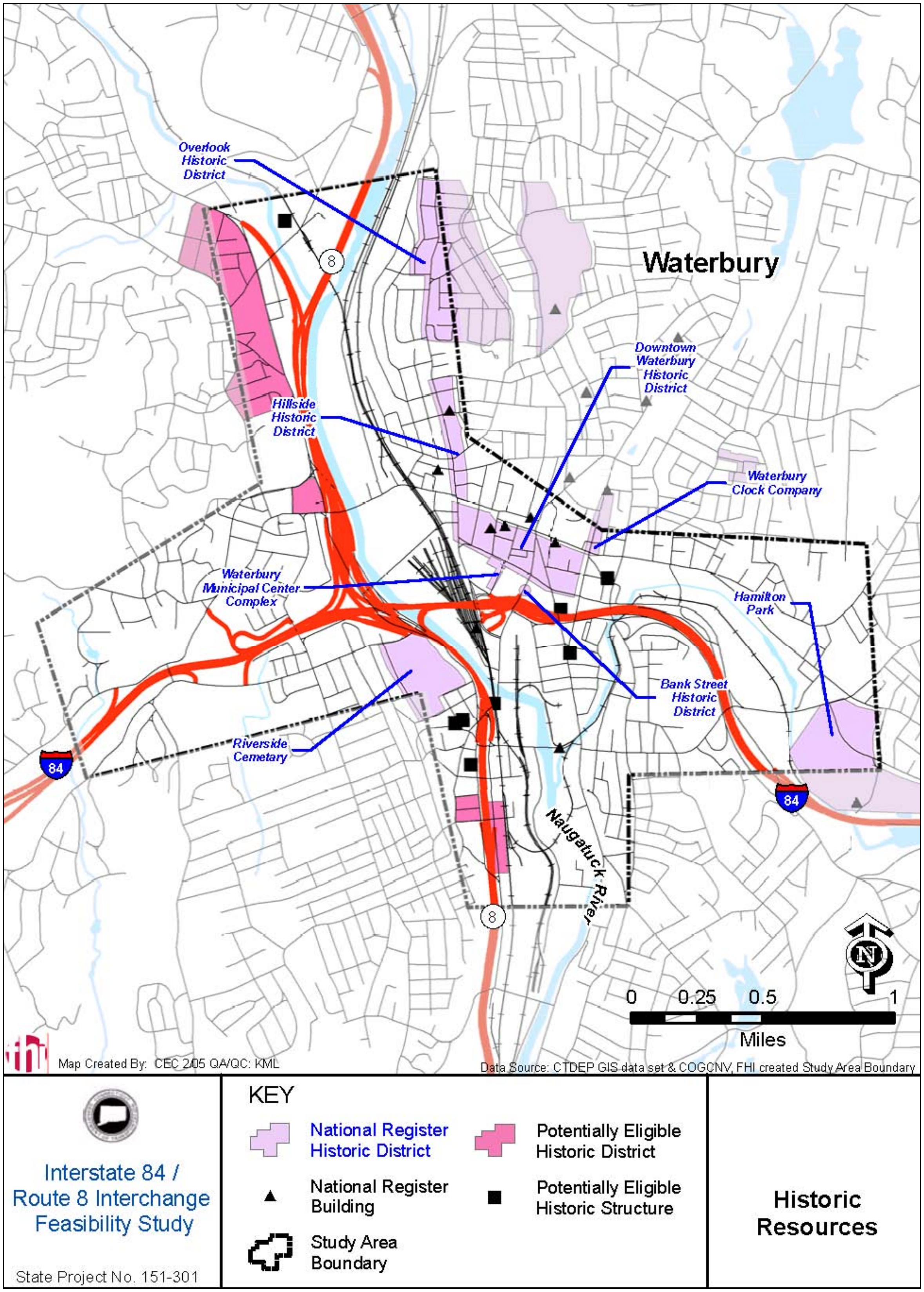
The following list indicates resources that may be eligible for inclusion on the National Register of Historic Places:

- Waterbury Rolling Mills, 240 East Aurora Street
- St. Anne's Roman Catholic Church, 515 South Main Street
- Our Lady of Lourdes Church, 309 South Main Street
- Railroad Trestle crossing Bank Street south of Downtown
- St. Mary's School, 43 Cole Street
- A cluster of houses located on the eastern end of Robin Street, east of Colley Street
- A grouping of various one-to-two-story brick industrial properties at 155-271 South Leonard Street
- A potential district of three family houses dating from c. 1910 along Charles Street; and Third, Fourth and Fifth Streets east of Bank Street
- St. Patrick's Church and Rectory, 50 Charles Street
- St. Joseph's Church, 46 Congress Avenue
- Brooklyn Elementary School (Formerly St. Joseph's School), 29 John Street
- The neighborhood of one, two and three family houses located on the western side of Route 73 and Route 8. This includes properties along the eastern ends of Newton Terrace (at the northern end of this neighborhood), south to Waterbury Hospital.

The SHPO is aware that a number of historic and architectural resources listed or eligible for the National Register exist in the study area. If a selected project advances, the SHPO would require additional project information, including preliminary design plans, in order for their professional staff to provide further technical assistance and guidance to ensure the protection of significant cultural resources along the corridor. A determination of effect on historic and archaeological issues would be issued, and mitigative measures would be necessary if an adverse effect would be expected.

A summary of registered and potentially eligible historic locations is shown in Figure 6-29.

Figure 6-29: Historic Resources



6.3.3 Archeological Resources

Areas of archeological sensitivity are found along the Naugatuck River and throughout the study area. As the project progresses to the next phase, these areas will be identified and closely reviewed by the State Archaeologist to determine any impacts to potential resources.

6.3.4 Public 4(f) and 6(f) Lands

Section 4(f) of the Department of Transportation Act of 1966 protects historic resources eligible for listing or listed on the National Register of Historic Places, public parks and recreation areas, and wildlife/waterfowl preserves from adverse impacts. Historic 4(f) resources were listed in Table 6-17. Section 6(f) of the Land and Water Conservation Funding Act of 1965 (LWCFA) states that any lands purchased with federal LWCFA funding may not be "converted" to another use without being replaced in kind by land of like size and value. For this study, a 250-foot buffer was used for determining parkland and Section 6(f) impacts. These potential Section 4(f) and Section 6(f) lands are shown in Figure 6-30.

Consultation with the Connecticut Department of Environmental Protection (DEP) and review of maps and local documentation provided by study area towns revealed that the following public parklands are located within approximately 250 feet of the study area:

- University of Connecticut, Waterbury Branch
- Naugatuck Valley Community College
- Kennedy High School
- West Side School and West End Middle School Complex
- Barnard School
- Kingsbury School
- Bunker Hill School and Bunker Hill Playground
- Washington School
- Maloney School
- State Street School
- Hayden Park
- The Waterbury Green
- Library Park
- Edmund Rowland Park
- Chase Park
- West Dover Street Playground
- Rolling Mill Playground
- Hamilton Park
- Washington Park

6.3.5 Other Community and Institutional Resources

There are a wide variety of other community and institutional facilities within the project corridor that could potentially benefit from the increased public access provided by the proposed project. These cultural and community facilities enhance the quality of life and provide services to the people who live and do business in the area. Figure 6-30 depicts the locations of schools, churches, fire stations, police stations, hospitals, post offices, libraries and other miscellaneous community resources within the study area.

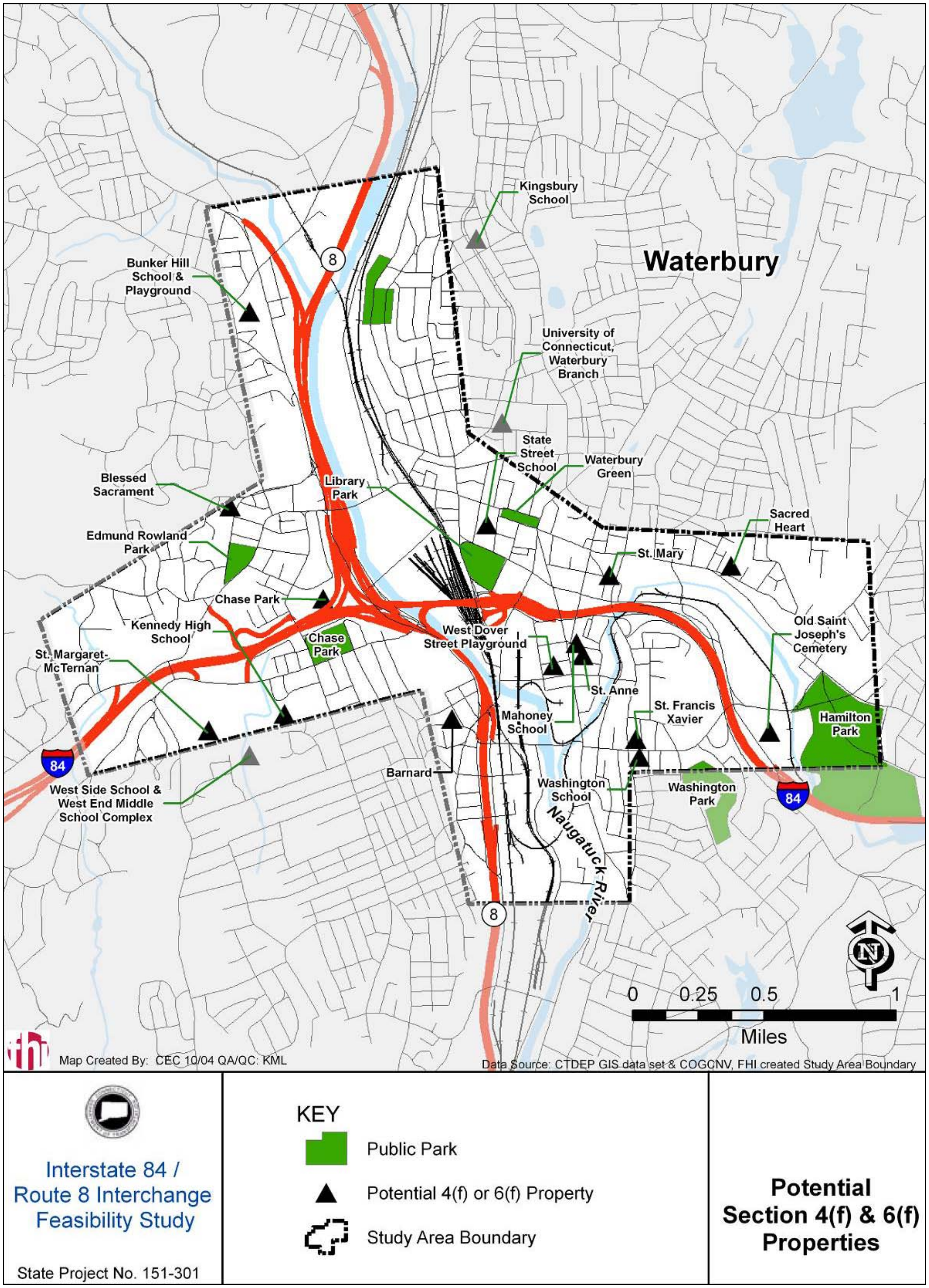
Cultural and Community Facilities Proximate to the Study Area

There are a number of cultural and community resources within walking distance of the study area. For this study, walking distance is considered to be within 2,000 feet of the corridor. These resources are:

- Municipal Stadium
- Country Club of Waterbury
- Lewis Fulton Memorial Park
- Scoville Rowhouse Historic District
- Huntington Avenue Playground
- Hopeville Playground

Future review of nearby community facilities will be necessary after alternatives are proposed for the project. This review will take place during the NEPA process.

Figure 6-30: Potential Section 4(f) & 6(f) Properties



6.4 Environmental Constraints

6.4.1 Surface Water and Groundwater

Surface Water

There are several watercourses within the study area. These watercourses are listed below and are briefly described as they relate to the existing I-84 and Route 8 interchange. Designated uses and descriptions of surface water quality classifications developed by the Connecticut Department of Environmental Protection (CTDEP) are presented in Table 6-18. Watercourses that are not classified by the CTDEP for water quality are presumed Class A, which is the default classification assigned by CTDEP to all surface waters where water quality data is unavailable.

- **Naugatuck River:** The Naugatuck River runs north-south through the study area, generally paralleling Route 8, which is located west of the river. Within the study area there are several crossings of the Naugatuck River; West Main Street and Freight Street (north of the I-84/Route 8 interchange), and Bank Street and Washington Avenue (south of the interchange). The freight and commuter rail tracks cross the Naugatuck River three times within the study area, all south of the I-84/Route 8 interchange, in the vicinity of Bank Street and near the Naugatuck River's confluence with the Mad River. The Naugatuck River runs under the I-84/Route 8 interchange along the east side of Route 8. The surface water quality classification of the Naugatuck River is C/B, indicating an existing classification of C, with the goal of attaining a classification of B.

- **Mad River:** The Mad River flows into the study area from the east. The Mad River's course north of I-84, generally, parallels I-84. From Hamilton Park, located at the southwest intersection of Route 69 (Silver Street) and East Main Street, the Mad River crosses Route 69. North of Route 69, the Mad River flows behind the Brass Mill Center and Commons. It then submerges, passes under I-84 and re-emerges north of Liberty Street. The Mad River continues its course south of I-84, between Mill Street and River Street, crossing South Main Street and Washington Avenue (northeast of this intersection). South of Washington Avenue, the Mad River empties into the Naugatuck River. The surface water quality classification of the Mad River is B.

- **Steele Brook:** Only a small portion of Steele Brook lies within the study area. Steele Brook flows south, east of Route 73 (Watertown Avenue) and crosses East Aurora Street before crossing Route 8, just northeast of Route 8 Interchange 35 (Route 73). Steele Brook empties into the Naugatuck River just east of Route 8 at this location. The surface water quality classification of the Steele Brook is B.

- **Tributaries to Hop Brook:** West of the I-84/Route 8 interchange, there are two smaller unnamed streams located partially within the study area that are associated with the Hop Brook watershed. One of these streams flows north to south along the western edge of the Naugatuck Valley Community College campus and crosses Chase Parkway, I-84, and Country Club Road, before exiting the study area. The second unnamed stream flows north to south from the vicinity of Chase Parkway through the Teikyo Post campus and then exits the study area. The surface water quality classification of both of these watercourses is A.

Table 6-18 CTDEP Surface Water Quality

Class	Designated Uses	Classification	
		Type	Description
A	Potential drinking water supply; fish and wildlife habitat; recreational use; agricultural, industrial supply; other legitimate uses including navigation.	A	Known or presumed to meet water quality criteria which support designated uses.
		A/AA	May not be meeting water quality criteria for one or more designated uses. The goal is Class A.
B	Fish and wildlife habitat; recreational use; agricultural and industrial supply; other legitimate uses including navigation.	B	Known or presumed to meet water quality criteria which support designated uses.
		B/A or B/AA	Presently does not meet the water quality criteria for one or more designated uses. The goal is Class B.
C	Certain fish and wildlife habitat; certain recreational activities; industrial supply; other legitimate uses, including navigation; swimming may be precluded; one or more Class B criteria or designated uses may be impaired; goal is Class B unless a CTDEP And EPA approved use attainability analysis determines certain uses are non-attainable.	C/A or C/B	Presently not meeting water quality criteria for one or more designated uses due to pollution. The goal for such waters may be Class A or Class B depending upon the specific uses designated for a watercourse. In those cases where an approved use attainability analysis has been conducted, certain designated uses may not be sought
D	Present conditions severely inhibit or preclude one or more designated uses for extended time periods or totally preclude attainment of one or more designated uses. May be suitable for certain fish and wildlife habitat; bathing or other recreational purposes; industrial supply; other legitimate uses, including navigation, may have good aesthetic value.	D/A or D/B	Presently not meeting water quality criteria for one or more designated uses due to severe pollution. The goal for such waters may be Class A or Class B depending upon the specific uses designated for a watercourse. In those cases where an approved attainability analysis has been conducted, certain designated uses may not be sought.

Source: Connecticut Department of Environmental Protection, Water Quality Standards, 1997.

Drinking water is supplied by the City of Waterbury throughout the majority of the study area. In westernmost parts of the study area, drinking water is supplied by residential wells.

Groundwater

According to the CTDEP's online "GIS Data Guide Aquifer Protection Areas" data layers, there are no potential well fields, sole source aquifers, aquifer protection zones, well-head zones, or stratified drift aquifers in the immediate vicinity of the proposed project.

Groundwater is classified as GB throughout most of the study area. However, there are a few locations where the groundwater is classified as GA. These locations include an area along the western portion of the study area in the vicinity of West Main Street and Chase Parkway, an area to the southwest of the I-84/Route 8 interchange near Porter Street and the Metro-North Waterbury Branch, and an area northwest of the I-84/Route 8 interchange between Aurora Street and Route 73. Designated uses and descriptions of groundwater quality classifications are presented in Table 6-19 and Figure 6-31.

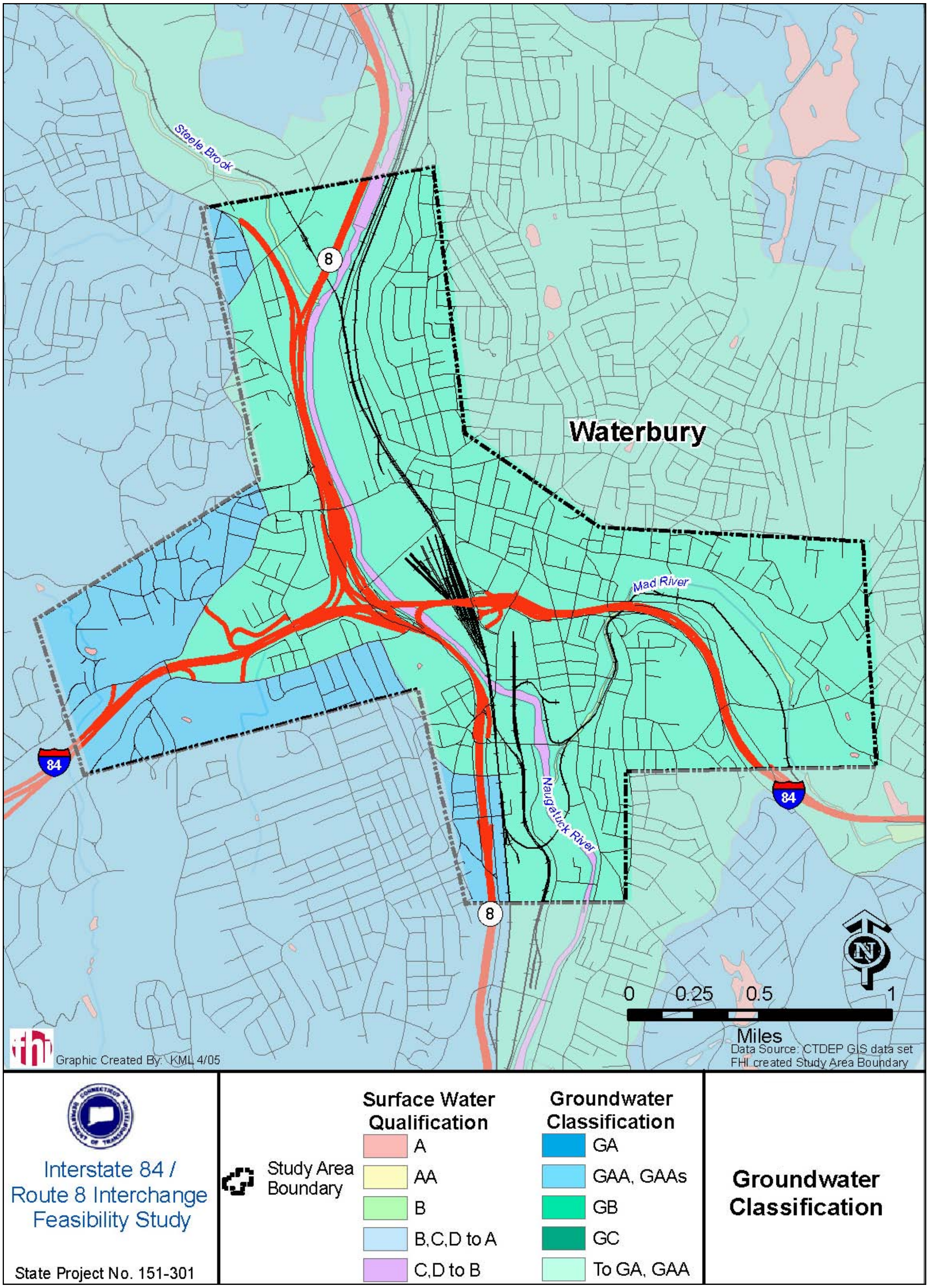
Table 6-19 CTDEP Groundwater Quality Classifications

Class	Designated Uses	Discharge Restricted to:
GAA	Existing or public water supply or water suitable for drinking without treatment; baseflow for hydraulically connected surface water bodies	Treated domestic sewage, certain agricultural wastes, certain water treatment discharges
GA	Existing private and potential public or private supplies of water suitable for drinking without treatment; baseflow for hydraulically connected surface water bodies.	Same as for GAA; discharge from septage treatment facilities subject to stringent treatment and discharge requirements; and other wastes of natural origin that easily biodegrade and present no threat to groundwater.
GB	Industrial process water and cooling waters; baseflow for hydraulically connected surface water bodies; presumed not suitable for human consumption without treatment.	Same as for GA. Note: same stringent treatment standards apply; certain other biodegradable wastewaters subject to soil attenuation.
GC	Assimilation of discharge authorized by the Commissioner pursuant to Section 22a-430 of the General Statutes. As an example, a lined landfill for disposal of ash residue from a resource recovery facility. The GC hydrogeology and setting provides the safest back up in case of technological failure.	Potential discharges from certain waste facilities subject to extraordinary permitting requirements.

Source: Connecticut Department of Environmental Protection, Water Quality Standards, 1997.

There is no significant use of groundwater wells for public drinking water in the study area. The exception is in the westernmost edge of the study area, where there are private, individual wells serving local residences. Most public drinking water is provided by the City of Waterbury's water service.

Figure 6-31: Ground and Surface Water Classification



6.4.2 Floodplains and Stream Channel Encroachment Lines

Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps and GIS data were reviewed to identify 100-year floodplains within the project study area, depicted in Figure 6-32 with 500-year floodplains. The 100-year flood is used by the National Flood Insurance Program (NFIP) as the standard for floodplain management and to determine the need for flood insurance. The 100-year floodplains located in, adjacent to, or in close proximity to the existing I-84/Route 8 interchange right-of-way are described below.

- **Naugatuck River**: The 100-year floodplain associated with the Naugatuck River parallels Route 8 through the study area, ranging from approximately 300 to 2,000 feet wide throughout the study area.

- **Mad River**: The 100-year floodplain associated with the Mad River is continuous through the study area. The 100-year floodplain ranges from approximately 200-feet wide, at narrowest point, south of I-84, to approximately 1,100-feet wide north and east of Silver Street.

- **Hop Brook:** At the western edge of the study area, the 100-year floodplain associated with the Hop Brook watershed's Welton Brook lies north of I-84 on either side of Chase Parkway in the vicinity of the Naugatuck Valley Community College campus. At its widest point in the study area, the floodplain is approximately 500 feet.

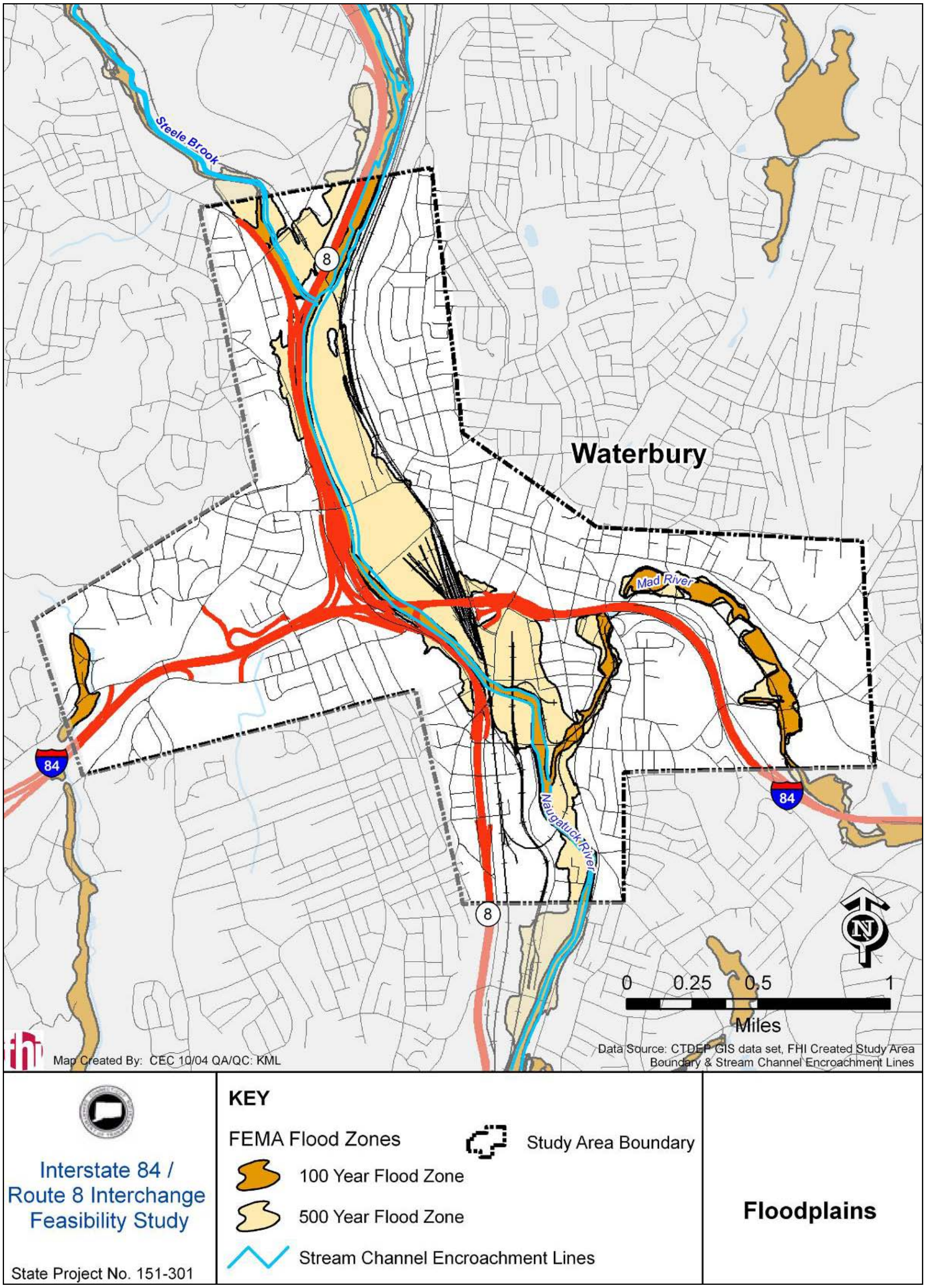
- **Steele Brook:** The 100-year floodplain associated with Steele Brook at the northern edge of the study area, lies between Route 8 and Route 73 (Watertown Avenue). This floodplain, at its widest point in the study area is 850 feet.

These 100-year floodplains are regulated areas. In the event that the project would require an activity within or affecting a floodplain, ConnDOT would obtain a permit from the CTDEP. Regulated activities include, but are not limited to, structures, obstructions, or encroachments proposed within the floodplain area.

<u>Stream Channel Encroachment Lines</u>

There are stream channel encroachment lines (SCELs) along the Naugatuck River and Steele Brook within the study area, also shown Areas within the SCELs are regulated by CTDEP to ensure that floodplain in Figure 6-32 development is compatible with river flood flows. In the event that areas within the SCELs would be impacted by the project, ConnDOT would obtain the appropriate permits from CTDEP.

Figure 6-32: Floodplains



6.4.3 Public Water Supplies

The City of Waterbury, Bureau of Water, provides drinking water to residents in the study area. The water is supplied primarily from surface reservoirs located in Litchfield County. The water is piped from the reservoir to the Harry P. Danaher Water Treatment Plant located in Thomaston prior to being distributed to City of Waterbury customers. A few small patches in the western portion of the study area are not served by the City of Waterbury, Bureau of Water. There are no public water supply reservoirs or stratified drift aquifers in the immediate vicinity of the proposed project.

6.4.4 Wetlands

Wetlands in the study area were identified using DEP's GIS Data Guide Wetland Soils. These wetlands are shown in **Figure 6-33.**

As shown, there are several wetlands in the Hop Brook watershed, west of the I-84 and Route 8 interchange. A large wetland is located south of I-84, southeast of the Chase Parkway and Country Club Road intersection, and is characterized by Carlisle muck soils. Another wetland area, also characterized by Carlisle muck, is located between I-84 and the Chase Parkway and West Main Street intersection.

It should be noted that the GIS wetland data is not necessarily comprehensive, and there are likely to be additional wetlands within the study area. As this project progresses, the area will be field-checked for wetlands so that impacts to wetlands from the project could be avoided or minimized to the extent possible. In the event that wetlands would be impacted by the project, ConnDOT would obtain all necessary permits per state and federal regulations.

6.4.5 Endangered Species

According to the CTDEP GIS data, there are no Natural Diversity Database records within the project study area. The U.S. Fish and Wildlife Service, in correspondence dated November 8, 2004, noted that there are no federally-listed or proposed, threatened, or endangered species or critical habitat known to occur within the study area. As this project progresses, ConnDOT will continue to coordinate with federal and state agencies to ensure that regulations on threatened and endangered species and critical habitat are observed.

6.4.6 Hazardous Materials Risk Sites

Within the proposed project area, there is a high risk for encountering contamination during project construction due to adjacent land uses. Information from the Environmental Protection Agency (EPA) Toxics Release Inventory (TRI) was used to identify potential hazardous sites. This TRI is a publicly available EPA database that contains information on toxic chemical releases and other waste management activities reported annually by certain covered industry groups as well as federal facilities. The TRI provides facility name and street address, used to show the locations of these potentially hazardous sites as shown in Figure 6-34.

There are 18 TRI sites identified in the study area where toxic releases have been reported. Of these 18 sites, two are active or archived superfund sites. These two sites are located southeast of the I-84 and Route 8 interchange, within a cluster of the hazardous materials risk sites bounded by South Leonard Street, South Main Street, and Washington Avenue.

Generally, the hazardous materials risk sites are located along the freight rail line, which runs north-south and parallel to Route 8.

Figure 6-33: Wetlands

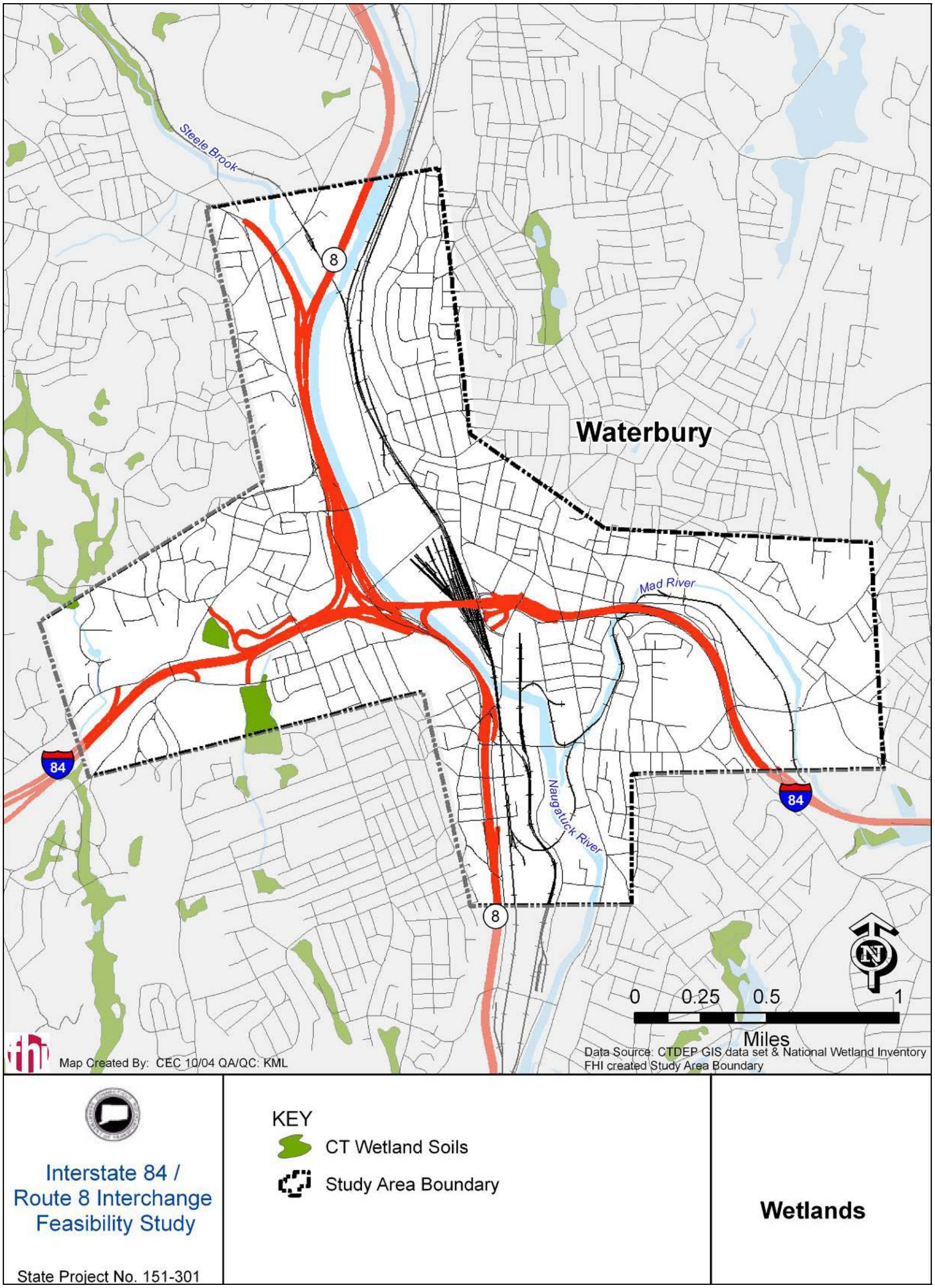
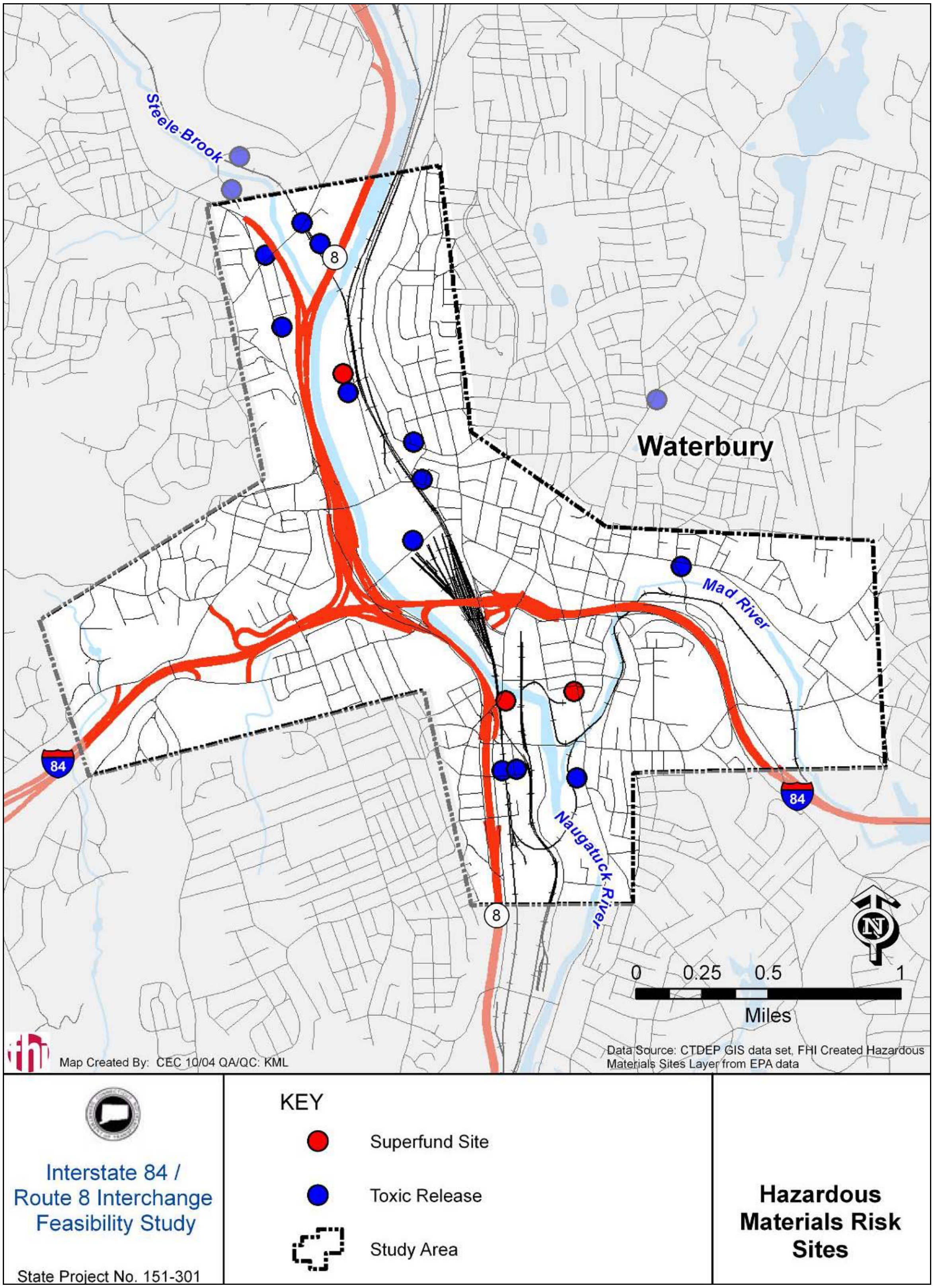


Figure 6-34: Hazardous Materials Risk Sites



6.4.7 Prime Farmland Soils

The U.S. Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) soils information, obtained in GIS format, was used to identify prime and statewide important farmland soils within the study area, as shown in Figure 6-35. These soils have not been field checked to determine if they have been developed and/or otherwise altered in use since the mapping, which would disqualify them as farmland, or to determine if they are actively farmed. Soils within ConnDOT rights-of-way or committed to another use would not be considered prime farmlands. As the project progresses, potential impacts to prime farmlands will be coordinated with regulatory agencies in accordance with state and federal farmland protection policies.

Figure 6-35 indicates that there is prime farmland to the immediate northwest of the I-84 and Route 8 interchange in the vicinity of Chase Park, as well as to the southwest of the interchange, in close proximity to Riverside Cemetery and Barnard School. There are additional soils of statewide importance shown along the western edge of Route 8, both north and south of the I-84 and Route 8 interchange. The prime farmland soils are described as Agawam Fine Sandy Loam with 8 to 15 percent slopes and Woodbridge Fine Sandy Loam with 3 to 8 percent slopes, and the additional farmland soils are Paxton and Montauk with 8 to 15 percent slopes.

Farther from the I-84 and Route 8 interchange, at the western edge of the study area, there are large patches of prime farmland soils, as well as additional soils of statewide importance, south of Interstate 84 in the vicinity of Country Club Road There are also prime farmland soils and statewide important farmland soils north of I-84 in the vicinity of Park Road, West Main Street, and Rowland Park, as well as Grandview Avenue. East of the I-84 and Route 8 interchange, there are small and scattered prime farmland soils and additional soils of statewide importance at the eastern edge of the study area in the vicinity of Route 69 (Silver Street) and East Main Street. There is also a small area of prime farmland soils and additional soils of statewide importance south of Interstate 84 at the corner of Washington Avenue and Sylvan Avenue.

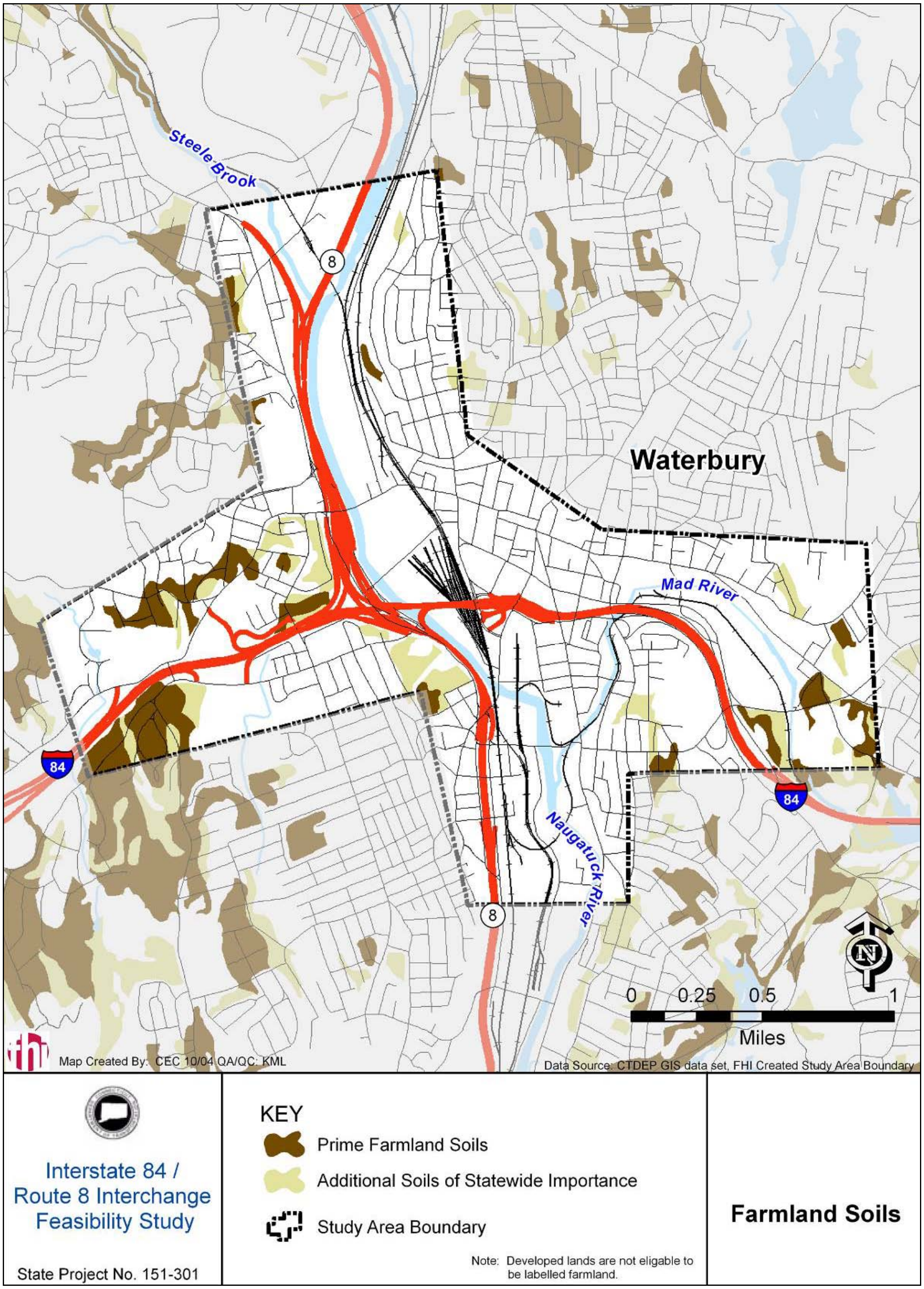
6.4.8 Air Quality

This section documents the existing air quality conditions in the Interstate 84 and Route 8 interchange study area and the encompassing Central Naugatuck Valley Region.

<u>Air Quality Attainment Status</u>

The Clean Air Act of 1970 and subsequent amendments established National Ambient Air Quality Standards (NAAQS) for six criteria pollutants including carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), lead (Pb), ozone, and particulate matter (PM). The Clean Air Act required states to monitor regional air quality to

Figure 6-35: Farmland Soils



determine if regions meet the NAAQS. If a region exceeds any of the NAAQS, that part of the state is classified as a non-attainment area for that pollutant, and the state must develop an air quality plan, called a State Implementation Plan (SIP), that will bring that region into compliance.

Motor vehicles are sources of CO, ozone precursors, and PM emissions. Other sources include stationary sources such as power plants and boilers, area sources such as bakeries painting activities, and non-road vehicle sources such as construction and farm equipment.

The current air quality attainment designations for the Central Naugatuck Valley Region are presented below for the six criteria pollutants.

- Carbon Monoxide: The entire state of Connecticut is now designated as being in attainment for CO.

- Ozone: The entire state of Connecticut is designated as non-attainment for the one-hour ozone standard. The Central Naugatuck Valley region is classified as a "serious non-attainment area" for the one-hour standard. The region must meet the ozone standard by 2007.

  In July of 1997, EPA promulgated a revised ozone standard based on an eight-hour averaging period rather than a one-hour period. EPA has not yet implemented the new standard or developed regulations for its implementation.

- PM: EPA has established NAAQS for two size ranges of PM. The Central Naugatuck Valley Region is currently in attainment of PM_{10} (particulate matter with a diameter of 10 microns or less). In July of 1997, EPA promulgated a new NAAQS for $PM_{2.5}$ (particulate matter with a diameter of 2.5 microns or less). EPA is currently establishing a nationwide monitoring network for $PM_{2.5}$.

NO_2, Pb, and SO_2: The entire state of Connecticut is in attainment for these pollutants.

State Implementation Plan (SIP)/Transportation Improvement Program (TIP) Conformity

Conformity requirements of the Clean Air Act stipulate that implementation of projects in Transportation Improvement Programs (TIP) and Long Range Plans (LRPs) must not cause or contribute to further violations of the NAAQS and must conform to the SIP's purpose of meeting air quality attainment. This demonstration requires an extensive modeling effort to estimate vehicle miles of travel on a regional transportation system and the resulting motor vehicle emissions. COGCNV, which serves as the metropolitan planning organization for the greater Waterbury area, prioritizes and places transportation projects on the region's TIP. That TIP is incorporated into the Connecticut Department of Transportation's (ConnDOT's) Statewide TIP and individual projects are moved forward each year for funding. At this time, the I-84 and Route 8 interchange project alternatives have not yet been fully developed and the project has not been formally included in a conforming TIP for the Central Naugatuck Valley region. However, the project has been identified as a potential project in the Central Naugatuck Valley Region's Long Range Regional Transportation Plan 2004–2030.

6.4.9 Noise

The Federal Highway Administration's Noise Abatement Criteria (NAC) documented in 23 CFR 772, *Procedures for Abatement of Highway Traffic Noise and Construction Noise* is based on Land Use Activity Categories. Land uses considered most sensitive to highway noise are designated as either Land Use Activity Category A or B. Land Use Activity Category A includes lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose. Such uses include outdoor amphitheatres, outdoor concert pavilions, and National Historic Landmarks with significant outdoor use. Land Use Activity Category B includes picnic areas, recreation areas, playgrounds, active sports areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals.

For this feasibility study, Category A and B land uses were identified using existing land use maps and GIS data. These noise sensitive land uses are listed below and are depicted in Figure 6-36.

Noise Sensitive Land Uses within the Study Area

<u>Land Use Activity Category A</u>

There are no Category A land uses within the study area

<u>Land Use Activity Category B</u>

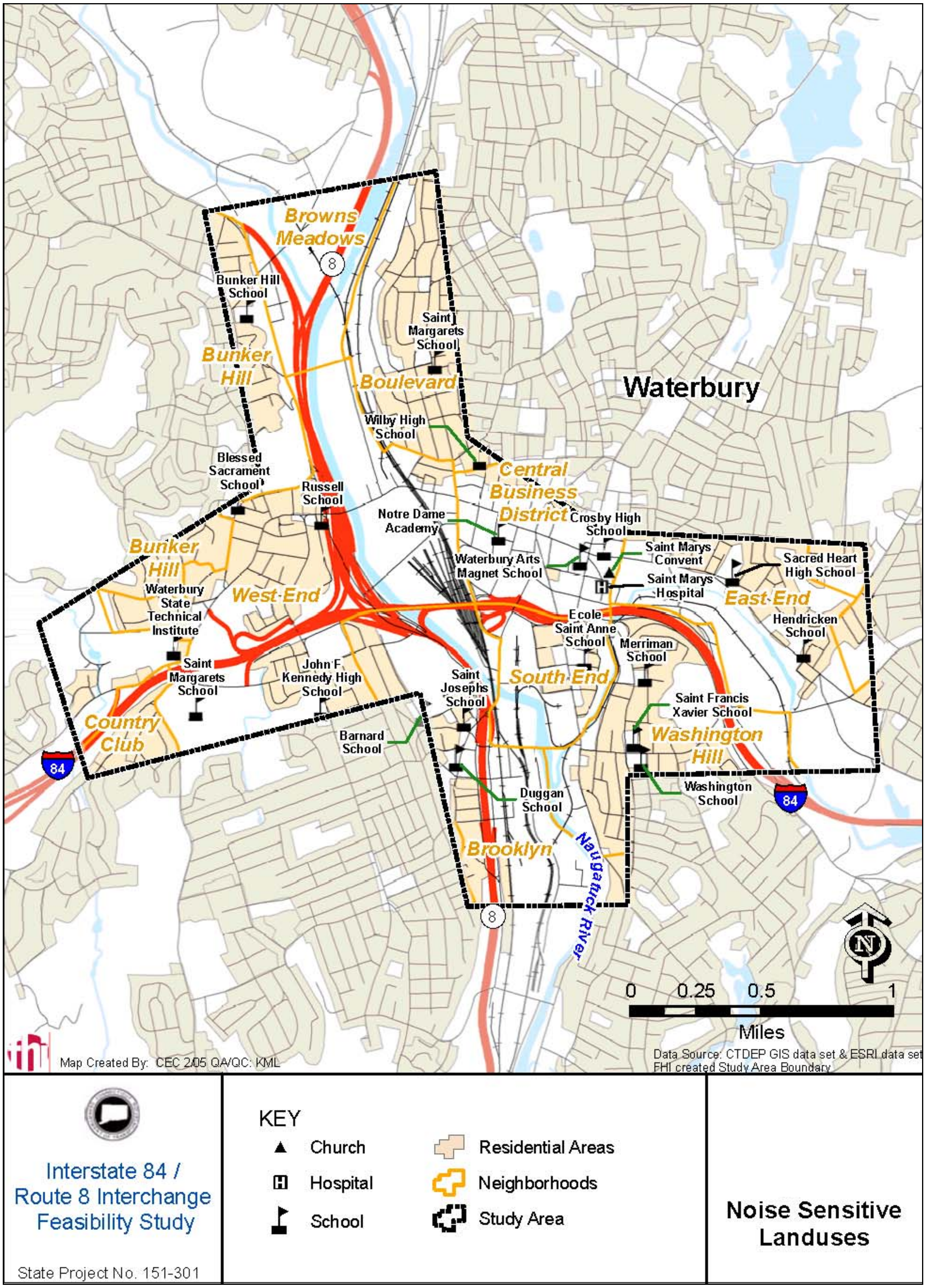
- Bunker Hill School
- Blessed Sacrament School
- Naugatuck Valley Community College
- Saint Margaret's School
- John F. Kennedy High School
- Barnard School
- Saint Josephs School
- Duggan School
- Washington School
- Xavier School
- Saint Francis School
- Merriman's School
- Saint Anne School

- Hendricken School
- Sacred Heart High School
- Saint Mary's Hospital
- Croft School
- Notre Dame Academy
- Russell School
- Waterbury Hospital
- Teikyo Post College
- Waterbury Arts Magnet School

The study area also traverses several residential neighborhoods including Brooklyn, Bunker Hill, Country Club, East End, South End, Town Plot, Washington Hill, and West End.

As potential alternatives become more developed and the study progresses, noise sensitive resources and potential impacts to them will be assessed in greater detail.

Figure 6-36: Noise Sensitive Land Uses



7 Needs and Deficiencies

This Existing and Future Conditions Technical Memorandum has analyzed the I-84/Route 8 Interchange study area from several safety and operational standpoints. Through this analysis, needs and deficiencies from each standard have been identified and are summarized in this section.

7.1 Traffic Operations

Traffic operations relates to ability of a roadway system to accommodate vehicles in terms of demand and distribution. In other words, the volume of traffic and the directional movements they make directly impact the capacity and geometric configuration of a road. In this regard, operations can be quantified through a number of analytic techniques. The first technique utilizes the methodology developed in the Highway Capacity Manual. The second technique involves the use of a micro-simulation model to evaluate the dynamic effect of vehicle evolution into a roadway system during a finite period of time. Each method has its strengths and weaknesses, but both are useful in identifying roadway deficiencies and will ultimately be necessary in order to test the effectiveness of improvement strategies.

7.1.1 Highway Capacity Software Analysis

The HCS utilizes methodologies developed in the Highway Capacity Manual (HCM). It is a static analysis, that is, it is based on a snapshot of traffic conditions at one specific location for the highest 15-minute volume in a peak hour. For this analysis, current year (2005) and future (2030) traffic volume was provided by the Connecticut Department of Transportation (ConnDOT). The future projected volume is unconstrained, and therefore represents the amount of traffic that desires to use the roadway in 25 years. The growth in traffic is based on projections of population and employment growth in the region.

Table 7-1 lists the results of the mainline capacity analysis. Based on the HCS, I-84 will increase from 11 deficient mainline locations in 2005 to 19 deficient mainline locations in 2030. Most of the deficiencies are expected to occur along I-84 eastbound. The constrained capacity of the two lane segment between Interchanges 19 and 20 will result in significant congestion in both the A.M. and P.M. peak hours.

Along Route 8, mainline conditions go from acceptable levels in the year 2005 analysis, and degrade in many areas in the year 2030 projection. The two segments that show the most significant problems are the southern and northern extents of the Route 8 corridor. In these locations, difficult merge and diverge conditions contribute to turbulence in traffic flow under 2030 projected volume conditions.

Table 7-1: Freeway Mainline Capacity Analysis

		2005				2030			
	Segment	**EB**	**WB**	**NB**	**SB**	**EB**	**WB**	**NB**	**SB**
I-84 Mainline	Between Int. 17 and Int. 18	-/X	X/X			X/X	X/X		
	Between Int. 18 and Int. 19	-/-	-/-			-/X	-/-		
	Between Int. 19 and Int. 20	-/-	-/-			X/X	-/-		
	Between Int. 20 and Int. 21	-/-	-/-			X/X	-/-		
	Between Int. 21 and Int. 22	-/-	X/X			X/X	X/X		
	Between Int. 22 and Int. 23	-/-	X/X			X/X	X/X		
	East of Int. 23	X/X	X/X			-/-	X/X		
Route 8 Mainline	Between Int. 29 and Int. 30			-/-	-/-			-/X	-/-
	Between Int. 30 and Int. 31			-/-	-/-			-/X	X/X
	Between Int. 31 and Int. 32			-/-	-/-			-/-	-/-
	Between Int. 32 and Int. 33			-/-	-/-			-/-	-/-
	Between Int. 33 and Int. 34			-/-	-/-			-/X	X/-
	Between Int. 34 and Int. 35			-/-	-/-			-/X	X/-
Total Mainline LOS Deficiencies:		**1/2**	**4/4**	**0/0**	**0/0**	**5/6**	**4/4**	**0/4**	**3/1**

Legend: '-' denotes no deficiency identified, 'X' denotes a deficiency.
Analysis results are displayed (A.M./P.M.)

Table 7-2 lists the interchange ramp merge and diverge analysis for I-84 and Route 8. Ramp capacity analysis is used to understand the effects of traffic interaction at the merge and diverge points at interchange ramps. Interchange ramps are often times choke points in a highway system as vehicles are entering and leaving the system at different speeds and are making lane changing decisions.

For I-84 eastbound, the number of ramp deficiencies increases from 8 to 24 over the 25 year planning period. Virtually every interchange is anticipated to experience congestions at the ramp merge and diverge points in year 2030. For I-84 westbound, the number of deficient locations increases from 9 to 21 over the 25 year planning period. As in the eastbound condition, every interchange is expected to be impacted by the increase in traffic in year 2030.

For Route 8 northbound, all of the deficiencies identified were for the P.M. peak hour condition. During this period, the number of deficiencies increases from 2 to 4 – mainly at the interchanges north of Interchange 32. For Route 8 southbound, the number of deficiencies for the A.M. peak hour increases from 2 to 3 and 0 to 2 for the P.M. peak hour..

Table 7-2: Interchange Ramp Capacity Analysis

I-84 Eastbound Merge/Diverge	A.M. Peak Hour	P.M. Peak Hour	Total Interchange Ramp Deficiencies
2005	Interchange 20 • Off ramp from Rt.8 SB • Off ramp from Rt.8 NB Interchange 21 • Off ramp to Meadow St.	Interchange 18: • Off Ramp to Chase Parkway • On Ramp from Chase Parkway Interchange 20: • Off ramp from Rt.8 SB • Off ramp from Rt.8 NB Interchange 21: • Off ramp to Meadow St.	**(A.M./P.M.)** **(3/5)**
2030	Interchange 18: • Off Ramp to Chase Parkway • On Ramp from Chase Parkway Interchange 19: • Off ramp to Sunnyside/Rt. 8 SB • Off ramp to Rt. 8 NB • On ramp from Highland Avenue Interchange 20: • On ramp from Rt. 8 SB • On ramp from Rt. 8 NB Interchange 21: • Off ramp to Meadow St. • On ramp from Meadow St. Interchange 22: • Off ramp to South Main Street Interchange 23: • Off ramp to Frontage road • On ramp from Hamilton Avenue	Interchange 18: • Off Ramp to Chase Parkway • On Ramp from Chase Parkway Interchange 19: • Off ramp to Sunnyside/Rt. 8 SB • Off ramp to Rt. 8 NB • On ramp from Highland Avenue Interchange 20: • On ramp from Rt. 8 SB • On ramp from Rt. 8 NB Interchange 21: • Off ramp to Meadow St. • On ramp from Meadow St. Interchange 22: • Off ramp to South Main Street Interchange 23: • Off ramp to Frontage road • On ramp from Hamilton Avenue	**(A.M./P.M.)** **(12/12)**

Table 7-2 (continued): Interchange Ramp Capacity Analysis

I-84 Westbound Merge/Diverge	A.M. Peak Hour	P.M. Peak Hour	Total Interchange Ramp Deficiencies
2005	Interchange 18: • Off ramp to West Main St./Highland Avenue Interchange 19: • On ramp from Rt. 8 SB Interchange 21: • Off ramp to Meadow St. Interchange 23: • Off ramp to Hamilton Avenue	Interchange 18: • Off ramp to West Main St./Highland Avenue Interchange 20: • Off ramp to Rt. 8 SB Interchange 21: • Off ramp to Meadow St. Interchange 22: • On ramp from Union Street Interchange 23: • Off ramp to Hamilton Avenue	**(A.M./P.M.)** **(4/5)**
2030	Interchange 18: • Off ramp to West Main St./Highland Avenue • On ramp from Chase Pkwy. Interchange 19: • On ramp from Rt. 8 SB • On ramp from Rt. 8 NB Interchange 20: • Off ramp to Rt. 8 SB Interchange 21: • Off ramp to Meadow Street • On ramp from Bank Street-left • On ramp from Bank Street-right Interchange 22: • Off ramp to Union Street • On ramp from Union Street Interchange 23: • Off ramp to Hamilton Avenue	Interchange 18: • Off ramp to West Main St./Highland Avenue • On ramp from Chase Pkwy. Interchange 19: • On ramp from Rt. 8 SB Interchange 20: • Off ramp to Rt. 8 SB • Off ramp to Rt. 8 NB Interchange 21: • Off ramp to Meadow Street • On ramp from Bank Street-left • On ramp from Bank Street-right Interchange 22: • On ramp from Union Street Interchange 23: • Off ramp to Hamilton Avenue	**(A.M./P.M.)** **(11/10)**

Table 7-2 (continued): Interchange Ramp Capacity Analysis

Route 8 NB Merge/Diverge	**A.M. Peak Hour**	**P.M. Peak Hour**	**Total Interchange Ramp Deficiencies**
2005		Interchange 33: • On ramp from Riverside Street Interchange 34: • On ramp from West Main Street	**(A.M./P.M.)** **(0/2)**
2030		Interchange 33: • On ramp from Riverside Street • On ramp from I-84 WB Interchange 34: • On ramp from West Main Street Interchange 35: • Off ramp to Rt. 73	**(A.M./P.M.)** **(0/4)**

Table 7-2 (continued): Interchange Ramp Capacity Analysis

Route 8 SB Merge/Diverge	**A.M. Peak Hour**	**P.M. Peak Hour**	**Total Interchange Ramp Deficiencies**
2005	Interchange 32: • Off ramp to Riverside Street Interchange 35: • On ramp from Rt. 73		**(A.M./P.M.)** **(2/0)**
2030	Interchange 32: • Off ramp to Riverside Street Interchange 33: • Off ramp to I-84 WB Interchange 35: • On ramp from Rt. 73	Interchange 32: • Off ramp to Riverside Street Interchange 35: • On ramp from Rt. 73	**(A.M./P.M.)** **(3/2)**

Table 7-3 lists the results of the weaving analysis along I-84 and Route 8. Weaves typically occur along segments of highway with closely spaces exit and entrance ramps. For example, and upstream entrance ramp and a downstream exit ramp creates a condition in which traffic must weave to make their necessary movements.

Based on the HCS, I-84 will increase from 3 deficient mainline weave locations in 2005 to 8 deficient mainline weave locations in 2030. This is mainly due to an increase in traffic volumes in the weaving movements in 2030. Along Route 8, the number of weave deficiencies increase from two to three from 2005 to 2030.

Table 7-3: Weave Analysis

		2005				2030			
	Weave Segment	**EB**	**WB**	**NB**	**SB**	**EB**	**WB**	**NB**	**SB**
I-84 Weave	Route 8 NB to Meadow Street	X/-				X/ X			
	Bank Street to Route 8 Northbound		-/X				X/ X		
	Bank Street to Route 8 Southbound		-/-				X/ X		
	Route 8 SB to Highland Ave.		X/-				X/ X		
Route 8 Weave	West Main Street to Watertown Ave.			-/X				-/X	
	Watertown Avenue to West Main Street				X/-				X/ X
	Total Weave LOS Deficiencies:	**1/0**	**1/1**	**0/1**	**1/0**	**1/1**	**3/3**	**0/1**	**1/1**

Legend: '-' denotes no deficiency identified, 'X' denotes a deficiency.
Analysis results are displayed (A.M./P.M.)

Table 7-4 lists the results of the intersection capacity analysis. Intersection operations can create localized congestion that may impact vehicles leaving the highway system as well vehicles entering the system.

The number of intersection deficiencies increase from 6 to 9 between 2005 and 2030 during the A.M. peak hour condition. During the P.M. peak hour, the number of deficiencies increased from 7 to 12 between 2005 and 2030.

Table 7-4: Intersection Capacity Analysis

INTERSECTION	2005		2030	
	A.M.	P.M.	A.M.	P.M.
Interchange 18				
I-84 WB Exit ramp and W. Main St.	X	X	X	X
Interchange 19-20				
Sunnyside St./Riverside St.				
Freight St./Riverside St. NB				
Freight St./Riverside St. SB				
W. Main St./Highland Avenue			X	X
W. Main St./Riverside St. NB		X		X
W. Main St./Riverside St. SB	X	X	X	X
Interchange 21				
I-84 EB Entrance ramp/Meadow St.				
I-84 EB Exit ramp/Meadow St.				
Field St./Meadow St.				
I-84 EB Exit ramp/South Main St.				
Grand Street/Meadow Street	X		X	
Meadow Street/Bank Street				
Grand Street/Bank Street				X
Union Street/S. Main St.		X	X	X
Union Street/S. Elm St.	X	X	X	X
Willow Street/Freight Street			X	X
Willow Street/Main Street	X	X	X	X
Interchange 22				
Baldwin St./McMahon Street/I-84				
Baldwin St./Scoville St.				
I-84 WB Exit ramp/Union St.				
Union/Brass Mill Entrance (West)				
Union/Brass Mill Entrance (East)				
Union Street/Mill Street				
Interchange 23				
I-84 WB Entrance ramp and Hamilton Ave.				X
I-84 WB Exit ramp and Hamilton Ave.				
I-84 EB Entrance ramp and Hamilton Ave.				X
Washington Street and Silver/Hamilton	X	X	X	X
Total Mainline LOS Deficiencies:	**6**	**7**	**9**	**12**

7.1.2 VISSIM Analysis

In addition to HCS, the VISSIM microsimulation model was used to analyze the systemic effect of traffic congestion under real-time conditions. This analysis is based on the desired traffic volumes provided by ConnDOT, but can be constrained by the actual capacity of the highway system. The results offered by VISSIM paint a more accurate picture of roadway operations and can be used to evaluate things such as the progressive build-up of vehicle queues at ramp termini or at highway choke points. VISSIM can also be used to determine the delay that would be caused by the closure of a lane due to a traffic accident.

Table 7-5 lists the segments of the highway system that experienced congested flow conditions as determined by VISSIM. For I-84 Eastbound, 12 locations show congestion during the A.M. and P.M. peak hours of the existing year 2005 scenario. In future year 2030, that number increases to 22.

For I-84 Westbound, 7 locations show congestion during the A.M. and P.M. peak hours of the existing year 2005 scenario. In future year 2030, that number increases to 16.

For Route 8 Northbound, 1 location shows congestion during the A.M. and P.M. peak hours of the existing year 2005 scenario. In future year 2030, that number increases to 5.

For Route 8 Southbound, 2 locations show congestion during the A.M. and P.M. peak hours of the existing year 2005 scenario. In future year 2030, that number increases to 4.

Vehicle queues obtained from VISSIM helped identify queue length deficiencies on a number of exit ramps for both existing year 2005 and future year 2030. Exit ramps with queue length deficiencies for the existing year 2005 are:

- I-84 westbound exit ramp at Interchange 23
- Route 8 southbound exit ramp at Interchange 30

Exit ramps with queue length deficiencies for the future year 2030 are:

- I-84 westbound exit ramp at Interchange 18
- I-84 westbound exit ramp at Interchange 22
- I-84 westbound exit ramp at Interchange 23
- Route 8 northbound exit ramp at Interchange 30
- Route 8 southbound exit ramp at Interchange 30
- Route 8 northbound exit ramp at Interchange 31

Table 7-5: VISSIM Analysis

I-84 Eastbound	A.M. Peak Hour	P.M. Peak Hour	LOS Deficiencies
2005	• Int. 19 Exit Ramp(Right) to Int. 19 Exit Ramp (Left) • Int. 19 Entrance Ramp to Int. 20 Entrance Ramp(Left) • Int. 20 Entrance Ramp (Left) to Int. 20 Entrance Ramp (Right) • Int. 20 Entrance Ramp (Right) to Int. 21 Exit Ramp (Meadow) • Int. 21 Exit Ramp (Meadow St.) to Int. 21 Exit Ramp (S. Main St.) • Int. 21 Exit Ramp (S. Main St.) to Int. 22 Entrance Ramp	• Int. 18 Exit Ramp to Int. 18 Entrance Ramp • Int. 19 Exit Ramp to Int.19 Exit Ramp • Int. 19 Exit Ramp to Int. 19 Entrance Ramp • Int. 21 Exit Ramp (Meadow St.) to Int. 21 Exit Ramp (S. Main St.) • Int. 21 Exit Ramp (S. Main St.) to Int. 22 Entrance Ramp • Int. 22 Entrance Ramp to Int. 23 Exit Ramp	**(6/6)**
2030	• Int. 18 Exit to Int. 18 Entrance Ramp • Int. 18 Entrance Ramp to Int. 19 Exit Ramp • Int. 19 Exit Ramp(Right) to Int. 19 Exit Ramp (Left) • Int. 19 Entrance Ramp to Int. 20 Entrance Ramp(Left) • Int. 20 Entrance Ramp (Left) to Int. 20 Entrance Ramp (Right) • Int. 20 Entrance Ramp (Right) to Int. 21 Exit Ramp (Meadow) • Int. 21 Exit Ramp (Meadow St.) to Int. 21 Exit Ramp (S. Main St.) • Int. 21 Exit Ramp (S. Main St.) to Int. 22 Entrance Ramp • Int. 22 Entrance to Int. 23 Exit Ramp • Int. 23 Exit to Int. 23 Entrance Ramp	• Int. 18 Exit to Int. 18 Entrance Ramp • Int. 18 Entrance Ramp to Int. 19 Exit Ramp • Int. 19 Exit Ramp(Right) to Int. 19 Exit Ramp (Left) • Int. 19 Entrance Ramp to Int. 20 Entrance Ramp(Left) • Int. 20 Entrance Ramp (Left) to Int. 20 Entrance Ramp (Right) • Int. 20 Entrance Ramp (Right) to Int. 21 Exit Ramp (Meadow) • Int. 21 Exit Ramp (Meadow St.) to Int. 21 Exit Ramp (S. Main St.) • Int. 21 Exit Ramp (S. Main St.) to Int. 22 Entrance Ramp • Int. 22 Entrance to Int. 23 Exit Ramp • Int. 23 Exit to Int. 23 Entrance Ramp	**(11/11)**

Legend: Analysis results are displayed in (A.M./P.M.)

Table 7-5 (continued): VISSIM Analysis

I-84 Westbound	A.M. Peak Hour	P.M. Peak Hour	LOS Deficiencies
2005	• Interchange 23 Entrance Ramp to Interchange 22 Exit Ramp • Interchange 22 Entrance Ramp to Interchange 21 Exit Ramp • Interchange 21 Exit Ramp to Interchange 21 Entrance Ramp	• Interchange 23 Entrance Ramp to Interchange 22 Exit Ramp • Interchange 22 Entrance Ramp to Interchange 21 Exit Ramp • Interchange 21 Exit Ramp to Interchange 21 Entrance Ramp • Interchange 21 Entrance Ramp to Interchange 20 Exit Ramp	**(3/4)**
2030	• Interchange 23 Exit Ramp to Interchange 22 Exit Ramp • Interchange 22 Entrance Ramp to Interchange 21 Exit Ramp • Interchange 21 Exit Ramp to Interchange 21 Entrance Ramp • Interchange 21Entrance Ramp (Right) to Interchange 21 Entrance Ramp (Left) • Interchange 21Entrance Ramp (Left) to Interchange 20 Exit Ramp • Interchange 19 Exit Ramp to Interchange 19 Entrance Ramp (Left) • Interchange 19 Entrance Ramp (Left) to Interchange 19 Entrance Ramp (Right) • Interchange 19 Entrance Ramp (Right) to Interchange 18 Exit Ramp	• Interchange 23 Exit Ramp to Interchange 22 Exit Ramp • Interchange 22 Entrance Ramp to Interchange 21 Exit Ramp • Interchange 21 Exit Ramp to Interchange 21 Entrance Ramp • Interchange 21Entrance Ramp (Right) to Interchange 21 Entrance Ramp (Left) • Interchange 21Entrance Ramp (Left) to Interchange 20 Exit Ramp • Interchange 20 Exit Ramp to Interchange 19 Exit Ramp • Interchange 19 Exit Ramp to Interchange 19 Entrance Ramp (Left) • Interchange 19 Entrance Ramp (Right) to Interchange 18 Exit Ramp	**(8/8)**

Legend: Analysis results are displayed in (A.M./P.M.)

Table 7-5 (continued): VISSIM Analysis

Route 8 Northbound	**A.M. Peak Hour**	**P.M. Peak Hour**	**LOS Deficiencies**
2005		• Int. 34 Entrance Ramp to Int. 35 Exit Ramp	**(0/1)**
2030		• Int. 30 Exit to Int. 30 Entrance Ramp • Int. 30 Entrance Ramp to Int. 31 Exit Ramp • Int. 31 Exit Ramp to Int. 32 Exit Ramp • Int. 32 Exit Ramp to Int. 33 Exit Ramp • Int. 34 Entrance Ramp to Int. 35 Exit Ramp	**(0/5)**

Table 7-5 (continued): VISSIM Analysis

Route 8 Southbound	**A.M. Peak Hour**	**P.M. Peak Hour**	**LOS Deficiencies**
2005	• Int. 35 Entrance Ramp to Int. 34 Exit Ramp • Int. 34 Exit Ramp to Int. 35 Exit Ramp		**(2/0)**
2030	• Int. 35 Entrance Ramp to Int. 34 Exit Ramp • Int. 34 Exit Ramp to Int. 35 Exit Ramp	• Int. 35 Entrance Ramp to Int. 34 Exit Ramp • Int. 31 Exit Ramp to Int. 30 Exit Ramp	**(2/2)**

Legend: Analysis results are displayed in (A.M./P.M.)

7.2 Roadway Safety

Over a three year period, roughly 1,500 accidents occurred on I-84 and Route 8 within the study area. Using a 365 day year, the average rate of accidents is 1.4 per day. Much of the congestion experienced on these roadways can be attributed to the high frequency of accidents. The contributing factors or causes for the accidents are listed in Table 7-6.

Table 7-6: Category of Contributing Factors

Factor Category	**Number**	**Pct.**
Driver Error	1377	92%
Road Condition	88	6%
Other	26	2%
Total	1491	100%

It is not surprising to find driver error the overwhelming contributing factor. The interchange was designed for roughly 1/3 of the vehicles that it currently carries and much of it is substandard by today's design standards. Additionally, trucks are involved in 31% of traffic accidents. This proportion is significantly higher than the percentage of all vehicles that are trucks (approximately 8%).

7.3 Roadway Design Deficiencies

The frequency of traffic incidents within the study area can be attributed to the physical geometry of the roadway system. Design standards have continuously evolved from the time the interchange was designed, and reflect the state of the art in terms of safety and operational efficiency. Much of the interchange system does not meet today's standards. Table 7-7 lists all of the locations that do not meet current AASHTO design standards.

Table 7-7: Roadway Design Deficiencies

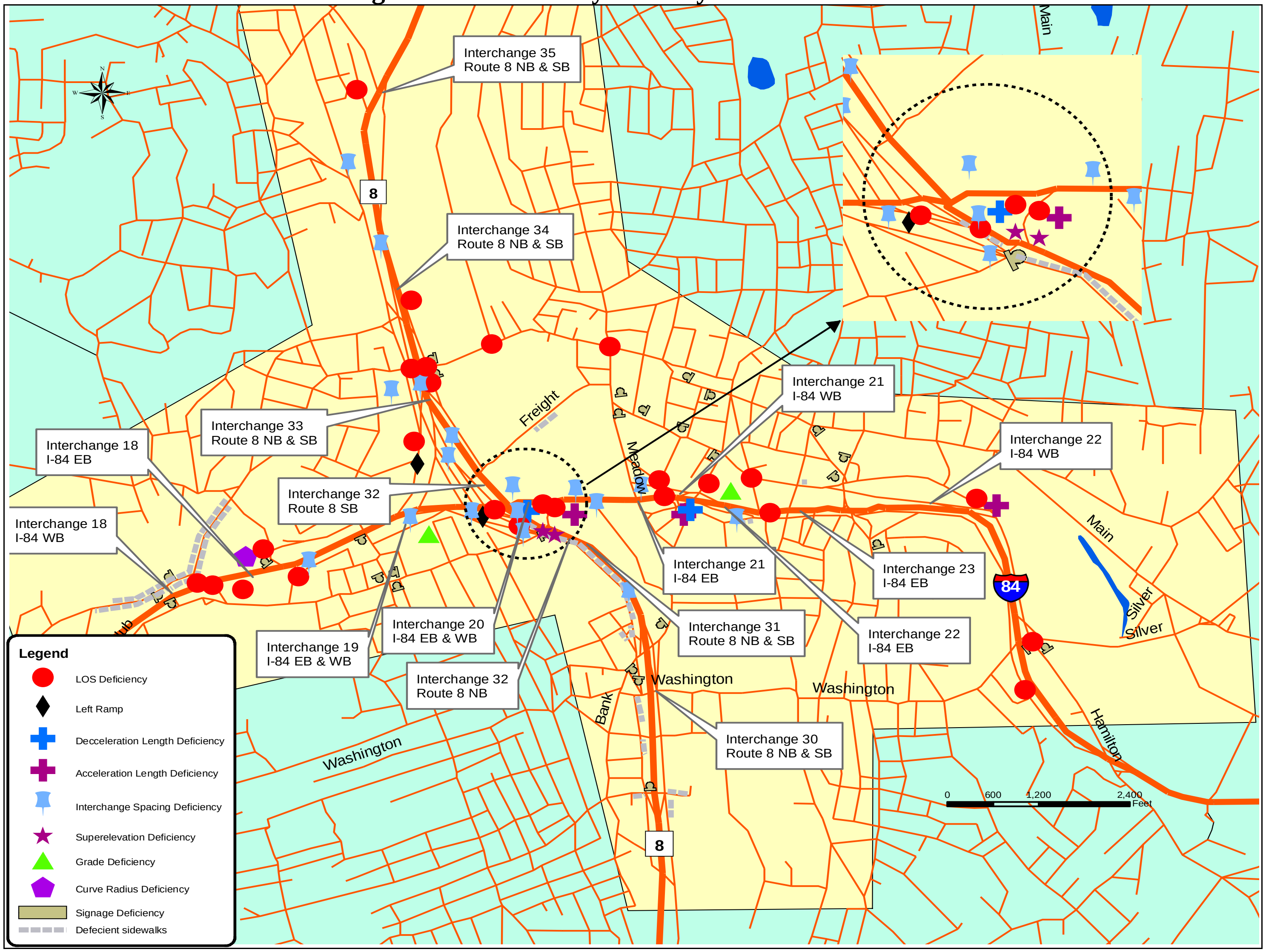
Substandard Condition	Location
Ramp Grades	• Interchange 21 westbound exit ramp (I-84) • Interchange 19 eastbound entrance ramp (I-84) • Interchange 31 southbound entrance ramp (Route 8)
Ramp Superelevation	• Interchange 31 exit ramp which connects Route 8 northbound to I-84 • Interchange 20 off ramp which connects I-84 westbound to Route 8
Entrance Ramp Acceleration Length	*I-84* • Interchange 20 Eastbound Entrance Ramp (Right Ramp) • Interchange 21 Westbound Entrance Ramp (Left Ramp) • Interchange 21 Westbound Entrance Ramp (Right Ramp) • Interchange 22 Eastbound Entrance Ramp • Interchange 22 Westbound Entrance Ramp *Route 8* • Interchange 31 southbound entrance ramp from Riverside Street
Exit Ramp Deceleration Length	*I-84* • Interchange 20 Westbound Exit ramp • Interchange 21 Eastbound Exit ramp (to South Main Street) • Interchange 22 Westbound Exit ramp
Interchange Ramp Spacing	*I-84 Eastbound* • Interchange 18 Entrance Ramp to Interchange 19 Exit Ramp (Right Ramp) • Interchange 19 Exit Ramp (on Right) to Interchange 19 Exit Ramp (Left Ramp) • Interchange 19 Entrance Ramp to Interchange 20 Entrance Ramp (Left Ramp) • Interchange 20 Entrance Ramp (Left Ramp) to Interchange 20 Entrance Ramp (Route 8 NB) • Interchange 20 Entrance Ramp (Route 8 NB) to Interchange 21 Exit Ramp (Meadow St) • Interchange 21 Exit Ramp (Meadow St) to Interchange 21 Exit Ramp (South Main St) • Interchange 22 Entrance Ramp to Interchange 23 Exit Ramp *I-84 Westbound* • Interchange 21 Entrance Ramp (from Right) to Interchange 21 Entrance Ramp (Left Ramp)

	• Interchange 21 Entrance Ramp (from Left) to Interchange 20 Exit Ramp • Interchange 20 Exit Ramp to Interchange 19 Exit Ramp • Interchange 19 Entrance Ramp (from Left) to Interchange 19 Entrance Ramp (Right Ramp) *Route 8 Northbound* • Interchange 30 Entrance Ramp to Interchange 31 Exit Ramp • Interchange 31 Exit Ramp to Interchange 32 Exit Ramp • Interchange 32 Exit Ramp to Interchange 33 Exit Ramp (Left Ramp) • Interchange 33 Entrance Ramp (84 WB) to Interchange 33 Entrance Ramp (84 EB) • Interchange 33 Entrance Ramp (84 EB) to Interchange 33 Entrance Ramp (Riverside St) • Interchange 34 Entrance Ramp to Interchange 35 Exit Ramp *Route 8 Southbound* • Interchange 35 Entrance Ramp to Interchange 34 Exit Ramp • Interchange 33 Exit Ramp to Interchange 32 Exit Ramp • Interchange 32 Exit Ramp to Interchange 31 Exit Ramp • Interchange 31 Entrance Ramp (from I-84 EB) to Interchange 31 Entrance Ramp (from Riverside St) • Interchange 31 Entrance Ramp (from Riverside St) to Interchange 31 Entrance Ramp (from I-84 WB)
Mainline Lane Continuity	*I-84 Eastbound* • Interchange 19 Exit Ramp (to Route 8 SB) • Interchange 21 Exit Ramp (to Meadow St.) *I-84 Westbound* • Interchange 20 Exit Ramp • Interchange 19 Exit Ramp • Interchange 18 Exit Ramp *Route 8 Northbound* • Interchange 31 Exit Ramp *Route 8 Southbound* • Interchange 34 Exit Ramp • Interchange 32 Exit Ramp (Left Ramp)
Left-Hand Ramps	*I-84 Eastbound* • Interchange 19 exit ramp • Interchange 20 entrance ramp *I-84 Westbound* • Interchange 19 entrance ramp • Interchange 21 entrance ramp

	Route 8 Northbound • Interchange 33 exit ramp • Interchange 33 entrance ramps from I-84 eastbound and I-84 westbound *Route 8 Southbound* • Interchange 31 exit ramp • Interchange 32 exit ramp
Shoulder Width	*I-84 Eastbound* • Interchange 19 Exit Ramp to Interchange 19 Entrance Ramp • Interchange 20 Entrance Ramp (from Route 8 NB) to Interchange 21 Exit Ramp (to Meadow St) • Interchange 22 Exit Ramp to Interchange 23 Exit Ramp *I-84 Westbound* • Interchange 22 Entrance Ramp to Interchange 19 Exit Ramp • Interchange 18 Exit Ramp to 18 Entrance Ramp *Route 8 Northbound* • Interchange 30 Entrance Ramp to Interchange 31 Exit Ramp • Interchange 32 Exit Ramp to Interchange 31 Entrance Ramp *Route 8 Southbound* • Interchange 31 Entrance Ramp to Interchange 30 Exit Ramp

A summary of the above deficiencies along with noted sidewalk and signage deficiencies is illustrated in Table 7-1.

Figure 7-1: Summary of Study Area Deficiencies



7.4 Structural Deficiencies

General Description of Bridges

There are 42 bridges within the study area with a span greater than twenty feet. These bridges have concrete decks with steel superstructures supported on concrete substructure units. Almost all of the bridges have a bituminous concrete overlay with membrane. All but one of the bridges was constructed in 1965 to 1967. Thirty one of the bridges have undergone rehabilitation. Twenty nine have been painted since 1990. Seven of the longest bridges have been seismically retrofitted. All but two of the bridges have inventory load ratings greater than the interstate load limit of 36 tons.

Table 7-8 shown below summarizes the ratings by number of bridges.

Table 7-8: Bridge Structure Ratings

		Deck		Superstructure		Substructure	
Rating		No.	%	No.	%	No.	%
4	Poor	0	0%	1	2%	1	2%
5	Fair	8	19%	3	7%	6	14%
6	Satisfactory	30	71%	23	55%	19	45%
7	Good	3	7%	12	29%	16	38%
8	Very Good	1	2%	3	7%	0	0%
	Totals	42	100%	42	100%	42	100%

7.5 Conclusions

In terms of deficiencies identified in this report, a majority of them occur on the I-84 mainline and associated interchange ramp system. To a lesser degree, Route 8 and its interchanges experience deficiencies, but lower overall traffic volumes on this highway are reported in both year 2005 and 2030 condition.

Field review of existing operating conditions did not result in the documentation of significant traffic congestion in the study area. Exceptions to this were along the eastern most segment of I-84 eastbound where a traffic incident east of the study area resulted in a vehicle queue that extended west of Interchange 23. The other areas of notable congestion were along the primary arterial roadways in Downtown Waterbury, particularly in the P.M. peak hour condition.

Anecdotal evidence indicates that recurrent congestion is prevalent within the study area. Based on the 3-year accident data that was collected, approximately 1,500 vehicle accidents were reported. This averages to more than one accident per day in the study area. The configuration of the interchange ramp system, sub-standard roadway and structural conditions, and heavy mix of complex vehicle distributions all contribute to an operational condition that allows little room for driver error. Traffic accidents, inclement weather conditions, and periodic construction and inspection operations all contribute to congested conditions that are not present under 'normal' operating conditions. Unfortunately, normal conditions are not frequently encountered within the study area.

Future projections of traffic in year 2030 will place an intense burden on the roadway's ability to safely and efficiently move traffic. Traffic congestion will become a daily event and the likelihood of a greater number of accidents will increase. The I-84 and Route 8 Interchange area will become the major bottleneck in the region, and will impact travel times for both local and inter-regional trips.

In addition to safety and operations, the condition of many of the bridge structures is average at best and the two main spans carrying I-84 are rated in poor condition. A program of continuous maintenance is necessary to keep these structures compliant with federal safety requirements. The future lifespan of the structures and cost of continued maintenance is a major consideration when it comes to planning for the future of the highway system.

Finally, alternative travel options in the area are limited. Transit serving Waterbury works reasonably well but transit options beyond Downtown Waterbury are limited. The Metro North commuter rail service is not highly utilized and demand for increased service options is relatively small. Bicycle routes for shorter distance trips do not exist although planning efforts are underway to address this. Pedestrian movement and sidewalk development is extensive in the core of Downtown Waterbury, but connections outside of that area are poor. Making Waterbury more accessible to bicyclist and pedestrians can help mitigate the need for short trip making using the automobile.

The complexity of traffic operations and the sub-standard geometry of the existing highway system is extensive. The deficiencies identified in this report, as well as others that might be suggested by the public or the Study Advisory Committee, will help define the types of improvements that will be studied in subsequent phases of this study. The improvements will focus on making the interchange area a safer and more efficient system, while providing better access to Downtown Waterbury and emerging redevelopment areas. The improvements should also be environmentally sensitive and not disproportionately impact economically or racially disadvantaged population groups.