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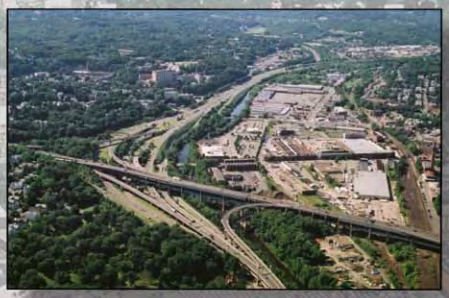

Deficiencies and Needs Report

I-84/Route 8 Waterbury Interchange Needs Study

State Project 151-301

CONNECTICUT DEPARTMENT OF TRANSPORTATION

WilburSmith ASSOCIATES
ENGINEERS PLANNERS ECONOMISTS

In association with:
Fitzgerald & Halliday, Inc.
URS Corporation AES
Keville Enterprises, Inc.

Final

Deficiencies and Needs Report

I-84/Route 8 Waterbury Interchange Needs Study

State Project 151-301

Prepared for

Connecticut Department of Transportation

June 2010

Prepared by

WilburSmith Associates — Engineers, Planners, Economists

In association with:

Fitzgerald & Halliday, Inc.

URS Corporation AES

Keville Enterprises, Inc.

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Executive Summary

The Connecticut Department of Transportation (CTDOT) and Council of Governments of the Central Naugatuck Valley (COGCNV) contracted the Wilbur Smith Associates consultant team to evaluate transportation deficiencies and define 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. They key goals of the I-84/Route 8 Waterbury Interchange Study (I-84/Route 8 WINS) were to:

- Increase safety
- Address operational deficiencies
- Address structural deficiencies
- Provide for future growth
- Consider financially feasible alternatives

An Advisory Committee (AC) consisting of representatives from the COGCNV, City of Waterbury, several state and federal agencies, and key area stakeholders was formed to provide input and guidance for the study. Public informational meetings were held at key milestones of the study to provide a forum for the general public to inquire and provide their input into the study process. Local outreach meetings were also conducted with local officials, COGCNV, local businesses, neighborhood associations and other key stakeholders.

Existing and Future Conditions

Existing (2005) and future (2030) conditions within the study area were assessed by evaluating transportation, traffic operations, geometric and structural conditions, environmental constraints, pedestrian and bicyclists' needs and safety.

Transportation

Within the study area, the automobile is the preferred mode of travel. Transit service within Waterbury works reasonably well but is limited beyond the downtown area. Bicycle routes for shorter distance trips do not exist although planning efforts are underway to address this. Downtown Waterbury has an extensive sidewalk system to encourage pedestrian activity however, beyond the downtown area, sidewalks are limited and for the most part in poor condition. The planning and development of a multi-use trail along the eastern side of the Naugatuck River, including an assessment of its potential community benefits and environmental impacts is currently being undertaken as part of the Naugatuck Greenway project.

Traffic Operations

Traffic on the I-84/Route 8 interchange has tripled since its construction in the 1960's. Currently, the interchange carries over 100,000 vehicles a day. The increase in traffic volume over the years has lead to traffic congestion on the highway and local intersections at ramp termini. An

assessment of existing and future traffic conditions indicated that traffic operations with the study area will deteriorate significantly over the next 25 years. Level of Service (LOS) analyses conducted in this study indicated the following:

- The number of highway mainline segment LOS deficiencies within the study area will increase from 11 in year 2005 to 27 in year 2030 during peak hours.
- The number of peak hour ramp LOS deficiencies will increase from 20 to 52 over the 25 year planning period.
- The number of intersection LOS deficiencies will increase from 13 in year 2005 to 21 in year 2030 during peak hour conditions.

Geometric Conditions

Geometric conditions play a significant role in traffic operations and safety particularly on such a high speed facility as the I-84/Route 8 interchange. A total of 61 geometric deficiencies were identified within the study area. These deficiencies include:

- Substandard ramp grades – 3 total
- Substandard curve radius – 1 total
- Substandard ramp superelevation – 2 total
- Substandard ramp acceleration and deceleration lengths – 9 total
- Substandard interchange spacing – 22 total
- Mainline lane discontinuity – 8 total
- Left hand ramps – 8 total
- Substandard shoulder widths – 8 total

Structural Conditions

Increased traffic on the interchange over the past 50 years has placed undue burden on the existing structure, resulting in considerable wear and tear. A review of the existing structure indicated that 71 percent of existing decks, 55 percent of existing superstructures, and 45 percent of existing bridge substructures within the study area currently require major maintenance. Over the 25 year planning period, most of these structures would require major rehabilitation.

Safety

Safety is a concern within the study area. Accident data reviewed for this study indicate that 1,500 accidents were recorded within the study area from 2001-2003. Approximately 22 percent of these accidents involved injury while 78 percent involved property damage. Three (3) fatalities; two on Route 8 and one on I-84 occurred during the three year period.

Preliminary Alternatives

Five preliminary improvement alternatives were initially developed to address the deficiencies identified in the study area. These alternatives included:

- ***Preliminary Alternative 1 (TSM/TDM/Transit)*** which involved transit service, traffic signal timings, and signage improvements within the study area. This alternative did not involve the construction of any new structures.

- ***Preliminary Alternative 2 (Safety and Operational Improvements)*** which involved traffic operations, safety improvements on the local roadway system, and new connector routes to enhance connectivity and traffic circulation within the downtown area.

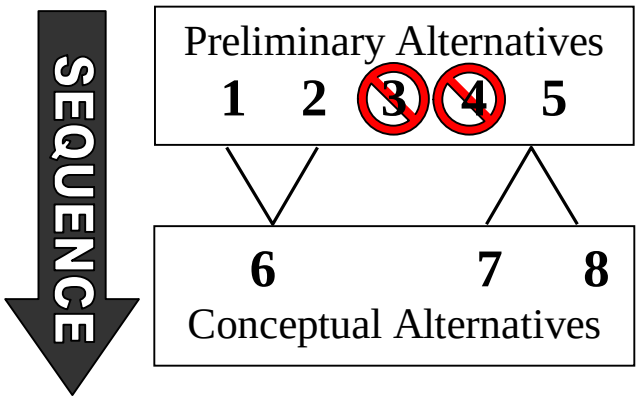
- ***Preliminary Alternative 3 (Partial Build – New I-84 Eastbound Mainline)*** which involved the replacement of the I-84 eastbound mainline with a new mainline running parallel to the existing I-84 westbound mainline as well as a series of Collector-Distributor (C/D) roads running parallel to the I-84 mainlines.

- ***Preliminary Alternative 3 (Partial Build – New I-84 Westbound Mainline)*** which involved a new I-84 westbound mainline running parallel to the existing eastbound mainline as well as a new eastbound C/D road running parallel to the I-84 eastbound mainline.

- ***Preliminary Alternative 5 (Full Build)*** which involved the construction of new I-84 eastbound and westbound mainlines running parallel to each other. Other aspects of this alternative involved two new C/D roads running parallel to the new I-84 mainlines.

Screening and Ranking Criteria

The preliminary alternatives were assessed and ranked based on nine (9) different criteria. These criteria included construction cost, life cycle cost, constructability, environmental impact, safety/meets design standards, connectivity, economic development, intermodal connections, and traffic operations/capacity accommodation. It was determined during the study that some criteria were more important than others therefore, weights ranging from a scale of 1 to 5 were assigned to each criterion.



Based on the ranking exercise, Preliminary Alternatives 3 and 4 were dropped. Preliminary Alternatives 1 and 2 were advanced as potential near term improvements with Preliminary Alternative 5 as a potential long term improvement.

Conceptual Alternatives

The three preliminary alternatives that were advanced were further refined into three conceptual alternatives. These conceptual alternatives are presented below and discussed in more detail in Chapter 4 of this report.

- ***Conceptual Alternative 6*** which was developed as a hybrid of Preliminary Alternatives 1 and 2. Key aspects of this alternative involved:

- Improvements to transit service, signage and traffic signal systems.
- New local road connections to improve downtown circulation.
- Pedestrian and bicyclist improvements.

- ***Conceptual Alternative 7*** which was developed as a derivative of Preliminary Alternative 5. Key aspects of this alternative involved:
  - New I-84 mainlines running parallel to each other, south of the current I-84 footprint.
  - New Route 8 mainlines within the existing Route 8 footprint.
  - Frontage roads to collect and distribute local traffic.

- ***Conceptual Alternative 8*** which was also developed as a derivative of Preliminary Alternative 5. Key aspects of this alternative involved:
  - New I-84 mainlines running parallel to each other, south of the current I-84 footprint.
  - New Route 8 mainlines east of the Naugatuck River.
  - Frontage roads to collect and distribute local traffic.
  - Two new interchanges at Freight and West Main Streets to improve downtown access.

The three conceptual alternatives were further screened based on the ranking criteria used in screening the five preliminary alternatives. As part of the screening process, the CTDOT in collaboration with the City of Waterbury requested the Department of Economic and Community Development (DECD) to undertake a study to assess the fiscal and economic impacts of the conceptual alternatives to the city. Based on the screening analyses, findings from the DECD Study and consensus from stakeholders, Conceptual Alternative 8 was selected as the Preferred Long-Term Improvement Alternative with elements of Conceptual Alternative 6 serving as near-term improvements. These two alternatives were combined together as one alternative referred to as Preferred Alternative 6-8.

Preferred Alternative 6-8

Preferred Alternative 6-8 was selected as the final recommendation of the I-84/Route 8 WINS. While this final recommendation is not a silver bullet for all the issues within the study area, it addresses the stated study goals and provides significant benefits in terms of traffic operations, roadway geometry, transit, and safety over a no-build condition. These benefits are summarized below and discussed in more detail in Chapter 6 of this report.

Transportation

This alternative will provide improved access to transit, management of existing traffic systems, improved pedestrian and bicycle amenities particularly in areas beyond the downtown area.

Traffic operations
It is anticipated that there will be no mainline or ramp LOS deficiencies under future (2030) conditions with the implementation of the Preferred Alternative, compared to 79 mainline and ramp LOS deficiencies if no improvements are implemented in the study area. In addition, the new east-west, north south local road connections will improve traffic circulation within the study area.

Geometric operations
Safety on a roadway is quite often tied to roadway geometry. In the course of this study, 61 geometric deficiencies were identified within the study area. These deficiencies include left hand ramps, substandard road grades and curvature, substandard acceleration and deceleration lanes and substandard interchange spacing. Under the Preferred Alternative, all but six (6) of the deficiencies will be eliminated.

Environmental Impacts

The following is a summary of environmental impacts associated with Preferred Alternative 6-8. These impacts are discussed in more detail in Chapter 7.

- Neighborhood – direct and indirect adverse impacts are anticipated within some neighborhoods.
- Major Employers – both positive and adverse impacts are anticipated.
- Visual and Aesthetic Impacts – some adverse impacts are anticipated.
- Historic, Archeological and Section 4(f) Resource Impacts – some adverse impacts are anticipated.
- Community Facilities and Resource Impacts – positive impacts are anticipated.
- Environmental Justice – both positive and adverse impacts are anticipated.
- Surface and Groundwater Impacts – some adverse impacts are anticipated.
- Flood Plains and Stream Channel Encroachment Lines – some adverse impacts are anticipated.
- Wetland Impacts – no adverse impacts to wetlands are anticipated.
- Endangered Species – there is no record of endangered species within study area.
- Hazardous Materials Sites – there is potential for adverse impacts.
- Farmlands – negligible impacts are anticipated.
- Air Quality – no adverse air quality impacts are anticipated.
- Noise Receptors – minor impacts to noise receptors are anticipated.

Construction Costs

A summary of 2009 and 2030 construction costs for Preferred Alternative 6-8 are presented below. Year 2030 costs were developed based on a 6 percent inflation rate provided by CTDOT.

Year 2009 $
Preferred Alternative 6 (Near term improvement)……$410 million
Preferred Alternative 8 (Long term improvement)……...$1.89 billion
Year 2030 $
Preferred Alternative 6 (near term improvement)……$581 million
Preferred Alternative 8 (Long term improvement)……...$6.44 billion

Details of the construction costs are presented in Chapter 8 of this report.

Funding

Given that the construction of Preferred Alternative 6-8 would be capital intensive, it is recommended that funding for such a project be obtained from several sources. Potential sources of funding may include but not limited to the following:

Federal Funding
Sources of federal funding could include the following:
- National Highway System Program (NHS)
- Interstate Maintenance Program (IM)
- Congestion, Mitigation and Air Quality Program (CMAQ)
- Surface Transportation Program (STP)
- Highway Bridge Program
- Transportation Enhancement Program

State Funding
Sources of State funding could include the following:
- Motor Vehicle Fuel Tax
- Motor Vehicle Excise Tax

Innovative Financing
Innovative financing could include the following:
- Public Private Partnerships (PPP)
- Tax Increment Financing
- Transportation Impact Fees
- Tolls

These sources of funding are discussed in more detail in Chapter 10 of this report.

1 Introduction

1.1 Study Background

The Connecticut Department of Transportation (CTDOT) and Council of Governments of the Central Naugatuck Valley (COGCNV) identified the need to evaluate transportation deficiencies and define 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 included CTDOT, 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-84/Route 8 WINS), was one part of an overall effort by CTDOT 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 was completed on I-84 from Interchange 23 in Waterbury east to Southington (State Project # 151-274 and 151-294). To the west, Interchange 17 & 18 improvements are entering into design phases, and an Environmental Impact Statement (State Project # 174-316) is being prepared for the section of I-84, from Interchange 18 to the New York State Line. To the south, a deficiencies and needs study was initiated in October 2008 for Route 8 from Interchange 30 in Waterbury southerly to Interchange 22 in Seymour. The study will incorporate the findings of I-84/Route 8 WINS for Interchange 30. Improvements currently being studied or in design were recognized in this study to provide overall consistency and operational effectiveness of the highway.

1.2 Study Team

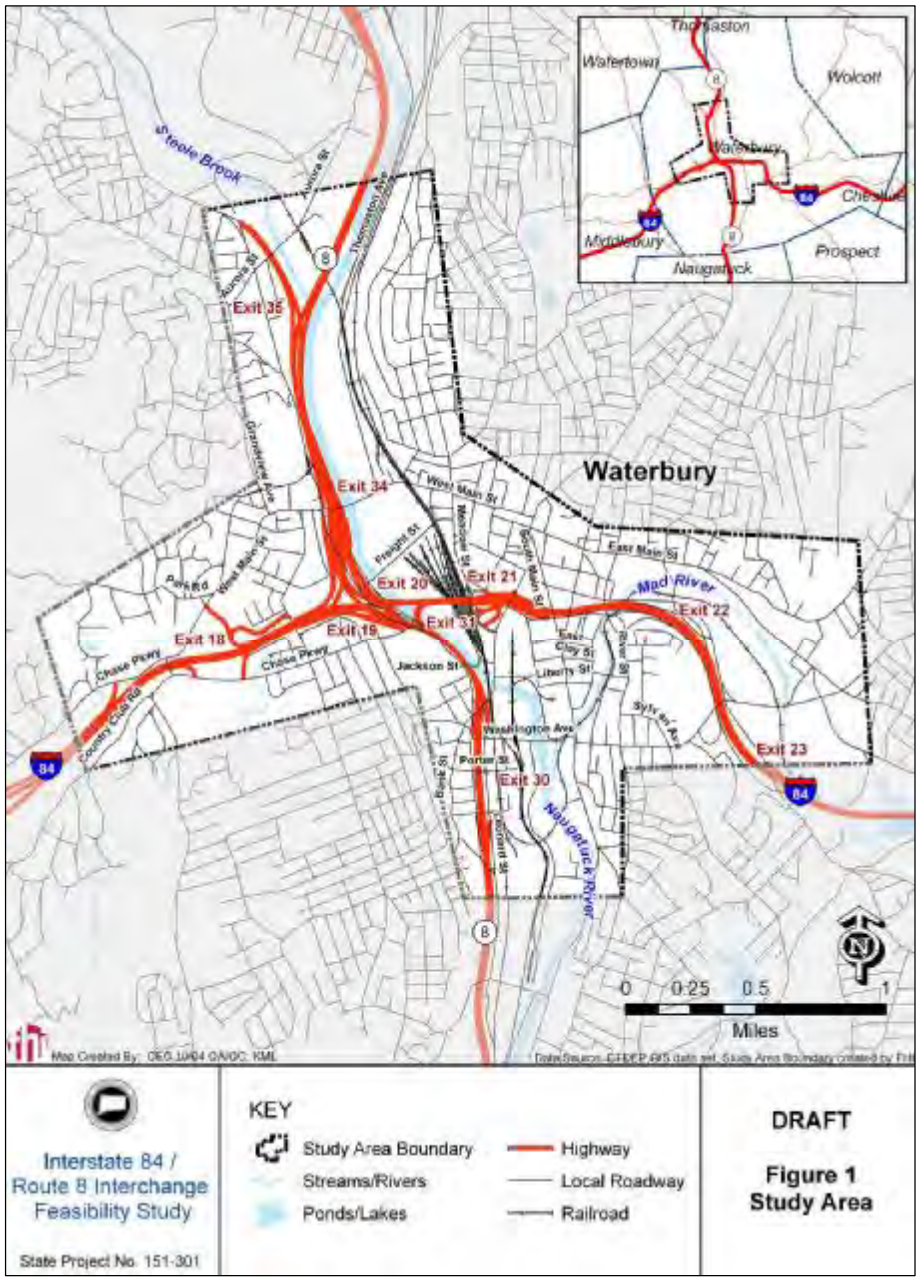
CTDOT retained WSA to undertake this needs and deficiencies study. WSA is a multi disciplinary transportation engineering and planning firm with extensive experience in multi-modal transportation studies. Additionally, WSA subcontracted three other firms to assist in this study. These firms are:

- ***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

The study area was defined as I-84 from Interchange 18 to Interchange 23 from west to east, respectively. Along Route 8, the limits are defined from Interchange 30 to Interchange 35 from south to north, respectively. Included in the study area were several 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 Study Goals and Objectives

Goals were defined in consultation with the Advisory Committee to guide the overall direction of the study. Some of the key goals with respect to the I-84/Route 8 WINS were:

Increase safety: Examine historical accident data on the freeways and ramps, identify locations where safety was of particular concern and address any issues.

Address operational deficiencies: Review and address highway capacity issues that affect the interchange such as number of lanes, interchange spacing, weave conditions, lane drops, and arterial operations.

Address structural deficiencies: Review the structural integrity of the interchange and develop improvement alternatives that would address structural deficiencies and also accommodate anticipated future traffic demands.

Provide for future growth: Develop improvements that support options for future development and accommodate growth in traffic flows, both regionally and locally.

Consider financially feasible alternatives: Address the feasibility of improvement alternatives based on their ability to be financed.

1.5 Public Involvement

An Advisory Committee (AC) consisting of representatives from the City of Waterbury, the COGCNV, several state and federal agencies, and key area stakeholders was formed. The group assisted in the collection of data and documents, review analysis and documentation prepared by the study team and provided input and guidance on study recommendations. The committee consisted 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 (FHWA)
- Federal Transit Administration (FTA)
- Rideworks
- Greater Waterbury Transit District (GWTD)
- Northeast Transportation

- Housatonic Valley Association (HVA)
- 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 (WERC)
- Waterbury Development Corporation (WDC)
- Naugatuck Valley Development Corporation (NVDC)
- Connecticut Department of Public Safety (CTDPS)

A number of Advisory Committee meetings were held during this study. These meetings provided the opportunity for members to participate in the review of documentation and discuss specific concerns.

Public informational meetings were held at key milestones throughout the study process to provide a forum for the general public to inquire about the study and to provide their input into the study process.

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

1.6 Previous Reports

Prior to this final report, three reports were developed at key milestones during the study.

Technical Memorandum #1 (Existing and Future Conditions Report) – In this report, existing and future conditions within the study area were assessed by evaluating traffic operations, safety, geometric design and structural integrity of bridges. Needs and deficiencies within the study area were identified and summarized to serve as a guide in developing future improvements.

Technical Memorandum #2 (Development of Alternatives Report) – In this report, five preliminary improvement alternatives were developed for the study area. These preliminary alternatives were screened and ranked based on criteria developed by CTDOT, FHWA, COGCNV, City of Waterbury and consultant staff to develop three conceptual alternatives.

Technical White Paper (Refinement of Alternatives) – In this white paper, the three conceptual alternatives were ranked based on criteria developed in Technical Memorandum #2 and further refined into a preferred improvement alternative.

2 Existing and Future Conditions

The I-84/Route 8 interchange, which was constructed in the 1960's, was designed to handle considerably less traffic than it handles today. I-84 for instance was initially designed to handle 35,000 vehicles per day. The emergence of the automobile industry in the U.S over the past 40 years has seen traffic volumes on the I-84/Route 8 interchange grow drastically to exceed its design volume. I-84 currently handles over 100,000 vehicles per day. This number is expected to increase to about 127,000 vehicles per day by 2030.

The increase in traffic volume over the years has lead to traffic congestion in the study area and placed undue burden on the existing interchange resulting in considerable wear and tear. In addition, there are safety concerns within the study area due to the substandard geometric conditions on some portions of the highway.

As part of the I-84/Route 8 WINS, existing and future conditions within the study area were assessed by evaluating existing transportation, traffic operations, geometric and structural conditions, environmental constraints, pedestrian and bicyclists' needs and safety. Based on the assessment, needs and deficiencies within the I-84/Route 8 study area were identified and summarized in an Existing and Future Conditions Report (Technical Memorandum # 1) to serve as a guide in developing future improvements. This chapter presents a summary of the analyses and findings in Technical Memorandum # 1.

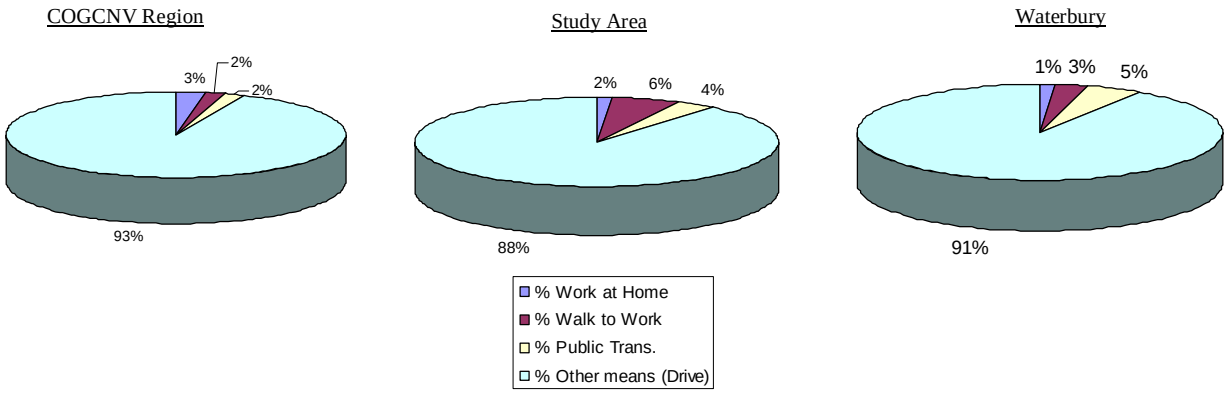
2.1 Existing Transportation

The automobile is the predominant mode of travel within the study area. 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. An evaluation of both the Waterbury Branch rail corridor and bus transit serving Waterbury is currently ongoing as part of the Waterbury and New Canaan Branch Lines Needs and Feasibility Study. 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 bicyclists and pedestrians can help mitigate the need for making short trips using automobiles.

2.1.1 Work Travel Modes

Work travel modes within the study area and the region in general are skewed towards driving as illustrated in Figure 2-1. The majority of study area workers do not use public transportation for their work commute, which may be a reflection of the lack of convenient and accessible transit options. 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.

Figure 2-1: Work Travel Modes



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

2.1.2 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.

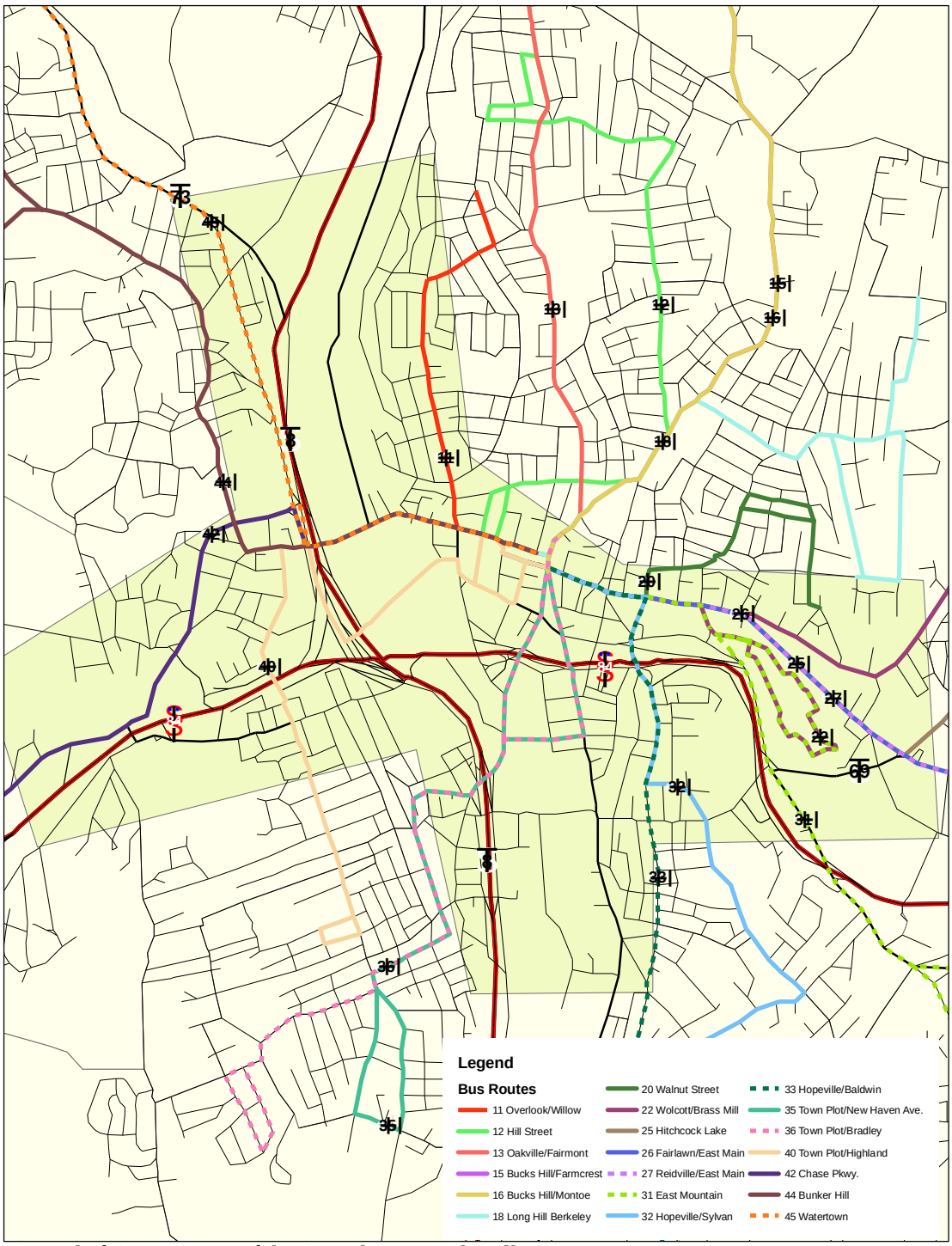
Source: http://en.wikipedia.org

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.

Local fixed-route and ADA paratransit for Waterbury is provided by Northeast Transportation Company doing business as CTTransit. The 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. These routes are presented in Figure 2-2. Buses on these routes typically run hourly

with the exception of Routes 11, 12, 18 and 33 which have 30 minute headways. 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.

Figure 2-2: Waterbury Local Fixed Route Bus Service



Source: Council of Governments of the Central 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 6:00 A.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 in Table 2-1.

Table 2-1: 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 CTDOT 2001.

2.1.3 Rail Service

Source: http://commons.wikimedia.org

Waterbury is also served by the Waterbury branch of the New Haven Line commuter rail system. CTDOT 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 seven arrivals (three during peak hours) and eight departures (two during peak hours) to and from Waterbury at frequencies varying between 2 to 4 hours. On weekends and holidays, there are five arrivals and departures to and from Waterbury.

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 10:00 A.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.

Source: www.trainweb.org

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.

2.1.4 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 in Table 2-2.

Table 2-2: Park and Ride Lots

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: CTDOT (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 underutilized. 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.

2.2 Bicyclist and Pedestrian Needs

Source: Suffolk County, NY website

Within 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, the need 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 is 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.

Source: www-nlpir.nist.gov

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. 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.

Beyond the downtown area however, the number of sidewalks is reduced. The sidewalks in these areas are generally in worse condition than those in the downtown area.

2.3 Traffic Operations

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.

For this study, the HCS was utilized to test the effects of existing and future traffic on existing highways and local roadways. This Chapter presents a summary of existing and future traffic operations analysis performed during this study. A more detailed analysis can be found in Technical Memorandum # 1- Existing and Future Conditions Report.

2.3.1 Level of Service

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.

2.3.2 Mainline Capacity Analysis

As earlier stated in this Chapter, capacity analyses on I-84 and Route 8 were conducted using the HCS program. Based on the analysis, mainline segments that recorded LOS E or F were flagged as deficient.

Table 2-3 presents a summary of mainline capacity analysis from the HCS program. Based on the analysis, it is anticipated that the number of mainline segment LOS deficiencies within the study area will increase from 11 in 2005 to 27 in 2030. I-84 eastbound is anticipated to record slightly more deficiencies than the westbound direction. The constrained capacity of the two lane eastbound 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 LOS in the year 2005 analysis, and degrade to poor LOS in many areas in the year 2030 projection. The most significant problems are noted in the southern and northern extents of the Route 8 corridor.

Table 2-3: Mainline Capacity Analysis

I-84 Segment	2005				2030			
	EB		WB		EB		WB	
	AM	PM	AM	PM	AM	PM	AM	PM
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
I-84 Mainline Deficiencies	**1**	**2**	**4**	**4**	**5**	**6**	**4**	**4**

Route 8 Segment	2005				2030			
	NB		SB		NB		SB	
	AM	PM	AM	PM	AM	PM	AM	PM
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	
Route 8 Mainline Deficiencies	**0**	**0**	**0**	**0**	**0**	**4**	**3**	**1**

Note: X- denotes deficiency

2.3.3 Ramp Merge/Diverge Analysis

Table 2-4 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. Interchange ramps are often 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 increased 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 ramp LOS

deficiencies increased from 9 to 21 over the 25 year planning period. As in the eastbound condition, virtually every interchange in the westbound direction is expected to experience congestion in year 2030.

For Route 8 northbound, the ramp LOS deficiencies identified were for the P.M. peak hour condition only. During this period, the number of LOS deficiencies was found to increase from 2 to 3 – mainly at the interchanges north of Interchange 32. For Route 8 southbound, the number of ramp LOS deficiencies was found to increase from 1 to 4.

Table 2-4: Interchange Ramp Capacity Analysis

	Deficient Ramps		Number of Deficiencies	
I-84 Eastbound	**A.M. Peak Hour**	**P.M. Peak Hour**	**A.M. Peak Hour**	**P.M. Peak Hour**
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.	**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	**12**	**12**

Table 2-4: Interchange Ramp Capacity Analysis (Continued)

	Deficient Ramps		Number of Deficiencies	
I-84 Westbound	**A.M. Peak Hour**	**P.M. Peak Hour**	**A.M. Peak Hour**	**P.M. Peak Hour**
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	**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	**11**	**10**

Table 2-4: Interchange Ramp Capacity Analysis (Continued)

	Deficient Ramps		Number of Deficiencies	
Route 8 Northbound	**A.M. Peak Hour**	**P.M. Peak Hour**	**A.M. Peak Hour**	**P.M. Peak Hour**
2005		Interchange 33: • On ramp from Riverside Street Interchange 34: • On ramp from West Main Street	**0**	**2**
2030		Interchange 33: • On ramp from Riverside Street • On ramp from I-84 WB Interchange 34: • On ramp from West Main Street	**0**	**3**
Route 8 Southbound	**A.M. Peak Hour**	**P.M. Peak Hour**	**A.M. Peak Hour**	**P.M. Peak Hour**
2005	Interchange 32: • Off ramp to Riverside Street		**1**	**0**
2030	Interchange 31: • Off ramp to I-84 EB Interchange 32: • Off ramp to Riverside Street Interchange 33: • Off ramp to I-84 WB	Interchange 32: • Off ramp to Riverside Street	**3**	**1**

2.3.4 Intersection Capacity Analysis

Intersection operations can create congestion on local roads which may impact vehicles leaving the highway system as well vehicles entering the system. For this analysis, intersections within the study area that recorded LOS E or F were flagged as deficient. Table 2-5 lists the results of existing and future intersection capacity analysis for the study area.

Based on the analyses, it was determined that the number of intersection deficiencies would 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. The increase in intersection LOS deficiencies could mainly be attributed to traffic growth over the 25 year period.

Table 2-5: 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

Table continued on next page

Table 2-5: Intersection Capacity Analysis (Continued)

INTERSECTION	2005		2030	
	A.M.	P.M.	A.M.	P.M.
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 Intersection LOS Deficiencies:	**6**	**7**	**9**	**12**

Note: X-denotes deficiency

2.4 Geometric Conditions

Geometric conditions play a major role in traffic operations and safety on a roadway. As a result, design standards are constantly evolving to provide for a safer and more traffic efficient environment for road users. For this study, geometric conditions on the mainlines and ramps were reviewed based on standards from "A Policy on Geometric Design of Highways and Streets" by the American Association of State Highway and Transportation Officials (AASHTO) - 2001 Edition and CTDOT's Highway Design Manual-2003 Edition. The review included assessment of ramp and mainline geometry, ramp acceleration and deceleration lengths, interchange spacing, lane continuity and configuration, lane and shoulder widths, superelevation rates, left hand ramps, sight distance and roadside safety features and clear zones.

2.4.1 Ramp Curve Radius

An assessment of ramp curve radius was conducted in the study area based on a ramp design speed of 25 mph which represents the minimum corresponding ramp design speed for a 50 mph mainline speed. Exhibit 3-14 of AASHTO (2001) stipulates a minimum ramp curve radius of 185 feet for a 25 mph design speed and a superelevation (e) rate of 6%. Therefore, any ramp radius that did not meet the minimum standard of 185 feet was identified as deficient.

2.4.2 Ramp Grades

Ramp grades were evaluated based on methodology from AASHTO (2001). A recommended range of ramp grade was obtained based on curve design speed. 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%. Based on the ramp design speed of 25 mph for this project, a maximum grade range of 5-7% was used for all ramps in the study area. Any ramp within the study area with a grade greater than the recommended AASHTO range of 5-7% was identified as deficient.

2.4.3 Mainline Grades

Similarly, grades on the highway mainline were evaluated. AASHTO standards recommend that a maximum grade of 5% be used for a highway design speed of 50 mph in an area with rolling terrain. Mainline grades steeper than the maximum allowable grade of 5% were identified as deficient.

2.4.4 Superelevation Rates

Superelevation rates on ramps and highway mainlines were also assessed based on the AASHTO recommended maximum standard of 6%. Superelevation rates greater than 6% were identified as deficient.

2.4.5 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. AASHTO guidelines stipulate a minimum acceleration length of 550 feet and minimum deceleration length of 355 feet for a ramp design speed of 25 mph and a highway design speed of 50 mph. Acceleration or deceleration lengths that did not meet the minimum AASHTO standard were identified as deficient.

2.4.6 Interchange Spacing

An analysis was conducted to ascertain whether the minimum ramp spacing between successive ramp terminals (entrance or exit), as specified by current design standards were satisfied. 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 spacing was obtained for the four different designated ramp combinations, using methodology from AASHTO (2001). AASHTO standards recommend a minimum interchange spacing of 500 feet for an exit ramp-entrance ramp combination, 1,000 feet for exit ramp-exit ramp or entrance ramp-entrance ramp combination and 2,000 feet for an entrance ramp-exit ramp combination. Any interchange spacing that did not meet the AASHTO standard was identified as deficient.

2.4.7 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 and take an exit ramp.

For this study, discontinuous mainline segments as well as left-hand ramps were identified as deficient.

2.4.8 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 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. Shoulder widths that did not meet the AASHTO standards were considered as deficient.

The results of the geometric conditions review for the I-84 and Route 8 mainlines were summarized in a table. Based on the review, there were no deficient mainline grades.

Table 2-6 lists all of the locations that did not meet current AASHTO design standards.

Table 2-6: Roadway Design Deficiencies

Substandard Condition	**Location**
Ramp Grades (> 7%)	• Interchange 21 westbound exit ramp (I-84) – 8% • Interchange 19 eastbound entrance ramp (I-84) – 8% • Interchange 31 southbound entrance ramp (Route 8) – 8%
Ramp Curve Radius (<185 feet)	• Interchange 18 Westbound Exit Ramp (I-84) – 180 feet
Ramp Superelevation (> 6%)	• Interchange 31 exit ramp which connects Route 8 northbound to I-84 – 8% • Interchange 20 off ramp which connects I-84 westbound to Route 8 – 8%
Entrance Ramp Acceleration Length (< 550 feet)	*I-84* • Interchange 20 Eastbound Entrance Ramp (Right Ramp) – 480 feet • Interchange 21 Westbound Entrance Ramp (Left Ramp) – 280 feet • Interchange 21 Westbound Entrance Ramp (Right Ramp) – 410 feet • Interchange 22 Eastbound Entrance Ramp – 450 feet • Interchange 22 Westbound Entrance Ramp – 350 feet *Route 8* • Interchange 31 southbound entrance ramp from Riverside Street – 300 feet
Exit Ramp Deceleration Length (< 355 feet)	*I-84* • Interchange 20 Westbound Exit ramp – 325 feet • Interchange 21 Eastbound Exit ramp (to South Main Street) – 320 feet • Interchange 22 Westbound Exit ramp – 250 feet
	Table continued on next page

Table 2-6: Roadway Design Deficiencies (Continued)

Substandard Condition	Location
Interchange Ramp Spacing Exit-Entrance (< 500 feet) Entrance-Entrance (< 1,000 feet) Exit-Exit (< 1,000 feet) Entrance-Exit (< 2,000 feet)	*I-84 Eastbound* • Interchange 18 Entrance Ramp to Interchange 19 Exit Ramp (Right Ramp) – 940 feet • Interchange 19 Exit Ramp (on Right) to Interchange 19 Exit Ramp (Left Ramp) – 380 feet • Interchange 19 Entrance Ramp to Interchange 20 Entrance Ramp (Left Ramp) – 792 feet • Interchange 20 Entrance Ramp (Left Ramp) to Interchange 20 Entrance Ramp (Route 8 NB) – 606 feet • Interchange 20 Entrance Ramp (Route 8 NB) to Interchange 21 Exit Ramp (Meadow St) – 487 feet • Interchange 21 Exit Ramp (Meadow St) to Interchange 21 Exit Ramp (South Main St) – 797 feet • Interchange 22 Entrance Ramp to Interchange 23 Exit Ramp – 1,120 feet *I-84 Westbound* • Interchange 21 Entrance Ramp (from Right) to Interchange 21 Entrance Ramp (Left Ramp) – 158 feet • Interchange 21 Entrance Ramp (from Left) to Interchange 20 Exit Ramp – 898 feet • Interchange 20 Exit Ramp to Interchange 19 Exit Ramp –793 feet • Interchange 19 Entrance Ramp (from Left) to Interchange 19 Entrance Ramp (Right Ramp) – 625 feet *Route 8 Northbound* • Interchange 30 Entrance Ramp to Interchange 31 Exit Ramp – 1,392 feet • Interchange 31 Exit Ramp to Interchange 32 Exit Ramp – 475 feet • Interchange 32 Exit Ramp to Interchange 33 Exit Ramp (Left Ramp) – 253 feet • Interchange 33 Entrance Ramp (84 WB) to Interchange 33 Entrance Ramp (84 EB) – 354 feet • Interchange 33 Entrance Ramp (84 EB) to Interchange 33 Entrance Ramp (Riverside St) – 507 feet • Interchange 34 Entrance Ramp to Interchange 35 Exit Ramp – 1,600 feet *Route 8 Southbound* • Interchange 35 Entrance Ramp to Interchange 34 Exit Ramp –1,560 feet • Interchange 33 Exit Ramp to Interchange 32 Exit Ramp – 377 feet • Interchange 32 Exit Ramp to Interchange 31 Exit Ramp – 311 feet • Interchange 31 Entrance Ramp (from I-84 EB) to Interchange 31 Entrance Ramp (from Riverside St) – 106 feet • Interchange 31 Entrance Ramp (from Riverside St) to Interchange 31 Entrance Ramp (from I-84 WB) – 615 feet
	Table continued on next page

Table 2-6: Roadway Design Deficiencies (Continued)

Substandard Condition	Location
Mainline Lane Continuity (Lane drops on mainline)	*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 (Mainline shoulder width < 12 feet)	*I-84 Eastbound* • Interchange 19 Exit Ramp to Interchange 19 Entrance Ramp – 3 to 5 feet • Interchange 20 Entrance Ramp (from Route 8 NB) to Interchange 21 Exit Ramp (to Meadow St) – 3 feet • Interchange 22 Exit Ramp to Interchange 23 Exit Ramp – 3 to 5 feet *I-84 Westbound* • Interchange 22 Entrance Ramp to Interchange 19 Exit Ramp – 6 to 8 feet • Interchange 18 Exit Ramp to 18 Entrance Ramp – 3 feet *Route 8 Northbound* • Interchange 30 Entrance Ramp to Interchange 31 Exit Ramp – 3 feet • Interchange 32 Exit Ramp to Interchange 31 Entrance Ramp – 3 feet *Route 8 Southbound* • Interchange 31 Entrance Ramp to Interchange 30 Exit Ramp – 3 to 5 feet

2.5 Structural Deficiencies

There are forty two (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 between 1965 and 1967. Thirty one (31) of the bridges have undergone rehabilitation. Twenty nine (29) have been painted since 1990. Seven (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.

The CTDOT inspects each of the bridges every two years. 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

Table 2-7 shown below summarizes the ratings by number of bridges, while Table 2-8 summarizes the condition ratings and lists the percent deck deterioration for each bridge. Based on the ratings, it is clear that a significant number of bridges currently require major maintenance or minor rehabilitation. Over the next 25 years, it is envisaged that most of these bridges would require major rehabilitation.

Table 2-7: Bridge Structure Ratings

Rating		Deck		Superstructure		Substructure	
		Number	**Pct.**	**Number**	**Pct.**	**Number**	**Pct.**
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 2-8: 2003 Bridge Condition Assessment and 2030 Needs

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				

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
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	

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
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

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
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					

2.6 Roadway Safety

Accident data within the study area from 2001- 2003 was obtained from CTDOT and analyzed. Over this three year period, roughly 1,500 accidents occurred on I-84 and Route 8 within the study area which translates to an average rate of 1.4 accidents per day. The severity of accidents within the study area was also assessed and is summarized in Table 2-9.

Table 2-9: Accidents by Severity

Segment	Total No.	Property Damage Only		Injury		Fatality	
		No.	%	No.	%	No.	%
I-84 EB	593	475	80%	118	20%	0	0%
I-84 WB	644	494	77%	149	23%	1	< 1%
I-84 Sub-Total	***1237***	***969***	***78%***	***267***	***22%***	***1***	***< 1%***
Route 8 NB	134	98	73%	35	26%	1	1%
Route 8 SB	120	97	81%	22	18%	1	1%
Route 8 Sub-Total	***254***	***195***	***77%***	***57***	***22%***	***2***	***1%***
Total	**1491**	**1164**	**78%**	**324**	**22%**	**3**	**< 1%**

As illustrated in Table 2-9, 22% of accidents in the study area involved injury while 78% involved property damage. Three fatalities; two on Route 8 and one on I-84 occurred during the three year period. The first fatality was caused by a motorcyclist who was driving under the influence; the second fatality was caused by a motorist driving too fast for conditions, while the third fatality occurred when the driver lost control of his vehicle in snowy weather.

Table 2-10 presents a summary of the number of accidents by type.

Table 2-10: Accidents by Type

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

The most common types of accident were fixed object (32%), rear-end (32%) and side-swipe (27%). Route 8 had a higher rate of fixed, moving object and side-swipe collisions than I-84, while the opposite was true for rear-end collisions.

The vast majority of collisions (92%) were attributed to driver error as illustrated in Table 2-11.

Table 2-11: 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 for the I-84/Route 8 interchange. The interchange was designed for roughly one-third 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%).

Lighting conditions did not appear to produce a bias in the number of accidents. 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 cause of accidents within the study area, as the number of accidents was slightly higher than would be expected during both wet and snowy or icy conditions.

2.7 Cultural Resources

2.7.1 Visual and Aesthetic Resources

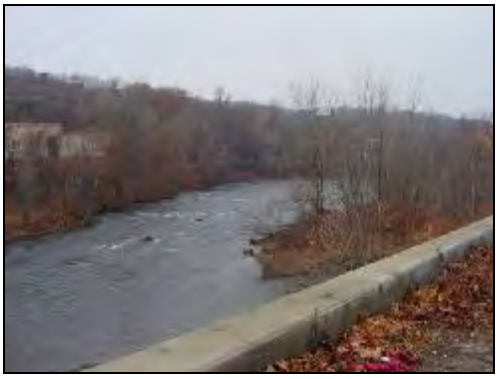
Visual and aesthetic resources in the study area include ridgelines, parks, historic sites and/or neighborhoods, and streetscapes. In particular, the *Waterbury-Republican American* newspaper company is housed in historic Union Station, a building whose landmark tower is visible from I-84, Route 8, and 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

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.

2.7.2 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 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 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 research and field reconnaissance revealed that five (5) previously listed National Register resources fall within the 500 foot APE. These historic resources are listed in the table below.

Table 2-12: 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.
Hillside Historic District	Bounded by Woodlawn Terrace, W. Main Street, and Willow Street	395 building of various styles dating from 1825 -1925	Listed on the National Register of Historic Places
Overlook Historic District	Bounded by Hecla Street., Farmington Boulevard, Columbia Boulevard, Cables Avenue, Clowes Terrace, Lincoln Street and Fiske Street	495 buildings of Late Victorian, Late 19th And Early 20th Century American Movements, Late 19th And 20th Century Revivals	Listed on the National Register of Historic Places
Bank Street Historic District	207-231 Bank Street	Three acres, four buildings, late victorian, colonial and revival buildings	Listed on the National Register

Name	Location	Description	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.

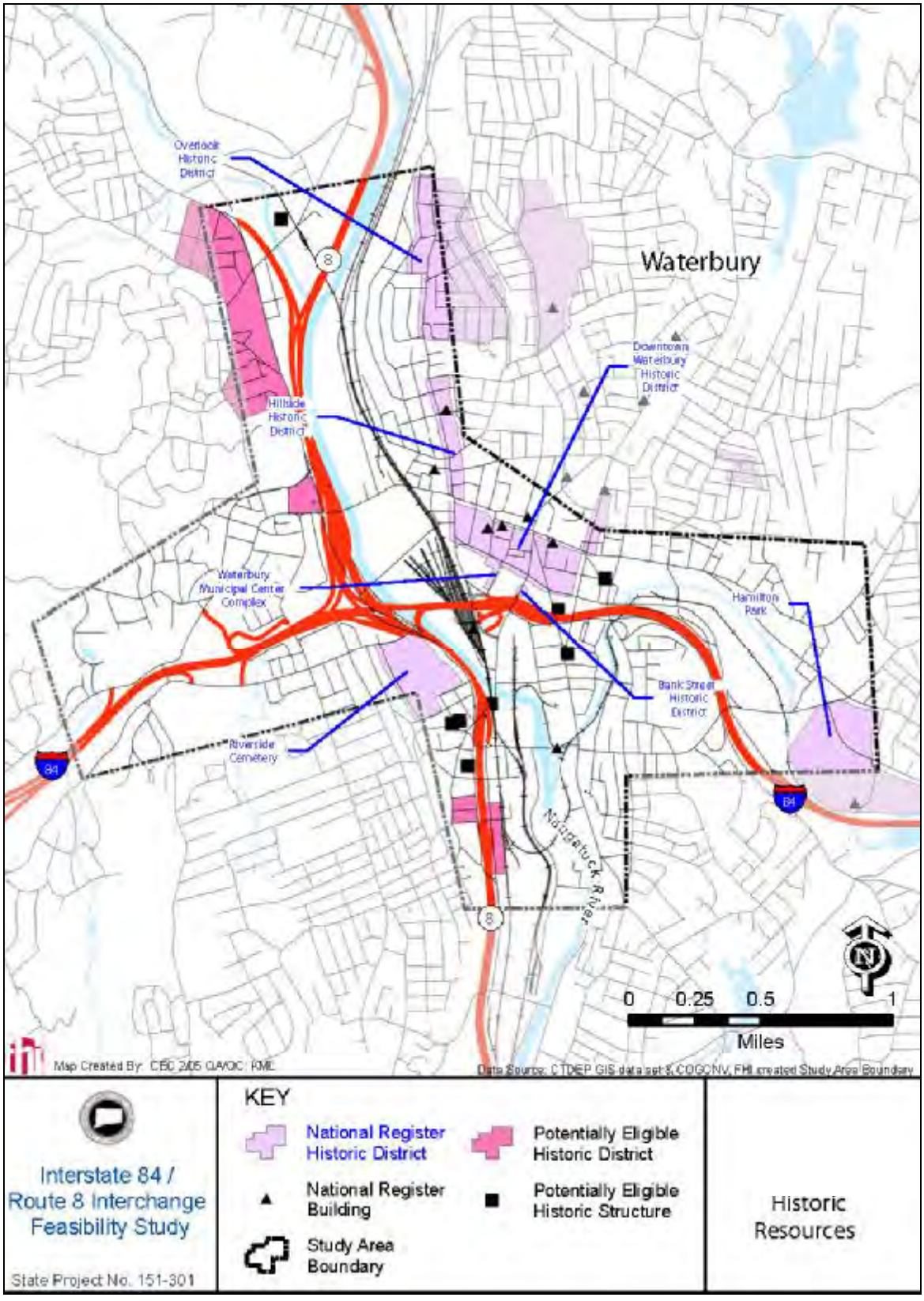
The following list indicates resources that may be eligible for inclusion on the National Register of Historic Places:

- 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 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 2-3.

Figure 2-3: Historic Resources



2.7.3 Archeological Resources

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

2.7.4 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 2-12. 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 2-4.

Consultation with the Connecticut Department of Environmental Protection (CTDEP) 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:

- Bunker Hill Playground
- Hayden Park
- The Waterbury Green
- Library Park
- Edmund Rowland Park
- Chase Park
- West Dover Street Playground
- Rolling Mill Playground
- Hamilton Park
- Washington Park

2.7.5 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 2-4 depicts the locations of schools, churches, fire stations, police stations, hospitals, post offices, libraries and other miscellaneous community resources within the study area.

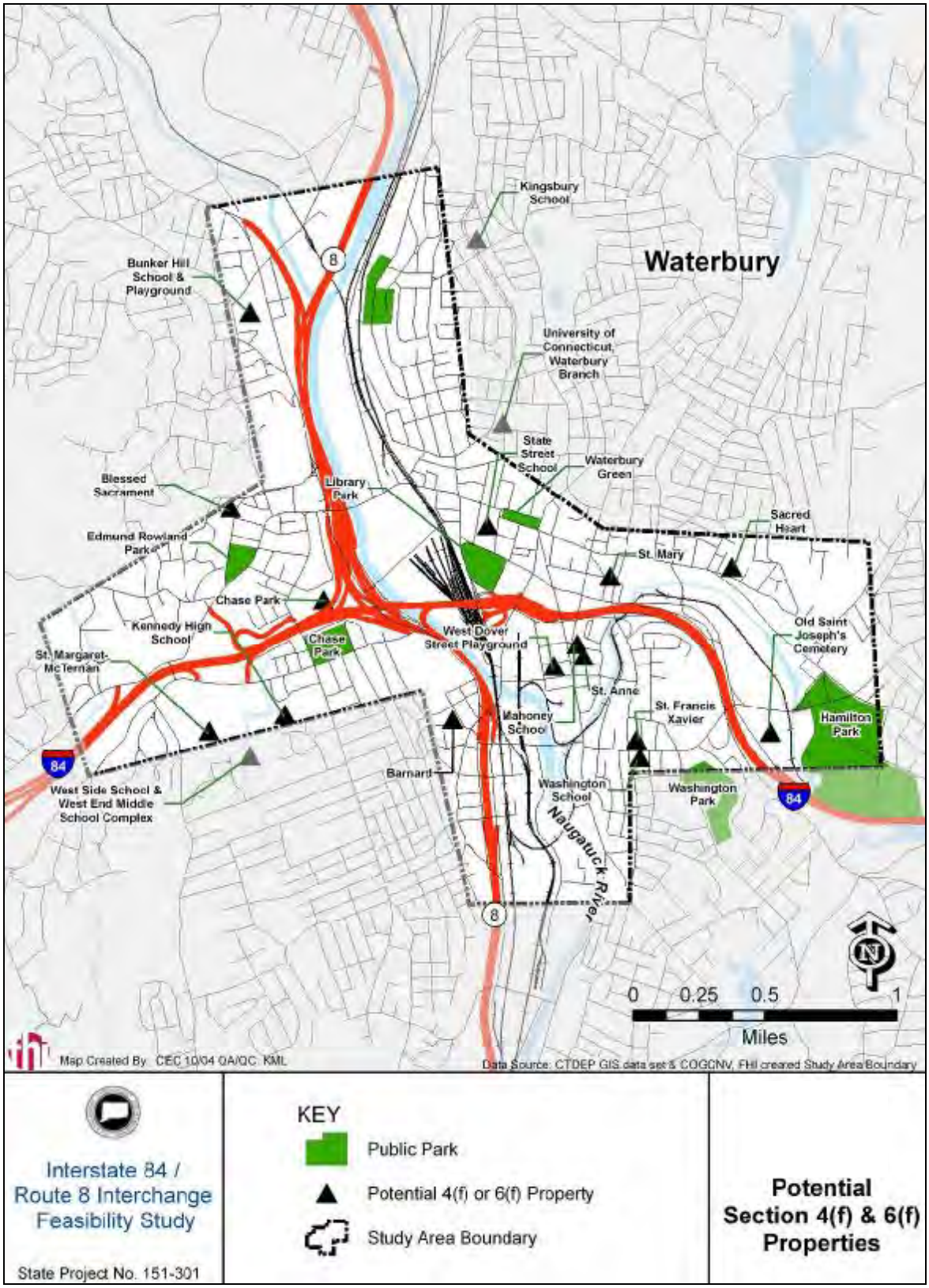
Cultural and Community Facilities Proximate to the Study Area

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
- 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
- Washington School
- Maloney School
- State Street School

Future review of nearby community facilities will be necessary during the NEPA process.

Figure 2-4: Potential Section 4(f) & 6(f) Properties



2.8 Environmental Constraints

2.8.1 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 CTDEP are presented in Table 2-13. 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 2-13: 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.

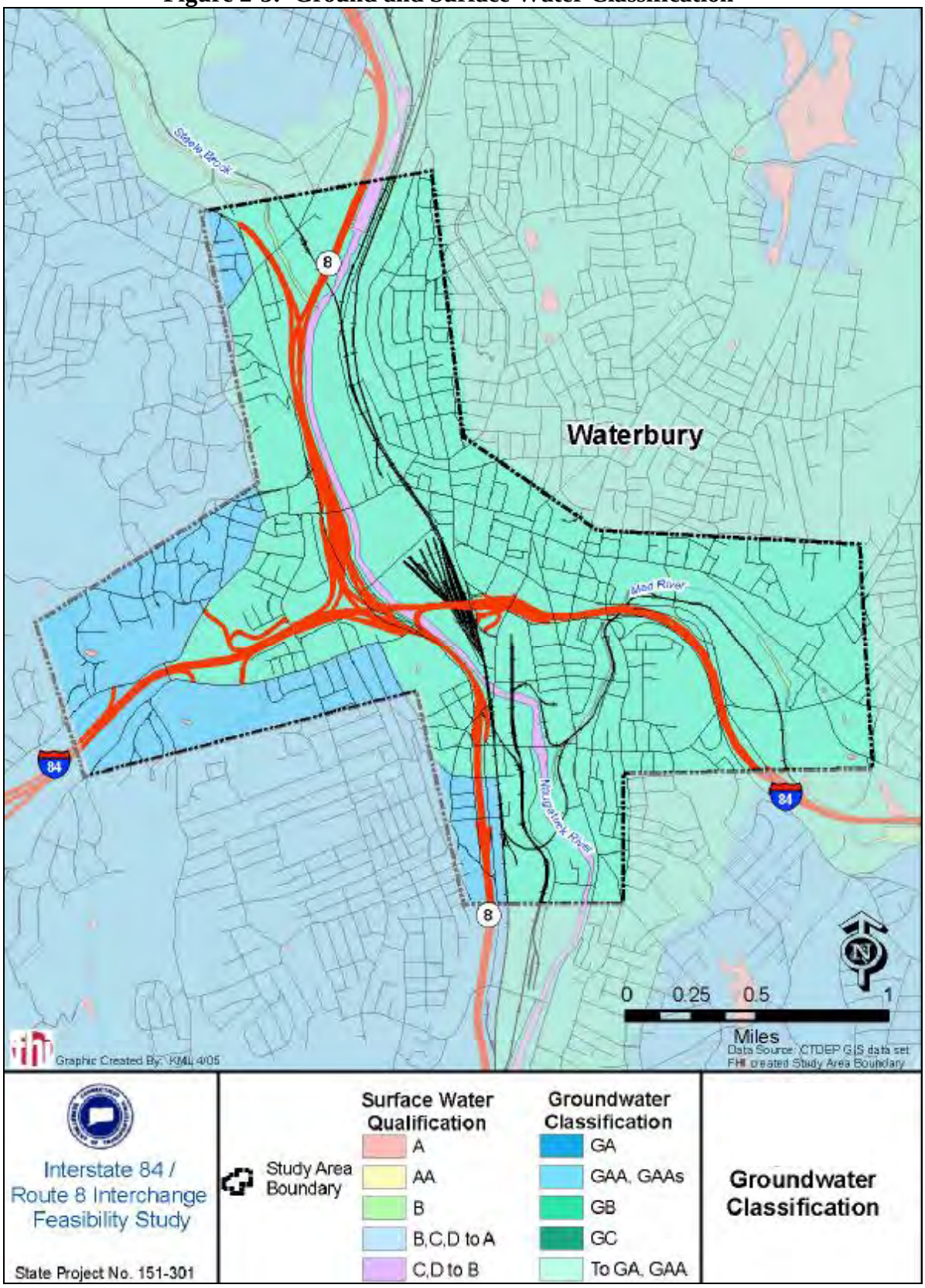
Groundwater is classified as GB throughout most of the study area. However, there are a few locations where the groundwater is classified as GA. These locations include an area along the western portion of the study area in the vicinity of West Main Street and Chase Parkway, an area to the southwest 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 2-14 and Figure 2-5.

Table 2-14: 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 2-5: Ground and Surface Water Classification



2.8.2 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 2-6 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.

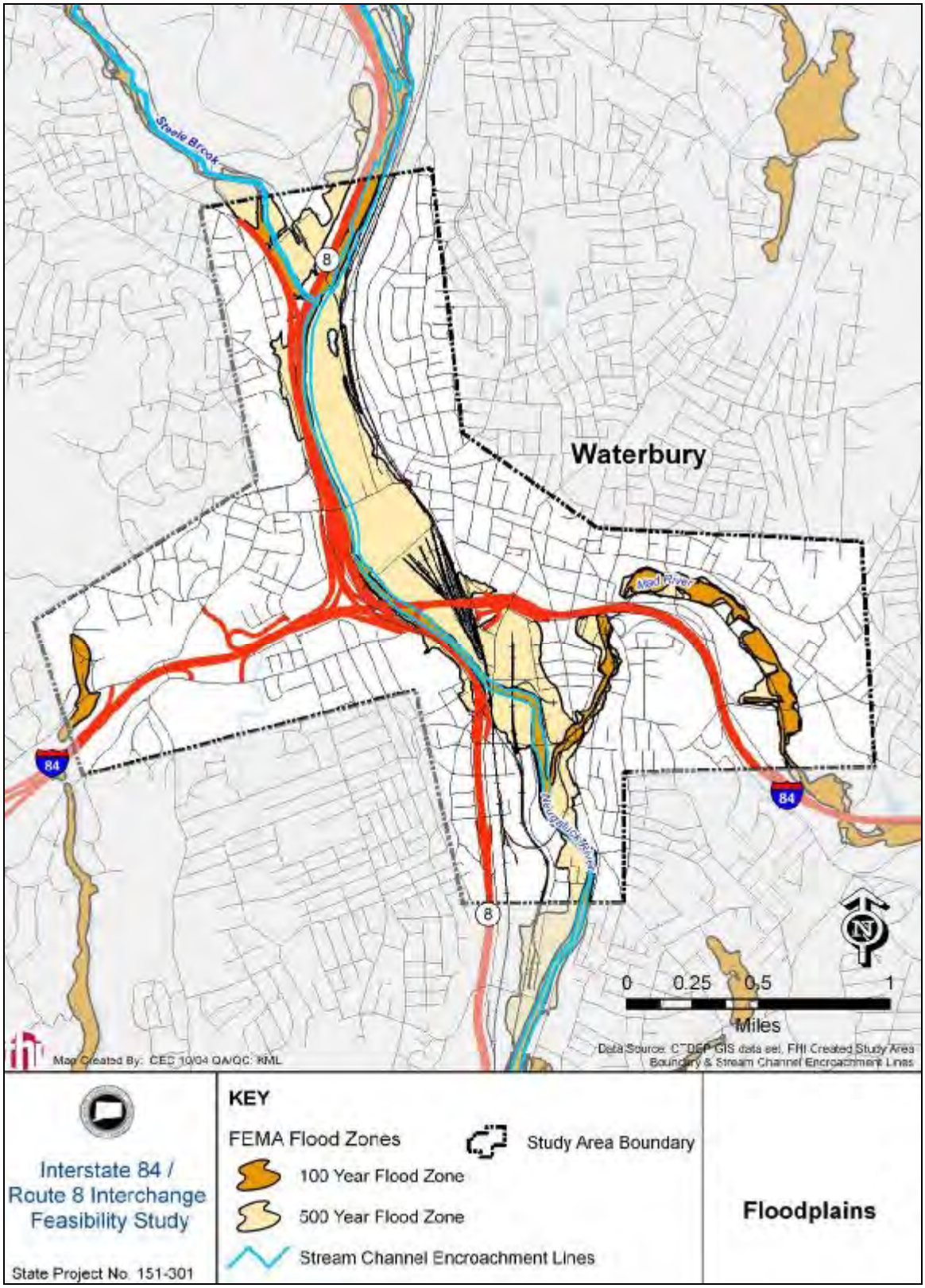
- **Steele Brook:** The 100-year floodplain associated with Steele Brook at the northern edge of the study area, lies between Route 8 and Route 73 (Watertown Avenue). This floodplain, at its widest point in the study area is 850 feet.

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

Stream Channel Encroachment Lines

Within the study area, there are stream channel encroachment lines (SCELs) along the Naugatuck River and Steele Brook, shown in Figure 2-6. SCELs are designated areas, along tidal or inland waterways or flood-prone areas that are considered for stream clearance, channel improvement, or any form of flood control or flood alleviation measures. Areas within the SCELs are regulated by CTDEP to ensure that floodplain development is compatible with river flood flows. In the event that areas within the SCELs would be impacted by the project, CTDOT would obtain the appropriate permits from CTDEP.

Figure 2-6: Floodplains



2.8.3 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.

2.8.4 Wetlands

Wetlands in the study area were identified using CTDEP's GIS Data Guide Wetland Soils. These wetlands are shown in Figure 2-7**.**

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, CTDOT would obtain all necessary permits per state and federal regulations.

2.8.5 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, CTDOT will continue to coordinate with federal and state agencies to ensure that regulations on threatened and endangered species and critical habitat are observed.

2.8.6 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 2-8.

There are 18 TRI sites identified in the study area where toxic releases have been reported. Of these 18 sites, three are active or archived superfund sites. Two of the 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. A third superfund site is located in the northern portion of the study area along the Naugatuck River, west of Thomaston Ave. Generally, the hazardous materials risk sites are located along the freight rail line, which runs north-south and parallel to Route 8.

Figure 2-7: Wetlands

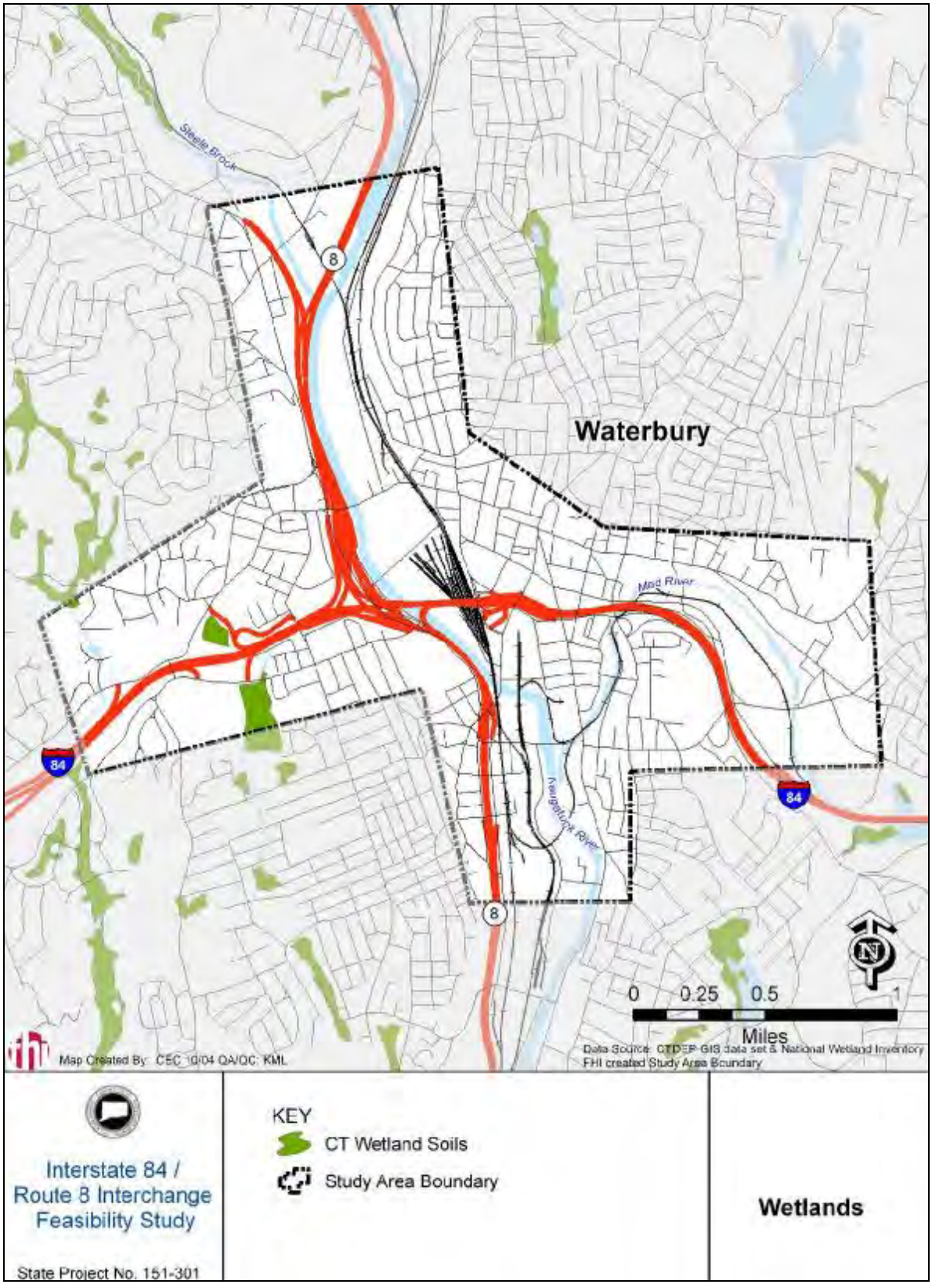
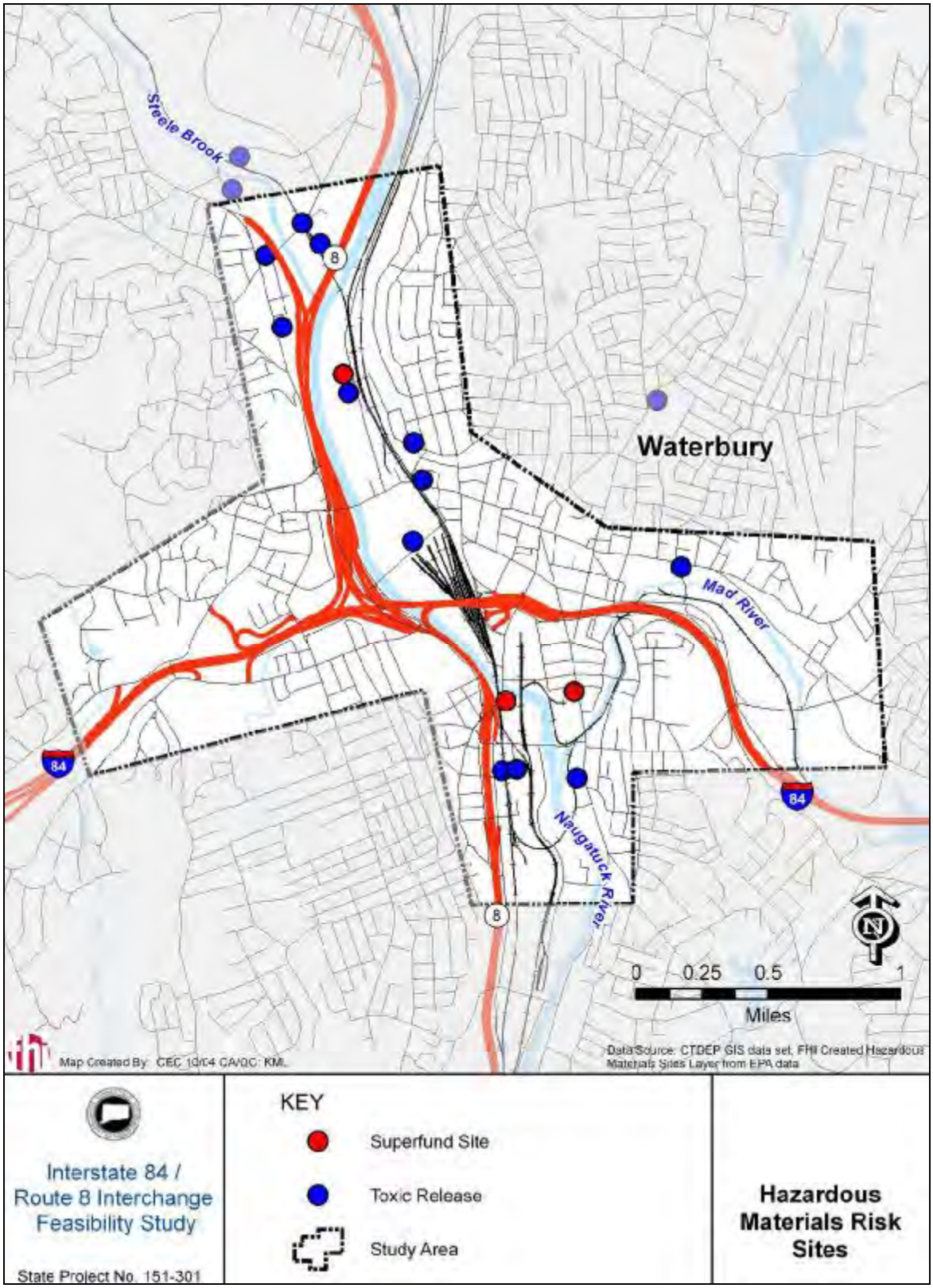


Figure 2-8: Hazardous Materials Risk Sites



2.8.7 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 2-9. 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 CTDOT 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 2-9 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.

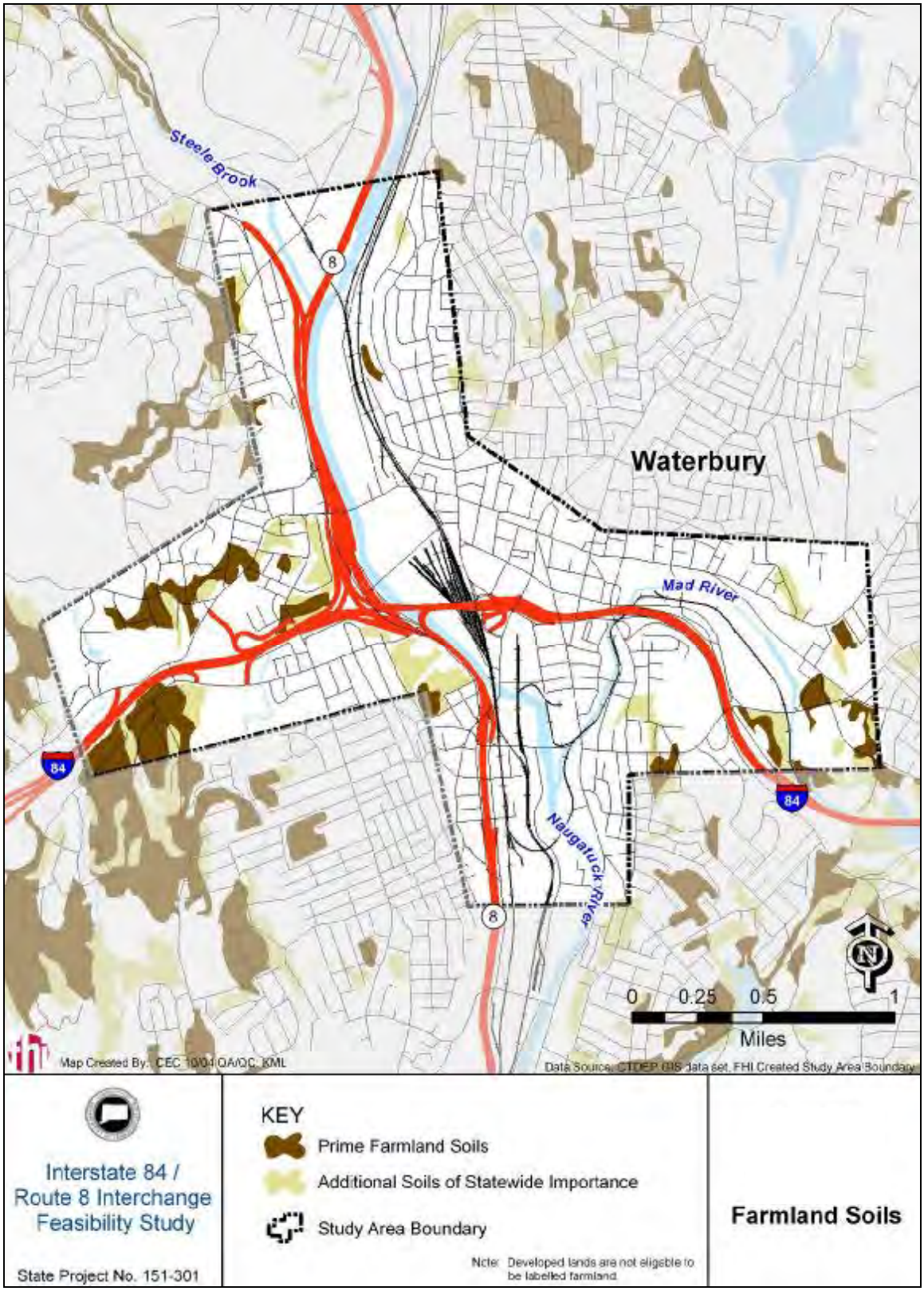
2.8.8 Air Quality

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.

Air Quality Attainment Status

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 2-9: 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 (CTDEP, December 2006) air quality attainment designations for the Central Naugatuck Valley Region, which is included within the Greater New York City Air Quality 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 April of 2004, the EPA determined the entire state of Connecticut to be in moderate non-attainment for the eight-hour ozone NAAQS. The maximum attainment date is projected to be June 2010.

- PM: EPA has established NAAQS for two size ranges of PM. The entire state of Connecticut is currently in attainment of PM_{10} (particulate matter with a diameter of 10 microns or less). In January of 2005, the EPA classified the Greater New York City Air Quality Region, which includes the project study area, as non-attainment for $PM_{2.5}$ (particulate matter with a diameter of 2.5 microns or less).

- 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 prioritizes and places transportation projects on the region's TIP. That TIP is incorporated into the CTDOT 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 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.

2.8.9 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 2-10.

Noise Sensitive Land Uses within the Study Area

Land Use Activity Category A

There are no Category A land uses within the study area

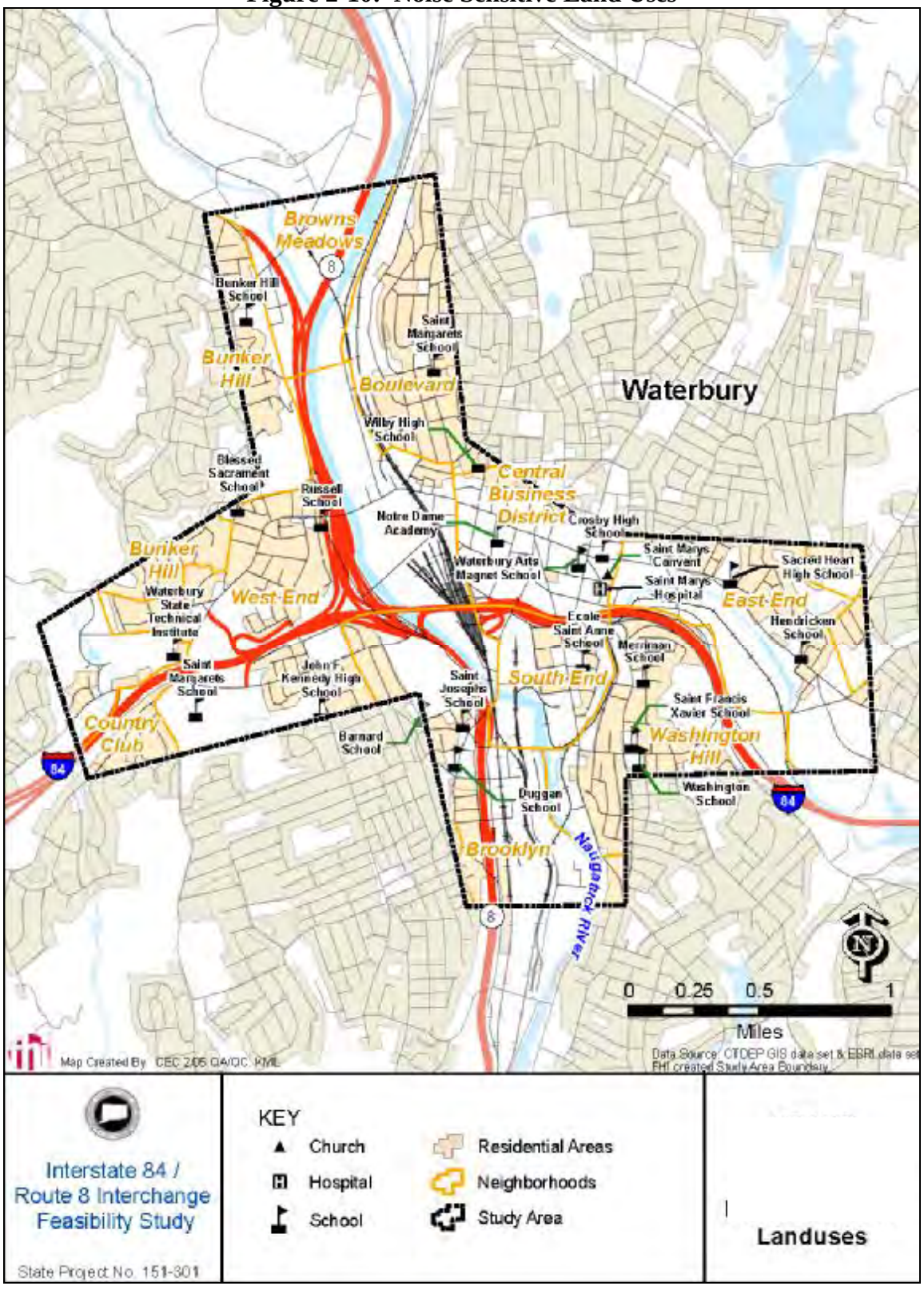
Land Use Activity Category B

- 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. Noise sensitive resources and potential impacts to them will be assessed in greater detail during the NEPA phase of this project.

Figure 2-10: Noise Sensitive Land Uses



3 Preliminary Alternatives

The needs and deficiencies identified in Chapter 2 highlighted the substandard design and state of disrepair of the existing I-84 and Route 8 mainlines and further underscores the need for improvements at the interchange.

A project workshop was held on May 5, 2005 to discuss ideas on potential improvement alternatives for the I-84/Route 8 Interchange. The workshop was attended by representatives of CTDOT, the City of Waterbury, COGCNV, and the Project Consultant team. Staff from various CTDOT bureaus were present at the meeting to provide their insight.

Attendees were divided into various working groups to develop alternatives that would address key areas – local access, interchange ramp capacity, mainline capacity, and alternative modes. Following the meeting, additional discussions were conducted with the CTDOT staff which resulted in the development of five preliminary improvement alternatives for this study. The five preliminary alternatives were analyzed in addition to a No-Build scenario and undertaken through a screening process; the results of which were documented in a Report (Technical Memorandum # 2- Development of Alternatives Report). This chapter presents a summary of the analyses and findings in Technical Memorandum # 2.

3.1 Description of Preliminary Alternatives

Preliminary Alternative 1 – TSM/TDM/Transit

This alternative was conceived as a "minimum build" concept that would maximize the operation of the existing transportation system without any roadway construction. Key aspects of Preliminary Alternative 1 involved improving transit service, traffic signal timings, and signage within the study area. This alternative did not involve the construction of any new structures.

Preliminary Alternative 2 – Safety and Operational Improvements

Preliminary Alternative 2 was developed to improve traffic operations and safety, particularly on the local roadway system within the study area. Improvements included the introduction of connector routes to enhance connectivity and traffic flow within the downtown area as well as improved pedestrian facilities to enhance safety. This alternative did not involve any major structural modifications.

Preliminary Alternative 3 – Partial Build - New I-84 Eastbound Mainline

Preliminary Alternative 3, which was the first of two partial build alternatives, was developed to enhance and expand mainline capacity and safety. This alternative was considered as a partial build because it did not require the full replacement of either the I-84 or Route 8 mainlines. Key aspects of this alternative involved the replacement of the I-84 eastbound mainline with a new mainline running parallel to the existing I-84 westbound mainline as well a series of Collector-Distributor (C/D) roads running parallel to the I-84 mainlines geared at reducing congestion on the mainlines.

Preliminary Alternative 4 – Partial Build - New I-84 WB Mainline

Preliminary Alternative 4 was the second partial build alternative developed to enhance and expand mainline capacity and safety. Key aspects of this alternative involved a new I-84 westbound mainline running parallel to the existing eastbound mainline as well as a new eastbound C/D road running parallel to the I-84 eastbound mainline to separate local traffic going to downtown Waterbury from traffic going through Waterbury to points further east.

Preliminary Alternative 5 – Full Build

Preliminary Alternative 5 was developed as a full build alternative geared at enhancing and expanding mainline capacity and safety. Unlike the partial build alternatives, Preliminary Alternative 5 involved the construction of new I-84 eastbound and westbound mainlines running parallel to each other. Other aspects of this alternative involved two new C/D roads running parallel to the new I-84 mainlines to separate local traffic going to/ from downtown Waterbury from traffic going through Waterbury to points further east or west.

3.2 Screening of Preliminary Alternatives

The five preliminary alternatives were seen as the initial step in the process of developing improvements for the I-84/Route 8 study area. These alternatives were significantly different in their design and represented a wide range of costs which made it necessary to streamline them into fewer more feasible alternatives from a cost and constructability standpoint. Consequently, the five preliminary alternatives went through a screening process based on ranking criteria developed during the study. The section below discusses the ranking criteria in more detail.

3.3 Ranking Criteria

CTDOT, FHWA, COGCNV, City of Waterbury, and consultant staff met on September 8, 2005 to develop criteria for ranking the preliminary alternatives. The process was a collaborative effort that resulted in a list of nine (9) ranking criteria.

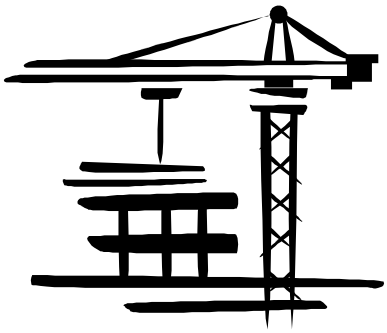
3.3.1 Construction Cost

Construction cost is defined as the cost of all the construction phases of a project. It is generally based upon the sum of the construction contracts (both materials and labor) along with other direct construction costs. It also includes the cost of right-of-way acquisition and the cost of design/permitting defined as a percentage of total construction cost.

3.3.2 Life Cycle Cost

Life cycle cost is defined as the amortized annual cost of owning, operating, and maintaining a transportation facility over its useful life. This figure considers long-term costs of each alternative after construction has been completed, since year-to-year expenditures could vary greatly. Infrastructure that is many years old will have greater life cycle costs from maintenance than would new infrastructure.

3.3.3 Constructability



Constructability considers the construction process and the need to balance design and environmental constraints while constructing something that can reasonably and feasibly be built. Constructability includes the process of planning and executing a Maintenance and Protection of Traffic (MPT) program that manages traffic operations during construction activities. The MPT plan considers which lanes accommodate traffic while construction is safely ongoing in the corridor.

3.3.4 Environmental Impact

Environmental Impact considers the net change (positive or negative) in the condition of human health and the physical, natural, and social environment associated with the project. Environmental impacts of the project would be evaluated in greater detail after this planning phase ends with documentation as required under the NEPA and the Connecticut Environmental Policy Act (CEPA) processes.

3.3.5 Safety/Meets Design Standards

This criterion is a measure of a roadway system's ability to safely and efficiently accommodate traffic. Safety refers to those conditions that can cause death or injury to people, and damage to or loss of equipment or property. "Meets Design Standards" quantifies the degree to which a transportation alternative meets current CTDOT and AASHTO design standards. The

alternatives address safety and design standards to a varying degree, depending on how much construction is proposed.

3.3.6 Connectivity

Connectivity refers to the ease of travel between two points, e.g., the degree to which streets or areas are interconnected and easily accessible to one another.

3.3.7 Economic Development

This criterion is a measure of a project's ability to strengthen an area's economy and employment base. Employers, manufacturers, and developers consider an area's accessibility to the national and world transportation network and local job market when determining where to invest in new facilities. Alternatives that improve local arterial roadways and the national highway system would likely have a positive influence in increasing economic development potential for an area.

3.3.8 Intermodal Connections

Intermodal connections refers to the use of multiple types of transportation to reach one destination. It includes combining the use of trains and buses, automobiles, bicycles, and pedestrian transport on a given trip.

3.3.9 Traffic Operations/Capacity Accommodation

This criterion refers to a transportation alternative's ability to manage demand and increase capacity to serve that transportation demand, whether through additional lanes or services, or through efficiency improvements.

3.4 Analysis of Preliminary Alternatives

All five preliminary alternatives were screened based on the ranking criteria described in the previous section. During this process, the following detailed analyses were conducted for each alternative:

- Capacity analysis
- Preliminary Cost Estimates
- Geometric Conditions Review

- Environmental Analysis

Each preliminary alternative was then assigned a score of 1 to 5 for each ranking criterion based on how best the alternative satisfied that criterion. A score of 1 implied that a goal was poorly satisfied while a score of 5 meant that a goal was fully satisfied.

3.5 Weighting Factors for Criteria

During the September 8, 2005 meeting, it was determined that some ranking criteria were more important than others. Therefore, weights for each criterion were defined on a scale from 1 to 5. The highest weighting score of 5 was assigned to Safety/Meets Design Standards, while the lowest weighting of 3 was assigned to Construction cost and Intermodal connections.

Table 3-1 shows the relative weights for each criterion.

Table 3-1: Criteria Weight Factors

Criteria	Weight
Safety/Meets Design Standards	5
Traffic Operations/Capacity Accommodation	4.5
Life Cycle Cost	4
Constructability	4
Connectivity	4
Environmental Impact	3.5
Economic Development	3.5
Construction Cost	3
Intermodal Connections	3

Source: Wilbur Smith Associates

The weighting factors were then applied to the scores for each criterion and totaled. The preliminary alternative with the highest score received the highest rank.

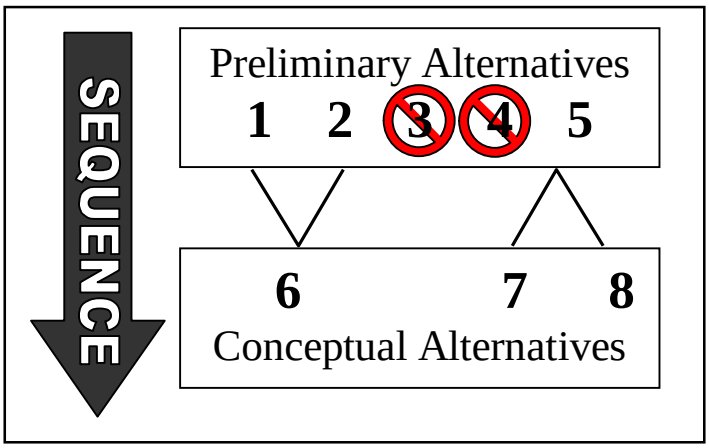
The results of the screening process are summarized in Table 3-2. A detailed description of the scoring and ranking of the preliminary alternatives can be found in Technical Memorandum # 2-Development of Alternatives Report, developed prior to this report.

Table 3-2: Decision Matrix for I-84/Route 8 Interchange Preliminary Alternatives

Grading Criteria	Criteria Relative Weighting (1-5)	No Build		Preliminary Alternative 1: TDM/TSM/ Transit		Preliminary Alternative 2: Circulation/ Operations/ Safety		Preliminary Alternative 3: Partial Build 1 New Westbound		Preliminary Alternative 4: Partial Build 2 New Eastbound		Preliminary Alternative 5: Full Build	
		Rating (1-5)	Weighted Rating	Rating (1-5)	Weighted Rating	Rating (1-5)	Weighted Rating	Rating (1-5)	Weighted Rating	Rating (1-5)	Weighted Rating	Rating (1-5)	Weighted Rating
Construction Cost	3	5	15	5	15	4	12	2	6	2	6	1	3
Life Cycle Cost	4	1	4	1	4	1	4	3	12	2	8	5	20
Constructability	4	5	20	5	20	5	20	1	4	1	4	3	12
Environmental Impact	3.5	4	14	5	17.5	4	14	3	10.5	2	7	3	10.5
Safety/Meets Design Standards	5	1	5	1	5	2	10	3	15	3	15	5	25
Connectivity	4	1	4	1	4	5	20	4	16	4	16	4	16
Economic Development	3.5	1	3.5	2	7	5	17.5	3	10.5	3	10.5	4	14
Intermodal Connections	3	1	3	5	15	3	9	2	6	2	6	2	6
Traffic Operations / Capacity Accommodation	4.5	1	4.5	2	9	2	9	3	13.5	4	18	5	22.5
Total Scores		73		96.5		115.5		93.5		90.5		129	
Ranking of Alternatives		6		3		2		4		5		1	

As illustrated in Table 3-2, the alternatives ranked from highest to lowest as follows:

- Preliminary Alternative 5 – Full Build
- Preliminary Alternative 2 – Safety and Operational Improvements
- Preliminary Alternative 1 – TSM/TDM/Transit
- Preliminary Alternative 3 – Partial Build (New I-84 Eastbound Mainline)
- Preliminary Alternative 4 – Partial Build (New I-84 Westbound Mainline)
- No-build – Includes Maintenance of Existing Interchange Structure Only



Based on the results of the screening analysis, the structural and constructability issues and the comparatively high cost associated with the partial build alternatives, Preliminary Alternatives 3 and 4 were dropped. Preliminary Alternatives 1 and 2 were advanced as potential near term improvements with Preliminary Alternative 5 as a potential long term improvement. These three alternatives were refined into three conceptual alternatives (Conceptual Alternatives 6, 7 and 8) as depicted in the illustration.

4 Conceptual Alternatives

As discussed in Chapter 3 of this report, the screening analysis conducted in the Development of Alternatives Report (Technical Memorandum #2) identified three transportation improvement alternatives from the five preliminary alternatives to be advanced to the next phase of the study. To maintain a consistent numbering convention, the three alternatives were referred to as Conceptual Alternative 6, 7, and 8. The goal during this phase of the study was to ultimately develop a preferred transportation alternative from the three conceptual alternatives. Therefore, the conceptual alternatives were also analyzed and undertaken through a screening process; the results of which were documented in a third report (Technical White Paper-Refinement of Alternatives). This chapter presents a description of the three conceptual alternatives and a summary of the analyses and findings presented in the Technical White Paper.

4.1 Conceptual Alternative 6

Conceptual Alternative 6 was developed as a combination of Transportation System Management (TSM), Transportation Demand Management (TDM), Transit and Safety improvements. This alternative looked at enhancing the efficiency and effectiveness of the existing transportation system by improving transit service, modifying traffic signal timing, and improving signage within the study area. The safety and operational enhancements undertaken under this alternative would improve traffic operations as well as driver and pedestrian safety particularly on the local roadway system. Conceptual Alternative 6 would not involve major structural modifications on the highway system.

4.2 Conceptual Alternative 7

Conceptual Alternative 7 was one of two Full Build alternatives derived from Preliminary Alternative 5 which was developed in the previous phase of this study. Conceptual Alternative 7 would expand mainline capacity and enhance roadway safety by reducing turbulent traffic flows resulting from the mix of local and high-speed through traffic. Under this alternative, frontage roads would be used to collect and distribute local traffic while the interstate mainline and associated high speed ramps would be dedicated to longer distance through trips.

Under this alternative, new I-84 and Route 8 mainlines would be constructed. The new I-84 eastbound and westbound mainlines would run parallel to each other and would be located south

of the current I-84 footprint. The new Route 8 mainline would for the most part, remain within the existing footprint of Route 8.

4.3 Conceptual Alternative 8

Conceptual Alternative 8 was the other Full-Build alternative that was considered. This alternative would expand mainline capacity and enhance safety by removing left-hand exit and entrance ramps and increasing spacing between ramps. In addition, this alternative would minimize construction staging, shorten the duration of construction, and maximize local access through the use of at-grade frontage roads.

Under this alternative, new I-84 and Route 8 mainlines would be constructed. The new I-84 eastbound and westbound mainlines would run parallel to each other and would be located south of the current I-84 footprint. The new Route 8 northbound and southbound mainlines would run parallel to each other and would be located east of the Naugatuck River. In addition, two new interchanges would be constructed at Freight and West Main Streets to improve access to the downtown area.

4.4 Ranking of Conceptual Alternatives

As indicated earlier in this report, the goal during this phase of the study was to ultimately screen the three conceptual alternatives into a Preferred Alternative. To accomplish this task, the project team held a series of meetings with CTDOT, the City of Waterbury, COGCNV and the WDC to assess each conceptual alternative on the basis of their strengths and weaknesses.

Key issues arising from the discussions related to how each conceptual alternative would fit into the City of Waterbury Long Range Economic Development plan, the constructability of the alternatives, various property impacts, and improvements to the local roadway system. The comments and feedback obtained from the deliberations proved to be a valuable guide in developing strategies to further refine the conceptual alternatives.

4.4.1 Ranking and Weighting Criteria

Early on in the study process, ranking criteria and weighting factors were developed and utilized in the screening of the preliminary alternatives. The ranking criteria included the following:

- Construction costs
- Life cycle costs
- Constructability
- Environmental impact
- Safety/meets design standards
- Connectivity

- Economic development
- Intermodal connections
- Traffic operations/capacity accommodation.

The ranking criteria and weighting factors are discussed in Chapter 3 of this report. These same criteria and factors were utilized in screening and ranking the three conceptual alternatives. Similar to the screening of the preliminary alternatives, each conceptual alternative was given a score of 1 (lowest score) to 5 (highest score) based on its ability to satisfy each ranking criterion. The scores were given based on detailed analysis presented in the Refinement of Alternatives Technical White Paper developed prior to this Report. In addition, weighting factors ranging from 1 to 5 were applied to the score for each ranking criterion. The results of the ranking exercise are summarized in Table 4-1 and discussed below.

Table 4-1: Decision Matrix for I-84/Route 8 Interchange Conceptual Alternatives

Grading Criteria	Criteria Relative Weighting (1 - 5)	No Build		Alternative 6		Alternative 7		Alternative 8	
		Rating (1 - 5)	Weighted Rating	Rating (1 - 5)	Weighted Rating	Rating (1 - 5)	Weighted Rating	Rating (1 - 5)	Weighted Rating
Construction Cost	3	5	15	4	12	1	3	2	6
Life Cycle Cost	4	1	4	1	4	5	20	5	20
Constructability	4	5	20	5	20	2	8	4	16
Environmental Impact	3.5	5	17.5	4	14	2	7	1	3.5
Safety/Meets Design Standards	5	1	5	2	10	5	25	4	20
Connectivity	4	1	4	4	16	4	16	5	20
Economic Development	3.5	1	3.5	2	7	4	14	5	17.5
Intermodal Connections	3	1	3	5	15	3	9	3	9
Traffic Operations/Capacity Accommodation	4.5	1	4.5	2	9	5	22.5	4	18
Total Scores		76.5		107		124.5		130	
Ranking of Alternatives		4		3		2		1	

4.4.2 Construction Cost of Conceptual Alternatives

For this ranking criterion, a high construction cost translated to a low score.

The No-Build – or do nothing – scenario had the lowest overall construction cost and was therefore given a score of 5.

Costs for the various Conceptual Alternatives were most affected by the significant structural costs associated with each alternative. For Conceptual Alternative 6, the structural costs would primarily involve maintaining the aging bridges that exist today and would remain in the future. The cost of maintaining the structures was found to be significant. Conceptual Alternative 6 was therefore given a score of 3.

Conceptual Alternative 7 was found to be the most expensive alternative. This can be attributed to the complete reconstruction of the I-84/Rte 8 interchange and the extensive number of temporary structures that would be required to maintain traffic during construction. Conceptual Alternative 7 was given a score of 1.

Conceptual Alternative 8 was found to be slightly less expensive than Conceptual Alternative 7, with its high cost also attributed to the complete reconstruction of the I-84/Rte 8 interchange. Conceptual Alternative 8 would still require temporary structures to maintain traffic during construction, but would have far fewer since most of the new alignment would be constructed off-line. Conceptual Alternative 8 was also given a score of 1.

4.4.3 Life Cycle Cost of Conceptual Alternatives

For the life cycle cost criterion, a high cost translated to a low score.

It was estimated that the life cycle score for the No Build scenario was a 1. This was primarily based on the fact that the existing stacked viaducts, which are non-redundant structures, would need to be continuously repaired to prevent a major failure or collapse of the structure. In addition, these particular structures would be difficult and expensive to repair, maintain, and improve, because of the difficulty involved in order to stage the work. This score also took into account the fact that multiple cycles of repair were anticipated on all structures during the lifetime of potential replacement structures.

Conceptual Alternative 6 includes transit improvements, modifying traffic signal timings, improving signage and minor structural improvements. This alternative was therefore given a score of 1 for life cycle cost.

Conceptual Alternatives 7 and 8 are both full-build alternatives, which would involve demolishing all existing viaducts and constructing new I-84 and Route 8 viaducts, new collector-distributor (C/D) viaducts, and new ramp structures. Due to the fact that the new structures constructed in each of these alternatives would have very long life spans and would not require frequent repair and maintenance, the life cycle ranking for both was estimated to be a 5.

4.4.4 Constructability of Conceptual Alternatives

For the constructability criterion, the more difficult the construction translated to a lower score.

The No Build scenario would not require any new structural modifications to the highway and local roadway network and was therefore given the highest ranking of 5. It should be noted that repair of existing structure is often difficult due to the existing configuration of the structure.

Conceptual Alternative 6 was found to maximize the operation of the existing transportation system with minimal structural modifications to the highway and local roadway network. This alternative would involve transit service, traffic signal timing, signage improvements, new local roads, and a couple of new bridges. Since Conceptual Alternative 6 would not require any structural modifications to I-84 and Route 8 mainline viaducts, this alternative was given a ranking of 5.

Conceptual Alternative 7 represents a Full Build alternative which would involve the replacement of both I-84 and Route 8 mainlines. Conceptual Alternative 7 was found to pose the greatest construction challenge, since this alternative involves rebuilding the new Route 8 structures within the existing structural footprint. Special construction techniques would be needed for cranes and other machinery to operate in such a constricted work environment. In addition, this alternative would require the highest level of effort in managing traffic operations while construction is ongoing. This alternative was therefore given the lowest ranking of 1.

Conceptual Alternative 8, while still challenging in terms of constructability, was found to be significantly simplified due to the fact that much of Route 8 would be constructed on new alignment away from the existing bridge footprint. The construction of this alternative lent itself to more traditional construction techniques and was therefore given a rating of 4.

4.4.5 Environmental Impact of Conceptual Alternatives

For the environmental impact criterion, a low environmental impact translated to a high score.

The No Build would have little or no effect (score of 5) on just about all socioeconomic and environmental resources; however, under the No Build condition the existing traffic congestion and circulation problems that currently plague Waterbury and the surrounding transportation system would continue to exist and would only become exacerbated over time, thereby further clogging infrastructure and adding to increased safety problems and delays. Since virtually the entire study area is comprised of an environmental justice (EJ) population, it is very likely that this EJ population would be increasingly affected in an adverse manner by the increased traffic and circulation problems if no improvements are made. Additionally, increased traffic congestion over time would only exacerbate air quality issues due to increased vehicle residence time in the study.

Conceptual Alternative 6 was found to be similar to the No Build scenario, but would include some new local roads and a multi-use trail. Impacts were expected to be minimal so it was given

a ranking of 4. Conceptual Alternatives 7 and 8 both had significant impacts on existing property and the Naugatuck River, although both attempted to minimize these impacts to the extent possible. Conceptual Alternative 8 included greater impact to existing properties, primarily because Route 8 is on a new alignment, but it could also be argued that these properties (many of them contaminated by hazardous materials) would be cleaned up to support new development. Conceptual Alternatives 7 and 8 were given scores of 2 and 1 respectively.

4.4.6 Safety/Meets Design Standards of Conceptual Alternatives

For the safety/meets design standards criterion, a high safety standard translated to a high score.

The safety of a roadway has much to do with the standards by which it has been designed. When I-84 was designed almost 50 years ago, design standards were different than they are today. The volume of traffic that the highway was expected to carry was far less than is realized today. In addition, the standards for ramp spacing and other geometric conditions were less stringent. The No Build scenario would not make any geometric improvements to the interchange and therefore, would not directly address deficiencies on the interstate itself. A score of 1 was therefore given.

Conceptual Alternative 6 would consolidate the closely spaced exit ramps of Interchanges 21 and 22 on I-84 eastbound, thereby making a minimal improvement to the overall safety of the system. A score of 2 was given. Conceptual Alternative 7 would address the greatest number of geometric deficiencies within the study area and was given a score of 5. Conceptual Alternative 8 was found to have one more ramp spacing deficiency than Conceptual Alternative 7 and as such was given a slightly reduced score of 4. Both Full Build alternatives dramatically reduce the number of substandard conditions that exist in the No Build scenario.

4.4.7 Connectivity of Conceptual Alternatives

For the connectivity goal, better connectivity to destinations within Waterbury translated to a higher score.

The No Build scenario would not improve local road circulation nor provide improved connectivity to emerging development areas downtown. For this reason it was given the lowest score of 1.

Conceptual Alternative 6 was found to improve local connections within Waterbury and consists of new roadways and intersections in the downtown along with two new connector roads. Conceptual Alternative 6 was found to improve transit connectivity and traffic signal timing in the downtown area and provides new local road connections to facilitate various transportation modes. For this reason, Alterative 6 was given a score of 4. Conceptual Alternative 7 would provide a high level of connectivity through the use of collector-distributor (C/D) roads along I-84 and new local roads to improve circulation. Conceptual Alternative 7 was also given a score of 4. Conceptual Alternative 8 was given a score of 5 because it would improve access to

portions of the city that are poorly served today, such as the industrial land surrounding Freight Street. Conceptual Alternative 8 would also provide more direct connectivity to Waterbury Hospital and other downtown destinations.

4.4.8 Economic Development of Conceptual Alternatives

For the economic development goal, the higher the score given translates into the alternative's ability to accommodate and stimulate economic growth.

The No Build scenario was given a score of 1 because the existing transportation system was found to be an impediment to economic growth. The traffic congestion projected to occur in 2030 would limit development opportunities as well.

The Naugatuck Valley Development Corporation has economic development initiatives near the Jackson Street and Freight Street corridors. While all three Conceptual Alternatives would accommodate access to this area, Conceptual Alternative 8 would provide the most direct access from Route 8 and I-84. Also, reclaiming the land on the west side of the Naugatuck River where the existing interchange ramps to and from Route 8 reside would make prime river front land available for new development. Therefore, Conceptual Alternative 8 was given a score of 5. Conceptual Alternatives 6 and 7 would provide enhanced local road connectivity to downtown Waterbury and emerging development parcels, but Conceptual Alternative 6 would do little to improve the congestion that is projected to occur in 25 years. Therefore, Conceptual Alternatives 6 and 7 were given scores of 2 and 4 respectively.

4.4.9 Intermodal Connections of Conceptual Alternatives

A high score for this criterion translated into the alternative's interconnection with multiple transportation modes (i.e. bike, pedestrian, auto, truck, transit, freight, etc.).

The No Build scenario would not improve or facilitate the efficient interconnection between transportation modes. For this reason it was given the lowest score of 1.

This goal was addressed most thoroughly by Conceptual Alternative 6, mainly due to the improved bicycle, pedestrian, local road, and transit connections, and was given a score of 5. Conceptual Alternatives 7 and 8 would both consist of improved local road connections and improved substandard ramp conditions that are currently challenging to trucks. For these reasons, Conceptual Alternatives 7 and 8 were both given a score of 3.

4.4.10 Traffic Operations/Capacity Accommodation of Conceptual Alternatives

For the traffic operations/capacity accommodation goal, the higher the score given translated into the alternative's ability to handle future travel demand.

For each Conceptual Alternative, freeway segments, weave areas and ramp junctions with LOS E and LOS F were identified as deficiencies. The number of operational/capacity deficiencies for each alternative was calculated and used as a basis of ranking the alternatives. Since the No-Build scenario would not improve any of the stated deficiencies, it was given a score of 1.

Conceptual Alternative 6 would improve the weaving issue on I-84 eastbound in the vicinity of Interchange 21. For this reason, Conceptual Alternative 6 was given a score of 2. Both Conceptual Alternatives 7 and 8 would operate at LOS D or better. However, Conceptual Alternative 7 was found to perform slightly better as it recorded more mainline and ramp locations with LOS C or better. For this reason, Conceptual Alternatives 7 and 8 were given scores of 5 and 4 respectively. A detailed level of service comparison of the three conceptual alternatives can be found in Technical Memorandum # 2- Development of Alternatives Report.

4.5 Preliminary Recommendation for Preferred Alternative

The results of the screening analyses conducted for each of the conceptual alternatives, led the study team to conclude that Conceptual Alternative 8 would best satisfy the stated study goals due to the following reasons:

- Conceptual Alternative 8 performed well with regard to improving traffic operations and reducing the number of substandard geometric conditions currently present at the existing interchange;
- Conceptual Alternative 8 would provide the best connections with local Waterbury destinations and is expected to support local economic development efforts in the city;
- Conceptual Alternative 8 could be built with minimal disruption in traffic flow making it inherently easier to construct relative to the other alternatives; and
- Conceptual Alternative 8 could also be built using conventional construction techniques because a majority of the structure would be built on new alignment.

An initial recommendation was therefore made by the study team, based on the screening analysis to advance Conceptual Alternative 8 as the long-term improvement alternative with elements of Conceptual Alternative 6 serving as near-term improvements.

4.6 Department of Economic and Community Development Study

A key consideration during the screening of alternatives was how well the Preferred Alternative for the I-84/Route 8 WINS would fit into the City of Waterbury Long Range Economic Development Plan as well as its impacts to the city from a fiscal and economic standpoint. For this reason, CTDOT in collaboration with the City of Waterbury requested the Department of Economic and Community Development (DECD) to conduct an independent study to assess the economic and fiscal impacts of each conceptual alternative on the city and surrounding towns. The goal of this study was to provide

additional information to assist CTDOT, the City of Waterbury, and project team in selecting a final Preferred Alternative for the I-84/Route 8 WINS.

The DECD study was conducted for two alternatives; Alternative 6-7, which is a combination of Alternatives 6 and 7 and Alternative 6-8, which is a combination of Alternatives 6 and 8. Each alternative was analyzed using the economic analysis model (REMI) under two hypothetical build out scenarios with or without the planned Greater Waterbury Intermodal Transportation Center (ITC) in place. The complete DECD study report is presented in the Appendix of this report. Table 4-2 and Table 4-3 present a summary of the fiscal impacts associated with Alternatives 6-7 and 6-8 respectively based on the DECD study.

Table 4-2: Fiscal Impact of Alt. 6-7 Build-Out Scenarios Average Annual Change, 2015-2050

Variable	City of Waterbury		Connecticut	
	without ITC	with ITC	without ITC	with ITC
Alternative 6-7 Scenario 1 (No land buildout)				
Total Revenue (Millions 2006$)	$3.67	$5.19	$17.62	$18.21
Total Expenditures (Millions 2006$)	$3.39	$4.78	$10.54	$14.30
Net Revenue (Millions 2006$)	$0.29	$0.41	$7.08	$3.91
Alternative 6-7 Scenario 2 (Mixed use + W/D)				
Total Revenue (Millions 2006$)	$24.89	$26.08	$74.51	$74.70
Total Expenditures (Millions 2006$)	$17.89	$18.98	$51.74	$54.69
Net Revenue (Millions 2006$)	$7.00	$7.09	$22.77	$20.01

Source: DECD
W/D- Warehouse/Distribution

Table 4-3: Fiscal Impact of Alt. 6-8 Build-Out Scenarios Average Annual Change, 2015-2050

Variable	City of Waterbury		Connecticut	
	without ITC	with ITC	without ITC	with ITC
Alternative 6-8 Scenario 1 (Residential)				
Total Revenue (Millions 2006$)	$30.93	$32.92	$83.38	$86.36
Total Expenditures (Millions 2006$)	$21.28	$23.11	$61.08	$66.22
Net Revenue (Millions 2006$)	$9.65	$9.81	$22.30	$20.14
Alternative 6-8 Scenario 2 (Warehouse/Distribution)				
Total Revenue (Millions 2006$)	$33.14	$35.20	$92.96	$97.29
Total Expenditures (Millions 2006$)	$23.34	$25.24	$67.15	$72.62
Net Revenue (Millions 2006$)	$9.80	$9.96	$25.82	$24.68

Source: DECD

As illustrated in Table 4-2 and Table 4-3, Alternative 6-8 was found to generate more net revenue than Alternative 6-7 for both the City of Waterbury and State of Connecticut. For instance, Alternative 6-8 under the warehouse/distribution development (Scenario 2) would generate net revenue of over $9.5 million (2006 dollars) for the city while Alternative 6-7 would generate approximately $7 million (2006 dollars).

Table 4-4 and Table 4-5 present a summary of the economic impacts associated with Alternatives 6-7 and 6-8.

Table 4-4: Economic Impact of Alt. 6-7 Build-Out Scenarios Average Annual Change, 2015-2050

Variable	New Haven County		Connecticut	
	without ITC	with ITC	without ITC	with ITC
Alternative 6-7 Scenario 1 (No Buildout)				
Total Employment	1,589	1,632	1,688	1,666
Total GRP (Millions 2006$)	$212.7	$1,215.8	$232.9	$1,259.4
Personal Income (Millions 2006$)	$106.2	$541.9	$138.4	$672.6
Population	1,308	1,847	1,596	2,165
Alternative 6-7 Scenario 2 (Mixed use + W/D)				
Total Employment	7,382	7,385	7,612	7,546
Total GRP (Millions 2006$)	$891.8	$1,071.0	$930.8	$1,107.0
Personal Income (Millions 2006$)	$467.1	$467.5	$587.8	$581.0
Population	6,910	7,332	7,828	8,278

Source: DECD

Table 4-5: Economic Impact of Alt. 6-8 Build-Out Scenarios Average Annual Change, 2015-2050

Variable	New Haven County		Connecticut	
	without ITC	with ITC	without ITC	with ITC
Alternative 6-8 Scenario 1 (Residential)				
Total Employment	8,210	8,455	8,448	8,652
Total GRP (Millions 2006$)	$997.6	$1,215.8	$1,037.7	$1,259.4
Personal Income (Millions 2006$)	$525.3	$541.9	$657.9	$672.6
Population	8,219	8,926	9,241	10,024
Alternative 6-8 Scenario 2 (Warehouse/Distribution)				
Total Employment	9,068	9,426	9,346	9,679
Total GRP (Millions 2006$)	$1,124.4	$1,354.7	$1,172.5	$1,408.8
Personal Income (Millions 2006$)	$584.0	$607.7	$732.7	$758.2
Population	9,015	9,746	10,159	10,991

Source: DECD

As illustrated in Tables 4-4 and 4-5, Alternative 6-8 would provide more economic benefits than Alternative 6-7. For instance, Alternative 6-8 under the warehouse/distribution development (Scenario 2) would generate between 9,000 to 9,700 new jobs while Alternative 6-7 would generate between 7,300 to 7,600 jobs. In addition, the total Gross Regional Product (GRP) for Alternative 6-8 would range from $1,120 - $1,410 million (2006 dollars) compared to $890 – $1,110 million (2006 dollars) for Alternative 6-7 under the mixed use and warehouse/distribution development scenario (Scenario 2).

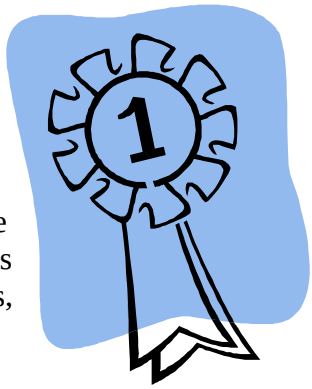
4.6.1 DECD Study Findings

The DECD Study found that the fiscal and economic benefits were greater under Alternative 6-8 than Alternative 6-7. Furthermore, the study concluded that the greatest economic benefits for the City of Waterbury and State of Connecticut would be derived under Alternative 6-8 where the land west of the Naugatuck River was used for warehouse/distribution development.

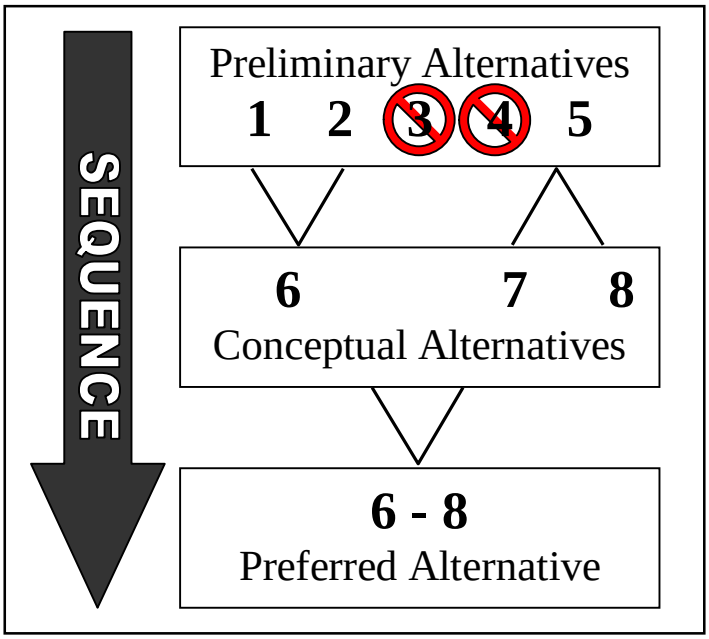
Therefore, these findings from a fiscal and economic standpoint supported the initial recommendations for a Preferred Alternative made during the Refinement of Alternatives phase of the study.

4.7 Selection of Preferred Alternative

Based on preliminary recommendations from the screening analyses of the conceptual alternatives and the findings from the DECD Study, Conceptual Alternative 8 was selected by the study team as the long-term Preferred Improvement Alternative with elements of Conceptual Alternative 6 serving as near-term improvements. These two Conceptual Alternatives have complimentary features and would serve to improve the transportation system both prior to and during the construction of the interchange. This Final Alternative was referred to as Preferred Alternative 6-8, and with the concurrence of study stakeholders, advanced as the final recommendation of the I-84/Route 8 WINS.



5 Preferred Alternative



A Preferred Transportation Alternative was selected for the I-84/Route 8 WINS after in-depth analyses, two screening iterations, public input and an independent economic impact study. The illustration highlights the steps involved in arriving at the Preferred Alternative.

To recap, five preliminary alternatives were initially identified as potential improvements for the study area. These preliminary alternatives were undertaken through a screening exercise based on different ranking criteria. Two alternatives (Preliminary Alternative 3 and 4) were dropped while Preliminary Alternatives 1, 2 and 5 were advanced to the next phase of the study.

Three conceptual alternatives (Conceptual Alternatives 6, 7 and 8) were developed from the three preliminary alternatives that were advanced. Conceptual Alternative 6 was developed as a hybrid of Preliminary Alternatives 1 and 2 while Conceptual Alternatives 7 and 8 were developed through the distillation of Preliminary Alternative 5. The three conceptual alternatives were also taken through a screening process to finally arrive at a Preferred Alternative. Conceptual Alternative 8 was selected as the Preferred Long-Term Improvement Alternative with elements of Conceptual Alternative 6 serving as near-term improvements.

5.1 Description of Preferred Alternative

5.1.1 Preferred Alternative 6 (Near Term Improvement)

Preferred Alternative 6 represents the final near term improvement recommendation for the I-84/Route 8 WINS. This alternative is a combination of Transportation System Management (TSM), Transportation Demand Management (TDM), Transit and Safety improvements. Preferred Alternative 6 looks at enhancing the efficiency and effectiveness of the existing transportation system by improving transit service, modifying traffic signal timing and improving signage within the study area. The safety and operational enhancements undertaken under this alternative would improve traffic operations as well as driver and pedestrian safety particularly on the local roadway system. Preferred Alternative 6 would not involve major structural modifications on the highway system.

Key features of Preferred Alternative 6 are highlighted below and illustrated in Figure 5-1.

- New local connections from:
  - Sunnyside Avenue to Field Street
  - West Main Street to Bank Street
  - Bank Street to South Main Street
- A new bus circulator route to run between Brass Mill Mall and Waterbury Hospital to compliment the existing bus system.
- The modification of existing transit service to improve intermodal connections between bus and rail transit in the downtown area. This includes providing efficient connections from the proposed intermodal transit center (site of existing train station) to existing pulse points at the City Green. The ongoing study of the proposed intermodal transit center is being closely monitored and the recommendations from that study will be coordinated with the planning recommendations presented in this study.
- Pedestrian and bicyclist facility improvements, particularly in the vicinity of the existing rail station, to enhance access to both rail and bus transit systems.
- I-84 and Route 8 signage/way-finding improvements at the following locations to improve access to the highway system from downtown Waterbury:
  - City Green
  - Intersection of Highland Avenue and Sunnyside Avenue
  - Intersection of Mill Street and Baldwin Street
  - Intersection of Bank Street and Meadow Street
- Traffic signal timing and coordination improvements at the Hamilton Avenue/Washington Street/Silver Lane intersection, Union Street/I-84 Entrance Ramp intersection, and Union Street/I-84 Exit Ramp/Brass Mill Mall Drive intersection to reduce congestion and delays on the Union Street corridor.
- Signal timing improvements on West Main Street/Thomaston Avenue intersection, West Main Street/Willow Street intersection, and Freight Street/Willow Street intersection.
- The consolidation of the I-84 eastbound exit ramps at Meadow and South Main Streets.

5.1.2 Preferred Alternative 8 (Long Term Improvement)

Preferred Alternative 8 is the long term improvement alternative recommended for the I-84/Route 8 WINS. This alternative is a full-build alternative which expands mainline capacity and enhances safety by removing left-hand exit and entrance ramps and increasing spacing between ramps. In addition, this alternative would minimize construction staging, shorten the duration of construction, and maximize local access through the use of at-grade frontage roads.

Under this alternative, new I-84 and Route 8 mainlines would be constructed. The new I-84 eastbound and westbound mainlines would run parallel to each other and would be located south of the current I-84 footprint. The new Route 8 northbound and southbound mainlines would run parallel to each other and would be located east of the Naugatuck River.

Key features of Preferred Alternative 8 are highlighted below and illustrated in Figure 5-2.

- New I-84 and Route 8 Mainlines.
- Two new interchanges at Freight and West Main Streets.
- The introduction of a frontage road off the I-84 westbound exit ramp at Interchange 22 to reduce congestion on the I-84 mainline, west of Interchange 22.
- The consolidation and relocation of the existing I-84 westbound ramps at Interchange 18 to the area west of Country Club Road.
- The consolidation of the existing I-84 eastbound ramps at Interchange 18 in the vicinity of the existing entrance ramp on Chase Parkway.
- The introduction of a new entrance ramp from Field Street to I-84 westbound
- The relocation of Interchange 30 on Route 8 from the Washington Street area to Fifth Street.
- The relocation of the Route 8 northbound exit ramp to I-84 eastbound at Interchange 30 further south to eliminate weaving on the Route 8 northbound mainline.
- New local connections from:
    - Sunnyside Avenue to South Main Street;
    - West Main Street to Meadow Street area;
    - West Main Street to Washington Avenue; and,
    - Bank Street to Baldwin Street.
- The conversion of South Leonard Street to a two-way street, south of Washington Avenue.

Conceptual critical cross-sections of Preferred Alternative 8 are illustrated in Figure 5-3 through Figure 5-7.

Legend

- Signage Improvements
- Signal Timing Improvements
- Signal Coordination
- Local Road Improvements
- New Bus Transit Route
- Pedestrian Facility Improvements
- Proposed Multi-use Trail
- To be Removed

N

0' 300' 600' 900'

PREFERRED ALTERNATIVE 6

I-84 / ROUTE 8 WATERBURY INTERCHANGE NEEDS STUDY

Waterbury, Connecticut

WilburSmith ASSOCIATES

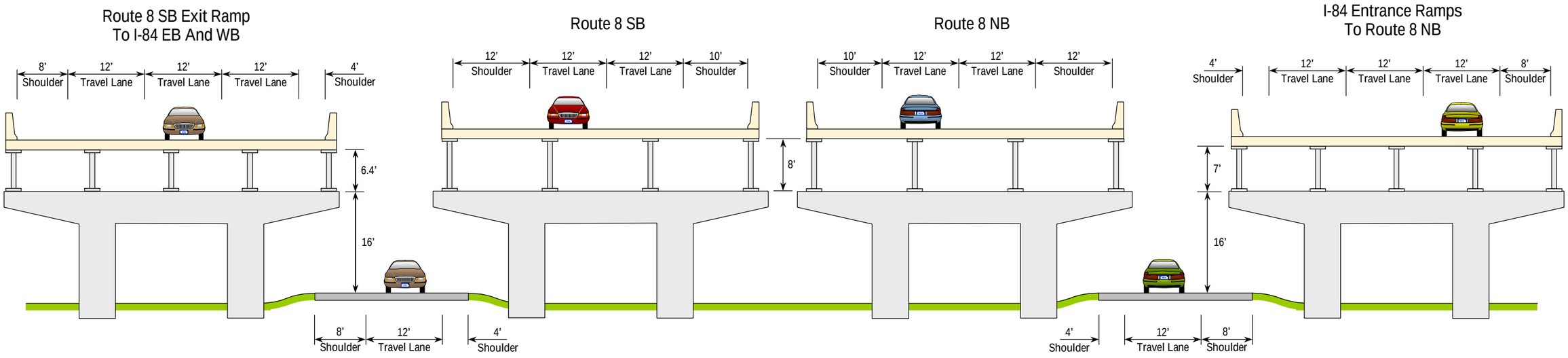
FIGURE 5-1

PREFERRED ALTERNATIVE 8

I-84 / ROUTE 8 WATERBURY INTERCHANGE NEEDS STUDY
Waterbury, Connecticut

WilburSmith ASSOCIATES

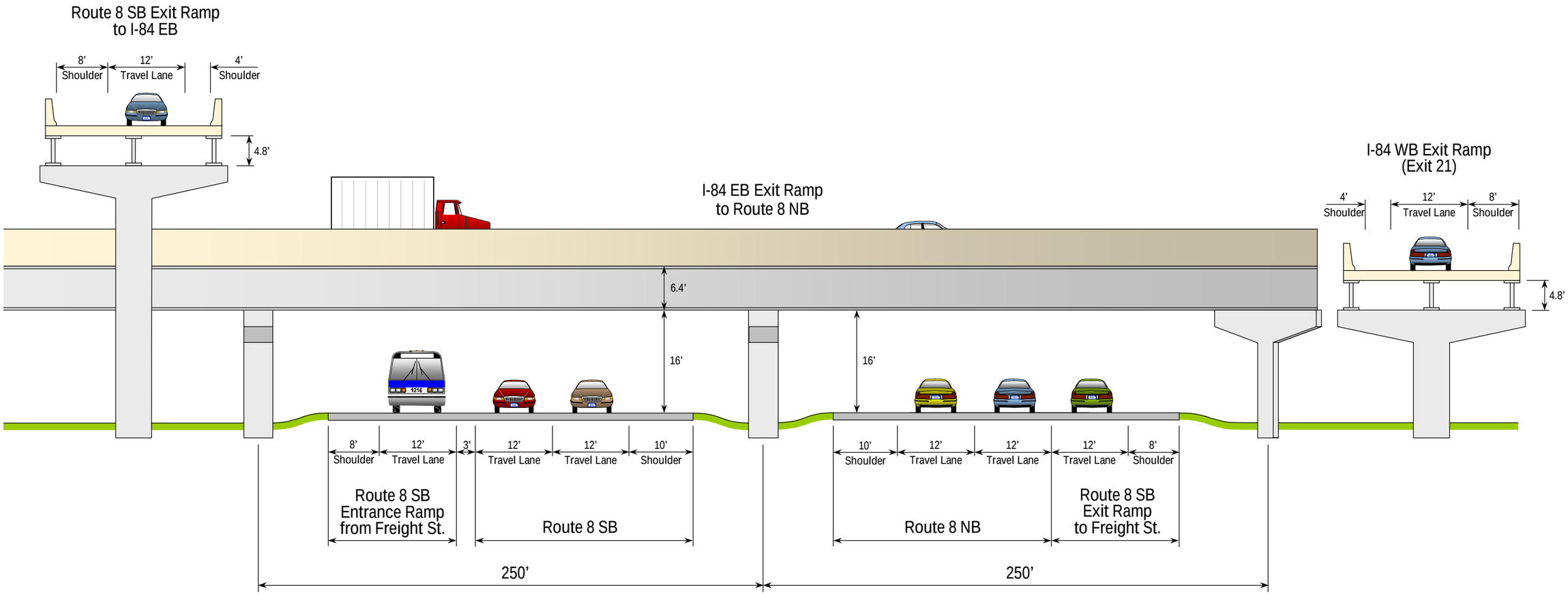
FIGURE 5-2



Route 8 SB Entrance Ramp
From Freight St.
(Existing Elevation +270’)

Route 8 NB Exit Ramp
To Freight St.
(Existing Elevation +270’)

Conceptual, Not To Scale



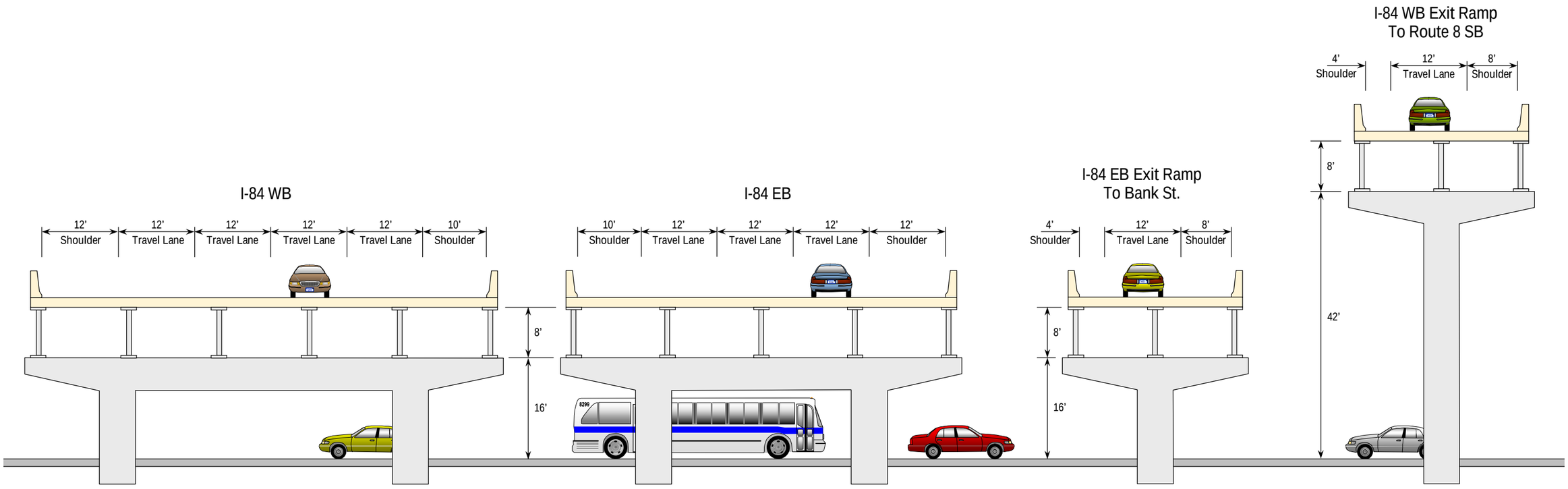
(Existing Elevation +270')

Conceptual, Not To Scale

WilburSmith ASSOCIATES

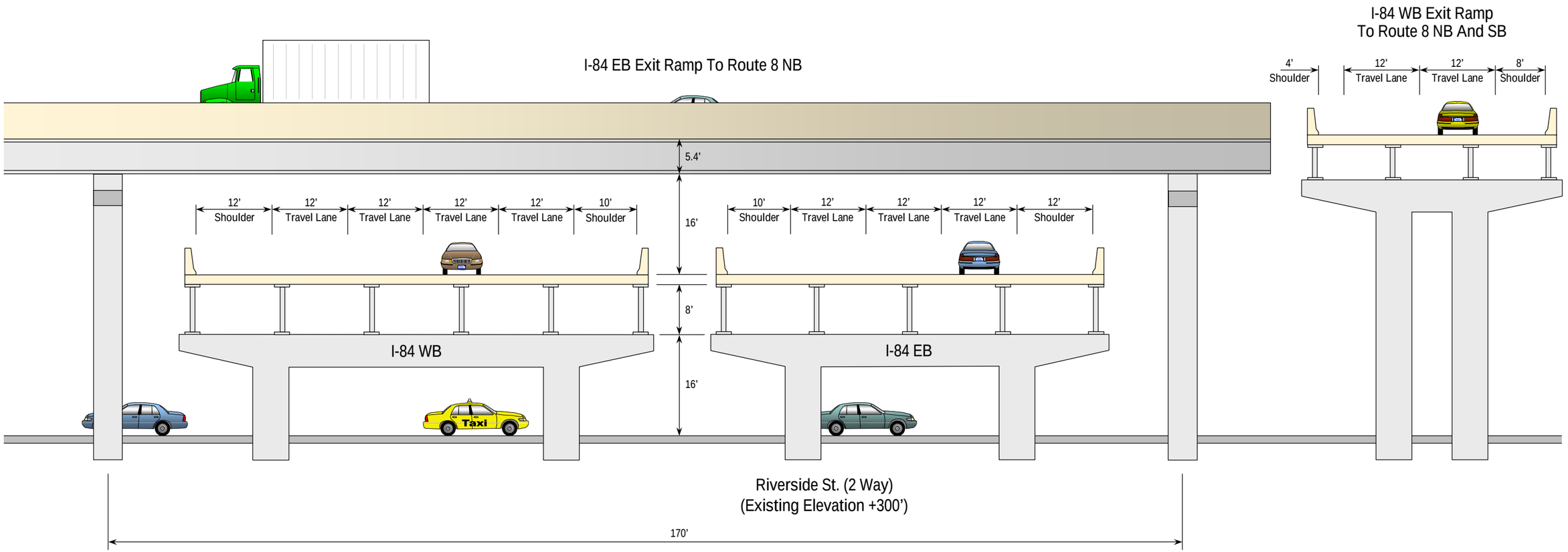
PREFERRED ALTERNATIVE CRITICAL CROSS SECTIONS - SECTION B-B

FIGURE 5-4

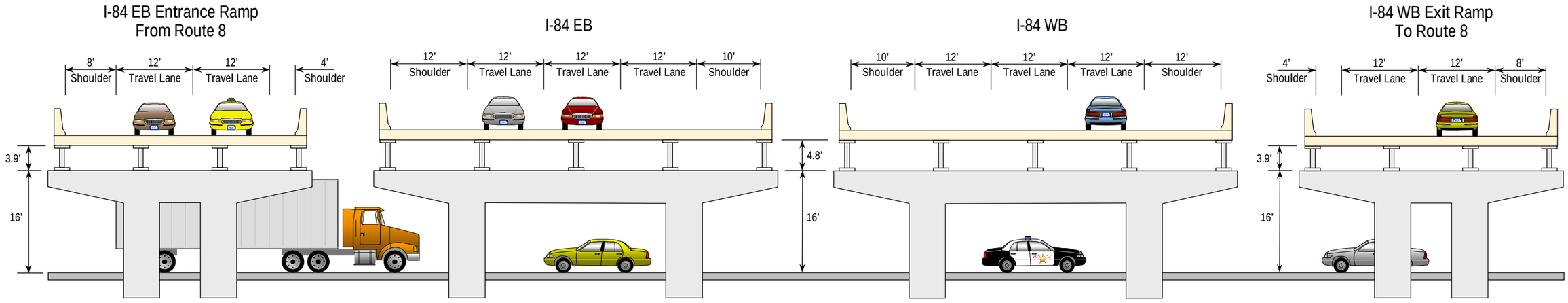


Jackson St. Connector (2 Way)
(Existing Elevation +260’)

Conceptual, Not To Scale



Conceptual, Not To Scale



Conceptual, Not To Scale

5.2 Visualization of Alternative 8

To better understand the visual impact of the Preferred Alternative, photosimulations looking north and west were developed on an aerial photograph of the I-84/Route 8 Interchange. Figure 5-8 shows the existing configuration of the interchange.

Figure 5-8: Existing Interchange

The Preferred Alternative's alignment would bisect the industrial properties on the east side of the Naugatuck River and reclaim the land currently occupied by the existing Route 8 ramps. This alternative would have some visual impact because it is considerably different from the current interchange layout. Numerous opportunities exist to redevelop adjacent industrial land, as well as accommodate new waterfront uses, with this alternative. Overall, it is anticipated that the Preferred Alternative will result in more developable land than the other alternatives and will open up more riverfront property for new uses. The vertical profile will be significantly lower than the existing structure and the intent is to construct visually appealing and safe pedestrian access to the west side of the structure. Every attempt will be made to minimize the physical barrier created by the realignment.

Figure 5-9 shows a rendering of the Preferred Alternative at the I-84/Route 8 Interchange looking north on Route 8.

Figure 5-9: Looking North on Preferred Alternative 8

Figure 5-10 shows a rendering of the Preferred Alternative at the I-84/Route 8 Interchange looking west on I-84.

Figure 5-10: Looking West on Preferred Alternative 8

It should be noted that the example land uses depicted in these photo-simulations are not intended to be viewed as recommendations for future development and have not yet been reviewed by the City of Waterbury.

6 Traffic and Safety Improvements

6.1 Capacity Improvements

During the course of this study, capacity and safety analyses were conducted for the Preferred Alternative. This section presents a summary of the traffic operation and safety improvements that can be realized under the Preferred Alternative.

6.1.1 Freeway Capacity Analysis

Freeway segments on both the I-84 and Route 8 mainline were analyzed under the future (2030) No-build and Build condition with the Preferred Alternative in place. The results of the analysis on I-84 and Route 8 are presented in Table 6-1 and Table 6-2 respectively.

Table 6-1: Future (2030) Freeway Capacity Analysis Summary-I-84

SECTION ALONG I-84	No-Build		Preferred Alternative	
	EB	WB	EB	WB
Between Int. 17 and Int. 18	F(F)	F(F)	C(D)	C(C)
Between Int. 18 and Int. 19	D(E)	D(D)	C(C)	D(D)
Between Int. 19 and Int. 20	F(F)	D(D)	D(D)	D(D)
Between Int. 20 and Int. 21	E(E)	D(D)	D(D)	D(D)
Between Int. 21 and Int. 22	E(E)	F(F)	D(D)	D(D)
Between Int. 22 and Int. 23	F(F)	F(E)	C(C)	D(D)
East of Int. 23	D(D)	F(F)	D(D)	D(D)

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

As illustrated in Table 6-1, most segments on the I-84 mainline would operate at LOS E or F during future (2030) No-Build peak hour conditions. Under the Preferred Alternative, it is anticipated that all segments would operate at LOS D or better under future (2030) peak hour conditions.

Table 6-2: Future (2030) Freeway Capacity Analysis Summary-Route 8

SECTION ALONG RTE 8	No-Build		Preferred Alternative	
	NB	SB	NB	SB
Between Int. 29 and Int. 30	D(E)	C(C)	B(C)	D(D)
Between Int. 30 and Int. 31	D(F)	E(E)	C(D)	C(C)
Between Int. 31 and Int. 32	C(D)	B(B)	C(D)	C(C)
Between Int. 32 and Int. 33	B(C)	C(C)	-	B(B)
Between Int. 33 and Int. 34	C(E)	E(C)	B(D)	C(B)
Between Int. 34 and Int. 35	C(F)	E(D)	D(C)	D(C)

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

As illustrated in Table 6-2, most segments on the Route 8 mainline would operate at LOS E or F during future (2030) No-Build peak hour conditions. Under the Preferred Alternative, it is anticipated that all Route 8 segments would operate at LOS D or better.

6.1.2 Ramp Merge/Diverge Analysis

Table 6-3 and Table 6-4 present the ramp merge/diverge analysis for the I-84 eastbound and westbound directions respectively while Table 6-5 and Table 6-6 represent the ramp analysis for the Route 8 northbound and southbound directions.

Table 6-3: Future (2030) Ramp Analysis Summary – I-84 Eastbound

	No-Build	Preferred Alternative
Interchange 18		
Exit ramp to Chase Parkway	F(F)	C(C)
Entrance ramp from Chase Parkway	F(F)	C(B)
Interchange 19		
Entrance ramp from Chase Parkway	-	B(C)
Exit ramp to Route 8 SB	F(F)	A(A)
Exit ramp to Route 8 NB	F(F)	A(A)
Entrance ramp from Highland Ave.	F(F)	-
Exit Ramp to Bank Street Connector	-	C(C)
Interchange 20-21		
Entrance ramp from Route 8 SB	F(F)	C(C)
Entrance ramp from Route 8 NB	F(F)	C(C)
Exit ramp to Meadow Street	F(F)	-
Entrance ramp from Meadow Street	F(F)	-
Interchange 22		
Exit ramp to South Main Street	F(F)	-
Entrance Ramp from Baldwin Street	-	C(C)
Table continued on next page		

	No-Build	Preferred Alternative
Interchange 23		
Exit ramp to Frontage Road	F(F)	C(D)
Entrance ramp from Hamilton Ave.	F(F)	C(D)

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

Table 6-4: Future (2030) Ramp Analysis Summary – I-84 Westbound

	No-Build	Preferred Alternative
Interchange 18		
Exit ramp to West Main St./Highland Ave.	F(F)	-
Entrance ramp from Chase Pkwy.	F(F)	B(B)
Interchange 19		
Entrance ramp from Route 8 SB	F(F)	D(D)
Entrance ramp from Route 8 NB	F(D)	D(D)
Exit ramp to West Main St./Highland Ave	-	A(A)
Interchange 20		
Exit ramp to Route 8 SB	F(F)	C(C)
Exit ramp to Route 8 NB	D(F)	C(C)
Entrance Ramp from Field St.	-	D(D)
Interchange 21		
Exit ramp to Meadow St.	F(F)	-
Entrance ramp from Bank St. (Left)	F(F)	-
Entrance ramp from Bank St. (Right)	F(F)	-
Interchange 22		
Exit ramp to Union St.	F(D)	C(C)
Entrance ramp from Union St.	F(F)	B(B)
Interchange 23		
Exit ramp to Hamilton Ave.	F(F)	C(C)

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

All I-84 ramp merges and diverges within the study area are anticipated to operate at LOS F during either the future (2030) A.M. or P.M. peak hour No-Build condition. Under the Preferred Alternative, all ramps are anticipated to operate at LOS D or better.

Table 6-5: Future (2030) Ramp Analysis Summary – Route 8 Northbound

	No-Build	Preferred Alternative
Interchange 30		
Exit ramp to South Leonard Street	B(C)	B(C)
Entrance ramp from South Leonard Street	C(D)	C(D)
Interchange 31		
Exit ramp to I-84 EB	C(D)	C(D)
Interchange 32		
Exit ramp to Riverside St.	B(C)	-
Interchange 33		
Exit ramp to I-84 WB	B(C)	B(C)
Entrance ramp from I-84 EB	B(D)	-
Entrance ramp from Riverside St.	D(F)	-
Entrance ramp from I-84 WB	C(F)	A(A)
Interchange 34		
Entrance ramp from W. Main Street	D(F)	A(A)
Interchange 35		
Exit ramp to Route 73*	N/A	N/A

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

Table 6-6: Future (2030) Ramp Analysis Summary – Route 8 Southbound

	No-Build	Preferred Alternative
Interchange 30		
Exit ramp to Charles Street	D(D)	D(D)
Entrance ramp from Charles Street	D(D)	D(D)
Interchange 31		
Entrance ramp from I-84 WB	D(D)	D(D)
Entrance ramp from I-84 EB	C(B)	D(D)
Entrance ramp from Riverside	B(B)	-
Exit ramp to I-84 EB	F(C)	-
Interchange 32		
Exit ramp to Riverside St.	F(E)	-
Interchange 33		
Entrance ramp from West Main Street	-	B(B)
Exit ramp to I-84 WB	E(C)	-
Exit ramp to Freight Street	-	B(B)
Entrance ramp from Freight Street	-	C(D)
Interchange 34		
Exit ramp to W. Main Street	C(C)	C(B)
Interchange 35		
Entrance ramp from Route 73	N/A	N/A

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

For Route 8, seven (7) ramp merges/diverges are anticipated to operate at either LOS E or F during either the future (2030) AM or PM peak hour No-Build condition. Under the Preferred Alternative, all ramps are anticipated to operate at LOS D or better during peak periods.

A comparison of the LOS for ramps and mainline segments under the No-Build and Preferred Alternative is presented in Table 6-7.

Table 6-7: Future (2030) Level of Service Summary

	No Build Condition	Preferred Alternative
Freeway Analysis – I-84		
LOS A-C	0	7
LOS D	9	21
LOS E-F	19	0
Freeway Analysis – Route 8		
LOS A-C	12	15
LOS D	4	7
LOS E-F	8	0
Ramp Analysis – I-84		
LOS A-C	0	34
LOS D	3	6
LOS E-F	45	0
Ramp Analysis – Route 8		
LOS A-C	16	15
LOS D	11	11
LOS E-F	7	0
TOTALS		
LOS A-C	**28**	**71**
LOS D	**27**	**45**
LOS E-F	**79**	**0**

6.2 Geometric Improvements

Geometric conditions under the Preferred Alternative and the No-Build condition were assessed during this study based on guidelines from AASHTO-2001 Edition and the CTDOT's Highway Design Manual-2003 Edition. The following deficiencies were assessed as part of the exercise.

- Left hand ramps;
- Substandard grades;
- Substandard acceleration and deceleration lengths;

- Substandard ramp spacing;
- Substandard curve radius; and
- Substandard ramp superelevation
- Lane discontinuity
- Substandard shoulder widths

A summary of geometric under the Preferred Alternative and the No-Build condition is presented in Table 6-8 and discussed below.

Table 6-8: Summary of Geometric Deficiencies

Geometric Deficiency	Number of Deficiencies	
	No Build Condition	Preferred Alternative
Left-hand Ramps	8	1
Substandard Grade	3	0
Substandard Acceleration Length	6	0
Substandard Deceleration Length	3	0
Substandard Ramp Spacing	22	5
Substandard Curve Radius	1	0
Substandard Superelevation	2	0
Mainline lane discontinuity	8	0
Substandard shoulder widths	8	0
Total	**61**	**6**

Left hand ramps
There are currently eight (8) left hand ramps within the study area. Under the Preferred Alternative, seven (7) of these left hand ramps would be eliminated.

Substandard Grades
There are three (3) ramps with substandard grades were identified under the existing highway configuration. Under the Preferred Alternative all sub-standard ramps would be improved.

Substandard Acceleration and Deceleration Lengths
There are currently six (6) substandard ramp acceleration lengths and three (3) substandard deceleration lengths on the highway system. Under the Preferred Alternative, all substandard acceleration and deceleration lengths would be improved.

Substandard Ramp Spacing
Under the existing interchange configuration, there are twenty-two (22) segments with ramp spacing deficiencies within the study area. Under the Preferred Alternative, there would be five (5) segments with substandard ramp spacing. These segments are:

- The I-84 eastbound segment from the Route 8 northbound entrance ramp to the Interchange 23 exit ramp (1395 feet);
- The Route 8 northbound segment from the Interchange 30 entrance ramp to the exit ramp to I-84 eastbound (1350 feet);

- The Route 8 northbound segment from the I-84 eastbound exit ramp to the I-84 westbound exit ramp (855 feet);
- The Route 8 southbound segment from the West Main Street entrance ramp to the I-84 westbound exit ramp (520 feet); and
- The Route 8 southbound segment from the I-84 entrance ramp to the Interchange 30 exit ramp (1310 feet).

It is expected that more detailed engineering design will identify solutions to address the remaining substandard spacing issues.

Substandard Curve Radius
Under the existing highway configuration, the I-84 westbound exit ramp at Interchange 18 is the only ramp with a substandard curve radius. Under the Preferred Alternative there would be no curves with substandard radius.

Substandard Ramp Superelevation
Under the No-Build condition, there are two ramps with substandard superelevation rates. Under the Preferred Alternative, there would be no ramps with substandard superelevation rates.

Mainline Lane Discontinuity
Under the No-Build condition, there are eight locations were mainline lanes are discontinued. Under the Preferred Alternative, there would be no locations with mainline lane discontinuity.

Substandard Shoulder Widths
Under the No-Build condition, there are eight locations with substandard shoulder widths. Under the Preferred Alternative, all shoulder widths will be to standard.

7 Environmental Analysis of Preferred Alternative

This Chapter details the screening level assessment of the potential impacts of the Preferred Alternative concept for improvements to this interchange area on natural, cultural, and community resources in the study area. The analysis process for this environmental screening involved the overlay of the preferred alternative on mapped resources. This task was completed primarily for the purposes of identifying potential fatal flaws of the Preferred Alternative concept (significant unavoidable environmental impacts) and to gain a planning-level view of potential issues and concerns associated with the Preferred Alternative configuration. A detailed impact analysis is neither prudent nor possible at this stage of project development. An in-depth analysis will be conducted for compliance with NEPA and CEPA requirements as the Preferred Alternative is advanced into preliminary design. Further refinements to the Preferred Alternative will be developed with the intent to minimize potential impacts identified within this study.

The environmental screening for potential natural resource impacts included an assessment of 100-year and 500-year floodplains, stream channel encroachment lines, wetlands, endangered and/or threatened species and critical habitats, surface and groundwater resources, and active farmlands and farmland soils. With respect to the built environment, the screening considered potential impacts to historic and archaeological resources, public parks and recreational facilities, existing land use and neighborhoods, major employers, and community facilities and institutions such as schools, churches, libraries, and hospitals. Also considered were potential impacts of the Preferred Alternative on concentrated areas of low income and minority (environmental justice) populations, the existing visual and aesthetic characteristics of the study area, known hazardous materials/risk sites, as well as effects on ambient air quality and known noise sensitive land uses.

7.1 Multi-Use Trail Component of the Preferred Alternative

The Preferred Alternative concept for the I-84/Route 8 Interchange Project includes a multi-use trail that runs through the heart of the study area along the eastern side of the Naugatuck River. The planning and development of this multi-use trail, including an assessment of its potential community benefits and environmental impacts is currently being undertaken through two projects separate from this effort. The two projects focusing on the overall Naugatuck Greenway are: one by the Waterbury Development Corporation focusing on Waterbury and the second effort, by the Council of Governments of the Central Naugatuck Valley (COGCNV), focusing on portions of the Greenway north and south of Waterbury. For this reason, potential impacts associated with the multi-use trail are not addressed herein.

7.2 Land Use and Neighborhood Impacts

Potential land use impacts were assessed by overlaying the conceptual design of the Preferred Alternative onto existing land use mapping in order to identify locations where impacts to land use patterns or alterations to land access may occur. Neighborhood cohesion impacts were considered to occur in those instances where the preferred alternative creates a new physical barrier to travel either within an established neighborhood or between a designated neighborhood and a known community facility or key resource.

The new local roads included as part of the Preferred Alternative will enhance access in the vicinity of Waterbury's Downtown and to industrial areas east of the I-84/Route 8 interchange. Access to mixed use commercial and residential areas located east of Route 8 and south of I-84 will also be enhanced. Industrial land acquisitions associated with the new local roadway configuration, however, may disrupt the existing pattern of land use in the area east of and immediately adjacent to the I-84/Route 8 interchange and new access may encourage changes in use. Additionally, a separate economic development analysis of the preferred alternative was completed by the DECD.

Enhanced access to the Country Club, West End, and South End neighborhoods may also be achieved under the Preferred Alternative. However, a drawback is that there may be some residential property takes in each of these neighborhoods as well as some neighborhood business impacts in the South End neighborhood. The creation of a cul-de-sac will also make access more circuitous for those homes and businesses that now have direct access to East Clay Street.

Neighborhood impacts would also involve direct and/or indirect effects on the following schools. Direct effects are those that require acquisition of some or all of a property whereas indirect effects are those occurring at some distance from the property or later in time following project completion. Those effects may include:

- St. Anne's Church/School – South End neighborhood; there may be some indirect effects to the school grounds to accommodate a new local road. This new local road may also enhance access to the school and church over current conditions.
- Maloney Elementary School – South End neighborhood; the reconfigured local road may have a direct impact on the school grounds. It may also direct more traffic past the school altering ease of access to the school during some times of the day.
- Industrial Management and Training Institute – South End neighborhood; the new local road providing access to Exit 22 may have a direct impact on the grounds of this school property.
- Chase Collegiate School – West End neighborhood; potential indirect effect on access to the school and potential direct effect on school grounds/parking area.
- West Side Middle School – West End neighborhood; potential indirect effect on access to the school and potential direct effect on school grounds/parking area.

- Naugatuck Valley Community College - Country Club neighborhood; potential indirect effect on access to the school and potential direct effect on school grounds/athletic fields area.

In addition, the Preferred Alternative could indirectly impact the historic and aesthetic Saint Anne's church in the South End neighborhood, which may be considered a substantive adverse impact to neighborhood cohesion. While there will be no direct impacts to the church cathedral or school building, the change in visual setting and addition of through traffic in the area may alter residents experience of their neighborhood, walkability and neighborhood character.

7.3 Impacts to Major Employers

Impacts to major employers are expected to be mixed. Several major employers may be fully displaced as a result of implementation of the Preferred Alternative. This may occur in the area of warehousing activity along and near Jackson Street. In particular, direct acquisition of all or part of the site for school bus storage/maintenance along Jackson Street is expected to be an adverse effect on the school transportation operations and the numerous employees associated with that. Conversely, there will be a beneficial effect on a variety of both large and small employers with enhanced access to Waterbury's downtown and adjacent commercial areas. The addition of bus service as part of the Preferred Alternative is expected to make job access easier at major employers such as the Brass Mill Mall and Waterbury Hospital.

7.4 Visual/Aesthetic Impacts

I-84 and Route 8 already comprise a substantive component of the study area visual backdrop. The Preferred Alternative will include some additional new local roads as well as substantial reconfiguration of the mainline highways and associated ingress and egress ramps. There will be a number of new bridge and/or ramp structures associated with the relocation of Route 8 to the east of the Naugatuck River. Much of the newly reconfigured I-84 / Route 8 interchange will be elevated above existing ground on piers. The new highway elements can be expected to intensify their predominance in the visual setting of the area; however the overall heights of the I-84 mainline bridge spans will be lower in elevation than the existing stacked viaduct structure.

In addition, the Preferred Alternative could impact the historic and aesthetic Saint Anne's church in the South End neighborhood. While a direct taking or impact to the church cathedral or school building is not planned, the change in visual setting and addition of through traffic in the area may alter residents' experience of their neighborhood, walkability, and neighborhood character. A positive visual benefit resulting from this alternative is the reclaiming of riverfront property on the west side of the Naugatuck River. The relocation of Route 8 will open up some

prime land and may allow for some attractive waterfront development. As discussed above, these economic development opportunities were addressed directly in the DECD report.

7.5 Historic, Archeological and Section 4(f) Resource Impacts

The Preferred Alternative would have a direct impact on Riverside Cemetery, a historic and Section 4(f) resource due to its listing on the National Register of Historic Places (NRHP). Another potential historic resource that would be indirectly impacted is Saint Anne's church located on South Elm Street. This church may be eligible for listing on the NRHP.

Some of the local roads to be improved under the Preferred Alternative concept appear to abut the edges of the Downtown Waterbury National Register Historic District. These improvements will primarily be enhancements to existing streets at the district's edge and consequently the impact to this historic district is expected to be minor.

With respect to public parkland that is protected under Section 4(f), there are two such parks that potentially would be directly impacted by the Preferred Alternative

- Chase Park (both parcels – located north and south of I-84 and west of Route 8). The northern parcel would be bisected by the proposed reconfiguration of local roadways and the southern parcel would be partially bridged by the new highway infrastructure.
- Library Park situated north of I-84 and just east of Route 8 may be affected by improvements to local roads there.

7.6 Community Facilities and Resource Impacts

The Preferred Alternative may benefit some community facilities indirectly by improved access on local roads in the northeast quadrant of the study area. This includes the downtown with a concentration of community resources such as the library. This Preferred Alternative is also expected to result in enhanced access to the Central Naugatuck Valley Community College off of Chase Parkway on the north side of I-84 near Interchange 19.

7.7 Environmental Justice

The Preferred Alternative is expected to improve access to community resources and employment opportunities for EJ populations. This is an important beneficial effect of the alternative considering the entire study area constitutes an EJ region within the City of Waterbury. However, a closer look at the Census Block groups within the study area relative to the percentage of minority populations indicates that the Preferred Alternative may also have some adverse impacts to the most highly concentrated EJ populations within the study area. In particular, potential residential property acquisitions and impacts to the South End neighborhood may create a direct negative impact to EJ neighborhood cohesion more so than would be experienced by the general population of the study area as a whole or the City of Waterbury.

Similarly, loss of subsidized housing in this area will have an adverse effect on housing opportunities for environmental justice populations and can be disruptive to social interaction and economic stability for displaced families.

7.8 Impacts to Surface and Groundwater

The Preferred Alternative may have some impact to rivers and streams where new support structures (piers) would be constructed adjacent to them or where reconstruction of existing bridges across these water bodies is required. The Preferred Alternative would include a modified river crossing on Sunnyside Avenue and new support structure for the interchange itself over the Naugatuck River. It may also include potential impacts to an unnamed stream in the vicinity of Interchange 19. Additionally, while the Mad River flows underground through the core of the study area, the widening and reconstruction of Interchanges 30 and 33 on Route 8 as well as Interchange 23 on I-84 may have an impact on this resource, especially if substantial excavation is required. The Preferred Alternative also includes modified crossings of the Naugatuck River on Freight and West Main Street which may impact the Naugatuck River in those locales.

7.9 Impacts to Floodplains and Stream Channel Encroachment Lines

Most of the new or improved local roads proposed as part of the Preferred Alternative occur within the Naugatuck River 500-year floodplain. A proposed new roadway located south of I-84 that extends from Bank Street east towards Baldwin Street may be partially located in a 100-year floodplain. Consequently, there may be some adverse effects to floodplain resources.

The Naugatuck River 100-year floodplain and stream channel encroachment line (SCEL) may also be impacted by new support structures for the new interchange configuration. In addition, the proposed West Main Street and Freight Street crossings of the Naugatuck River may further impact 100-year floodplain and SCEL.

7.10 Impact to Wetlands

Overlaying the Preferred Alternative onto a CTDEP GIS coverage depicting state and federal wetlands reveals that the Preferred Alternative does not appear to have any impacts to known, mapped wetlands. Site reconnaissance will be necessary during future planning and engineering studies to verify the presence and/or absence of wetlands in the project study area and any potential impacts should they exist.

7.11 Endangered Species

According to the DEP Natural Diversity Database there are no records of any threatened or endangered species or species of special concern within the project study area. The U.S. Fish and Wildlife Service (USFWS), 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. Therefore, no impacts to this resource are anticipated from the Preferred Alternative. However, the USFWS requires that consultations relative to threatened and/or endangered species and critical habitats be updated annually if the project is to move forward.

7.12 Impacts to Hazardous Materials Risk Sites

The Preferred Alternative has the potential to encounter hazardous materials during construction of local roads in the vicinity of the Freight Street industrial area and in any location where the project may interface with the rail line. This would include the new connector roads proposed between West Main Street and Bank Street. Construction of the new local road located south of I-84 that extends from Bank Street east towards Baldwin Street may also encounter hazardous materials given the mixed land use in this area. In addition, the alternative may have the potential to disturb hazardous risk sites in the vicinity of the proposed reconfiguration and/or reconstruction of several exits including Interchanges 22 and 23 on I-84 and Interchange 30 on Route 8.

7.13 Impacts to Prime Farmlands

Due to the developed nature of the study area, no significant impacts to prime or statewide important farmland soils are anticipated from the Preferred Alternative. Areas where these soils occur and may be affected by the Preferred Alternative are in use for purposes other than farming and the potential for future agricultural use is negligible.

7.14 Impacts to Air Quality

The primary source of potential air quality impacts with this project would be motor vehicles. The Preferred Alternative is intended to enhance the existing roadway infrastructure to improve safety and reduce congestion. As proposed it will not increase traffic volumes on the highway mainlines, but will be configured to respond to growth in travel demand that will occur in the area over time. Nonetheless, there may be some localized change to air quality as new ramps and intersections alter traffic flows and potentially add traffic to some new spot locations in the study area. In summary, no significant adverse impacts to air quality are anticipated and some beneficial effect may occur if congestion and related idling of vehicles is reduced.

7.15 Impacts to Noise Sensitive Receptors

The noise sensitive receptors in the project study area occur in an urban environment where a heightened level of background noise is common. I-84 and Route 8 are existing highway structures that contribute to that background noise under existing conditions. The Preferred Alternative will move these highway elements as well as local roads closer to some noise sensitive resources, particularly residences. Consequently, there may be some limited adverse noise impacts but these impacts are not expected to elevate area noise levels significantly. Areas of particular concern include Waterbury Hospital and the residential neighborhoods close to Interchanges 18 on I-84 and 30 on Route 8. There may be some particular yet minor adverse noise effects from the Preferred Alternative in these locations.

8 Cost Estimates of Preferred Alternative

8.1 Civil Highway Cost Estimates

For the preferred alternative, construction costs were developed for the following civil highway construction items as applicable:

- Earthwork and Embankment Items
- Drainage and Hydraulics Items
- Pavement and Subgrade Items
- Traffic Signals and Traffic Safety Related Items
- Roadside Safety Items

8.1.1 Costing Assumptions and Justification

Unit costs for each of the various civil highway items were based on the Connecticut Department of Transportation Preliminary Cost Estimating Guidelines dated January 2009, CTDOT Weighted Unit Pricing documents, past experience, and professional judgment.

Quantities for earthwork and embankment items were developed from the measurement of overall lengths of roadway on embankment, the width of various roadway types based on standard cross sectional dimensions (a.k.a. 12 foot travel lanes, inside and outside shoulders up to 10 feet wide and inside and outside berms up to 4 feet), and assumed heights of embankment. The preferred alternatives depict various roadways crossing over or under other roadways within the corridor. It was assumed that there is a 22-foot difference in elevation between roadways that cross one another. Additionally, it was assumed that along the length of various roadways there is a transition in height from one crossing level to another and a varied height above the existing ground elevation to various roadway crossing elevations.

The length, width, and height determinations were combined to arrive at cubic volumes of earthwork for each roadway segment. The segments were totaled and assumption was made that 60 % of the total volume of earthwork was on filled embankment and 40% of the total volume of earthwork was existing ground to be excavated.

Of the excavated earthwork volume 15% was assumed to be rock excavation. The excavation and redistribution of on-site (waste) earthwork materials is generally considered to be less expensive by volume than the location, hauling and placement of off-site (borrow) earthwork materials. Proper handling, treatment and disposal of contaminated and hazardous earth materials can be very expensive, especially in a historically active manufacturing city such as Waterbury.

At this stage of alternative development, details concerning the existence of rock, contaminated and hazardous soils, unsuitable materials (muck), and borrow quantities versus waste quantities, are not available. In order to provide a conservative buffer of potential project costs, volumes of these expensive items were assumed to be present and required.

Drainage and hydraulic items were calculated based on the assumption that new roadways would require new drainage infrastructure while widened or resurfaced existing roadways would require expansion or renovation of the existing drainage system.

Pavement and sub-grade items include bituminous pavement, formation of sub-grade (fine grading and accurate surveying of top of embankment), sub-base (processed aggregate material between the top of earth embankment and bottom of bituminous pavement) and concrete pavement. Quantities for the various pavement and sub-grade items were developed similar to the earthwork items described above.

Traffic signals and traffic safety features such as pavement markings and signage were quantified based on specific intersection requirements for the Preferred Alternative.

Roadside safety items including concrete median barrier, curbing and guiderail were calculated using the overall lengths of various roadways and professional judgment as to the extent of usage. Median barrier was assumed to be required on 15% of the overall length of mainline roadways. Curbing was assumed to be required the length of all turning roadways, ramps and local streets. Guiderail was assumed to be required on 20% of the overall length of all roadway segments.

8.2 Structural Cost Estimates

For each of the near and long term components of the Preferred Alternative, costs were developed for proposed bridges, retaining walls, miscellaneous and temporary structures, demolition, and repair. The results are discussed further in the following narrative.

8.2.1 Costing Assumptions and Justification

Proposed Bridges

A raw structure cost of $375 per square foot of deck area was used for the majority of the proposed bridges. Bridges that were deemed difficult to construct due to limited access, as well as the flyover ramp structures, were assessed a higher cost per square foot of deck area. These costs were based on several sources, namely, the Connecticut Department of Transportation Preliminary Cost Estimating Guidelines dated January 2009, bid tabulations for the recently awarded New Haven Harbor Crossing Improvements Contracts C2, B1, & B, past experience, and professional judgment.

The 2009 CDOT Preliminary Cost Estimating Guidelines state that new bridges should be estimated at $375 per square foot. However, it should be noted that this number has changed significantly from the 2005 Guidelines. Actual individual items may have had a higher inflationary cost (chiefly fuel, Portland cement, and structural steel).

Bid tabulations for Contract C2 resulted in structure costs between approximately $250 and $475 per SF. The ramp structures varied between $280 and $475 per square foot, while the mainline single span structure was $250 per square foot.

Retaining Walls

Based on current projects that are in the design phase, as well as past experience and judgment, a raw unit cost of $140 per square foot of exposed face of wall was used for the proposed retaining walls.

Miscellaneous & Temporary Structures

These structures include primarily temporary bridge structures that may be required to maintain traffic during reconstruction of the interchange. Since the scope of this study did not allow for evaluating the maintenance and protection of traffic and construction staging in detail, a lump sum cost for each alternative was assumed based on professional judgment and past experience.

Demolition

Demolition cost was estimated as $85 per square foot of deck area. The 2009 CDOT Preliminary Cost Estimating Guidelines state that Removal of Superstructure should be estimated at approximately $75 per square foot for removal over water or rail, which constitutes the majority of the structures to be removed. An additional $10 per square foot was estimated for substructure demolition.

Repair

A prior phase of this study investigated a condition assessment for all existing structures associated with the general area of this interchange, and assigned required repairs to each structure. In this phase, costs were assigned to each repair type based on broad assumptions.

Repair types were classified as Routine Maintenance, Deck Patching, Deck Replacement, Substructure Patching, Complete Painting, Spot Painting, Bearing Replacement, Repair Impact Damage to Beams, Safety Walk Retrofit, and Seismic Retrofit. Estimates of costs for significant repair types such as Deck Patching, Deck Replacement, Complete Painting, Spot Painting, and Safety Walk Retrofit were developed, while nominal costs per square foot were assigned for the other types of repairs based on past experience and professional judgment.

- Deck Patching – the 2009 CDOT Guidelines suggest using $3,000 per cubic yard for full depth patching. Assuming an 8” thick deck, this translates into approximately $75 per square foot of deck area.

- Deck Replacement – the 2009 CDOT Guidelines suggest using $100 - $150 per square foot of deck area. $125 per square foot was used for this study.
- Complete Painting – based on experience, the 2009 cost for this item was estimated to be approximately $30 per square foot of painted area. This cost includes containment required for lead-based paints. A typical 5' deep steel plate girder with 18" wide flanges represents approximately 14.5 square foot of painted area; adding 20% to account for details results in 17.4 square foot of painted area; using a typical 8.5' spacing yields roughly two square feet of painted area per square foot of deck area. Therefore a cost of $60 per square foot of deck area was used.
- Spot Painting – this was estimated to be 5% of the area of complete painting, resulting in a cost of $3 per square foot of deck area.
- Safety Walk Retrofit – based on recent weighted unit bid prices, this retrofit item is approximately $170 per linear foot. For a typical 50' wide bridge with two parapets, this translates to a 2009 unit cost of approximately $7.50 per square foot of deck area.

8.2.2 Discussion of Structural Improvements

Preferred Alternative 6

This alternative involves only minor structural improvements. Four new bridges and ten new retaining walls are proposed, with no requirements for miscellaneous & temporary structures anticipated. Three bridges would be demolished under this alternative. Repairs would be made to all existing structures within the project limits, except for the three bridges being demolished. While this is the least costly alternative in terms of initial cost, it is likely to be at least as expensive as the full-build alternatives in terms of life cycle cost, due to the tendency for construction costs to outpace inflation over time.

Preferred Alternative 8

This alternative is the full-build alternative, and involves shifting the alignment of I-84 over the Naugatuck River to the south, shifting a portion of Route 8 northbound and southbound to the east of the river, and reconstructing the I-84/Route 8 interchange to the east of the river. In addition, several bridges along the I-84 and Route 8 corridors in the vicinity of the interchange would be constructed or replaced.

A total of 52 new bridges and 34 new retaining walls are proposed for this alternative. For a few of the bridges within the interchange itself, pier placement will be very limited and will depend on the maintenance and protection of traffic and construction staging sequencing. However, we would expect that cranes would generally be able to access the site, resulting in conventional construction for all of the proposed bridges. It is expected that this alternative will require some temporary structures and other works in order to be able to maintain traffic during construction. Therefore, we have provided a budget of $10,000,000 for miscellaneous and temporary structures for this alternative.

A total of 40 existing structures would be demolished and a total of two existing structures would be retained and repaired for this alternative.

8.3 Lump Sum Items

Costs were developed for Lump Sum Items and included the following:

- Clearing And Grubbing (2%)
- Maintenance & Protection of Traffic (4%)
- Mobilization (7.5%)
- Construction Staking (1%)

The lump sum item percentages were applied to the sum of Civil Highway and Structural Costs.

Also, costs were developed for Additional Items and included the following:

- Incidentals (21%)
- Contingencies (10%)
- Utility Cost (3%)
- Right-Of-Way (Estimated)

The additional item percentages were applied to the sum of Civil Highway Costs, Structural Costs and Lump Sum Items.

A summary of Cost Estimates for the Preferred Alternative is presented in Table 8-1.

Table 8-1: Summary of Preferred Alternative Costs

Item	Preferred Alternative 6	Preferred Alternative 8
Civil Highway Items	$23,080,848	$158,718,979
Structural Bridge Items	$180,161,804	$800,187,094
Subtotal A (Major Items)	**$203,242,652**	**$958,906,073**
Minor Items (25%)	$50,810,663	$239,726,518
Subtotal B	**$254,053,315**	**$1,198,632,591**
Lump Sum Items	$36,837,731	$173,801,726
Subtotal C	**$290,891,046**	**$1,372,434,317**
Additional Items	$118,902,956	$516,627,668
Total Cost	**$409,794,001**	**$1,889,061,984**
2009 Total Cost (Rounded)	**$409,800,000**	**$1,889,100,000**
Total Cost based on an assumed 2015 and 2030 year of construction for Alternative 6 and 8 respectively[1]	**$581,300,000**	**$6,422,100,000**

Note:
[1] based on a 6% inflation rate provided by CTDOT

9 Constructability Review

9.1 Conceptual Construction Sequencing of Preferred Alternative 8

Preferred Alternative 8 is a "Full-Build" Alternative expanding mainline capacity and enhancing safety by removing left-hand exit and entrance ramps and increasing spacing between ramps. The following is a construction phase sequence for Preferred Alternative 8 and a list of construction impacts that will potentially affect the cost and duration of the project. The phasing sequence is also illustrated in Figures 9-1 to 9-6.

Phase 1 – Construct New Alignment Not Impacting Existing (Figure 9-1)

- Construct Route 8 mainline new alignment and associated ramps to limits not impacting existing traffic flow east of the Naugatuck River. Approximately from West Main Street at the northern end to Jackson Street at the southern end.

- Construct I-84 mainline new alignment and associated ramps to limits not impacting existing traffic flow. Approximately from the east side of the Naugatuck River to South Elm Street.

- Consider shifting ramp for proposed I-84 westbound to Route 8 NB/SB split – Moving the split 50'-100' south of its current alignment would allow for construction of this interchange without impacting traffic flow on existing I-84. This would also eliminate the need for additional temporary roads and bridges to maintain traffic flow during construction.

Phase 1A – Route 8 – Northern and Southern Most Alignment (Figure 9-1)

- At the northern end of existing Route 8, north of West Main Street – Widen existing Route 8 SB to accommodate traffic switches and temporary realignments of existing Route 8 NB/SB during the construction of proposed Route 8 mainline. This widening will also serve as a means to keep the existing Route 8 SB to I-84 westbound ramp active when proposed Route 8 alignment is open.

- At the southern end of existing Route 8, south of Bank Street – Widen existing Route 8 SB to accommodate traffic switches and temporary realignments of existing Route 8 NB/SB during the construction of new ramps, bridges and proposed Route 8 mainline.

Phase 1B – Route 8 – Local Road Improvements (Figure 9-1)

- At the northern end of Route 8 – Upgrade existing local road alignments and build proposed roads and ramps to aid in rerouting traffic during non-peak hours for construction purposes.

- At the southern end of Route 8 – Upgrade existing local road alignments and build proposed roads and ramps to aid in rerouting traffic during non-peak hours for construction purposes.

Phase 2 – Transition Existing Route 8 to Proposed Alignment (Figure 9-2)

- Proposed Route 8 – Transition existing mainline to new alignment.

- At the northern end of Route 8
  - Maintain existing Route 8 southbound ramp to I-84 westbound on existing alignment until proposed I-84 is complete.
  - Transition Route 8 southbound to I-84 eastbound onto new alignment. Meet and match existing I-84 at grade between South Elm Street and Baldwin Street.

- At the southern end of Route 8
  - Transition Route 8 northbound to I-84 eastbound onto new alignment. Meet and match existing I-84 at grade between South Elm Street and Baldwin Street.
  - Temporary roadwork and bridgework will be required in order to transition Route 8 northbound to I-84 westbound. Access to the existing Route 8 and I-84 interchange must be available to transition to proposed alignment.

Phase 3 – Construct I-84 Collector Distributor Roads (Figure 9-3)

- On the west side of Interstate 84.
  - Construct eastbound and westbound collector-distributor roads, bridges and associated on and off ramps to accommodate traffic switches for the construction of proposed I-84 mainline alignment. The intent is to shift existing NB/SB traffic to the outside on the new collector-distributor and construct the new proposed mainline alignment.

  - Transition ramp traffic on new alignment west of Highland Avenue.

  - Highland Avenue Bridge - Possible need for a temporary bridge to maintain traffic flow and avoid congestion of secondary roads north and south of I-84.

- On the east side of Interstate 84.
  - Construct an oversized (width) proposed I-84 Exit 22 off-ramp to be used as temporary I-84 eastbound. This new ramp will also be utilized for staging traffic switches and temporary realignments during the construction of proposed I-84 mainline alignment. The intent is to shift existing eastbound traffic onto the new

oversized ramp and shift westbound traffic onto the existing eastbound highway. This will allow proposed I-84 westbound to be constructed. Westbound traffic will then be shifted east onto the new westbound alignment in order to construct the new proposed I-84 eastbound alignment.

- Construct bridges and associated on and off ramps.

- Transition ramp traffic on new alignment east of Baldwin Street.

- Baldwin Street Bridge - Possible need for a temporary bridge to maintain traffic flow and avoid congestion of secondary roads north and south of I-84.

Phase 4 – Demolish Elevated Portions of Existing Route 8 (Figure 9-4)

- Demolish elevated portions of existing Route 8 while maintaining Route 8 NB ramp traffic to existing I-84 westbound.
  - Demolish elevated portions of existing Route 8 where proposed I-84 is to be constructed. Lower levels of existing Route 8 may be utilized for construction staging purposes and traffic switches while remaining proposed I-84 bridges, fly-over's and ramps are constructed.

Phase 5 – Construct Remaining Proposed I-84 Interchange (Figure 9-5)

- Construct remaining portions of proposed I-84, surface roads and bridges.

- Consider shifting the proposed I-84 alignment on the west side of the Naugatuck River to the south in an effort not to impact existing I-84 traffic while constructing the four new bridges crossing the Naugatuck River. More specifically, move proposed Route 8 NB/SB to I-84 WB ramp/bridge, proposed I-84 NB/SB bridges and proposed Exit 19 ramp/bridge. By shifting this alignment south and moving the bridges closer together, the impact on existing I-84 traffic will be greatly reduced during construction.

  - Based on the new alignment mentioned above, construct remaining proposed I-84 bridges, ramps, and flyovers crossing the Naugatuck River.

  - Construct remaining portions of I-84 mainline and collector-distributor ramps on the west side of the Naugatuck River to Highland Avenue.

  - Construct remaining portions of proposed Route 8 NB/SB to I-84 westbound ramps.

  - Construct remaining bridges and roadwork associated with Sunnyside Avenue crossing the Naugatuck River.

  - Construct remaining bridges and roadwork associated with Freight Street crossing the Naugatuck River.

Phase 6 – Transition Existing I-84 to Proposed Alignment (Figure 9-6)

- Proposed I-84 – Transition existing mainline to new alignment.
- On the east side of Naugatuck River.
  - Transition existing I-84 westbound to new alignment.
  - Transition Exit 20 Entrance ramp traffic to new alignment.
- On the west side of Naugatuck River.
  - Transition existing I-84 eastbound to new alignment.
  - Transition Exit 19 Entrance ramp traffic to new alignment.
  - Transition Exit 20 Exit ramp traffic to new alignment.

Phase 7 – Remaining Demolition and Punch List Items

- Remaining demolition.
  - Demolish existing I-84 mainline and ramps.
  - Demolish remaining portions of existing Route 8 west of the Naugatuck River.
  - Demolish temporary roads and bridges project wide.
- Remaining punch list items.
  - Installation of permanent signage and striping.
  - Complete mitigation site-work.
  - Landscaping.

9.2 Impacts of Preferred Alternative 8

9.2.1 Temporary Elevated Structures and At-Grade Roadway

Transitioning from the existing alignment to the proposed will require temporary elevated structures, bridges and roadways. It has been the study team's experience on similar highway construction projects of this magnitude that this transition is the primary cause for a substantial increase in project cost and time. Based on the complexity of the existing stacked viaducts and ramps; multiple temporary structures, ramps, and roadways will need to be constructed to allow for the new build and subsequent connection to the new alignment.

9.2.2 Temporary and Permanent Utility Relocation

Based upon the conceptual alignment, the relocation of utilities may include, but are not limited to: storm water drainage, sanitary sewer, domestic water, gas, electric, fiber-optic and communications, steam, etc. Therefore, coordination with utility companies would be essential during construction. On I-84, Route 8, local roads and ramps, temporary storm drainage will have to be installed and maintained. At a conceptual level of design, the extent of utility relocations is undetermined and could potentially become costly both in time and money.

9.2.3 Maintenance of Existing and Temporary Structures

Maintain existing and temporary utilities, signage, bridges and roadways.

9.2.4 Modification of Existing Traffic Intersections

Due to an anticipated increase in volume on local roads; existing, temporary and new signalized intersections will need to be constructed, modified and reconfigured to support the construction of temporary roads, ramps and detours.

9.2.5 Premium Cost for Night Work

The magnitude of the project in conjunction with the complexity of working over live vehicle traffic and a railroad right-of-way will require a substantial amount of night work. Constructing elevated structures while traffic is detoured will require multiple crews, specialty equipment, traffic management and police details. Many variables associated with night work and road closures will result in inefficient production.

9.2.6 Traffic Management

Maintaining continuous flow of traffic with minimal inconvenience to the public will command extensive traffic studies on the existing highway and local roads. Temporary signage, variable message boards and well delineated traffic routes must established, constructed and maintained throughout the project. Historically on complex projects, 24 hour police details, and road service contracts have had significant cost impacts.

9.2.7 Intelligent Transportation Systems (ITS)

Smart highways may be required based on funding. These systems are costly and could potentially extend a project schedule due to system configuration, testing and acceptance.

9.2.8 Land Acquisitions and Mitigation

Phasing of construction may be impacted due to the process of acquiring land subsequently extending the life of the project. Other factors that result from the acquisition of land are betterments for private and commercial property. These betterments may include: noise walls, retaining walls, updated local roads and sidewalks to meet current standards, landscaping and plantings.

9.2.9 Environmental Impacts

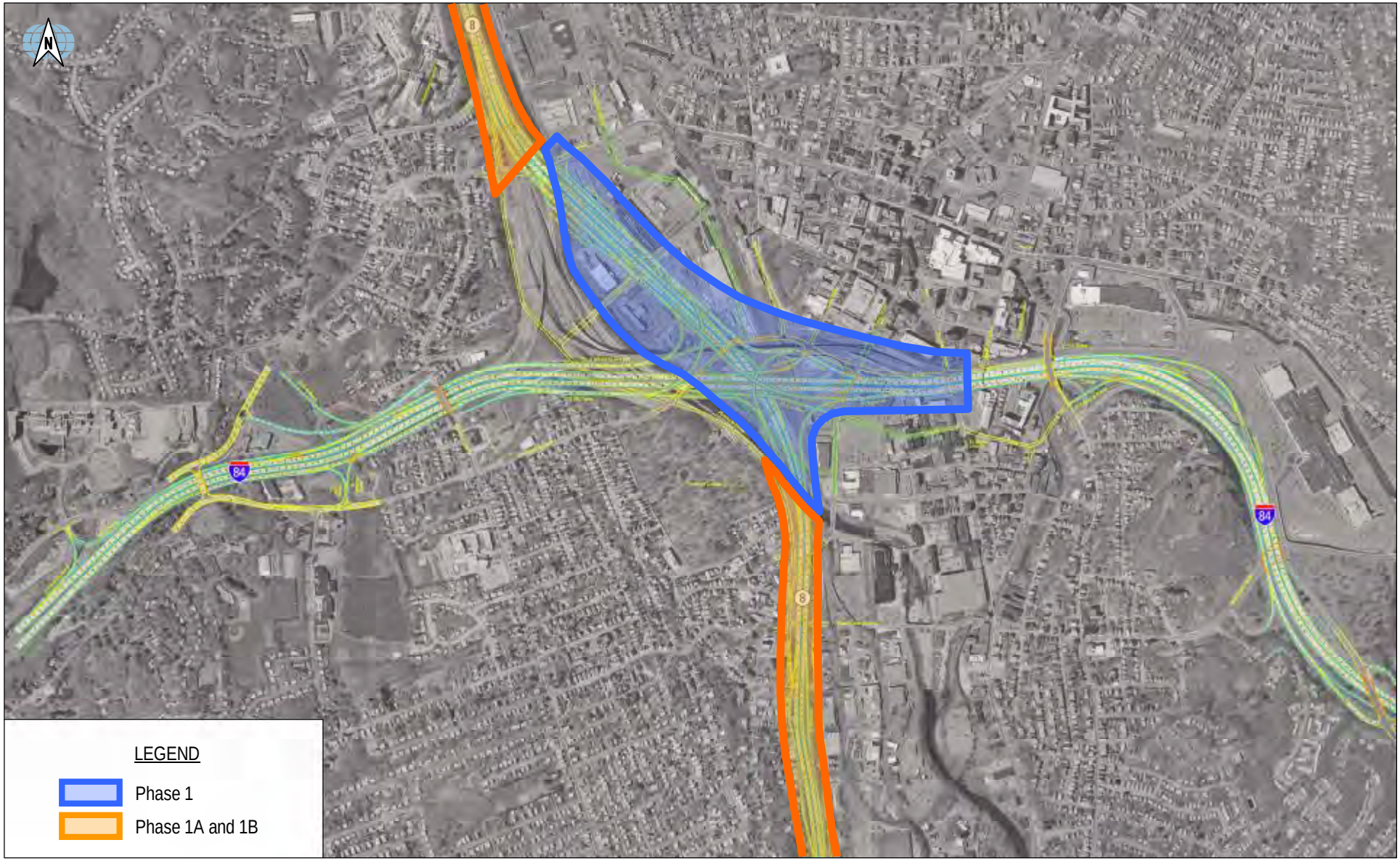
Constructing along and over the Naugatuck River exposes a contractor to additional risk maintaining environmental controls. A Storm Water Pollution Prevention Plan will be developed and monitored daily for compliance. An environmental sub-consultant will need to be present for daily construction activities.

9.2.10 Construction Sequence Design Process

A project of this complexity will require a great deal of time spent on designing, developing and phasing the construction sequence. In comparison to the time spent designing all of the alternates considered for this project, the staging and construction sequence must have the same attention. Time and money spent during the construction sequence design process will minimize the cost and schedule impacts during construction.

9.2.11 Abatement of Hazardous Material

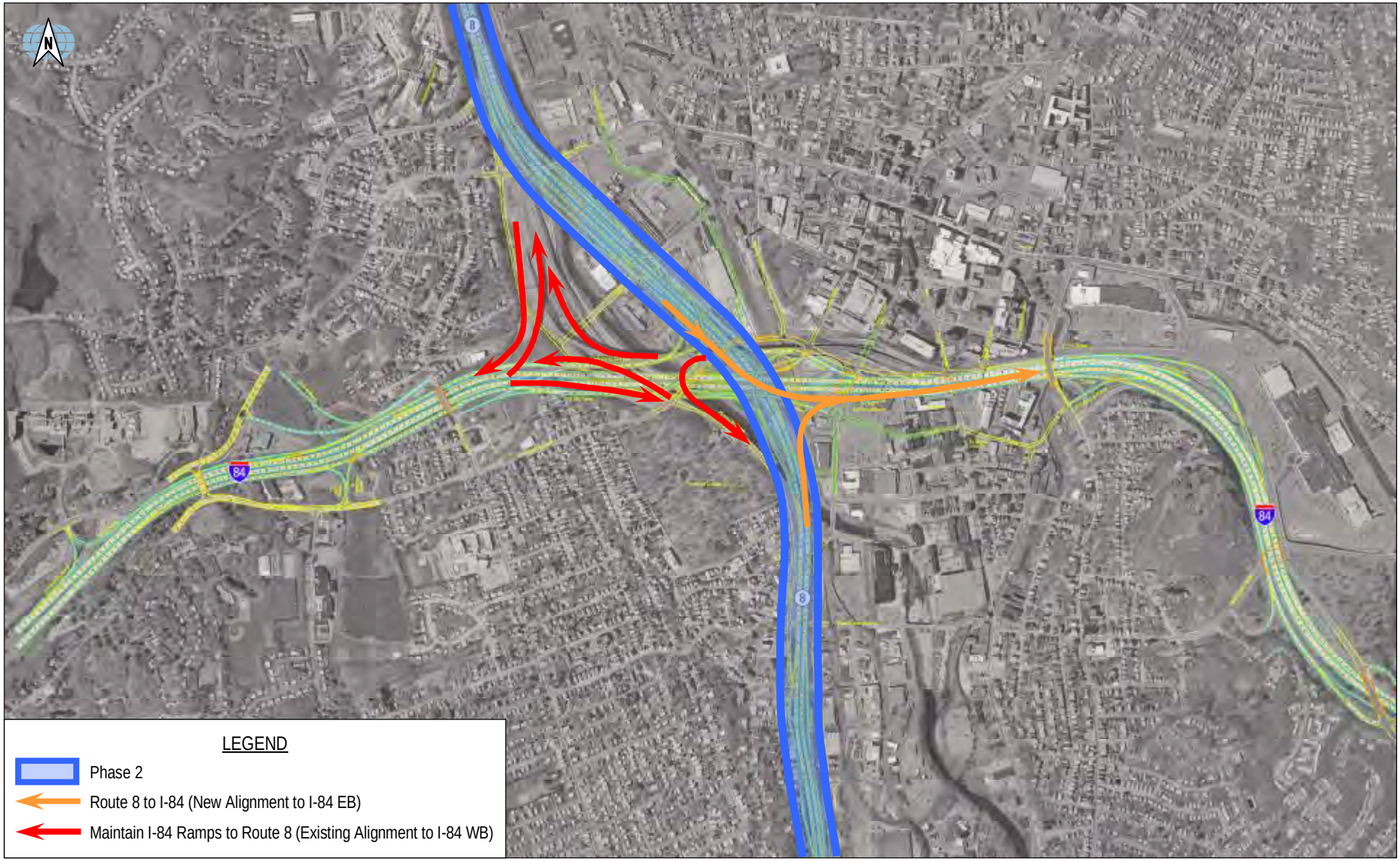
At a conceptual level of design, it should be anticipated that some level of abatement will have to be performed (i.e. lead paint, asbestos, contaminated soil excavation).



WilburSmith ASSOCIATES

CONSTRUCTABILITY OF PREFERRED ALTERNATIVE - PHASE 1, 1A, 1B

FIGURE 9-1



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CONSTRUCTABILITY OF PREFERRED ALTERNATIVE - PHASE 2

FIGURE 9-2

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CONSTRUCTABILITY OF PREFERRED ALTERNATIVE - PHASE 3

FIGURE 9-3

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CONSTRUCTABILITY OF PREFERRED ALTERNATIVE - PHASE 4

FIGURE 9-4

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CONSTRUCTABILITY OF PREFERRED ALTERNATIVE - PHASE 5

FIGURE 9-5

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CONSTRUCTABILITY OF PREFERRED ALTERNATIVE - PHASE 6

FIGURE 9-6

9.3 Recommendations for Potential Cost Savings

9.3.1 Project Labor Agreement

For a project of this scale and exposure, it is beneficial for an owner to enter into a Project Labor Agreement with the local trade labor unions. With this agreement an owner can avoid construction delays due to union verses nonunion conflicts resulting in an inability to work. As single labor contract for the duration of the project, the Project Labor Agreement can be negotiated such that the trade unions agree not to strike and quickly resolve any inter-union disputes without impacting the cost or schedule.

9.3.2 Owner Controlled Insurance Program

The intention of implementing an Owner Controlled Insurance Program (OCIP) is to provide the owner with a cost savings through the ability to obtain insurance at a discounted price, lower than the contractors cost. This would allow the owner to avoid paying each contractors individual insurance and markup. Also, having a single insurance carrier can be more efficient and less expensive during the claim resolution process.

Along with a cost savings incentive there is some risk. The owner becomes responsible for insuring the project and administering loss prevention programs. The owner also becomes exposed to the risk of increased premiums for unexpected losses; although it is possible that the owner will benefit from premium rebates if claims are less than anticipated. In exchange for this risk, the owner should anticipate a cost savings.

9.3.3 Safety Incentive Programs

Implement Safety Incentive Programs that monetarily reward the construction workers for exceptional performance in achieving the lowest incident rate for a predetermined period of time. This incentive will aid in the reduction of job site accidents and ultimately lower the owner's workers' compensation insurance cost. This type of program is excellent for the safety and moral of a project.

9.3.4 Project Delivery Methods

Implement different Project Delivery Methods:

- **A+B Bidding** - A cost-plus-time bidding procedure that selects the low bidder based on a monetary combination of the contract bid items (A) and the time (B) needed to complete the project or a critical portion of a project.

- **Alliancing** - Instead of a fixed lump sum contract price, the general arrangement is that the project owner pays the non-owner (i.e. the contractor) on a 100% open book compensation model. The owner pays the direct project costs, overheads, a fee to cover corporate overheads and a normal profit.

- **Design Build** - Construction delivery system that combines the responsibility for the delivery of design services and construction services within a single contract. This system is used to minimize the project risk for an owner and to reduce the delivery schedule by overlapping the design phase and construction phase of a project.

9.4 Work Zone Safety Plan

Nationally, improving the safety of both motorists and construction workers has led departments of transportation to implement a work zone safety plan in an effort to minimize the occurrences of accidents and fatalities during periods of construction work on interstates. Changes in traveling conditions typically associated with construction work zones increase the likelihood of accidents. It is therefore important to inform the traveling public well in advance of a construction work zone and the changing conditions that lie ahead.

Anticipated impacts of roadway improvement projects need to be assessed and managed through a Work Zone Safety Plan and the Transportation Management Plan (TMP). Strategies to mitigate anticipated safety and mobility impacts may include the following:

- Comprehensive Public Awareness Program
- Real time variable message signs
- Radar speed monitoring display units used as a speed deterrent
- Temporary traffic barrier to provide physical separation of work zone from vehicle traffic
- Crash-cushions / impact attenuators
- Visual screen mounted on temporary barrier to reduce distraction of vehicle traffic
- Temporary rumble strips to alert motorists of a change in roadway conditions
- Intrusion alarm to detect vehicles entering an area between motorists and construction workers
- Construction Safety Inspectors
- Safety awards and incentives to reduce safety impacts associated with the work zone
- Project team meetings on a regular basis to discuss TMP strategies, implementation, and monitoring, particularly related to safety concerns.

Implementing programs such as a Work Zone Safety Plan and a Transportation Management Plan make for a safe, efficient, and cost effective construction project, which is the ultimate goal.

10 Financial Plan

The process of advancing a project from its conceptual phase through construction is not guaranteed. The reality is that many projects of which the I-84/Route 8 WINS is no exception; require substantial capital in order to be constructed.

With fiscal constraints and increasing inflation of materials brought about by the downturn of the U.S. economy, projects have to constantly compete for the limited funds available for construction. It has therefore become imperative to identify sources of funding well in advance of a project and lobby rigorously for the limited funds available.

There are a number of sources that could be utilized in funding the improvements recommended in I-84/Route 8 WINS. This financial plan identifies some of these potential sources that can be utilized in funding the project.

10.1 Federal Funding

Federal Grants remain the major source of funding for highway projects in the country. The Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) law which was enacted by congress in 1995 guarantees funding for highway, highway safety and public transportation projects through a number of programs. Some of the programs under the SAFETEA-LU that could serve as funding sources for the I-84/Route 8 WINS are described below.

10.1.1 National Highway System Program (NHS)

The NHS program offers funding for improvements to roads and highways that are part of the National Highway System. Connecticut's apportionment under this program for year 2009 is approximately $46.8 Million[1].

10.1.2 Interstate Maintenance Program (IM)

The Interstate Maintenance Program offers funding for resurfacing, restoration, rehabilitation and reconstruction projects on Interstate highways. Connecticut's apportionment under the IM program for year 2009 is approximately $50.8 Million[2].

[1] Source: USDOT
[2] Source: USDOT

10.1.3 Congestion, Mitigation and Air Quality Program (CMAQ)

This program offers funding for projects that are geared towards attainment and maintenance of national ambient air quality standards for ozone, carbon monoxide, and particulate matter.

The CMAQ program recognizes two categories for funding: Diesel retrofitting projects and transportation system management/operations projects which reduce congestion and emissions and improve overall air quality. Clearly, the goals of the I-84/Route 8 study are consistent with the latter category and could therefore be a candidate for funding under this program. Year 2009 funds available to Connecticut under the CMAQ program is approximately $32.9 Million[3].

10.1.4 Surface Transportation Program (STP)

This program provides funding to be used for any federal-aid highway projects. Funds allotted to Connecticut under this program for year 2009 is approximately $59.8 Million.

10.1.5 Highway Bridge Program

This program offers funding to States for bridge replacement, rehabilitation, and maintenance projects. Connecticut's share of this fund for 2009 is approximately $127.7 Million[4].

10.1.6 Transportation Enhancement Program

The TEP provides funding for projects of cultural, aesthetic, historic, and environmental significance. Funding for this program comes out of each State's Surface Transportation and usually constitutes 10 percent of the STP.

10.2 State Funding

Within the State of Connecticut, the Motor Vehicle Fuel Tax and Motor Vehicle Excise Tax are the two major sources of funding for highway projects. Reliance on the revenue from these two sources is becoming unrealistic as more people shift to using fuel efficient cars and transit.

[3] Source: USDOT
[4] Source: USDOT

10.3 Innovative Financing

It has become increasingly clear in recent years that it would be naive for one to rely on equity from federal, state, and local governments alone to fund projects. Funding from these levels of government has not kept up with inflation; as a result, it has become necessary to explore alternative sources of funding to bridge the funding gap. The use of innovative financing methods has gained popularity in recent years and could be a potential funding source for the improvements recommended under I-84/Route 8 WINS. Some of these funding methods are described below.

10.3.1 Public Private Partnerships (PPP)

The FHWA defines Public-Private Partnerships (PPP) as contractual agreements formed between a public agency and private sector entity that allow for greater private sector participation in the delivery of transportation projects.

Public Private Partnerships have been used with great success to fund projects in many parts of the world. In the U.S, the use of Private Public Partnerships in the delivery of public services has grown steadily since the 1980's primarily because in many ways the PPP model is seen as win-win relationships between both sectors. On one hand the public sector is able to undertake highway infrastructure projects and deliver services that are so badly needed while transferring the costs and associated financial risks to the private sector. In return, the private sector assumes management and maintenance of such projects and is placed in a position to recoup and make profit on their investment.

The Chicago Skyline Bridge in Illinois and the Dulles Greenway are widely cited success stories of PPP projects in the country.

10.3.2 Tax Increment Financing

Tax Increment Financing (TIF) has been used for redevelopment and community improvements for over half a century in the United States. TIF is a public financing method which utilizes future gains in taxes to finance current improvements projects that would realize those gains. TIF typically entails local governments borrowing money to fund projects that would invariably raise property values in the area of the project. The increase in the tax revenues as a result of the higher property values is then used to service the loan.

10.3.3 Transportation Impact Fees

Transportation Impact Fees are a funding mechanism in which charges are imposed by local governments on new developments based on the traffic that development is anticipated to

generate. The revenue collected is used to improve facilities that would be impacted by the new traffic.

10.3.4 Tolls

With the need for innovative financing for highway infrastructure projects apparent, the discussion on tolls in Connecticut has begun to gain traction. Legislators and stakeholders are beginning to rethink the possibility of re-introducing tolls in the State as an alternate source of funding for highway projects.

In this light, the Connecticut Transportation Strategy Board contracted Cambridge Systematics, Inc. to undertake an electronic tolling and congestion pricing study which was to assess various tolling options for the State and serve as framework for informed decision making. Some of the tolling options included:

- New Toll Express Lanes
- Border Tolling
- Truck Only Tolling
- HOV to HOT Lane conversions
- HOT Lane Conversions of Existing Shoulders on Limited Access Facilities
- Tolling Individual Highways Needing New Capacity
- Statewide Tolling
- Congestion Pricing Corridor

Electronic tolling could be a potential funding source for the I-84/Route 8 Interchange project in the event that tolls were reintroduced in the State. SAFETEA-LU allows States the flexibility to utilize funds from tolls to finance infrastructure improvement projects through the Interstate System Construction Toll Pilot and Interstate System Reconstruction and Rehabilitation Construction Toll Pilot Programs.

10.4 Implementation

A phased approach is recommended in implementing the final improvement alternatives for the I-84/Route 8 WINS. The near term improvements (Alternative 6) can be potentially broken up into smaller individual projects. The following near projects; arranged in no particular order are recommended:

Project 1: Traffic Signals and Signage
Project 2: Sunnyside Avenue-Field Street Connector
Project 3: Bank Street -West Main Street Connector
Project 4: Bank Street-South Main Street Connector
Project 5: I-84 Eastbound Ramps at Interchange 21

These near term projects should be pursued over the next 5 to 10 years. These improvements are less capital intensive and would have very minimal impact on the existing interchange. In addition, the near term improvement projects could serve as a launching pad for the long term improvement recommended for the study area.

Due to the capital intensive nature of Alternative 8, its complexity of construction and anticipated environmental permitting process, a realistic time frame for this alternative to begin would be in the next 15 to 20 years. Table 10-1 presents a summary of the funding and implementation plan for the I-84/Route 8 Waterbury Interchange Needs Study.

Table 10-1: Funding and Implementation Plan

Improvements	Capital Cost (2009 $)[1]	Time Frame	Potential Funding Sources
Alternative 6	**$409,800,000**	**2015-2020**	**Federal/State/Local/Private**
Project 1: Traffic Signals and Signage	$1,400,000	2015-2020	State/Local/Private
Project 2: Sunnyside Avenue-Field Street Connector	$47,400,000	2015-2020	State/Local/Private
Project 3: Bank Street -West Main Street Connector	$19,900,000	2015-2020	State/Local/Private
Project 4: Bank Street-South Main Street Connector	$13,100,000	2015-2020	State/Local/Private
Project 5: I-84 Eastbound Ramps at Interchange 21	$14,300,000	2015-2020	Federal/State/Local
Alternative 8	**$ 1,889,100,000**	**2025-2030**	**Federal/State/Private**

Note:
[1] Cost for each individual project under Alternative 6 does not include bridge maintenance and repair costs of existing I-84/Route Interchange