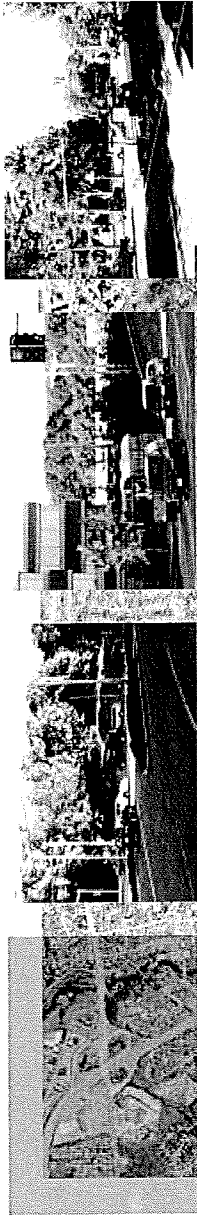


APPENDIX C

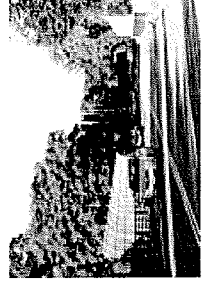
CTPS Study



Potential I-95 (Route 128) – Kendrick Street Interchange, Needham, Massachusetts An Evaluation of Traffic Impacts



A report produced
by the Central
Transportation
Planning Staff for the
Boston Metropolitan
Planning Organization



DEC 2003

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Potential I-95 (Route 128)–Kendrick Street Interchange, Needham, Massachusetts

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EXECUTIVE SUMMARY

Needham and Newton are significantly developed along their border near the I-95 (Route 128)–Highland Avenue interchange, as are locations in Needham south of that area. Past studies identified those developed areas as having persistent traffic congestion. The I-95/I-93 (Route 128) Transportation Improvement Project will add two general-purpose lanes, one northbound and one southbound, on I-95.¹ This will alleviate some of the congestion near the Highland Avenue interchange. A recommendation of that project that required further study was the construction of an interchange on I-95 at Kendrick Street in Needham. The purpose of the interchange would be to address congestion issues related to access and egress to and from the businesses in the Highland Avenue/Kendrick Street area.

In 2002, the Town of Needham rezoned the New England Business Center and the Wexford/Charles Industrial District.² The locations of these sites are shown in Figure 1, which depicts the study area. The rezoning allows the addition of approximately 2.5 million square feet to the existing 5.0 million, bringing the total at these sites to 7.5 million. Both Needham and Newton are concerned with the traffic impacts on local roads of a potential Kendrick Street interchange and of future development projects in the area. They requested the present study in order to learn more about those impacts. The study aims to present information about present and future conditions in the study area that will aid in deciding what type of interchange at Kendrick Street, if any, should be constructed.

The Central Transportation Planning Staff conducted the study in conjunction with an Advisory Task Force composed of representatives from Needham, Newton, Wellesley, the Massachusetts Highway Department, the Metropolitan Area Planning Council, the Newton-Needham Chamber of Commerce, and the Route 128 Business Council, and of elected officials. The Advisory Task Force met seven times during the course of the study at the Needham Town Hall where the work program for the study and the task products were presented for comments and feedback.

The area supports a variety of land uses, including—residential, industrial, commercial, and recreational. Specific uses include office parks, forested areas, and nonforest freshwater wetlands. The area has a well-established land use pattern, so future development can be

¹ *Environmental Assessment/Final Environmental Impact Report (IEOE4 No. 5072), I-95/I-93 (Route 128) Transportation Improvement Project, Wellesley to Randolph, Massachusetts*, Volume 1, FHWA and MassHighway, February 1999.

² *Land Use, Zoning, and Traffic Study for the Needham Business Center, Highland Avenue Corridor, and Wexford/Charles Street Industrial District. Final Report to the Town of Needham*, June 2001.

expected to be mostly redevelopment at existing sites. According to analysis conducted by the Metropolitan Area Planning Council, the portion of the study area in Newton adjacent to Needham Street has several “brownfields” (large sites available for infill development). The area east of I-95 in Needham is designated as a redevelopment district. Neither Newton nor Needham is state-designated as an economically distressed/economic target area. Developments expected in the area over the next ten to fifteen years include redevelopment of about 65% of the existing properties in the New England Business Center and completion of the Avalon at Upper Falls apartment complex and day care center in Newton.

The area under study is served to a limited degree by public transportation, including bus routes and light rail transit. However, 90% of the commuting trips to or through the study area are made by auto. I-95 carries the bulk of the commuter traffic to and through the area. Its interchanges with Highland Avenue, Great Plain Avenue, and Route 135 are the main access and egress points.

Among the traffic concerns in the study area are traffic congestion, cut-through traffic, and concerns related to access and egress to and from the area’s businesses, safety, and mobility. Field surveys and traffic analyses indicate that I-95, the arterial streets, and some of the intersections along the arterials are congested and are operating at unacceptable levels of service during the peak periods. A number of highway improvement projects have been planned for the area that are intended to increase capacity, to improve safety, mobility, and circulation, to improve access/egress for the area’s businesses, and to help facilitate redevelopment occurring in the area. Of these projects, the I-95/I-93 Transportation Improvement Project is the most significant.

For the present study, a no-build alternative and seven build alternatives were developed, with the participation of the Massachusetts Highway Department and the study’s Advisory Task Force, for testing and evaluation. All of the build alternatives are design variations of a Kendrick Street interchange on I-95. A transportation planning model was used to produce 2025 traffic forecasts for the no-build and for each build alternative. Some of the objectives in developing the build alternatives were for the improvements to tie in well with the planned highway projects, to enhance access/egress for the area’s businesses, and to address congestion and cut-through traffic in the study area. The criteria used in evaluating the alternatives included their safety impacts and their environmental/visual impacts.

The increased traffic on Kendrick Street in 2025 will mostly be the result of the redevelopment of existing properties at the New England Business Center and future traffic growth. This study found that providing an interchange at Kendrick Street would have the following effects (*this assessment is confined to traffic operations effects*): A Kendrick Street interchange would increase traffic volumes and impacts on Kendrick Street and could use up all of the available capacity. The interchange would have no significant impact on Nahanton Street, as most of the commuter trips to the area’s businesses would do so via improved I-95/Route 128. A Kendrick Street interchange would reduce significantly the ramp traffic at the Highland Avenue interchange, improve access to and egress from the area’s businesses, and reduce cut-through traffic on Greendale Avenue in Needham.

Assessment of the build alternatives *from a traffic operations point of view* indicates that Alternative 6 provides the most congestion relief, effects the most improvement to access/egress for the area’s businesses, and minimizes cut-through traffic on Greendale Avenue. However, it is also associated with major land-takings, with impacts on wetlands, and with other environmental/visual impacts; these must be taken into account before a decision on a preferred alternative is made.

1 INTRODUCTION

Needham and Newton are significantly developed along their border near the I-95 (Route 128)–Highland Avenue interchange, as are locations in Needham south of that area. Studies conducted by the Central Transportation Planning Staff in the mid-1980s identified those developed areas as having persistent traffic congestion that calls for both short- and long-term improvement measures. A long-term measure will be provided by the I-95/I-93 (Route 128) Transportation Improvement Project, which will add two general-purpose lanes, one northbound and one southbound, on I-95 from Randolph to Wellesley. This widening will alleviate some of the congestion near the Highland Avenue interchange. A recommendation of that project that required further study was the construction of an interchange on I-95 at Kendrick Street in Needham. The purpose of the interchange would be to address congestion issues related to access and egress to and from the businesses in the Highland Avenue/Kendrick Street area.

In 2002, the Town of Needham rezoned the New England Business Center (NEBC) and the Charles/Wexford Industrial District.³ The locations of these sites are shown in Figure 1, which depicts the study area. The rezoning allows the addition of approximately 2.5 million square feet to the existing 5.0 million in the next ten to fifteen years, bringing the total at these sites to 7.5 million. Both Needham and Newton are concerned with the traffic impacts on local roads of a potential Kendrick Street interchange and of future development projects in the area. They requested the present study in order to learn more about those impacts.

This study aims to present information about present conditions in the study area, and about future conditions under various alternative scenarios, that will aid in deciding what type of interchange at Kendrick Street, if any, should be constructed. The Central Transportation Planning Staff conducted the study in conjunction with an Advisory Task Force composed of representatives from Needham, Newton, Wellesley, the Massachusetts Highway Department, the Metropolitan Area Planning Council, the Needham-Newton Chamber of Commerce, and the Route 128 Business Council, and of elected officials. The Task Force met seven times during the course of the study at the Needham Town Hall where the work program for the study and the task products were presented for comments and feedback. Appendix A shows the dates and attendance at those meetings and comments on the draft report.

The following chapter of this report documents the study area's existing and future transportation network and land use characteristics. The third chapter describes existing traffic conditions, while the fourth chapter presents data, obtained through a license plate survey, on commuting patterns in the area. Chapter 5 explains the process for calibrating the transportation planning model. The final chapter describes the alternative improvements that were analyzed in the study, their traffic impacts, and the study's findings.

³ *Ibid.*



2 TRANSPORTATION SYSTEM AND LAND USE

2.1 Current Land Use

The area supports a variety of land uses, including residential, industrial, commercial, and recreational. Specific uses include office parks, forest areas, and nonforest freshwater wetlands (Figures 1 and 2). In Newton, the study area is zoned as mixed-use along Needham Street and mostly as residential and recreational elsewhere. In Needham, the study area is zoned as industrial east of I-95 to the Newton town line, residential west of I-95, and mixed-use along the Highland Avenue corridor.

The area under study has a well-established land use pattern, so future developments can be expected to be mostly redevelopment of existing sites (Figure 1). According to analysis conducted by the Metropolitan Area Planning Council, the portion of the study area in Newton adjacent to Needham Street has several “brownfields” (large sites available for infill development). The area east of I-95 in Needham is designated as a redevelopment district. Neither Newton nor Needham is state-designated as an economically distressed area/economic target area.

2.2 Current Transportation

The area under study is served to a limited degree by public transportation, including bus routes and light rail transit. However, 90% of the commuting trips to or through the study area are made by auto.

I-95, the area’s thoroughfare, carries the bulk of the commuter traffic to and through the area. Its interchanges with Highland Avenue, Great Plain Avenue, and Route 135 are the main access and egress points. The Highland Avenue interchange offers the most direct access point to the area’s businesses. Due to congestion at the direct access point, the Great Plain Avenue and Route 135 interchanges have become secondary access points to the businesses via Greendale Avenue and Kendrick Street. One accesses the business areas in Needham via Highland Avenue or Kendrick Street, and the business areas in Newton via Needham Street or Nahanton Street. Currently, the right shoulders/breakdown lanes of I-95/I-93 between Route 24 in Randolph and Route 9 in Wellesley are used as travel lanes between 6:00 AM and 10:00 AM and between 3:00 PM and 7:00 PM on weekdays. Construction of the I-95/I-93 Transportation Improvement Project will eliminate the need for shoulders/breakdown lanes to be used for travel.

The Massachusetts Highway Department has administrative control over I-95, its interchanges, and arterial road segments near the

interchanges. It also controls Needham Street and Route 9 in Newton. The remaining arterial and collector roads are city- or town-owned.

Figure 3 shows the area’s roadway and public transportation system. The Needham Shuttle bus, serving the Needham Street Business Center, the Highland Avenue corridor, and the Newton Highlands Green Line station, is operated by the Route 128 Business Council. The Route 59 bus service (Needham Junction–Watertown Square via Needham Street) and the Route 52 bus service (Dedham Mall–Watertown Square via Winchester Street and Nahanton Street) are operated by the Massachusetts Bay Transportation Authority. The MBTA’s Green Line D branch station at Newton Highlands serves the project area via the Needham Shuttle. Finally, the MBTA’s Needham Heights commuter rail station is close to the project area, but there is no connecting bus or shuttle service.

2.3 Planned Developments

In consultation with the City of Newton and the Town of Needham, it was determined that two developments, described below, are currently anticipated in the area (Figure 4).

A zoning bylaw approved in 2002 allows Needham to increase the developable space in the New England Business Center and the Wexford/Charles Industrial District in the next ten to fifteen years. The redevelopment is expected to add approximately 2.5 million square feet to the existing 5.0 million, bringing the site total to 7.5 million.³ As described above, the Executive Office of Environmental Affairs/Metropolitan Area Planning Council buildout analysis designates this area as a redevelopment district.

The Avalon at Upper Falls complex on Needham Street in Newton, which is presently almost complete, will add 294 apartment units to Newton’s housing stock.⁴

2.4 Planned Highway Improvements

A number of highway improvement projects have been planned for the area that are intended to increase capacity, to benefit safety, mobility, and circulation, to improve access/egress for the area’s businesses, and to facilitate redevelopment. The locations of these projects are shown

in Figure 4, which also presents for each project a description and the Transportation Improvement Program status.

The I-95/I-93 Transportation Improvement Project will add two general-purpose lanes, one northbound and one southbound, on I-95/I-93 from Randolph to Wellesley and will replace or reconstruct I-95 bridges within the project limits. This project, already approved, has been programmed in the current Transportation Improvement Program for fiscal years 2003 through 2008.

Another highway project planned for the study area is the Needham Street/Highland Avenue Improvement Project. In Newton, the project would widen Needham Street to three lanes—two travel lanes and a two-way left-turn lane in the center—between the Needham Street/Winchester Street/Dedham Street intersection and the Needham town line. In Needham, the project would widen Highland Avenue to provide four homogeneous travel lanes, two in each direction, from the Webster Street intersection to the Newton town line. It would also improve intersection capacity at Highland Avenue/Second Avenue by widening the westbound approach to provide for an exclusive left-turn lane and two through lanes, and by widening the northbound approach to provide for an exclusive right-turn lane. Work would also include upgrades of traffic signals, signalization of some currently unsignalized intersections, and reconstruction of the bridge over the Charles River to accommodate the upgrade in travel lanes.

All of the arterial street projects have been planned so as to coordinate with the I-95/I-93 Transportation Improvement Project. In general, they aim at improving mobility, enhancing access/egress for businesses and facilitating redevelopment.

³ *Ibid.*

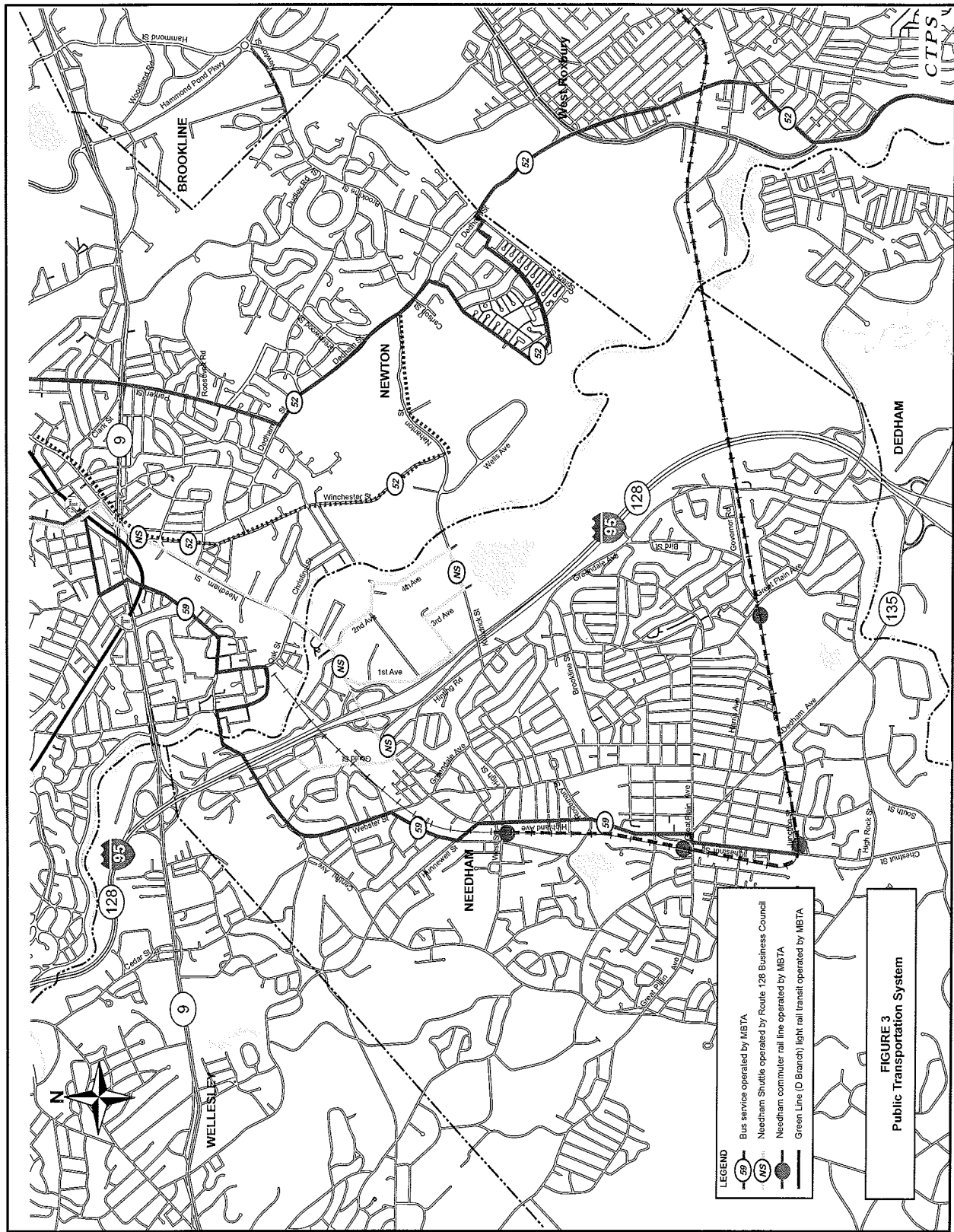
⁴ *Traffic Impact and Access Study, Proposed Avalon at Upper Falls, Newton, Massachusetts* (March 2001).

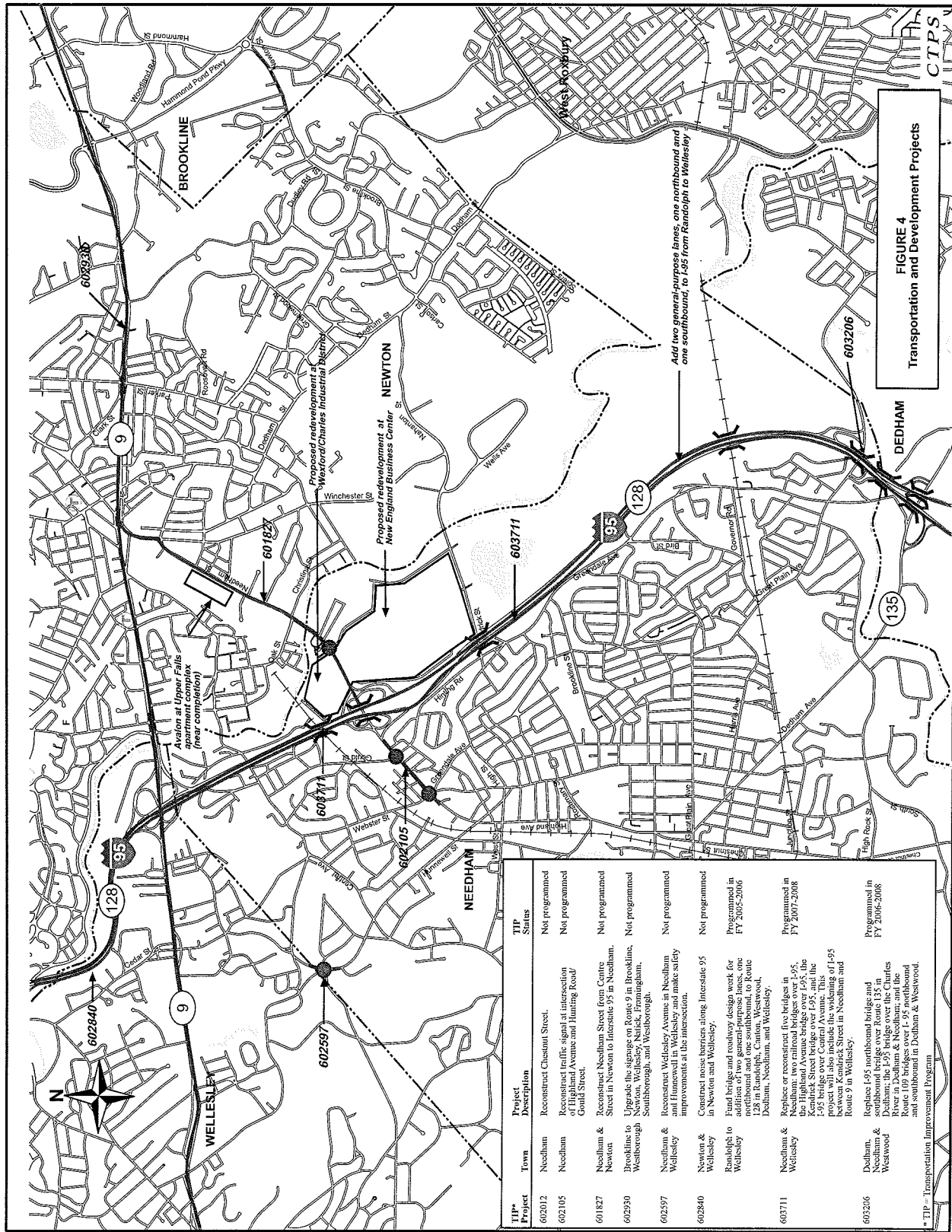


LEGEND

- Light to medium-density residential
- Multi-unit residential
- Mixed use 1
- Mixed use 2
- Cemeteries, parks, forest
- Commercial
- Industrial
- Wetland
- Open water
- Recreation
- Transportation
- Urban public
- Urban open

FIGURE 2
Land Use Pattern





3 EXISTING TRAFFIC CONDITIONS

3.1 Inventory of Traffic Concerns

Through meetings with the Advisory Task Force and field reconnaissance, CTPS developed a list of traffic concerns in the study area. They include but are not limited to the following:

1. Cut-through traffic on Greendale Avenue in Needham. This traffic, generally headed for the New England Business Center or the Wells Avenue Office Park, avoids traffic congestion on I-95 by exiting onto Great Plain Avenue or Route 135 and using Greendale Avenue and Kendrick Street to access the business sites.
2. Cut-through traffic on Nahanton Street in Newton. This traffic uses the internal streets in Newton to access the businesses along Nahanton Street and Kendrick Street or head for the I-95 corridor.
3. Traffic congestion along I-95 during peak periods causing drivers to divert onto the parallel and intersecting routes.
4. Traffic congestion on Highland Avenue in Needham and Needham Street in Newton during peak periods.
5. Access and egress to and from the businesses in the Highland Avenue/Kendrick Street/Needham Street area. The primary access point to the area from I-95, the Highland Avenue interchange, is congested during peak periods.
6. Traffic speeding along Greendale Avenue during off-peak periods. The Greendale Avenue speed limit is posted at 40 mph.
7. Potential future traffic impacts from construction of a potential new interchange at Kendrick Street.
8. Potential future traffic impacts from redevelopment in the area.

3.2 Operational Performance (Levels of Service)

3.2.1 Background

Several kinds of data were collected for quantifying and evaluating the existing traffic conditions. They include traffic volumes, travel times, and origin-destination data. Turning-movement counts were collected at the major intersections and at the I-95 interchanges shown in Figure 5. These counts were conducted during the morning peak travel period (7:00 AM to 9:00 AM) and the afternoon peak travel period (4:00 PM to 6:00 PM) on weekdays in November and December 2001. The

counts were recorded in 15-minute intervals. In addition, the Town of Needham and the City of Newton provided automatic traffic recorder (ATR) counts for selected locations. Those ATR counts were collected in March 2002 and January 2002, respectively. Massachusetts Highway Department (MassHighway) ATR counts for I-95 were also used. All of the traffic count data are summarized in Figure 6.

The peak hour traffic volumes were produced from the 15-minute flows. The AM peak hour was not consistent; half of the study intersections had a peak hour of 7:30 AM–8:30 AM and half 8:00 AM–9:00 AM; therefore, an AM peak hour of 7:45 AM–8:45 AM was used. On the other hand, the PM peak hour was consistent across the study intersections: 5:00 PM–6:00 PM. The traffic counts were adjusted by applying seasonal adjustment factors based on factor group (facility type and location) and month of the year to account for seasonal variations.

To rate the performance of an element of a highway system, it may be assigned what is called a level of service (LOS). There are six levels of service: LOS A through LOS F. The range LOS A through LOS D is considered acceptable; LOS E and LOS F are unacceptable—the facility is either at capacity or unable to handle traffic demands. For the different elements of a highway system, different measures of performance are used to assess the element's level of service. For intersections (both signalized and unsignalized), the performance measure is control delay; for arterial segments, it is the travel speed; for freeway facilities, it is the density of vehicles. Appendix B shows how these performance measures are used to determine levels of service.

3.2.2 Intersections and Ramp-Arterial Junctions

The computer program SYNCHRO 5 was used to determine the levels of service of selected intersections and ramp-arterial junctions. Figures 7 and 8 show the AM and PM peak period levels of service, respectively. Many of the major intersections on the arterials providing access to the area's businesses are operating at unacceptable levels of service during the AM and PM peak periods. The intersection of Highland Avenue and Webster Street was undergoing capacity improvements during this study; the intersection of Highland Avenue and Gould Street/Hunting Road was undergoing a traffic signal upgrade.

The I-95 ramp junctions with Great Plain Avenue and Route 135 are operating well within acceptable levels of service. At the Highland Avenue interchange, the ramp-arterial junctions operate at

unacceptable levels of service during the AM and PM peak hours due to the heavy traffic demand. At those junctions, long queues sometimes extend onto I-95.

3.2.3 I-95

Freeway facilities are composed of connected segments consisting of basic freeway segments, ramp segments, and weaving segments. When several of these segments occur in sequence, there are significant interactions between them. Presently, the right shoulders of I-95 in the study area are used as travel lanes during the periods 6:00 AM–10:00 AM and 3:00 PM–7:00 PM.

Highway Capacity Software (HCS) was used to determine the levels of service of the segments of I-95; the results are shown in Figure 9. The northbound segments all operate at LOS E or F during both the AM and the PM peak hours. The southbound segments also operate at LOS E or F during the PM peak hour, but operate at LOS D or better during the AM peak hour.

3.3 Safety

The study area has four high-crash locations, all located in Needham. The Highland Avenue/I-95 interchange had 197 crashes between 1997 and 1999; it ranks #42 on the MassHighway list of the state's top 1,000 high-crash intersections. The Great Plain Avenue/I-95 interchange ranked #179 on the list with 57 crashes in the same period. The Highland Avenue/Webster Street intersection ranked #274 with 39 crashes. Highland Avenue/Wexford Street ranked 276 with 41 crashes.

3.4 Travel Time/Mobility

According to the most recent available counts, the 2000 average daily traffic (ADT) on I-95 north of Great Plain Avenue was 143,000 vehicles, the 2001 ADT on Needham Street west of Tower Road was 25,200 vehicles, the 2002 ADT on Highland Avenue east of First Avenue was 36,700 vehicles, and the 1999 ADT on Kendrick Street west of Third Avenue was 18,000 vehicles.⁵

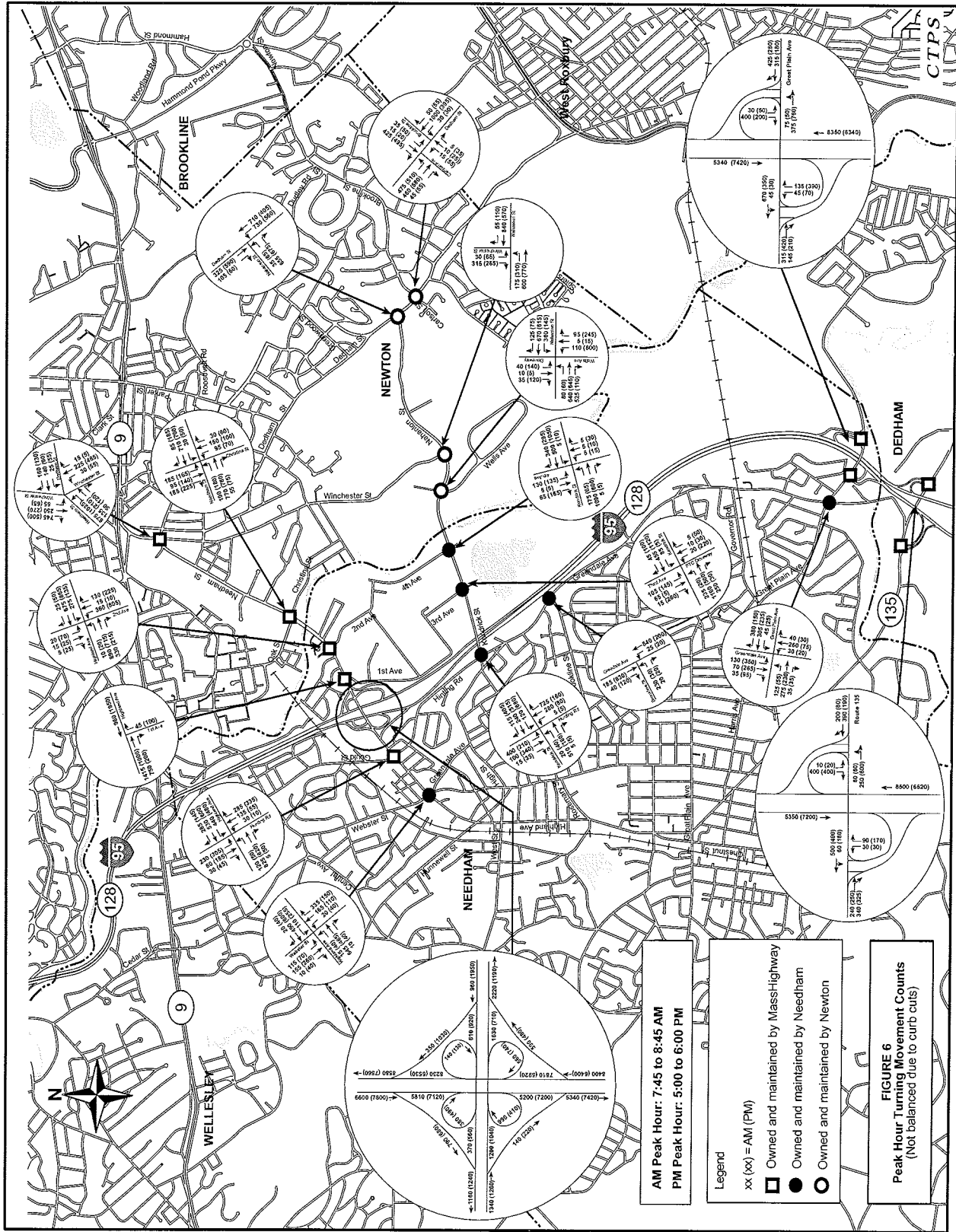
A travel time survey was conducted to determine the average travel times and speeds on the major highways and streets in the study area. Each route was surveyed during the AM and PM peak periods over

⁵ Sources: For I-95 and Needham Street, MassHighway 2002 Traffic Volumes, for Kendrick Street, the Proposed Office Redevelopment at 140 Kendrick Street (by Vanasse & Associates, Inc.); for Highland Avenue, Highland Avenue Corridor Improvement Functional Design.

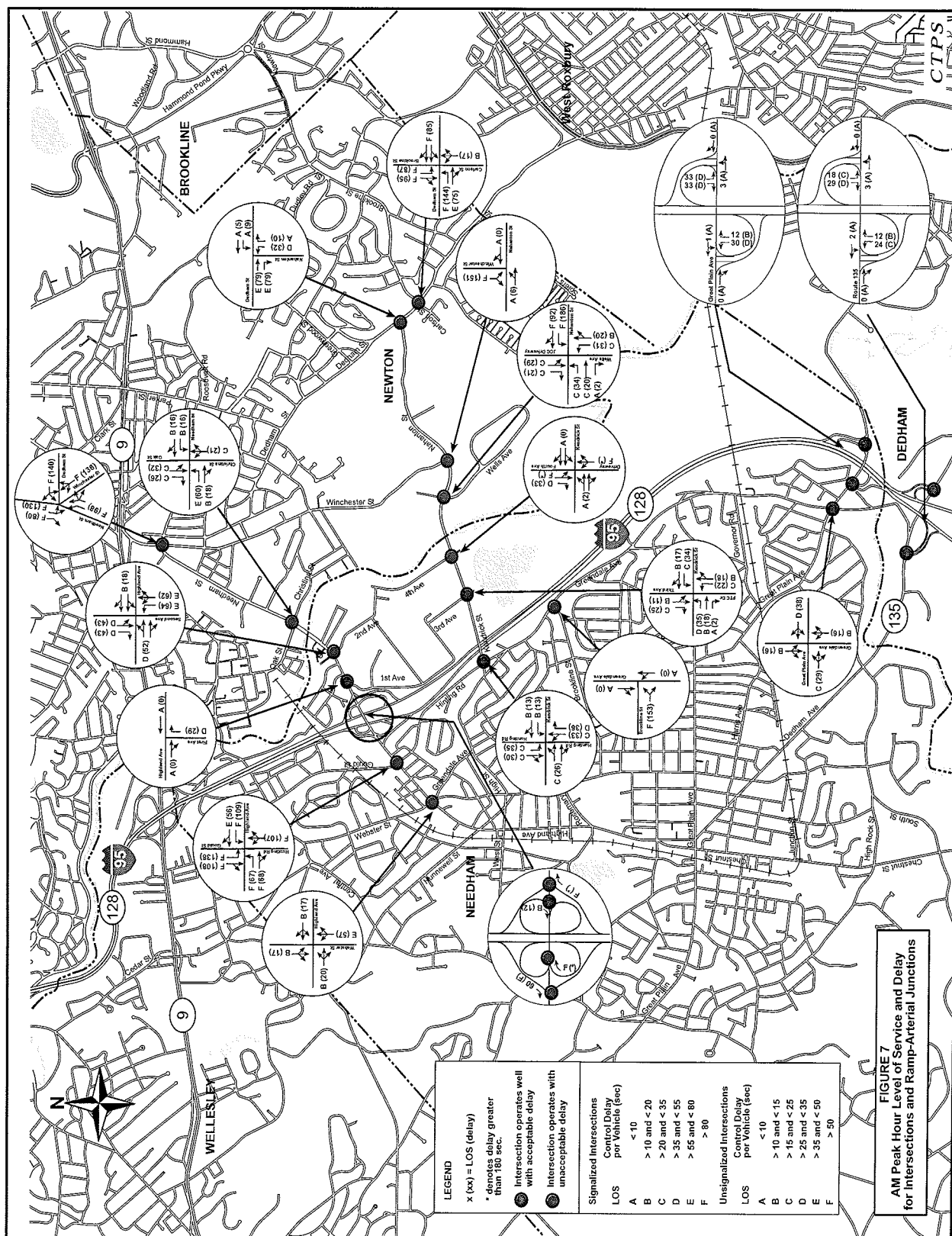
FIGURE 5
Study Intersections

FIGURE 5
Study Intersections

-
- FIGURE 5**
Study Intersections



Existing Nov/Dec
 condition = 2001



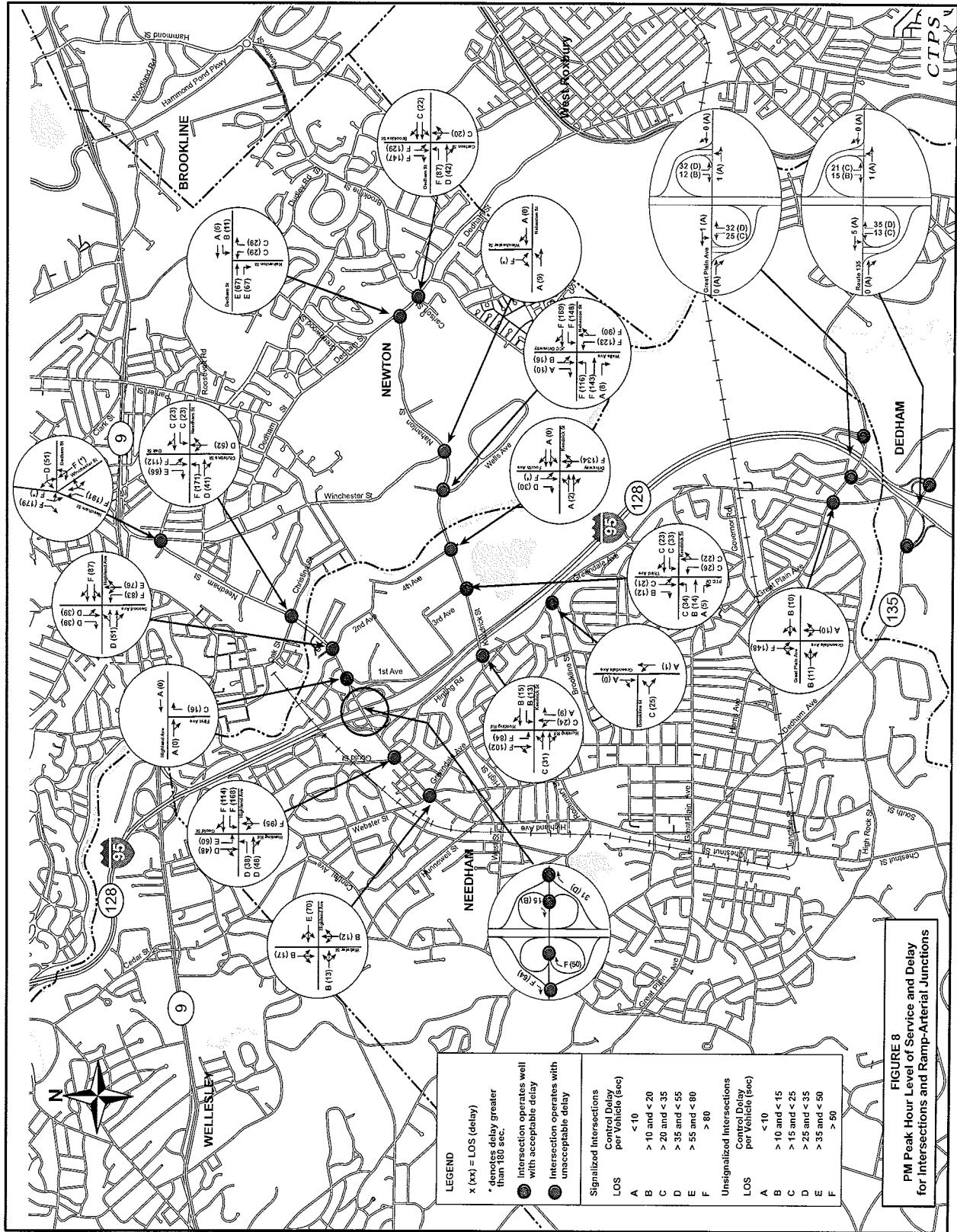
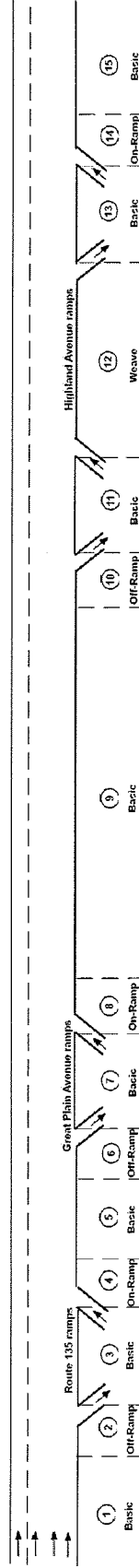


FIGURE 8
PM Peak Hour Level of Service and Delay
for Intersections and Ramp-Arterial Junctions

FIGURE 9
Existing Levels of Service, Densities, and Speeds on I-95:
AM and PM Peak Hours

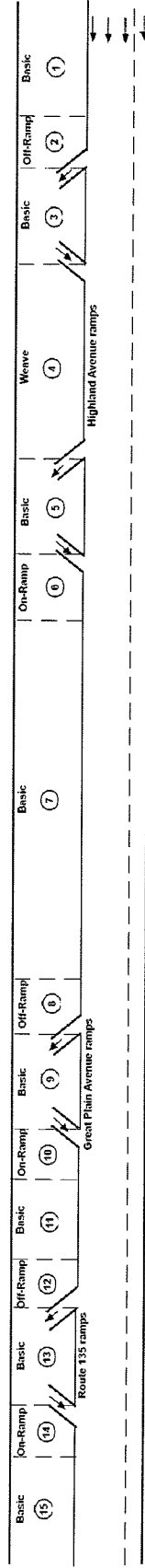
I-95 Northbound



Section Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Type of Facility	Basic	Off-Ramp	Basic	On-Ramp	Basic	Off-Ramp	Basic	On-Ramp	Basic	Off-Ramp	Basic	Weave	Basic	On-Ramp	Basic
LOS*	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
Density (veh/lane/mile)	53	54	59	54	54	54	61	51	51	51	61	63	52	52	52
Speed (mph)	30	30	25	30	30	30	25	32	32	32	25	26	31	31	31
Speed (mph)	21	21	18	20	20	20	18	23	23	23	19	23	24	25	25

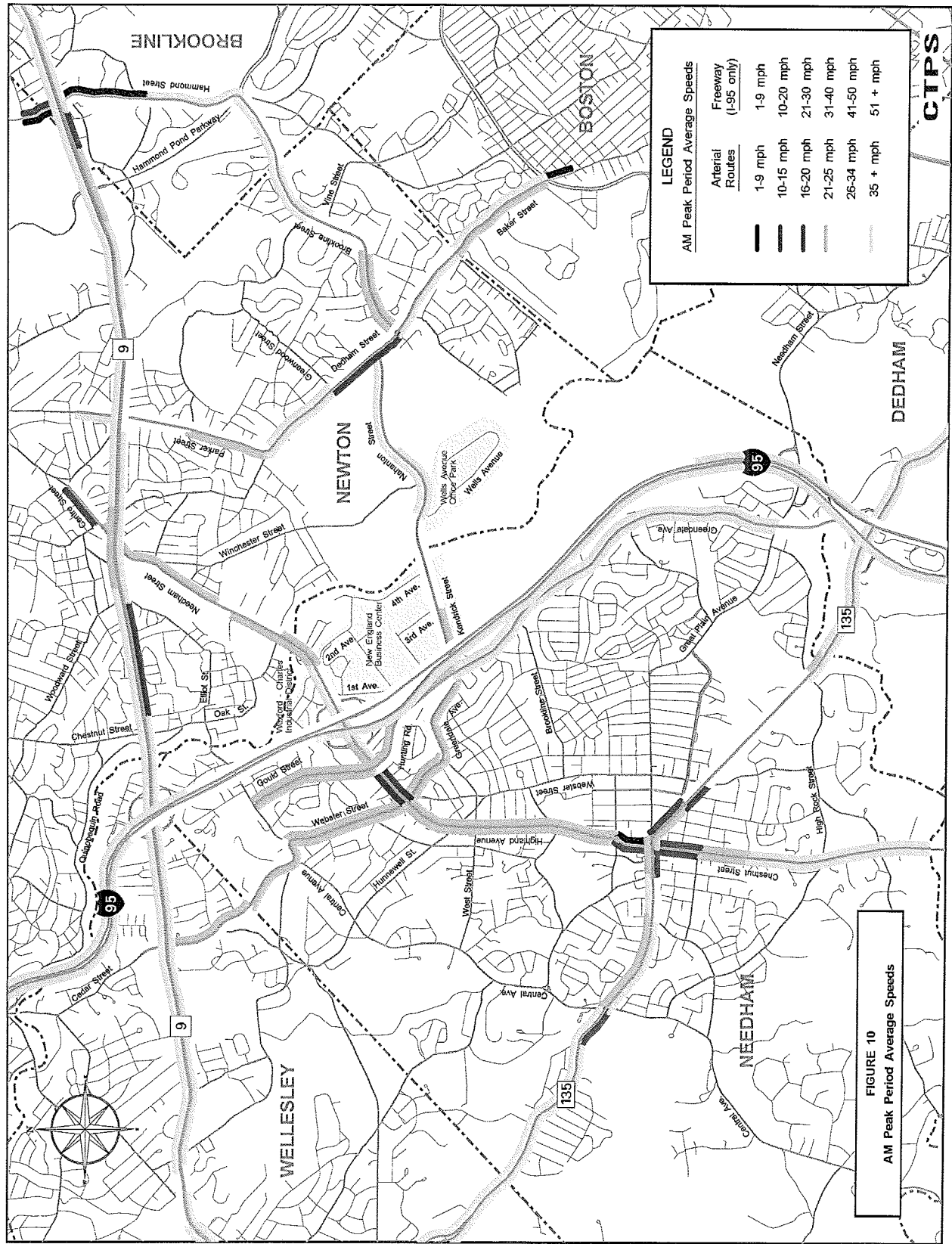
* See Appendix A for LOS definitions.

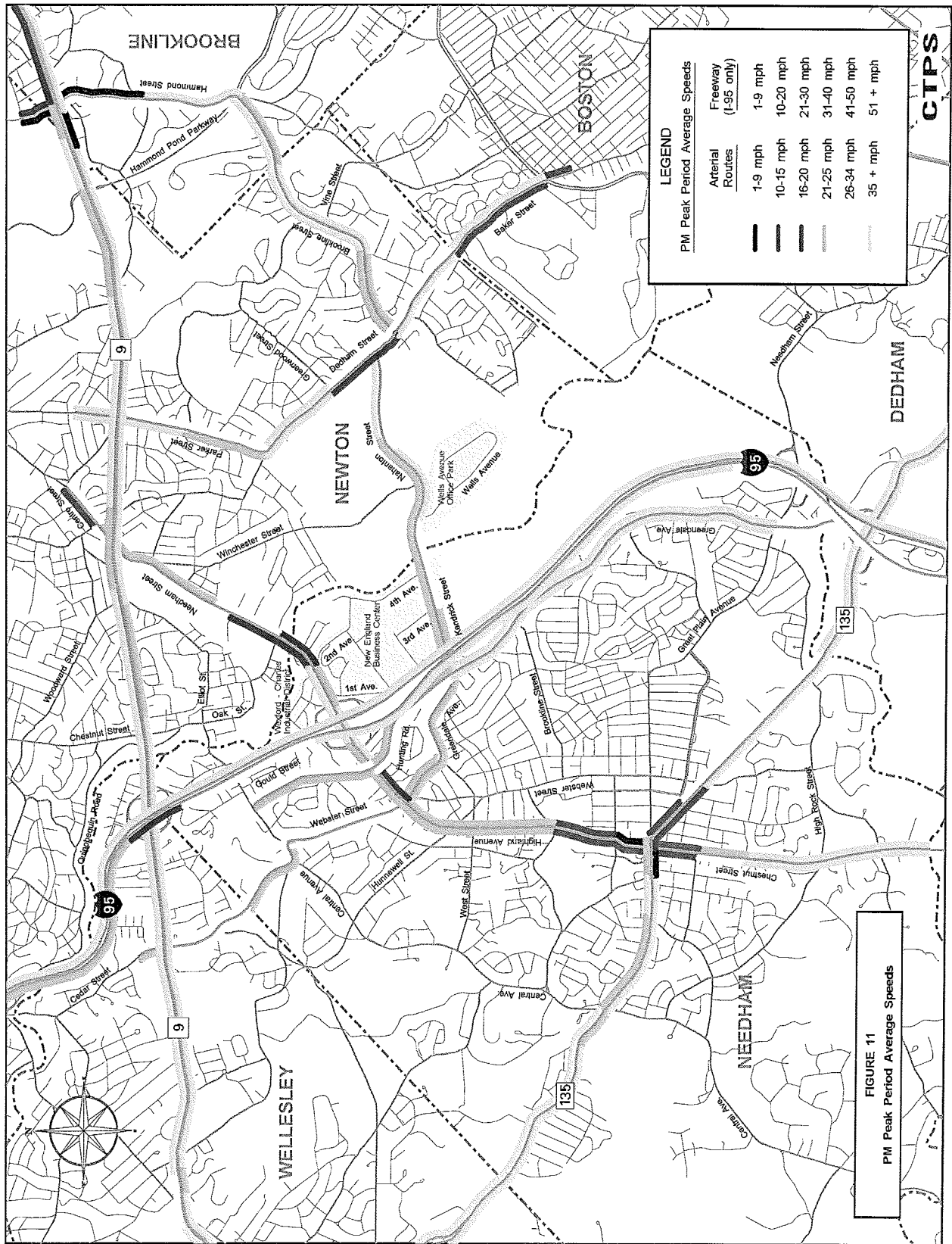
I-95 Southbound



Section Number	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Type of Facility	Basic	On-Ramp	Basic	Off-Ramp	Basic	On-Ramp	Basic	Off-Ramp	Basic	On-Ramp	Basic	Weave	Basic	Off-Ramp	Basic
LOS*	D	D	D	D	D	D	C	C	D	D	D	D	D	D	F
Density (veh/lane/mile)	27	28	27	27	27	25	23	23	27	35	35	36	33	35	44
Speed (mph)	49	52	53	52	52	52	54	55	52	47	47	46	47	47	36
Speed (mph)	36	27	26	29	29	29	25	29	39	33	36	32	32	36	36

* See Appendix A for LOS definitions.





5 MODEL CALIBRATION

To forecast, on a systematic basis, future traffic volume changes resulting from changes in the transportation network or in land use, a planning model used. The transportation planning model used in this study is the one adopted by the Boston Region MPO. Its socioeconomic components are based on forecasts produced by the Metropolitan Area Planning Council. The model is calibrated at a regional level for 164 cities and towns, which include all of the 101 in the MPO region.

For site-specific development and transportation projects, the model has to be calibrated to replicate local travel patterns in the project area before it is used to forecast future impacts of the project. The primary tool used in model calibration is the transportation planning model set implemented in TransCAD software.⁶

5.1 Model Development and Input Data

The basic input data for the model are:

1. Recent traffic counts on the existing roadways. These are compared to the model's present-day traffic volumes on those roadways, and the model is adjusted as necessary. In the present study, the ATR counts and the turning-movement counts described in Chapter 3 (Figure 5) were used for this purpose.
2. Socioeconomic data—population, employment, and households in the study area. For the present study, these data were already available (developed by MAPC) for both the base year and 2025 from the regional planning model set. They were used to create the regional trip tables, which consist of the zone-to-zone trips for the region.
3. Highway network data: an inventory of all the roadways in the regional model's area of influence. Free-flow speeds, numbers of lanes, capacities, distances between intersections, and other physical characteristics are included, together with such variables as whether a roadway is one-way or two-way, whether there are turn prohibitions at certain locations, and impacts of traffic signals and stop signs. Table 1 shows the free flow speeds and capacities used.

For the present study, the regional model network was “windowed-in” to the study area, where several enhancements were made to the input data before calibration:

1. The traffic analysis zones in the study area were subdivided to better reflect land use and circulation patterns.
2. Links were added to the highway network to represent the minor arterial and collector streets and the major driveways to the office and industrial parks in the study area.
3. Special turn links were added at the major interchanges and intersections to allow for turn penalties and evaluation of the turning movements.
4. Trips were adjusted for a few zones in the NEBC area based on the results of the traffic counts and the origin-destination license plate survey.

TABLE 1
Free-Flow Speeds and Capacities Used as Input Data

Functional Classification of Roadway	Free Flow Speed (mph)	Capacity (vphpl)
Freeway	60	2000
Ramp	30	1800
Principal Arterial	35–40	800
Minor Arterial	30	600
Collector	30	600
Centroid Connector	25	N/A

vphpl: vehicles per hour per lane

5.2 Calibration Results

The results of the model calibration are presented in Figures 13 and 14 for the AM peak hour and in 15 and 16 for the PM peak hour. The performance of the model was measured by comparing assigned traffic volumes, where possible, to available ground traffic volumes. In these comparisons, the percentage error—assigned traffic volume divided by the ground traffic volume—was evaluated. In each case, it was found to be within the acceptable range. The acceptable range for each functional classification of roadway is shown in Table 2. In addition, the model's assigned travel times were compared to the observed travel times and found to be comparable.

TABLE 2
Acceptable Range of Error in Traffic Volume Estimates,
by Functional Classification of Roadway

Functional Classification of Roadway	Error of the Estimate
Freeway	Less than 7%
Ramp	Less than 7%
Principal Arterial	Less than 10%
Minor Arterial	Less than 15%
Collector	Less than 25%

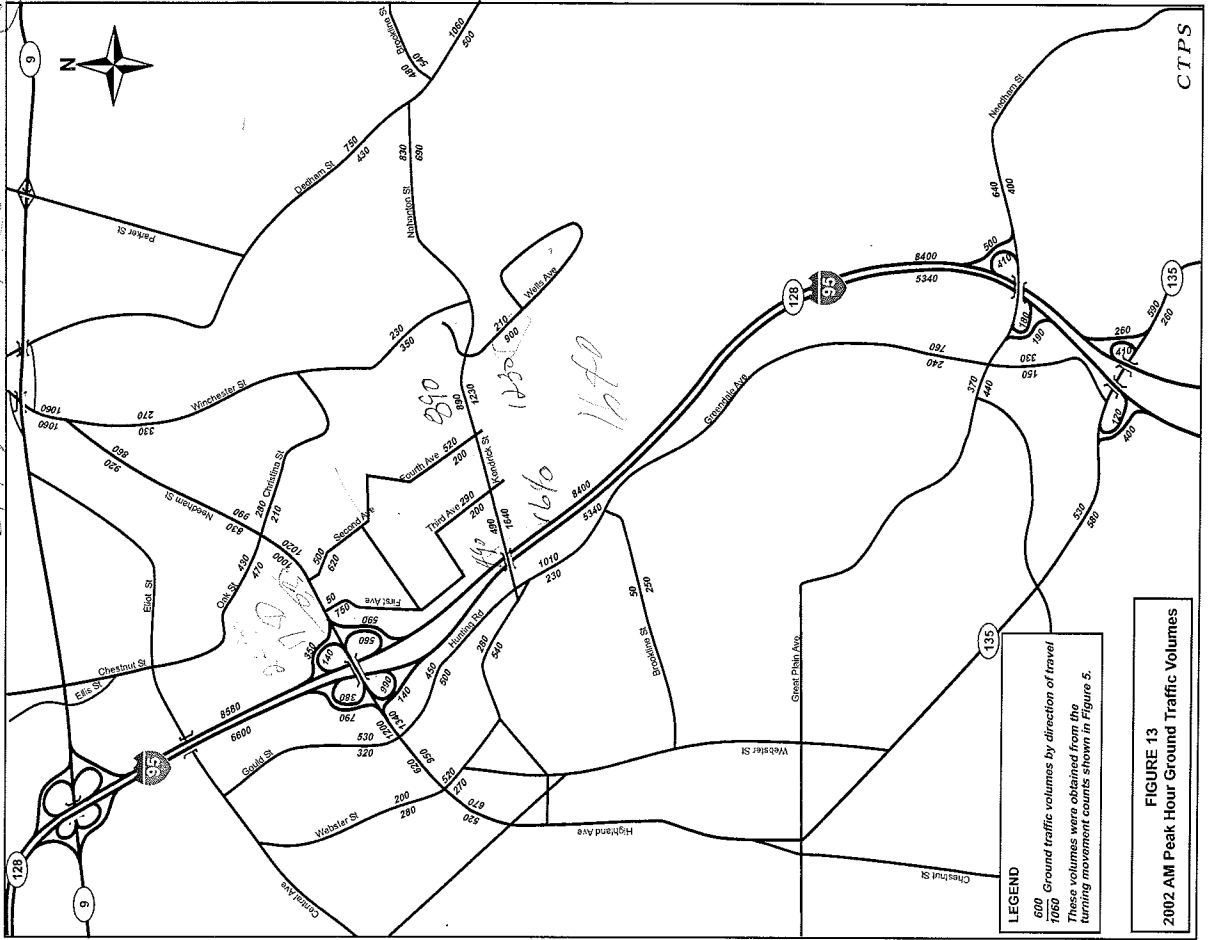
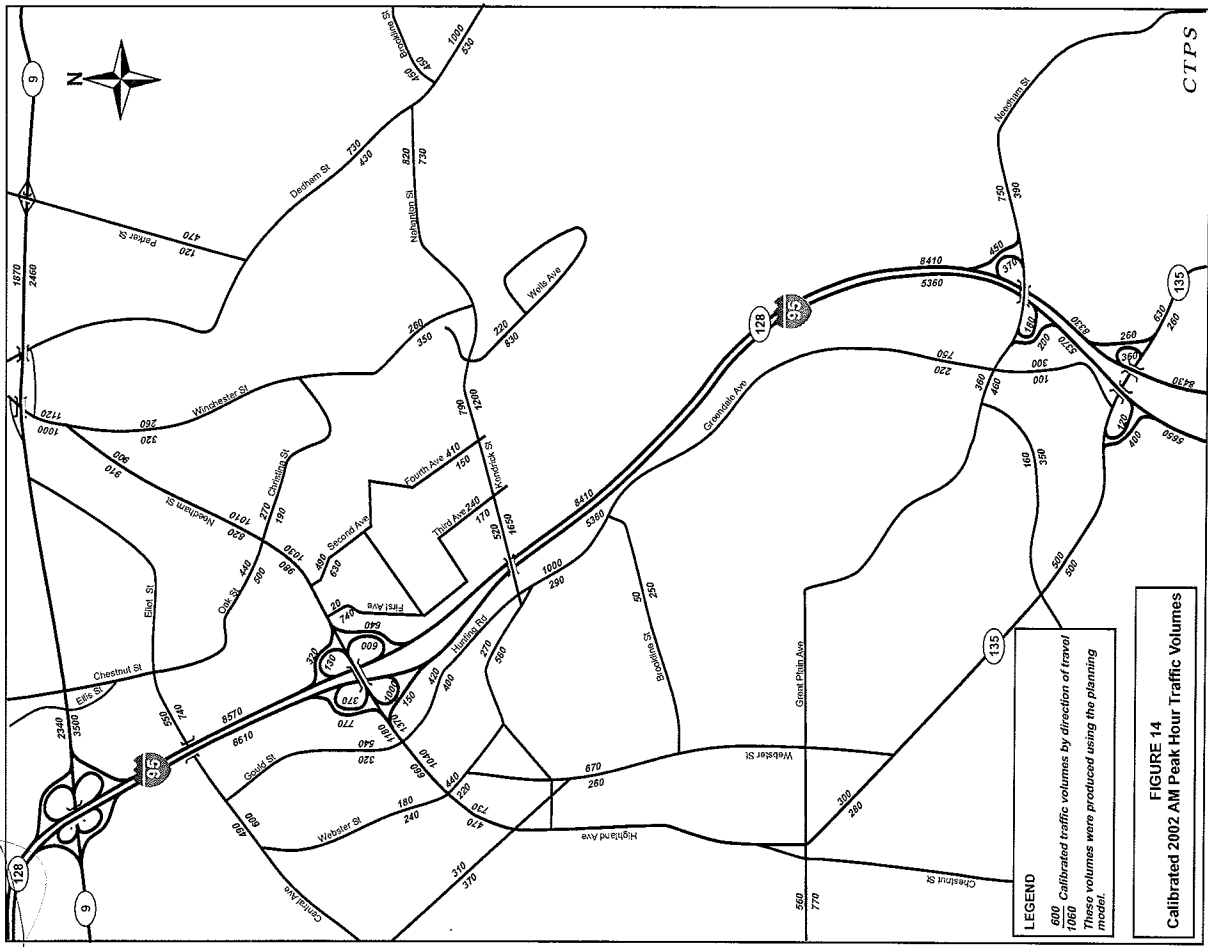
Source: U.S. Department of Transportation, Federal Highway Administration, *Calibration and Adjustment of System Planning Models*, Publication No. FHWA-ED-90-015 (December 1990).

⁶ Caliper Corporation, TransCAD Version 4.0, Build 156 (June 2002).

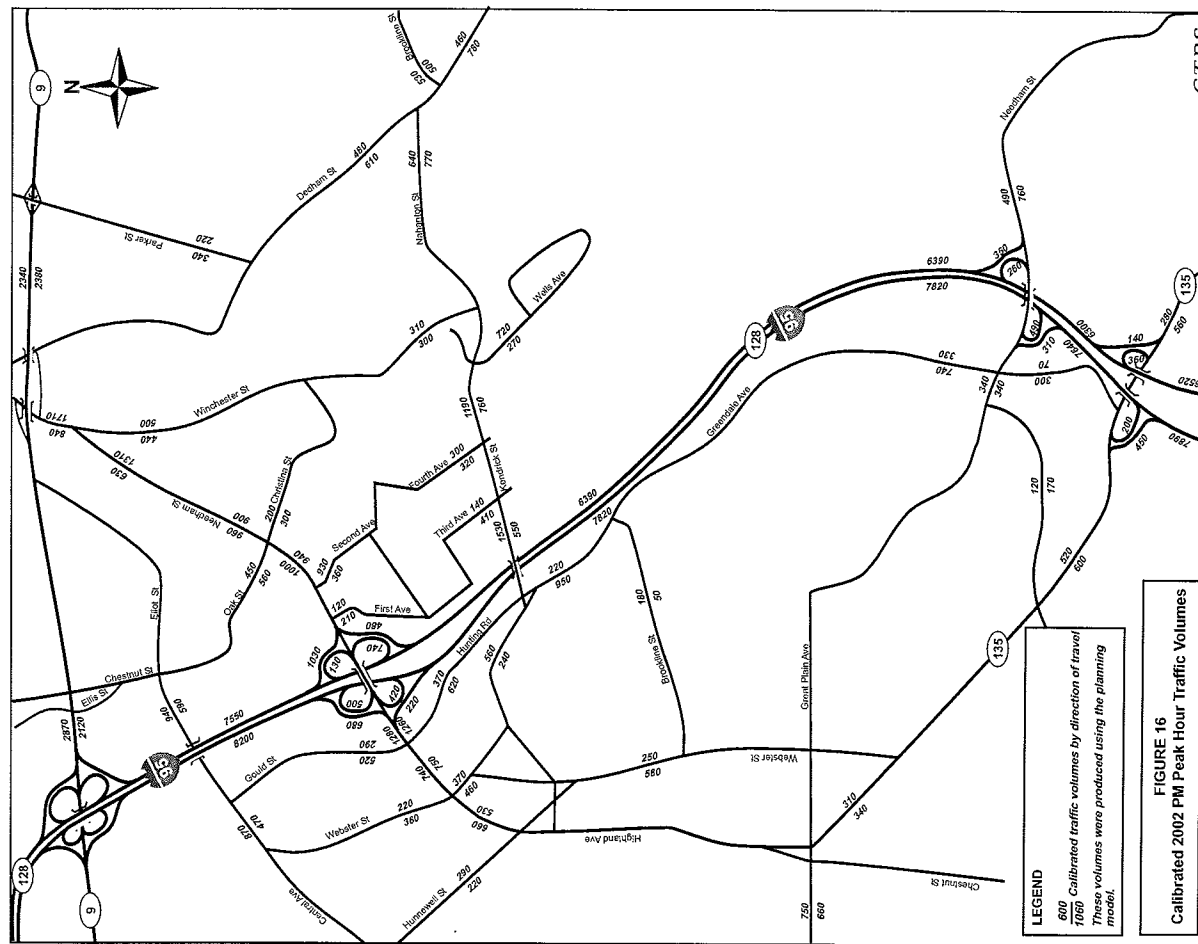
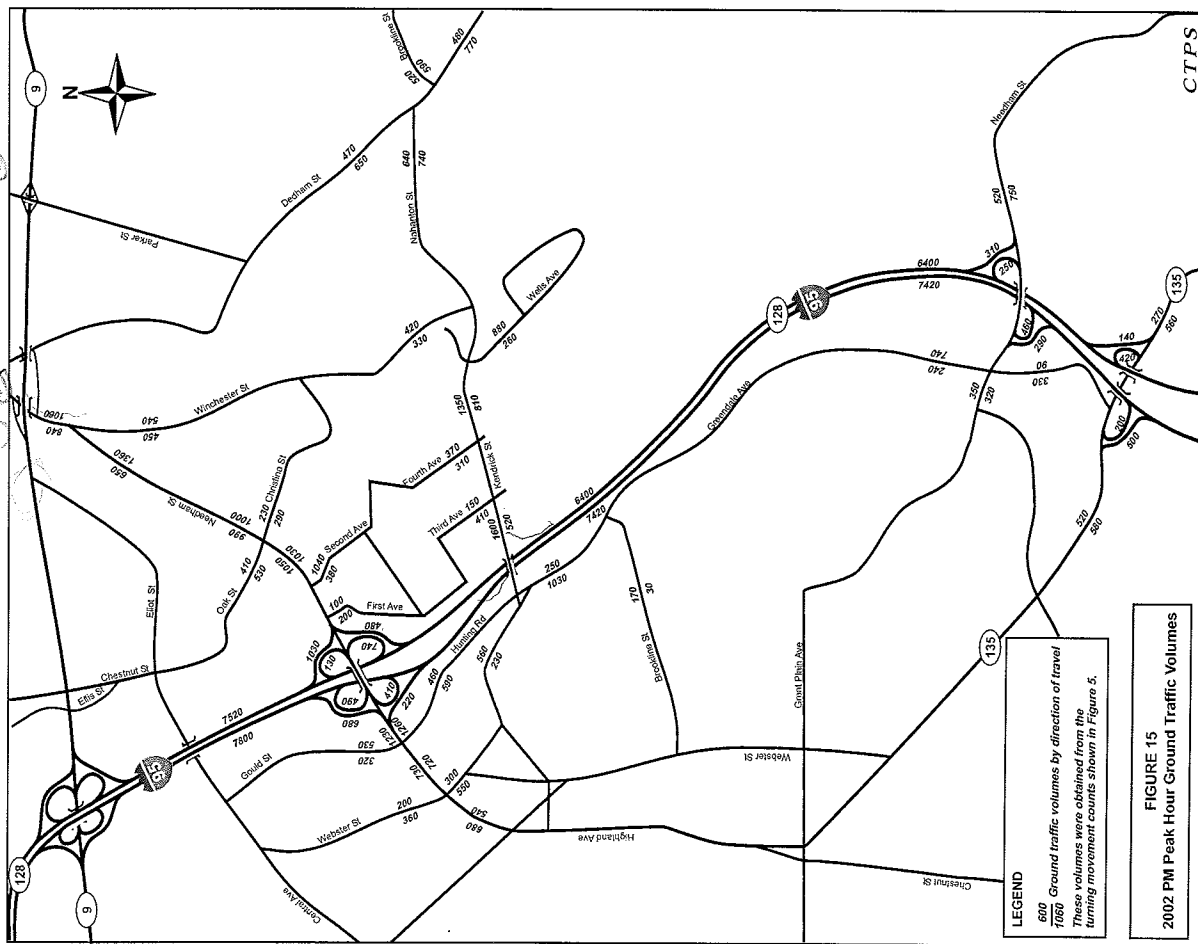
Staging

1200

1370
400
470



1140
 580
 520
 500
 500



6 FUTURE TRAFFIC IMPACTS

6.1 Packages of Alternatives

6.1.1 No-Build

The no-build alternative, which was the baseline used in assessing the impacts of the build alternatives as well as traffic from the existing (2002) conditions and shown in Figure 17, includes the following projects and developments:

1. The I-95/I-93 Transportation Improvement Project, which has been approved and programmed for fiscal years 2003 through 2008 in the TIP. This project will add a fourth travel lane and shoulder to I-95/Route 128 in each direction.
2. All of the arterial improvement projects expected in the area in the near future, which are described in Chapter 2.
3. All of the developments expected in the area in the near future, which are also described in Chapter 2.

6.1.2 Build Alternatives

Seven build alternatives were developed in conjunction with the Advisory Task Force and MassHighway for testing and evaluation. They are all variations of a Kendrick Street interchange on I-95. In

developing the alternatives, some of the objectives were for the improvements to tie in well with the I-95/I-93 Transportation Improvement Project, to enhance access to and egress from businesses in the area, and to address congestion and cut-through traffic.

The build alternatives are shown in Figures 18 through 24; they have been ordered to allow for incremental assessment of the traffic impacts of each component of the alternatives. The components (improvements) are shown in blue, to differentiate them from the no-build alternative, which is shown in yellow. *All of the alternatives have some form of turn treatments or prohibitions to prevent cut-through traffic into Needham neighborhoods.*

Alternative 1 was developed to enhance access to the area's businesses from the south via I-95 by providing a northbound off-ramp at Kendrick Street and thus reduce the cut-through traffic on Greendale Avenue during the AM peak period.

Alternative 2 was developed to enhance both access and egress to and from the area's businesses from the south via I-95 by providing a northbound off-ramp and a southbound on-ramp at Kendrick Street.

This alternative is expected to reduce the cut-through traffic on Greendale Avenue during the AM and PM peak periods.

Alternative 3 was developed to enhance access to and egress from the area's businesses for travelers from the north and the south using I-95 by providing a diamond interchange at Kendrick Street. This alternative is expected to reduce the cut-through traffic on Greendale Avenue during the AM and PM peak periods as well as relieve congestion pressure at the Highland Avenue interchange. The distances between proposed Kendrick Street's north side ramps and Highland Avenue's south side ramps need to be investigated, as they may not meet design standards or may require design exception.

Alternatives 4 and 5 were developed to enhance access to and egress from the area's businesses for travelers from the south using I-95 by providing a northbound off-ramp and a southbound on-ramp at Kendrick Street. An additional objective of this alternative was to enhance traffic operations on I-95 by providing collector/distributor roads paralleling it that would handle merging, weaving, diverging, and queuing interactions, removing them from its main travel lanes. In addition, it would be expected to reduce the cut-through traffic on Greendale Avenue during the AM and PM peak periods.

Alternative 6 was developed to enhance access to and egress from the area's businesses for travelers from the south and north using I-95 by providing a diamond interchange at Kendrick Street. An additional objective of this alternative was to enhance traffic operations on I-95 by providing collector/distributor roads paralleling it that would handle merging, weaving, diverging, and queuing interactions, removing them from its main travel lanes. This alternative is expected to reduce the cut-through traffic on Greendale Avenue during the AM and PM peak periods. The distances between proposed Kendrick Street's north side ramps and Highland Avenue's south side ramps need to be investigated, as they may not meet design standards or may require design exception.

Alternative 7 was added at the later stages of the study at the suggestion of MassHighway. It was developed to enhance access to and egress from the area's businesses for travelers from the south using I-95 by providing a northbound off-ramp and a southbound on-ramp at Kendrick Street. An additional objective of this alternative was to enhance traffic operations on I-95 northbound by providing a collector/distributor road paralleling it on the northbound side that would handle traffic exiting onto Highland Avenue eastbound, removing it from its main travel lanes. In addition, it would be expected to reduce the cut-through traffic on Greendale Avenue during the AM and PM peak periods.

6.2 Future Traffic Volumes

The forecast horizon year was 2025. The 2025 regional model includes all the transit and highway projects expected in the MPO region by that year. It also accounts for the effects of plans for land development and growth in employment, households, and population; for the present study, data on these factors were already available (developed by MAPC) for 2025 from the regional planning model set. They were used to create 2025 regional trip tables that consist of zone-to-zone trips. Both the area's future developments and the planned highway improvement projects described in Chapter 2 were included in the model.

As in the model calibration stage (Chapter 5), the 2025 regional model network was "windowed-in" to the study area, where several enhancements were made to the input data before forecasting:

1. The traffic analysis zones in the study area were subdivided to better reflect land use and circulation patterns.
2. Links were added to the highway network to represent the minor arterial and collector streets and the major driveways to the office and industrial parks in the study area.
3. Special turn links were added at the major interchanges and intersections to allow for turn penalties and evaluation of the turning movements.
4. Trips were adjusted for a few zones in the NEBC area based on future developments.

The results of the 2025 AM and PM peak hour forecasts are presented in Appendix D. The forecasts for the no-build alternative serve as a baseline for comparing the impacts of the build alternatives. That is, for each build alternative, the traffic increases/decreases compared to the no-build alternative are presented.

The no-build alternative also serves as a baseline for comparing the traffic increases/decreases from the calibrated 2002 model (see Appendix D, Figures D-3 and D-4).

6.3 Evaluation of Impacts

The following criteria were used to evaluate the impacts of the seven build alternatives:

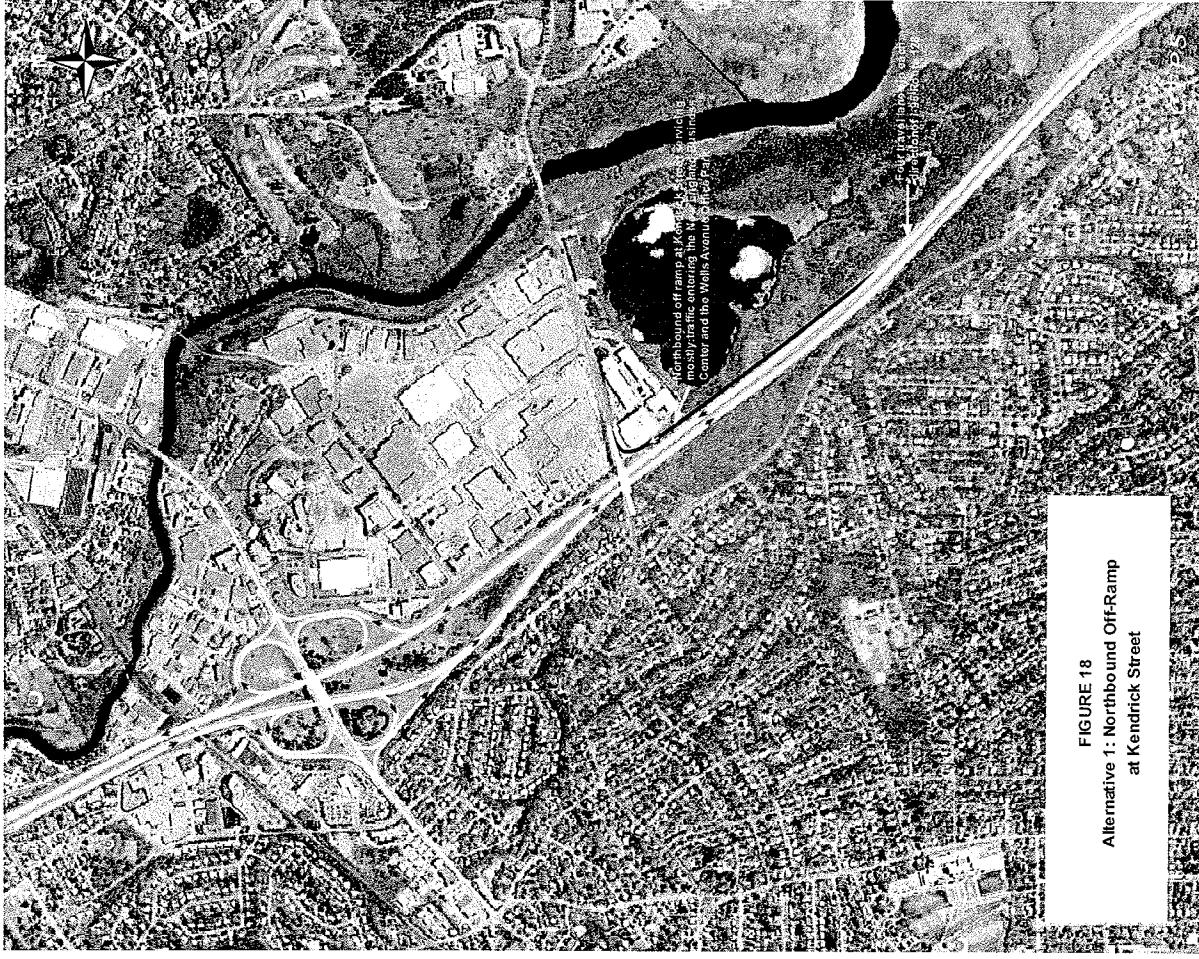
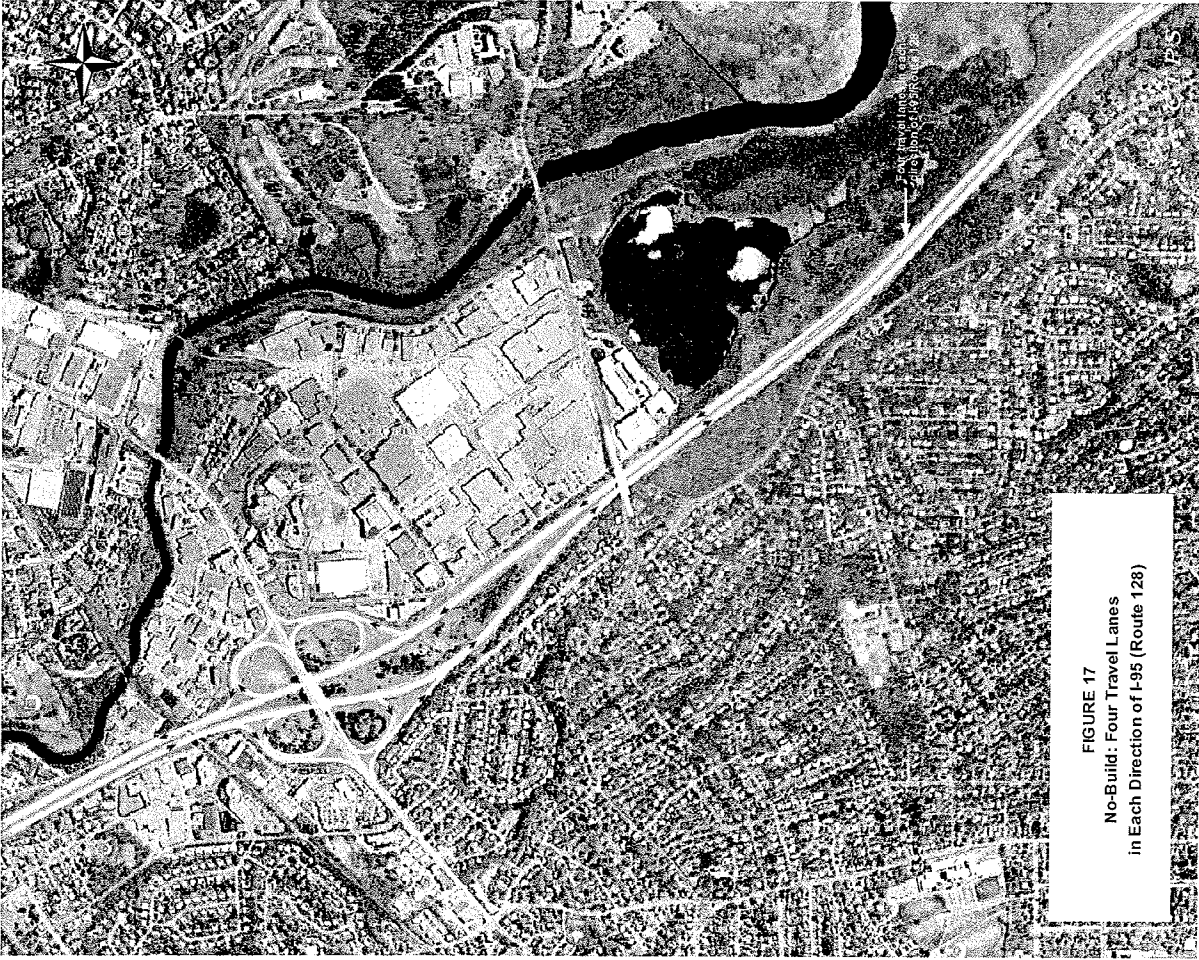
- Minimize cut-through traffic
- Minimize delay
- Maximize safety
- Minimize environmental/visual impacts

The results of the evaluations are presented in Table 3. No preferred alternative was selected in the study because other factors, such as design and environmental issues, right-of-way/land takings, and construction costs, need to be examined in detail. *From a traffic operations perspective only*, the following are the general findings:

1. All of the alternative Kendrick Street interchanges examined in this study (Alternatives 1–7) increase traffic volumes and impacts on Kendrick Street and could use up all of the available capacity.
2. Although any Kendrick Street interchange increases traffic volumes on Kendrick Street, with any of them, the traffic volume increase on Kendrick Street—and on Needham Street and Nahanton Street as well—results from the redevelopment of existing properties at the New England Business Center and of future traffic growth.
3. None of the Kendrick Street interchanges has, in itself, a significant impact on Needham Street or Winchester Street, as they all service mostly the commuter traffic to the NEBC and the Wells Avenue Office Park.
4. None of the Kendrick Street interchanges causes a significant increase in traffic on Nahanton Street, as most of the commuter trips to the area's businesses would be made via improved I-95/Route 128.
5. Any of the half diamond or full diamond Kendrick Street interchanges examined (Alternatives 2–7) reduces significantly the ramp traffic at the Highland Avenue interchange and improve traffic operations there.
6. Any of the Kendrick Street interchanges improves access to the area's businesses, and any of the half diamond or full diamond interchanges (Alternatives 2–7) improve both access to them and egress from them.
7. Any of the half diamond or full diamond Kendrick Street interchanges (Alternatives 2–7) reduces cut-through traffic on Greendale Avenue in Needham because of the improved access to and egress from the area's businesses.

8. Any of the half diamond or full diamond Kendrick Street interchanges (Alternatives 2–7) reduces significantly traffic diversions from I-95 onto the local roads at the Great Plain Avenue and Route 135 interchanges. This is mostly commuter traffic headed for the businesses along Kendrick Street in Needham and Nahanton Street in Newton.

In conclusion, *from a traffic operations point of view*, Alternative 6 seems the most beneficial of the options studied, providing the most improvement in terms of congestion, access/egress to/from the area's businesses, and cut-through traffic on Greendale Avenue. However, it is also associated with land takings of considerable magnitude, impacts on wetlands, and other environmental/visual impacts. Again, such factors must be carefully studied before a course of action is decided upon.



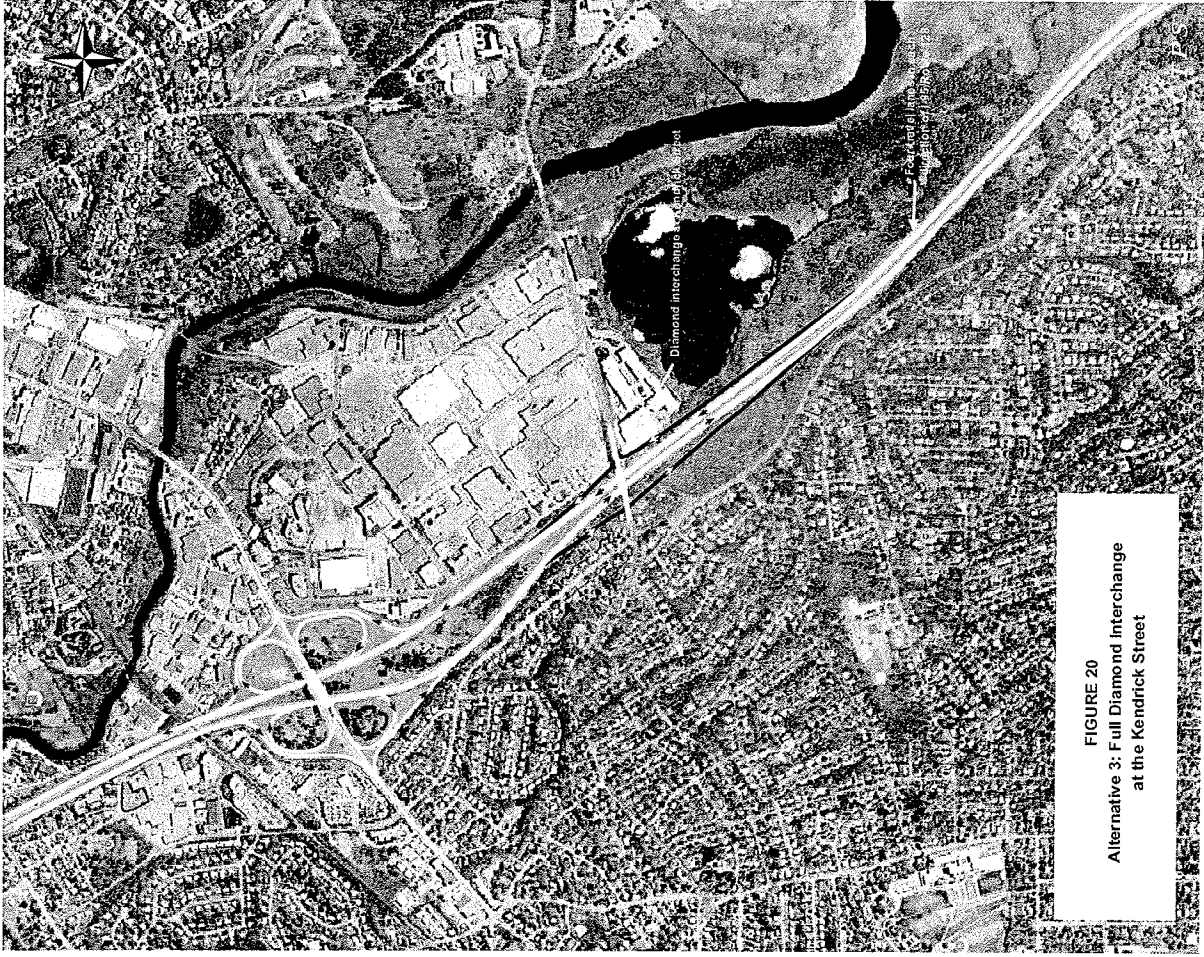


FIGURE 20
Alternative 3: Full Diamond Interchange
at the Kendrick Street



FIGURE 19
Alternative 2: Half Diamond Interchange at the
South Side of Kendrick Street

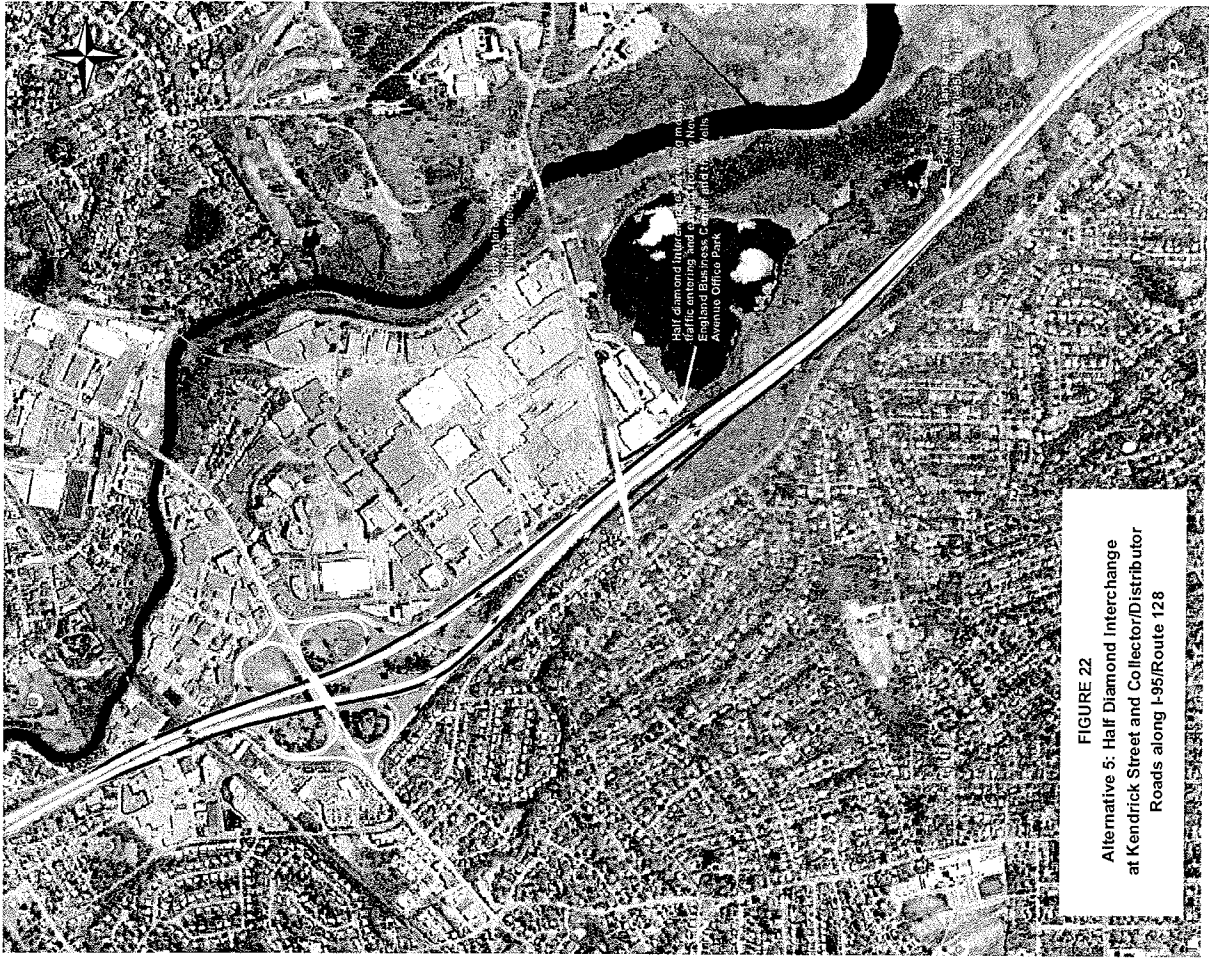


FIGURE 22
Alternative 5: Half Diamond Interchange
at Kendrick Street and Collector/Distributor
Roads along I-95/Route 128



FIGURE 21
Alternative 4: Half Diamond Interchange
at Kendrick Street and Collector/Distributor
Roads North of Kendrick Street

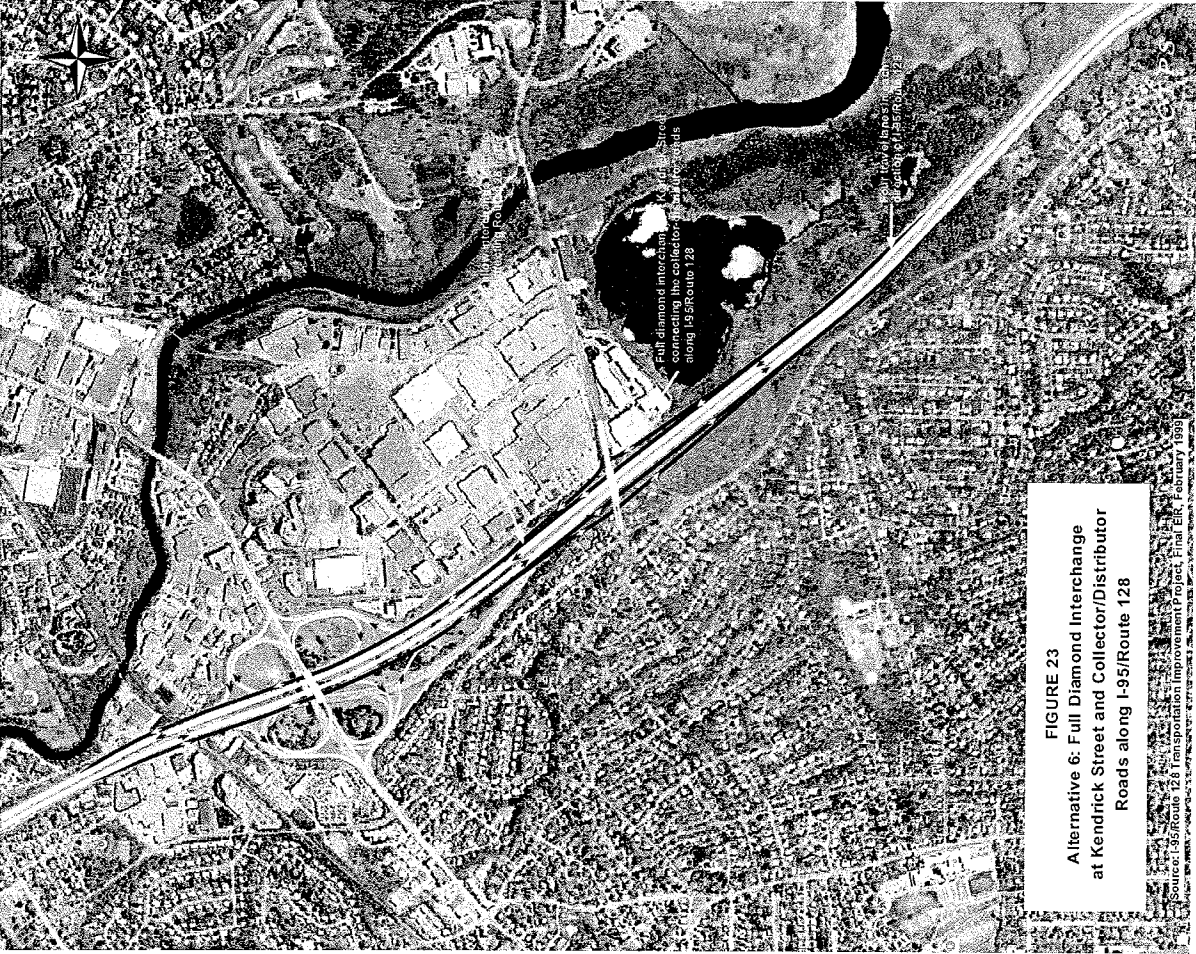


FIGURE 23

Alternative 6: Full Diamond Interchange
at Kendrick Street and Collector/Distributor
Roads along I-95/Route 128

Source: USGS, 1996; ESRI, 1996; and FHWA, 1996. Prepared by FHWA, February 1997.

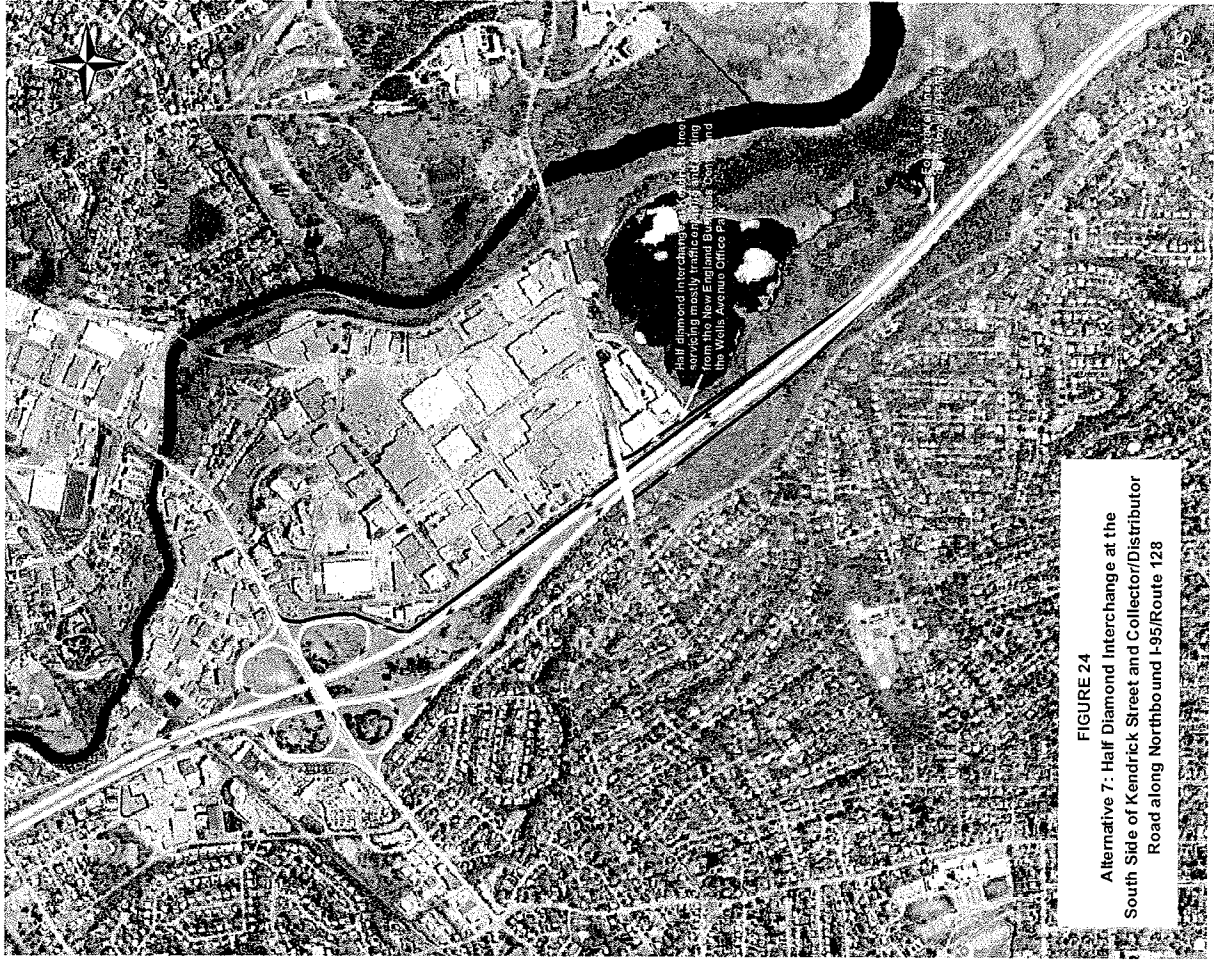


FIGURE 24

Alternative 7: Half Diamond Interchange at the
South Side of Kendrick Street and Collector/Distributor
Road along Northbound I-95/Route 128

Source: USGS, 1996; ESRI, 1996; and FHWA, 1996. Prepared by FHWA, February 1997.

TABLE 3
Comparison of Alternatives

Alternative	Concept Elements	Purpose	Impacts ¹							Construction and Cost	
			Traffic Operations	Minimization of Cut-Through Traffic	Traffic Safety	Access/Egress	Wetlands ²	Economic Development	Right-of-Way		Visual ³
No-Build	Construction of a fourth lane and a shoulder in each direction of I-95/Route 128 as part of the I-95/I-93 Transportation Improvement Project.	Improve traffic flow and safety on I-95/Route 128 mainline and at ramp junctions.									
1	A northbound off-ramp at Kendrick Street.	Improve traffic flow, safety, and Kendrick Street access from I-95/Route 128 south of Kendrick Street.	LOW Reduces traffic congestion and ramp queues at the northbound off-ramp of the Highland Avenue interchange; increases traffic on Route 128 south of the new ramp.	MEDIUM Minimizes cut-through traffic on Greendale Avenue mostly during the AM peak period; increases traffic on Hunting Avenue mostly during the AM peak period; reduces traffic on Highland Avenue west of the interchange; has no impact on Newton roads.	LOW Potential crash reduction at the northbound off-ramp at Highland Avenue; may be offset by crashes at new northbound off-ramp at Kendrick Street interchange.	LOW Addresses access to businesses in Highland Avenue/Kendrick Street areas, but not egress.	MEDIUM Potential wetlands impacts within the Highland Avenue and Kendrick Street areas.	LOW	LOW	LOW-MEDIUM New ramp will change the appearance and character of the Highland Avenue and Kendrick Street area.	\$
2	A half diamond interchange at the south side of Kendrick Street.	Improve traffic flow, safety, and Kendrick Street access/egress from/to I-95/Route 128 south of Kendrick Street; improve traffic operations at the Highland Avenue interchange.	MEDIUM Reduces traffic congestion and ramp queues at Highland Avenue interchange; increases traffic on Kendrick Street; increases traffic on I-95/Route 128 south of the new ramp.	HIGH Minimizes cut-through traffic on Greendale Avenue; reduces traffic on ramps at the Highland Avenue interchange, Great Plain Avenue interchange, and Route 135 interchange; increased traffic on Hunting Road; has no impact on Newton roads.	MEDIUM Potential crash reduction at Highland Avenue; may be offset by crashes at new Kendrick Street interchange.	MEDIUM Provides fairly good access and egress to and from businesses in the Highland Avenue/Kendrick Street area.	MEDIUM Potential wetlands impacts within the Highland Avenue and Kendrick Street areas.	MEDIUM Improves economic development opportunities at the nearby establishments.	LOW	MEDIUM New ramps will change the appearance and character of the Highland Avenue and Kendrick Street area.	\$\$
3	A full diamond interchange at Kendrick Street.	Improve traffic flow, safety, and Kendrick Street access/egress from/to I-95/Route 128 both south and north of Kendrick Street.	HIGH Reduces traffic congestion and ramp queues at Highland Avenue interchange; increases traffic on Kendrick Street; reduces traffic on Highland Avenue in the vicinity of First and Second Avenues; increases traffic on I-95/Route 128 south of the new ramp.	HIGH Minimizes cut-through traffic on Greendale Avenue; reduces traffic on ramps at the Highland Avenue interchange, Great Plain Avenue interchange, and Route 135 interchange; increases traffic on Hunting Road; has no impact on Newton roads.	MEDIUM Significant crash reduction at Highland Avenue; may be offset by crashes at new Kendrick Street interchange.	HIGH Provides very good access and egress to and from businesses in the Highland Avenue/Kendrick Street area.	HIGH Potential wetlands impacts within the Highland Ave and Kendrick St areas.	MEDIUM Improves economic development opportunities at the nearby establishments.	MEDIUM Requires some land taking within the New England Business Center in the vicinity of Kendrick Street.	MEDIUM New ramps will change the appearance and character of the Highland Avenue and Kendrick Street area.	\$\$\$

1. Most of the potential environmental impacts of a Kendrick Street interchange have been addressed in large part by the I-95/I-93 (Route 128) Transportation Improvement Project.
2. The I-95/I-93 (Route 128) Transportation Improvement Project will address aesthetic impacts by replacing lost landscaping and adding landscaping of the interchange, roadides, and banks where appropriate.
3. The I-95/I-93 (Route 128) Transportation Improvement Project will create replication areas within the Highland Avenue interchange and at the crossings of the Charles River to mitigate wetland impacts.

(cont.)

**TABLE 3 (cont.)
Comparison of Alternatives**

Alternative	Concept Elements	Purpose	Impacts ¹					Economic Development	Right-of-Way	Visual ³	Construction and Cost
			Traffic Operations	Minimization of Cut-Through Traffic	Traffic Safety	Access/Egress	Wetlands ²				
4	A half diamond interchange at Kendrick Street and collector/distributor roads along Route 128, beginning north of Kendrick Street and ending north of Highland Avenue.	Improve traffic flow, safety, and Kendrick Street access/egress from/to I-95/Route 128 south of Kendrick Street; improve traffic operations at the Highland Avenue interchange.	MEDIUM Reduces traffic congestion and ramp queues at Highland Avenue interchange; increases traffic on Kendrick Street; increases traffic on I-95/Route 128 south of the new ramp; reduces traffic on Highland Avenue in the vicinity of First and Second Avenues.	HIGH Minimizes cut-through traffic on Greendale Avenue; reduces traffic on ramps at the Highland Avenue interchange; Great Plain Avenue interchange, and Route 135 interchange; increases traffic on Hunting Road; has no impact on Newton roads.	MEDIUM Collector/distributor roads provide safe exit and entry without affecting through traffic on the freeway; significant crash reduction at Highland Avenue may be offset by crashes at new Kendrick Street interchange.	MEDIUM Provides fairly good access and egress to and from businesses in the Highland Avenue/Kendrick Street/Needham Street area.	MEDIUM Potential wetlands impacts within the Highland Avenue and Kendrick Street areas.	MEDIUM Improves economic development opportunities at the nearby establishments.	LOW	MEDIUM New ramps and collector/distributor roads will change the appearance and character of the Highland Avenue and Kendrick Street area.	\$\$\$
5	A half diamond interchange at Kendrick Street and collector/distributor roads along Route 128 beginning south of Kendrick Street and ending north of Highland Avenue.	Improve traffic flow, safety, and Kendrick Street access/egress from/to I-95/Route 128 south of Kendrick Street; improve traffic operations at the Highland Avenue interchange.	MEDIUM Reduces traffic congestion and ramp queues at Highland Avenue interchange; increases traffic on Kendrick Street; increases traffic on I-95/Route 128 south of the new ramp; reduces traffic on Highland Avenue in the vicinity of First and Second Avenues.	HIGH Minimizes cut-through traffic on Greendale Avenue; reduces traffic on ramps at the Highland Avenue interchange; Great Plain Avenue interchange, and Route 135 interchange; increases traffic on Hunting Road; has no impact on Newton roads.	MEDIUM Collector/distributor roads provide safe exit and entry without affecting through traffic on the freeway; significant crash reduction at Highland Avenue may be offset by crashes at new Kendrick Street interchange.	MEDIUM Provides fairly good access and egress to and from businesses in the Highland Avenue/Kendrick Street/Needham Street area.	MEDIUM Wetlands impacts along Route 128 between Highland Avenue and Kendrick Street.	MEDIUM Improves economic development opportunities at the nearby establishments.	LOW	MEDIUM New ramps and collector/distributor roads will change the appearance and character of the Highland Avenue and Kendrick Street area.	\$\$\$
6	A full diamond interchange at Kendrick Street and collector/distributor roads along Route 128.	Improve traffic flow, safety, and Kendrick Street access/egress from/to I-95/Route 128 both south and north of Kendrick Street; improve traffic operations at the Highland Avenue interchange.	HIGH Reduces traffic congestion and ramp queues at Highland Avenue interchange; increases traffic on Kendrick Street; increases traffic on I-95/Route 128 south of the new ramp; reduces traffic on Highland Avenue in the vicinity of First and Second Avenues.	HIGH Minimizes cut-through traffic on Greendale Avenue; reduces traffic on ramps at the Highland Avenue interchange; Great Plain Avenue interchange, and Route 135 interchange; increases traffic on Hunting Road; has no impact on Newton roads.	MEDIUM Collector/distributor roads provide safe exit and entry without affecting through traffic on the freeway; significant crash reduction at Highland Avenue may be offset by crashes at new Kendrick Street interchange.	HIGH Best accommodates access/egress between I-95/Route 128 and businesses in the Highland Avenue/Kendrick Street/Needham Street area.	HIGH Wetlands impacts along Route 128 between Highland Avenue and Kendrick Street.	MEDIUM Improves economic development opportunities at the nearby establishments.	MEDIUM Requires some land taking within the New England Business Center in the vicinity of Kendrick Street.	MEDIUM New ramps and collector/distributor roads will change the appearance and character of the Highland Avenue and Kendrick Street area.	\$\$\$\$
7	A half diamond interchange at Kendrick Street and collector/distributor road along the northbound Route 128 beginning south of Kendrick Street and ending north of Highland Avenue.	Improve traffic flow, safety, and Kendrick Street access/egress from/to I-95/Route 128 south of Kendrick Street; improve traffic operations at the Highland Avenue interchange.	MEDIUM Reduces traffic congestion and ramp queues at Highland Avenue interchange; increases traffic on Kendrick Street; increases traffic on I-95/Route 128 south of the new ramp; reduces traffic on Highland Avenue in the vicinity of First and Second Avenues.	HIGH Minimizes cut-through traffic on Greendale Avenue; reduces traffic on ramps at the Highland Avenue interchange; Great Plain Avenue interchange, and Route 135 interchange; increases traffic on Hunting Road; has no impact on Newton roads.	MEDIUM Collector/distributor roads provide safe exit and entry without affecting through traffic on the freeway; significant crash reduction at Highland Avenue may be offset by crashes at new Kendrick Street interchange.	MEDIUM Provides fairly good access and egress to and from businesses in the Highland Avenue/Kendrick Street/Needham Street area.	MEDIUM Wetlands impacts along Route 128 between Highland Avenue and Kendrick Street.	MEDIUM Improves economic development opportunities at the nearby establishments.	LOW	MEDIUM New ramps and collector/distributor roads will change the appearance and character of the Highland Avenue and Kendrick Street area.	\$\$\$

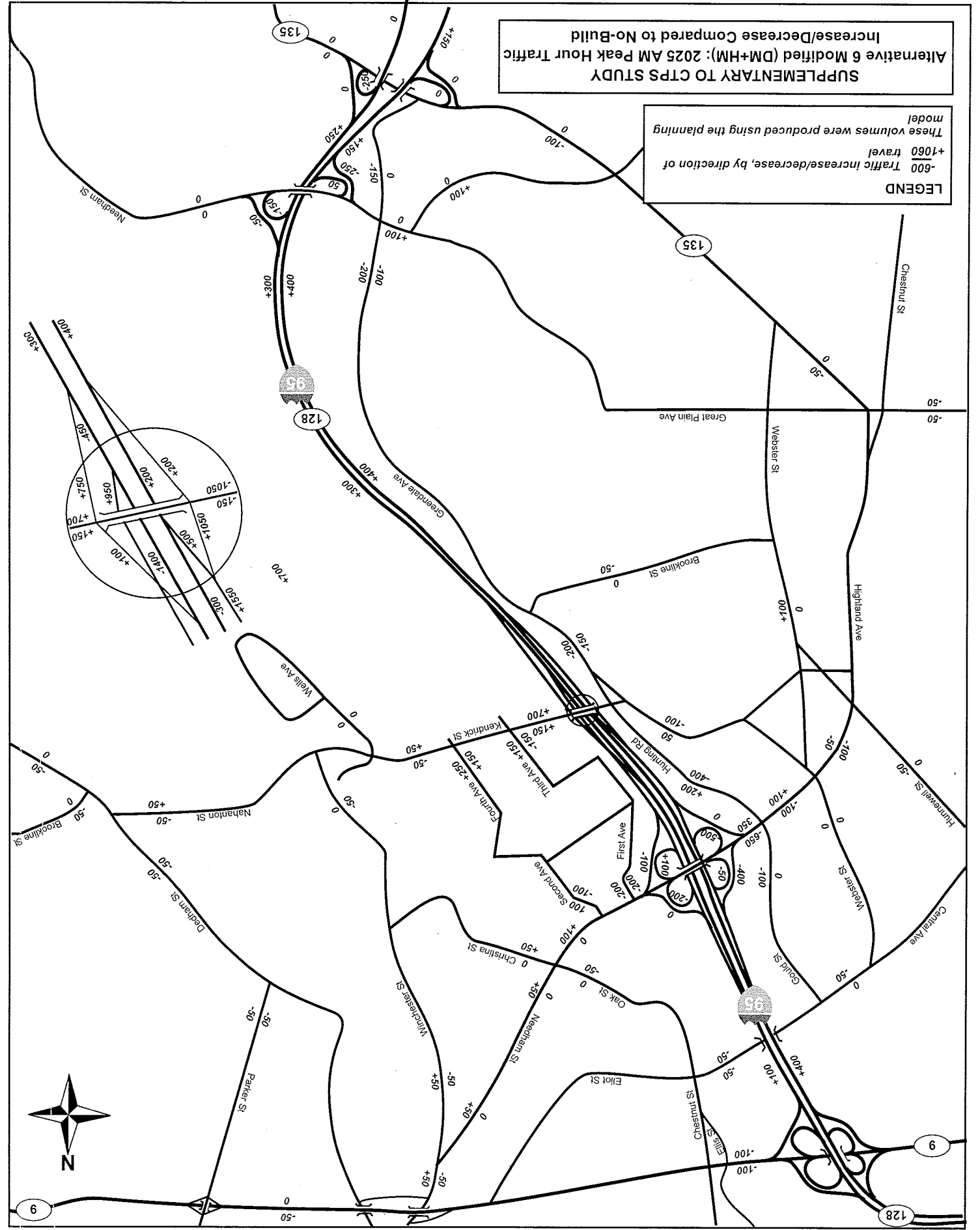
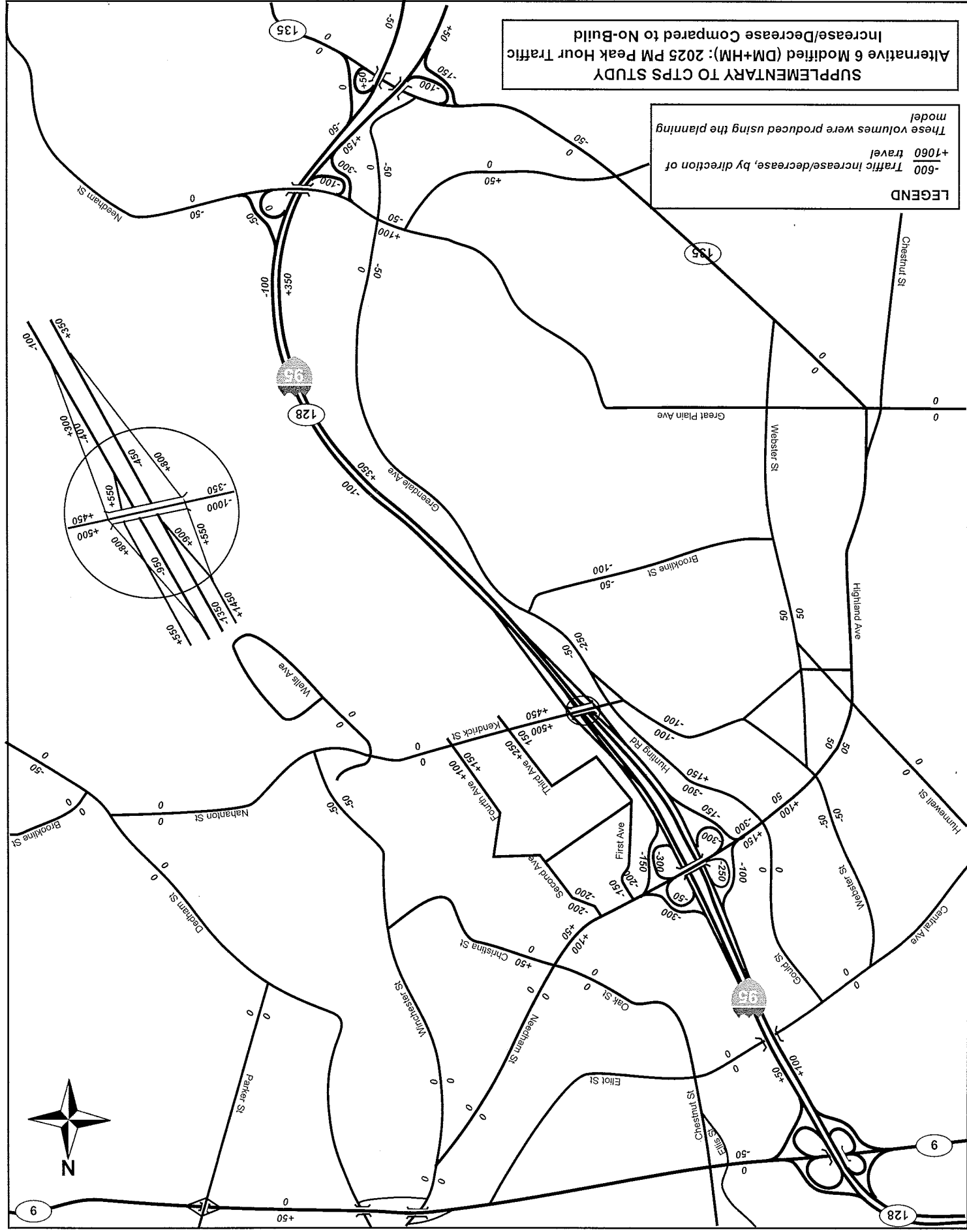
4 LICENSE PLATE SURVEY

A license plate survey was conducted to determine commuter travel patterns to the area's businesses and thus aid in identifying what type of interchange would be appropriate for I-95/Kendrick Street. Both video cameras and tape recorders were used to record license plate numbers at selected sites, shown in Figure 12. The sites were chosen to make possible the tracing of the logical path of a vehicle through the area or to a destination in the primary destination area, which consists of the New England Business Center and Wells Avenue Office Park and is shown in the figure. The survey was conducted during the morning peak period, 7:00 to 9:00 AM, in April 2002. The plate numbers were looked up in the Registry of Motor Vehicle database to determine the town which the vehicles were registered. Detailed results of the survey are presented in Appendix C.

Some of the important findings of the survey are summarized below.

1. Commuter traffic to and through the study area is regional in nature; it originates in all 101 cities and towns of the Boston Region MPO and beyond.
2. The majority of the morning peak period traffic on Highland Avenue, Needham Street, Kendrick Street, and Nahanton Street has its beginning and end outside of the primary destination area (New England Business Center and Wells Avenue Office Park). It must be emphasized that some of this traffic has destination in the study area outside of the primary destination area.
3. Greendale Avenue experiences high volumes of cut-through traffic. This traffic pattern is partly due to congestion on I-95 and partly due to the poor access from I-95 northbound to the business areas in Needham and Newton. The majority of the cut-through traffic comes from communities south of I-95. Interstate 95 exits 17 and 18, where Route 135 and Great Plain Avenue, respectively, cross the interstate, are the access points for this cut-through traffic.
4. A substantial portion of Nahanton Street eastbound traffic is pass-through traffic originating from towns west of the study area including Franklin, Natick, Wellesley, Dover, Medfield, Medway, and Holliston. Nahanton Street is also one of the primary access routes for commuters from Boston, Newton, and Brookline to the Wells Avenue Office Park and to the businesses on Kendrick Street. In addition, Nahanton Street is used as a cut-through route by commuters from the communities south of I-95 who avoid the freeway's traffic congestion by exiting onto Route 1 or Route 109 and using the internal road network (VFW Parkway and Dedham Street) to access Nahanton and the area's businesses.





APPENDIX A

Public Participation

- Public Comments
 - Town of Needham
 - City of Newton
 - City of Newton's Comprehensive Planning Advisory Committee
- CTPS Responses to Public Comments on the Draft Report
- Attendance at Advisory Task Force Meetings



TOWN OF NEEDHAM
TOWN HALL
Needham, MA 02492-2669

Office of
BOARD OF SELECTMEN
June 10, 2003

Arnold J. Soolman, CTPS Director
Central Transportation Planning Staff
Massachusetts Highway Department
10 Park Plaza
Boston, MA

JUN 12 2003

TEL: (781) 455-7513
FAX: (781) 449-4569
TDD: (781) 455-7558

RE: CTPS Project No. 53212 Needham/Newton Traffic Impact Study

Dear Mr. Soolman:

The Town on Needham has reviewed the six different options outlined in the Preliminary Comparisons of Alternatives for the I-95/Route 128 and Kendrick Street Interchange presented during the meetings held by the CTPS Staff, the City of Newton and Town of Needham over the past year. The Town of Needham is very impressed with the professionalism displayed by the CTPS staff regarding this highly complex and comprehensive study. The analysis was presented in understandable terms and addressed a multitude of aspects regarding traffic related issues and impacts to both Needham and Newton. It was a pleasure to be involved with this project.

The Town of Needham is a forward looking community seeking to foster growing opportunities in business in a safe and responsible manner. Traffic accommodation is a necessary facet of that growth. Opportunities to improve safety and enhance capacity occur infrequently and Needham believes that every opportunity should be pursued. In keeping with this philosophy, Needham recommends and supports Option 6 - A full diamond interchange at Kendrick Street and collector-distributor roads along Route 128. This option provides the best opportunities for the distant future and maximizes the benefits to the region while addressing existing traffic safety issues.

We look forward to proceeding with the proposed I-95/Route 128 Transportation Improvement Project and stand ready to assist MassHighway with the limited available resources at our disposal.

Very truly yours,

Efi Pagitsas, Principal

Seth Asante, Manager

John H. Caswell
BOARD OF SELECTMEN

cc: Efi Pagitsas, Principal
Seth Asante, Manager

City of Newton



DEPARTMENT OF PUBLIC WORKS
ENGINEERING DIVISION- TRANSPORTATION
1000 Commonwealth Avenue
Newton Centre, MA 02459-1449

David B. Cohen
Mayor

November 7, 2003

Mr. Seth Asante
Project Manager
Central Transportation Planning Staff
10 Park Plaza, Suite 2150
Boston, MA 02116-3968

Dear Mr. Asante:

This letter contains review comments compiled by the City of Newton on the CTPS report entitled "Potential I-95 (Route 128)-Kendrick Street Interchange, Needham, Massachusetts: An Evaluation of Traffic Impacts." The comments below are referenced by the report page number and represent the combined review of our Planning and Engineering Departments.

Page 4- The study should list the advisory task force members and meeting dates.

Page 5- The 2025 build-out analysis, based on EOE and MAPC projections, should be updated with projections from the City of Newton, which is in the process of conducting its own build-out analysis. The study's statement that there are absolute development constraints in Newton is incorrect. Although the City's analysis has not yet been completed, we believe that the potential for redevelopment of parcels along the Needham Street corridor by 2025 is significant, as many of the parcels are underbuilt by today's zoning controls. As one example, there is an 11.1-acre parcel about to be auctioned to the highest bidder at 55 Tower Road.

Page 5- The Needham Street corridor is currently zoned "Mixed Use 1" and "Mixed Use 2," not "Industrial."

Page 5- References to the city's "Nexus Plus Bus System" should be removed, as the fixed route system was eliminated on July 1, 2003.

Page 5- The Avalon Bay project on Needham Street includes 294 apartments, but does not include a day care center.

Page 5- The study should note the existing location and time of day use of the breakdown lanes, which act as a de facto fourth lane on portions of Route 128/95 where the "Add-a-Lane" project is proposed.

Page 9- The month and year of all traffic counts should be provided. Seasonal adjustments, if made, should be documented.

Page 9- The methodology used to determine the peak hour for the study area intersections should be described and the results provided (e.g., 7:30-8:30 AM, 4:30-5:30 PM).

Figure 5 should include labels that indicate signalized and unsignalized intersections.

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Page 16- The month and year of the license plate survey should be provided.

Page 16- The claim made by Bullet #2 seems unsupported by the data. For example, some vehicles recorded at station 7 may be destined for the Needham Street corridor (inside the study area) or for Route 128 (outside the study area). Based on the other station locations, it could not be determined which portion of trips ended inside the study area versus outside the study area.

Page 20- The study should examine the feasibility/effectiveness of any transit or carpool alternatives that would reduce the number of single occupant vehicle trips to/from the study area.

Page 20- The study provides no details regarding the trip generation methodology employed or the annual background growth rate of traffic assumed.

Page 20- The study should demonstrate the impacts of a) new highway access and b) new development in two separate steps. To do this, we propose that CTPS run the calibrated 2002 model with the only variable being each of the 6 identified highway access alternatives. This would enable the City of Newton to understand how the new access would shift existing trips away from the Highland Avenue interchange and to Kendrick Road/Nahanton Street. This would allow a more accurate baseline comparison to the 2025 scenario. At present, we are not confident about the accuracy of the projected traffic impacts to Needham Street, Winchester Street, or Nahanton Street.

Page 20- The study concludes by acknowledging its own limited scope, i.e., only a traffic operations analysis was used to evaluate the alternatives. The City of Newton would need to understand any and ALL impacts (e.g., environmental, cost, visual, etc.) of the 6 alternatives, not just the traffic operations impacts, before we could support advancement of any alternative.

Appendix B- The distribution of vehicles observed at Site 4 should be added.

On behalf of the City of Newton, I appreciate your consideration of these comments and look forward to working together on this important effort.

Sincerely,

Clint Schuckel, P.E.
City Traffic Engineer
Department of Public Works
1000 Commonwealth Avenue
Newton, MA, 02459-1449

Cc: Mayor David Cohen
Alderman Christine Snow Samuelson, Chair, Public Safety and Transportation Committee
Robert Rooney, Commissioner of Public Works
Michael Kruse, Director of Planning

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The following comments from the City of Newton's Comprehensive Planning Advisory Committee were received after the commenting period and after the final report was approved by the Transportation Planning and Programming Committee on December 18, 2003. Therefore, they were not addressed nor considered in this study. However, we have decided to include them in the appendix so that they would be available for consideration in further investigations and processes required for the advancement of any of the alternatives and the final selection of a preferred alternative.



COMPREHENSIVE PLANNING ADVISORY COMMITTEE

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 Philip B. Herr, Committee Chair
 Telephone (617) 969-1805 FAX (617) 332-9499
 Michael Kruse, Director, Dept. of Planning & Development
 Telephone (617) 796-1130 FAX (617) 796-1142
 Nancy Rautovich, Chief Planner
 Telephone (617) 796-1137 FAX (617) 796-1142

December 29, 2003

Karl H. Quackenbush
 Deputy Technical Director
 Central Transportation Planning Staff
 10 Park Plaza, Suite 2150
 Boston, MA 02116

Re: Kendrick Street Interchange, Rt. 128/I-95 Project

Dear Mr. Quackenbush,

Thank you for the opportunity to pass along comments on the draft report on the "Potential I-95 (Route 128) – Kendrick Street Interchange, Needham, Massachusetts: An Evaluation of Traffic Impacts." Since this project has the potential to have serious impact on traffic and quality of life in Newton, it is important that it be thoroughly evaluated and studied. As pointed out in the November 7 letter from Clint Schuckel, the Newton City Traffic Engineer, further study is needed before definitive choices can properly be evaluated. However, the comprehensive perspective of our planning group may still be helpful to the process if heard now rather than later.

The Transportation Committee of the City of Newton Comprehensive Planning Advisory Committee ("CPAC") is one of the groups currently compiling a comprehensive plan for the City. The members, none of whom live on streets directly impacted by the project, reviewed and discussed the materials on the Project, following which the Chair of that group, Srdjan Nedeljkovic, wrote a series of observations and recommendations. They have been copied into this letter with only minor editorial change by me. I confidently agree with the mitigation recommendations below, and believe that the analysis of choice among alternatives provided below is a helpful input to the ultimate choice among a number of closely competing though different alternatives, for which further information is really required, as pointed out in Clint Schuckel's letter. Neither I nor the Committee really was able to make as clear a choice as their chair was able to do.

Choice Among Alternatives

1) The report presents six alternatives for a new intersection between Kendrick Street in Needham and I-95 (Route 128). It is apparent from the study that all of these alternatives will increase traffic on Newton's streets. In particular, traffic on Nahanton Street and

Winchester Street will increase. Because the new interchange will provide a convenient "cut-through" route to Brookline and Boston via Nahanton Street and Brookline Street, traffic throughout the south side of Newton will increase as a result of any of those alternatives. From the draft report, Figure 6 indicates that even now, without the Kendrick Street interchange, all of the intersections on this route in Newton operate with unacceptable delays during both the AM and PM peak traffic times. Figures 9 and 10 show that Hammond Street in Brookline, which would likely absorb much of this new cut-through traffic, currently operates at speeds of 1-9 mph at AM and PM peak. According to Figures 12-15, Nahanton Street, which is a two-lane roadway, carried from 640-840 vehicles per peak hour in each direction in 2002.

The Committee chair believes that the changes in traffic volumes for 2025 shown in Figure C are unrealistic and incorrect. Figure C purports to show how traffic will change with various Kendrick Street interchange parameters. However, its indication that traffic on Nahanton Street, Dedham Street, and Brookline Street will not increase at peak hour compared to the non-build scenario is not credible. Because it is likely that traffic congestion will worsen on Rt. 9 and Needham Street as new development occurs along these corridors, the new Kendrick Street interchange, with access on back roads to Boston and Brookline, will provide a convenient cut-through route that will markedly increase traffic on Newton's local roads. One goal of the whole of CPAC is that such cut-through traffic on Newton's residential streets should be minimized. None of the alternatives presented in the draft report achieve that.

2) The CTPS has recommended that Alternative 6 be the preferred choice. The City of Newton CPAC Transportation Committee can't yet endorse any choice. Its chair specifically does not endorse the choice of Alternative 6. This alternative involves creating a diamond interchange between Kendrick Street and I-95 (Route 128), with additional parallel access lanes built along I-95 between Kendrick Street and Highland Avenue. These new lanes would be in addition to the expansion to four lanes in each direction that is planned for I-95. Because of the tremendous amount of cut-through traffic this option could induce, Alternative 6 would be the most devastating to Newton.

Instead, the Transportation Committee chair endorses Alternative 2, which involves building a northbound I-95 (Route 128) off-ramp to Kendrick Street and a southbound on-ramp from Kendrick Street to I-95 (Route 128). This option does not include excess parallel lanes along I-95, which will be expanded to 4 lanes in each direction in any event. Option 2 is preferable to Option 6 because it accomplishes the goal of enhancing access to the important Needham Industrial Park (New England Business Center) while resulting in the least stimulus to traffic on Newton's streets. Briefly, Option 2 is superior because:

- It creates major improvements to access the businesses in the Needham Industrial Park and in the Wells Office Park in Newton.

- It creates major improvements to access the businesses in the Needham Industrial Park and in the Wells Office Park in Newton.
- It would generate the least through-traffic on Newton's residential streets and on Needham Street, while allowing for Needham to solve problems of cut-through traffic on Greendale Avenue.
- It incurs the least cost.
- It involves the least consumption of land, including wooded land, wetland, and potentially buildable land.
- It would have relatively small visual and environmental impacts.

Mitigation

It is clear that any Kendrick Street interchange with I-95 (Rt. 128) will produce a negative impact for Newton in terms of inducing traffic and reducing quality of life in adjacent neighborhoods. Therefore, mitigation will be necessary. The CPAC as a whole has a goal to improve public transportation options for residents and businesses in Newton, thereby reducing reliance on automobile travel as the sole mode of transport. One attractive proposal being explored by CPAC involves extending light rail service along Needham Street, on a line that would extend from the Green Line in Newton Highlands to the commuter rail at Needham Heights. The CTPS has already been introduced to this proposal as part of the Program for Mass Transportation.

As mitigation for the increased traffic generated by the proposed Kendrick Street interchange process, the CPAC Transportation Committee chair and I advocate further study and future funding of the Newton-Needham light rail proposal. The following recommendations are made:

- For the study to be complete, the CTPS must perform a study of the impact that light rail service would have on traffic on Needham Street, Rt. 9, Highland Avenue, and Chestnut Street. Traffic reduction by implementing rail service should be based on the Needham Industrial Park's proposed build-out of 2.7 million square feet of commercial space. A build-out in the Needham Street corridor in Newton should also be considered, which based upon build-out studies being prepared for CPAC by City staff can be modeled as ranging from 1 to 2 million square feet of new commercial space and up to 600 new residential units on Needham Street or within 1/4 mile of the rail corridor.
- The rail alternative should be based on a dual-track line with stations at I-95/Rt.128 and the Needham Industrial Park, Newton Upper Falls, Needham Street, and Needham Heights. The Rt. 128 station should be modeled as having direct access/egress to the highway. A shuttle bus service to access the Needham Industrial Park south of Highland Avenue should also be included. Service frequency of the rail line should be every 10 minutes throughout the day.
- Capital funds should be redirected from the I-95 (Route 128) highway account and other highway accounts to pay for this rail expansion project.

- Any study of the Kendrick Street/Rt.128/Highland Avenue region should include the impact of roadway widenings and expansions on induced travel demand.

The CPAC Transportation Committee chair insists that any roadway widening project that increases automobile traffic capacity must be mitigated by complementary measures to improve public transportation options. Increasing roadway capacity at Kendrick Street will induce new traffic, increase emission of pollutants, and result in traffic congestion along Newton's residential streets. Alternatively, integrated rail transit with a feeder system of bus routes is the wave of the future. Including a rail option within the Kendrick Street – Rt. 128 project will support initiatives for sustainable development and allow for reduced reliance on the automobile as the sole mode of travel. The rail alternative is consistent with recent State initiatives, such as Governor Romney's support for clustering housing and jobs near rail stations. Bringing a rail link to this corridor is also compatible with policies of groups such as the Conservation Law Foundation and the Sierra Club, which indicate that the State should focus on rail transit in future transportation projects.

Although Kendrick Street does not fall within the boundaries of Newton, the effects of adding an interchange with I-95 (Route 128) will certainly affect the City's south side. For that reason, I am grateful for this opportunity to submit these observations.

Sincerely,

Philip B. Herr

Cc: Mayor David Cohen
Alderman Christine Snow Samuelson, Chair, Public Safety and Transportation Committee
Robert Rooney, Commissioner of Public Works
Michael Kruse, Director of Planning
Clint Schuckel, P.E., City Traffic Engineer
Srdjan Nedeljkovic, M.D., CPAC Transportation Group Chair

CTPS RESPONSES TO PUBLIC COMMENTS ON THE DRAFT REPORT*

Source	Comment	Response
Town of Needham	The Town of Needham is a forward-looking community seeking to foster growth opportunities in business in a safe and responsible manner. Traffic accommodation is a necessary facet of that growth. Opportunities to improve safety and enhance capacity occur infrequently and Needham believes that every opportunity should be pursued. In keeping with this philosophy, Needham recommends and supports Alternative 6—a full diamond interchange at Kendrick Street and collector-distributor roads along Route 128. This option provides the best opportunities for the distant future and maximizes the benefits to the region while addressing traffic safety issues. We look forward to proceeding with the proposed I-95/Route 128 Transportation Improvement Project and stand ready to assist MassHighway with the limited available resources at our disposal.	As stated in the report, the final decision on the preferred design will be based on, in addition to the traffic impacts assessment, other factors such as environmental impacts, right-of-way needs, and cost.
	The report is well written, comprehensive and professional; an impressive example of objective engineering work. On a personal note, it is a good feeling to have confirmatory findings of the work previously conducted by the Norfolk County Engineering Department and the Needham Engineering Division.	Reference to that study will be included in the final report.
MassHighway	Add Alternative 7 that includes a collector-distributor road only on the northbound side of I-95 and a half diamond interchange at the south side of Kendrick Street. List the Advisory Task Force members and meeting dates.	Alternative 7 will be added to the final report. In the final report, the Advisory Task Force will be listed on the back of the cover and Appendix A will include the meeting dates and attendance.
City of Newton	The 2025 build-out analysis based on EOEa and MAPC projections should be updated with projections from the City of Newton, which is in the process of conducting its own build-out analysis. The study's statement that there are absolute development constraints in Newton is incorrect. Although the City's analysis has not yet been completed, we believe that the potential for redevelopment of parcels along the Needham Street corridor by 2025 is significant, as many of the parcels are underbuilt by today's zoning controls. As one example, there is an 11.1-acre parcel about to be auctioned to the lowest bidder at 55 Tower Road. The Needham Street corridor is currently zoned as "Mixed-Use 1" and "Mixed-Use 2," not "Industrial." Reference to the City's "Nexus Plus Bus System" should be removed, as the fixed route system was eliminated on July 1, 2003. The Avalon Bay project on Needham Street includes 294 apartments, but does not include a day care center.	The traffic forecasts from the model are not based on build-out analysis, but on 2025 forecasts, which were developed with input from the City. The report notes that there are several "brownfields"—large sites available for infill development—adjacent to the Needham Street corridor. At the beginning of the study, both Needham and Newton were requested to submit potential developments expected in the study area by 2025. Those developments that were submitted were considered in the study. The final report will reflect this correction. References to the Nexus Plus Bus System will be removed from the report. The final report will reflect this correction.

* The comments from the two municipalities are from letters, which are reproduced opposite, except for the second comment from Needham, which is from an e-mail. Those comments are given in this table verbatim. The comments from Fred Douglas of Vanasse & Associates are from telephone conversation and are paraphrased here. The responses were given to the commenting party in advance of the release of this final report.

Source	Comment	Response
	The study should note the existing location and time of day use of the breakdown lanes, which act as a de facto fourth lane on portions of Route 128/1-95 where the Add-a-Lane project is proposed.	The existing location and time of day of use of the breakdown lanes will be defined in the final report. (The section of I-93/I-95 from the junction of Route 24 in Randolph to Route 9 in Wellesley, from 6:00 AM to 10:00 AM and 3:00 PM to 7:00 PM on weekdays.)
	The month and year of all traffic counts should be provided. Seasonal adjustments if made, should be documented. The methodology used to determine the peak hour for the study area should be described and results provided.	The month and year of all the counts will be given and the adjustment documented. The methodology used to determine the peak hour will be described.
	Figure 5 should include labels that indicate signalized and unsignalized intersections	A separate figure will be added to the report that specifies the signalized and unsignalized intersections.
	The month and year of the license plate survey should be provided.	The month and year of the license plate survey will be given.
City of Newton (continued)	The claim made [in Chapter 4] by Bullet #2 seems unsupported by the data. For example, some vehicles recorded at station 7 may be destined for the Needham Street corridor (inside the study area) or for Route 128 (outside the study area). Based on the other station locations, it could not be determined which portions of the trips ended inside the study area versus outside the study area.	The text referred to should have spoken in terms of a primary destination area (consisting of the New England Business Center and the Wells Avenue Office Park) rather than the study area. In the final report, this problem will be corrected.
	The distribution of vehicles at Site 4 should be added.	The distribution of vehicles at Site 4 can be found in Appendix C.
	The study should examine the feasibility/effectiveness of any transit or carpool alternatives that would reduce the number of single occupant vehicle trips to/from the study area.	This task was not part of the study's work program.
	The study should provide detail regarding the trip generation methodology or the annual background growth rate of traffic assumed.	The details about the forecasting process in Chapter 6 will be expanded in the final report.
	The study should demonstrate the impacts of a) new highway access and b) new developments in two separate steps. To do this, we propose that CTPS run the calibrated 2002 model with the only variable being each of the 6 identified highway access alternatives. This would enable the City of Newton to understand how the new access would shift trips away from Highland Avenue to Kendrick Street/Nahant Street. This would allow a more accurate baseline comparison to the 2025 scenario. At present, we are not confident about the traffic impacts to Needham Street, Winchester Street, and Nahant Street.	A comparison of traffic increase/decrease between the calibrated 2002 model and the 2025 No-Build model has been provided.
Fred Douglas of Vanasse & Associates, Inc.	The intersection of Highland Avenue and Gould Street/Hunting Road has recently undergone a traffic signal upgrade.	This fact was taken into account in the study analyses, and mention of it will be added to the report.
	The distances between the proposed north side ramps at Kendrick Street and the south side ramps at Highland Avenue will require further investigation, as they may not meet state and federal standards.	This issue regarding the distances had been considered; if Alternative 3 or 6 is selected, a design exception would need to be requested. These points will be added to the report.
	Check traffic forecast for Third Avenue in Needham in Alternative 3.	The diamond interchange in Alternative 3 would draw some traffic bound for the New England Business Center that previously used Highland Avenue and either First or Second Avenue. Some of that traffic would now use Kendrick Street and Third Avenue.

ATTENDANCE AT ADVISORY TASK FORCE MEETINGS

Newton/Needham Study 11/16/01

Name	Affiliation	Phone #
Seth Asank	CTPS	617-473-7098
Lou Mervin	City of Newton Planning	617 552-7135 X114
		Mervin@ci.newton.ma.us
Richard Lipof	Alderman Newton	617-332-8909 ext. 2
Harvey Swack	MAPE REP	781-449-4555
Roy LaMotte	Newton Traffic Plan	617-552-7992
JACK Cogswell	Needham Selectman	781-444-0852
Anthony DelGaudio	Needham Town Engineer	781-455-7541
Kerry Ramsdell	" Asst "	781-455-7540
Rock Merson	Needham OPW Dir	781-455-7537

Needham-Newton Traffic Impact Study
November 30 2001

Name	Affiliation	Phone #
Seth Asank	CTPS	617-473-7098
JACK Cogswell	Selectman-Needham	781-444-0852
Lee Newman	Planning Board	781-455-7520
Harvey Swack	MAPE REP	781-449-4555
Anthony DelGaudio	Needham Town Engineer	781-455-7541
Kerry Ramsdell	" Asst "	781-455-7540
Sharon Sandrine	Frank	617 332 8603
Lou Mervin	Newton Planning	617 552-7135 X114
Rock Merson	Needham OPW	781-455-7537
Eji Pazitsas	CTPS	(617) 923-7046

Needham-Newton Traffic Impact Study
Advisory Task Force Meeting
January 25, 2002, 8:30 am
Selectmen Meeting Room, Needham Town Hall

Name	Agency	Telephone
Seth Asante	CTPS	617-923-7098
Amy Rosenthal	Office of Senator Jacques	617-722-1555
Lance Hansen	Wellesley Planning Board	781-431-1019 x-238
Jack Cogswell	Selectman - Needham	781-444-0852
Harvey Swack	MARC Rep Needham	781-449-4555
Ray LaMotte	City Traffic Engineer Needham	617-512-7036
Lou Mercuni	City of Newton Planning	617-552-7135 X114
Mike Cogswell	City of Newton Planning	508-657-4313 617-552-7135 x10
Richard Lipof	Alderman - Newton	617-332-8909 x24
Mark Berger	Mass Highway - Planning	617-973-7340
Anthony Del Gaizo	Needham Town Engineer	781-455-7541
Joe Onorato	MHD D4	781-641-8479
Richard Merson	Needham DPW	781-455-7537
Myra Tattenbaum	Representing Sen. Creedy	617-722-1639
Lee Newman	Needham Planning	781-455-7526
Curt Dooling	Rep. Harkins	617-722-2300
Ed Papitcas	CTPS	617-923-7106

Needham-Newton Traffic Impact Study
Advisory Task Force Meeting
April 5, 2002
Needham Town Hall

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Seth Asante	CTPS	617-973-7098
Jack Cogswell	Selectman - Needham	781-444-0852
Harvey Swack	MARC Rep Needham	781-449-4555
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Old. Christine Sammon	City of Newton	617-244-8789
Lou Mercuni	City of Newton	(617) 552-7135 X114
Stephen Habbe	Sen. Jacques Ofc.	617-722-1555
Lawrence Ramsdell	Needham, First Tr. Eng.	781-455-7540
Joe Onorato	MHD D4	781-641-8479
Ray LaMotte	Needham Town Engineer	617-552-7096
Mark Berger	Mass Highway - Planning	617-973-7340
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Richard Merson	Needham DPW	781-455-7537
Lee Newman	Needham Planning	781-455-7526
Edna Marita	Needham Planning	781-455-7526
Myra Tattenbaum	Office of Sen. Creedy	617-722-1639
Carolann Connor	128 Business Council	781-890-0093
Christine Nolan	Rep. Harkins Office	617-722-2300

Needham-Newton Traffic Impact Study
Advisory Task Force Meeting
Friday, July 26, 2002
Selectmen's Meeting Room

Needham-Newton Traffic Impact Study
Advisory Task Force Meeting
November 22, 2002

<u>Name</u>	<u>Agency</u>	<u>Telephone</u>	<u>Name</u>	<u>Agency</u>	<u>Telephone</u>
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Jordan Branstky	Representative Linda Harkin	617-722-2320	JACK Cogswell	Selectman-Needham	781-444-0852
Shannon E. Delan	Greene - Parsons Inc	508-492-7200	Tony Del Garzo	Needham Town Engineer	781-455-7541
David Charveta	FAY, SPOFFORD & THORNDIKE, INC	781-221-1030	Ethan Britland	Mass Highway Planning	617-973-8236
Lawrence Ramsdell	Needham DPW, Asst. Tr. Eng	781-455-7540	Caroline CORNWY	128 Needham St Council	781-890-0093
Tony Del Garzo	Needham Town Engineer	781-455-7541	Olga Gorlocki	Needham Traffic Impact Comm.	781-449-1288
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Christie Samuelson	Newton Bd. of Ald.	617-244-8789	Nina Wang	City of Newton	617-796-1490
Mark Berger	Mass Highway - Planning	617-973-7534	FRED DOUGLAS	VANASSE & ASSOC.	978-474-8800
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	Needham		Garry Ramsdell	Needham, Asst. Tr. Eng.	781-455-7540
			Ricardo Pearson	Needham DPW - Director	781-455-7537
			Thomas Erdlen	Greene - Parsons Inc	508-492-7200
			Handy Patel	Mass Highway - Highway Design	617-973-7728
			Christie Samuelson	Newton Bd. of Ald.	
			Emelyn Adante	City of Newton	
			Edo Pappas	CTPS	973-7106

Needham-Newton Traffic Impact Study
Advisory Task Force Meeting
April 11, 2003

Name	Agency	Telephone
Seth Asante	CIPS	617-973-2098
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Hina Wang	City of Newton	617-796-1490
Christine Samuels	Newton Bd of Ald	617-244-8789
Caroline Connor	198 Busse Road Council	781-890-0093
Ace Newman	Needham Planning	781-455-7526
Ethan Britland	Mass Highway Planning	617 973 8236
Joe Onorato	MHD DOT	791-641-8479
LENNY BARBIERI	FAY SPORFORD & THORNDIKE	781-221-1240
LARRY CASH	MHD - ENGINEERING	617-973-7384
Harley Ford	" - Highway Design	617-973-7728

APPENDIX B

Definitions of Levels of Service⁷

Signalized Intersections

LOS	Control Delay (sec/veh)
A	≤ 10
B	> 10–20
C	> 20–35
D	> 35–55
E	> 55–80
F	> 80

sec/veh denotes seconds per vehicle

Unsignalized Intersections

LOS	Control Delay (sec/veh)
A	≤ 10
B	> 10–15
C	> 15–25
D	> 25–35
E	> 35–50
F	> 50

sec/veh denotes seconds per vehicle

Urban Streets, by Class

Urban Street Class	I	II	III	IV
Range of free-flow speeds (FFS)	55 to 45 mph	45 to 35 mph	35 to 30 mph	35 to 25 mph
Typical FFS	50 mph	40 mph	35 mph	30 mph
LOS	Average Travel Speed (mph)			
A	> 42	> 35	> 30	> 25
B	> 34–42	> 28–35	> 24–30	> 19–25
C	> 27–34	> 22–28	> 18–24	> 13–19
D	> 21–27	> 17–22	> 14–18	> 9–13
E	> 16–21	> 13–17	> 10–14	> 7–9
F	≤ 16	≤ 13	≤ 10	≤ 7

⁷ Transportation Research Board, *Highway Capacity Manual* (2000).

Freeways: Basic Segments

LOS	Density (pc/mi/ln)
A	≤ 0–11
B	> 11–18
C	> 18–26
D	> 26–35
E	> 35–45
F	> 45

pc/mi/ln denotes passenger cars per mile per lane

Freeways: Weaving Segments

LOS	Density (pc/mi/ln)
A	≤ 10
B	> 10–20
C	> 20–28
D	> 28–35
E	> 35–43
F	> 43

pc/mi/ln denotes passenger cars per mile per lane

Freeways: Ramp Merge and Diverge Areas

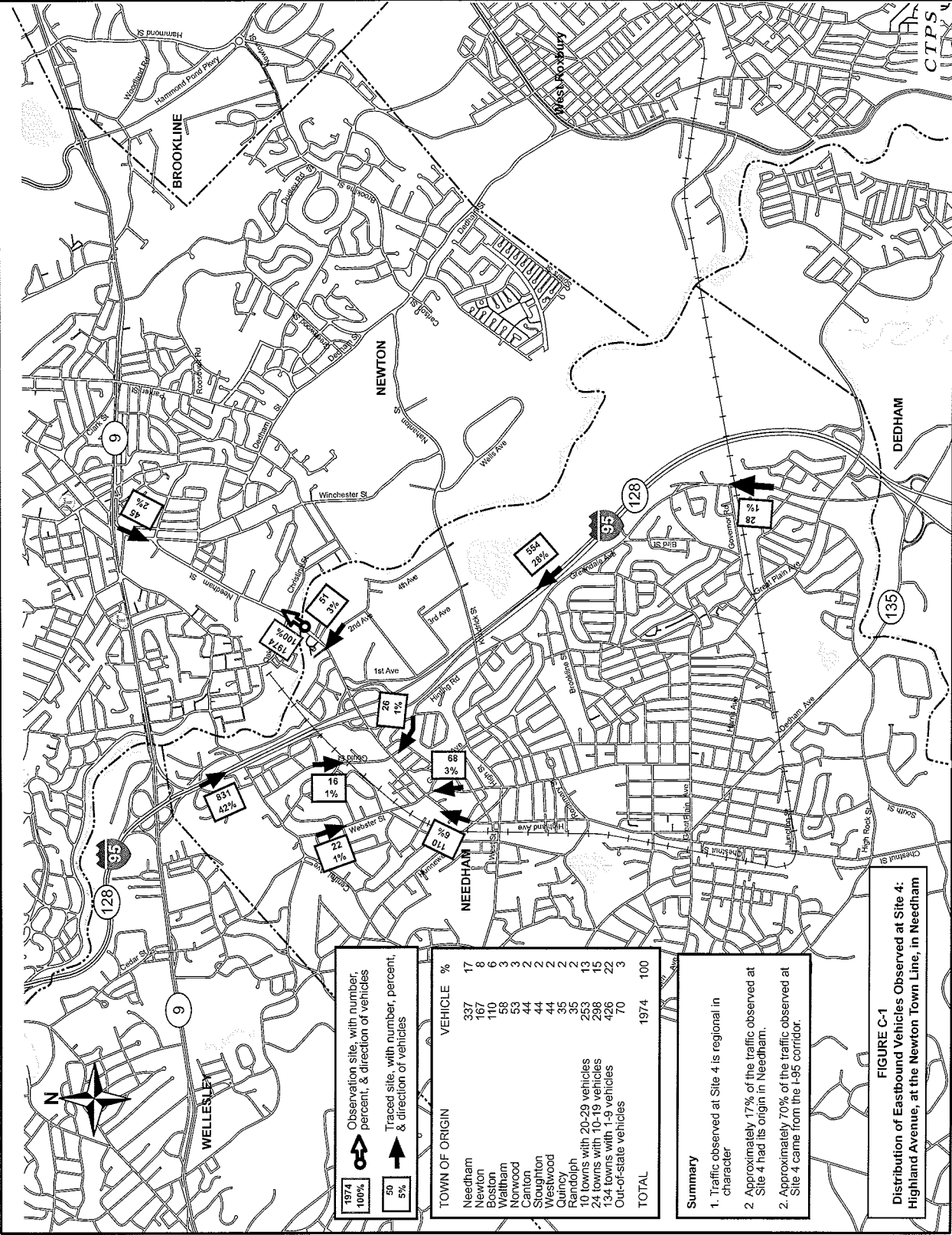
LOS	Density (pc/mi/ln)
A	≤ 10
B	> 10–20
C	> 20–28
D	> 28–35
E	> 35
F	Demand exceeds capacity

pc/mi/ln denotes passenger cars per mile per lane

APPENDIX C

License Plate Survey Results: Distribution of Vehicles, by Observation Site

- C-1 Distribution of Vehicles Observed at Site 4
- C-2 Distribution of Vehicles Observed at Site 5
- C-3 Distribution of Vehicles Observed at Site 6
- C-4 Distribution of Vehicles Observed at Site 7
- C-5 Distribution of Vehicles Observed at Site 8
- C-6 Distribution of Vehicles Observed at Site 9
- C-7 Distribution of Vehicles Observed at Site 10
- C-8 Distribution of Vehicles Observed at Site 11
- C-9 Distribution of Vehicles Observed at Site 12
- C-10 Distribution of Vehicles Observed at Site 13
- C-11 Distribution of Vehicles Observed at Site 14
- C-12 Distribution of Vehicles Observed at Sites 15 & 16



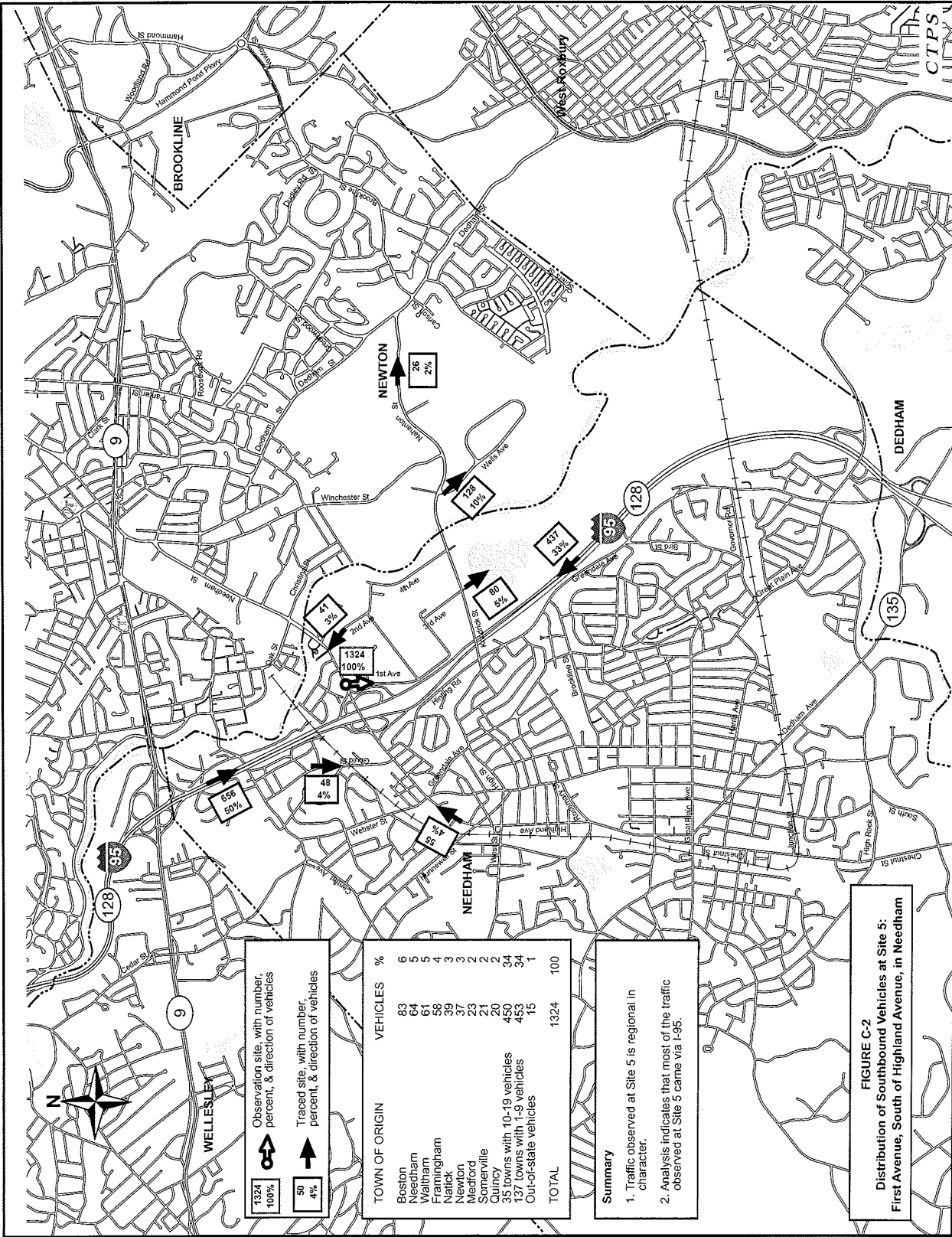
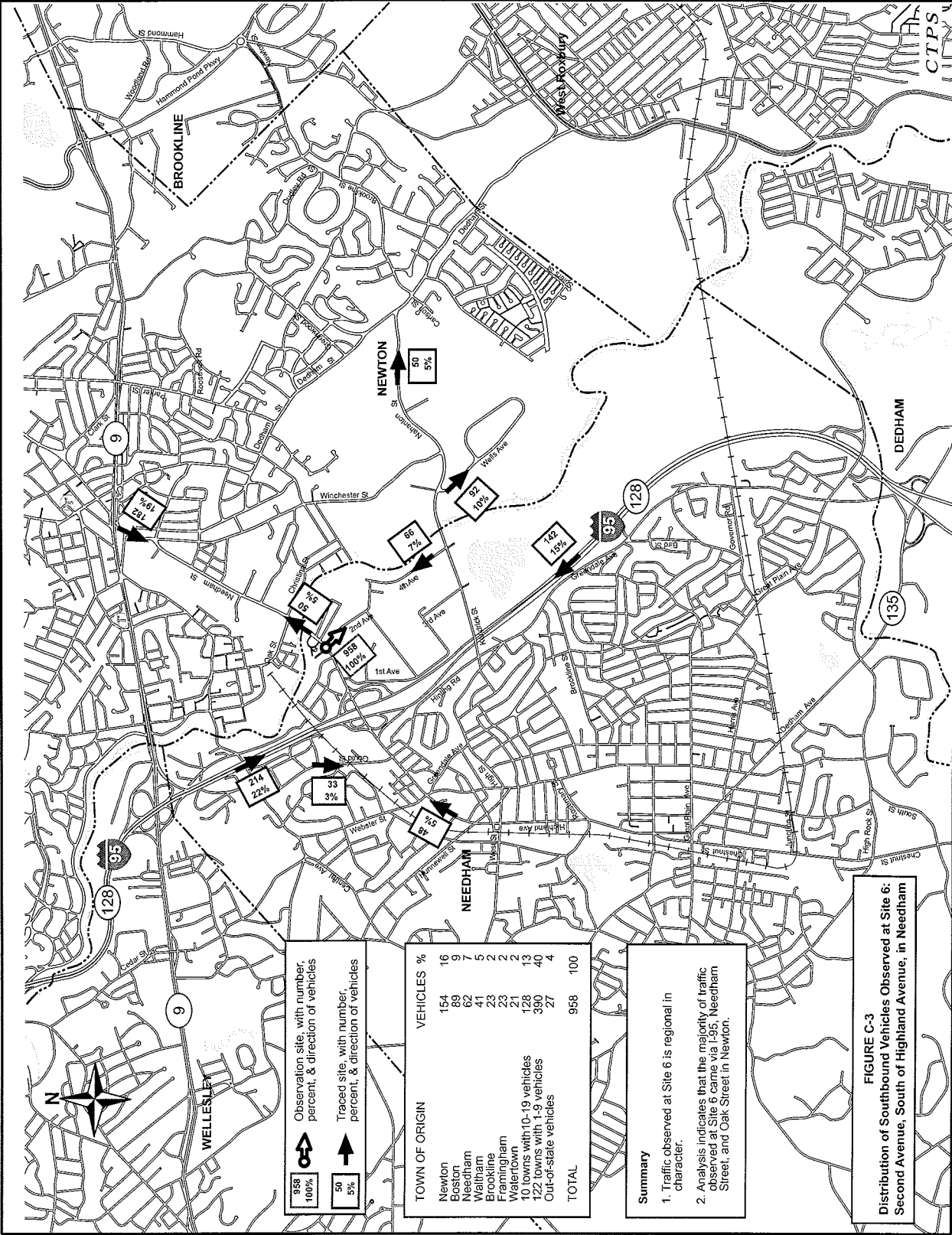
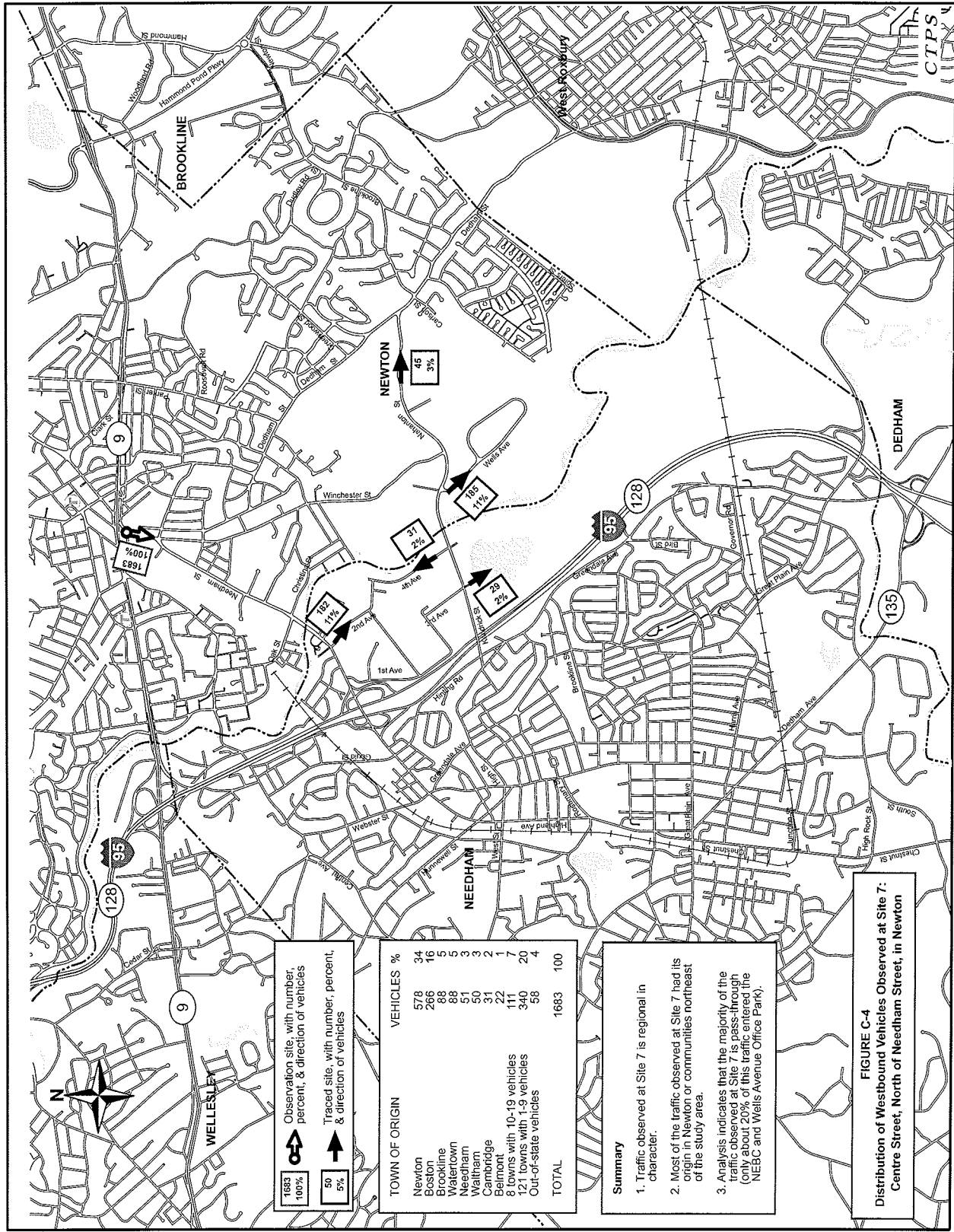


FIGURE C-2
Distribution of Southbound Vehicles at Site 5:
First Avenue, South of Highland Avenue, in Needham





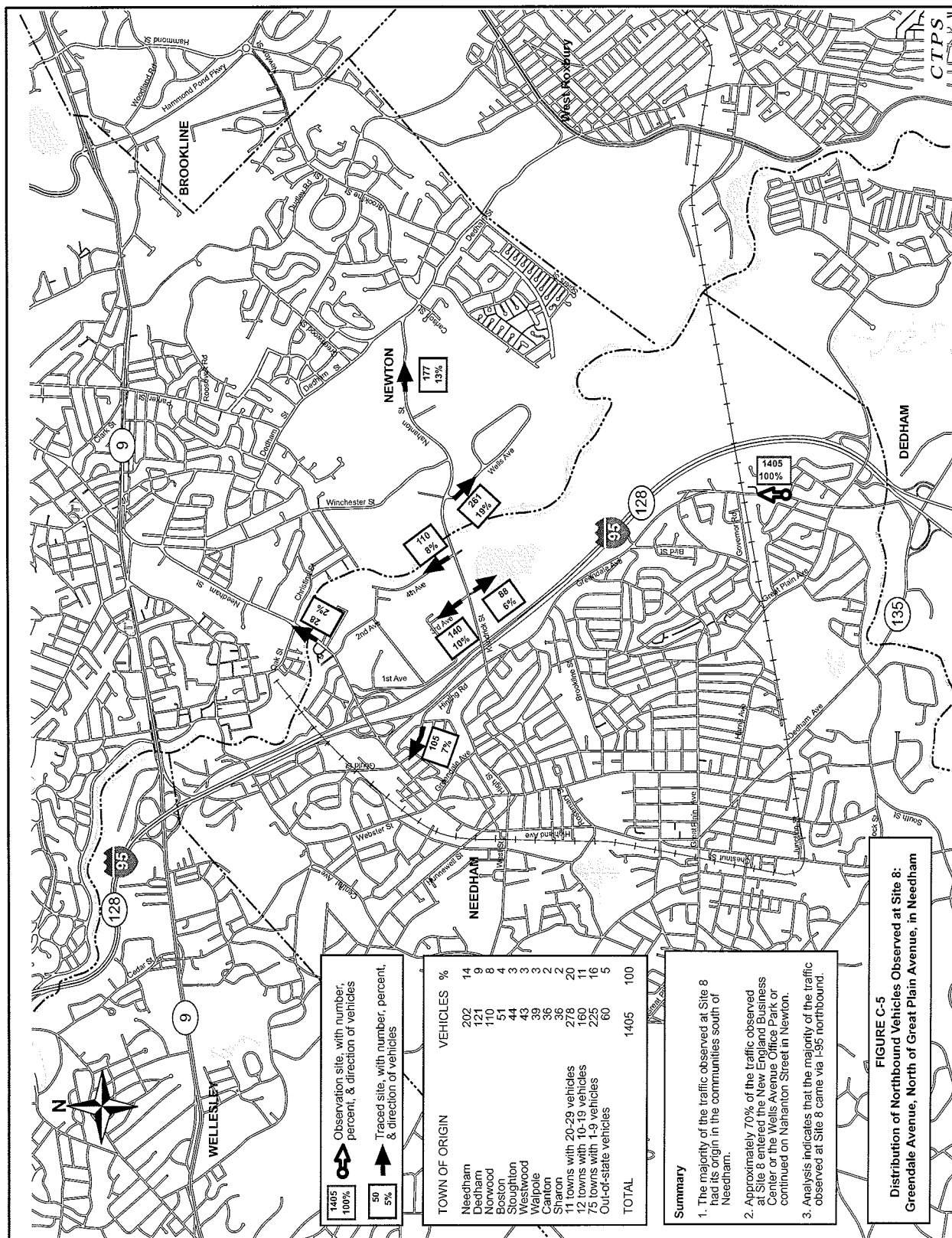


FIGURE C-5
Distribution of Northbound Vehicles Observed at Site 8:
Greendale Avenue, North of Great Plain Avenue, in Needham

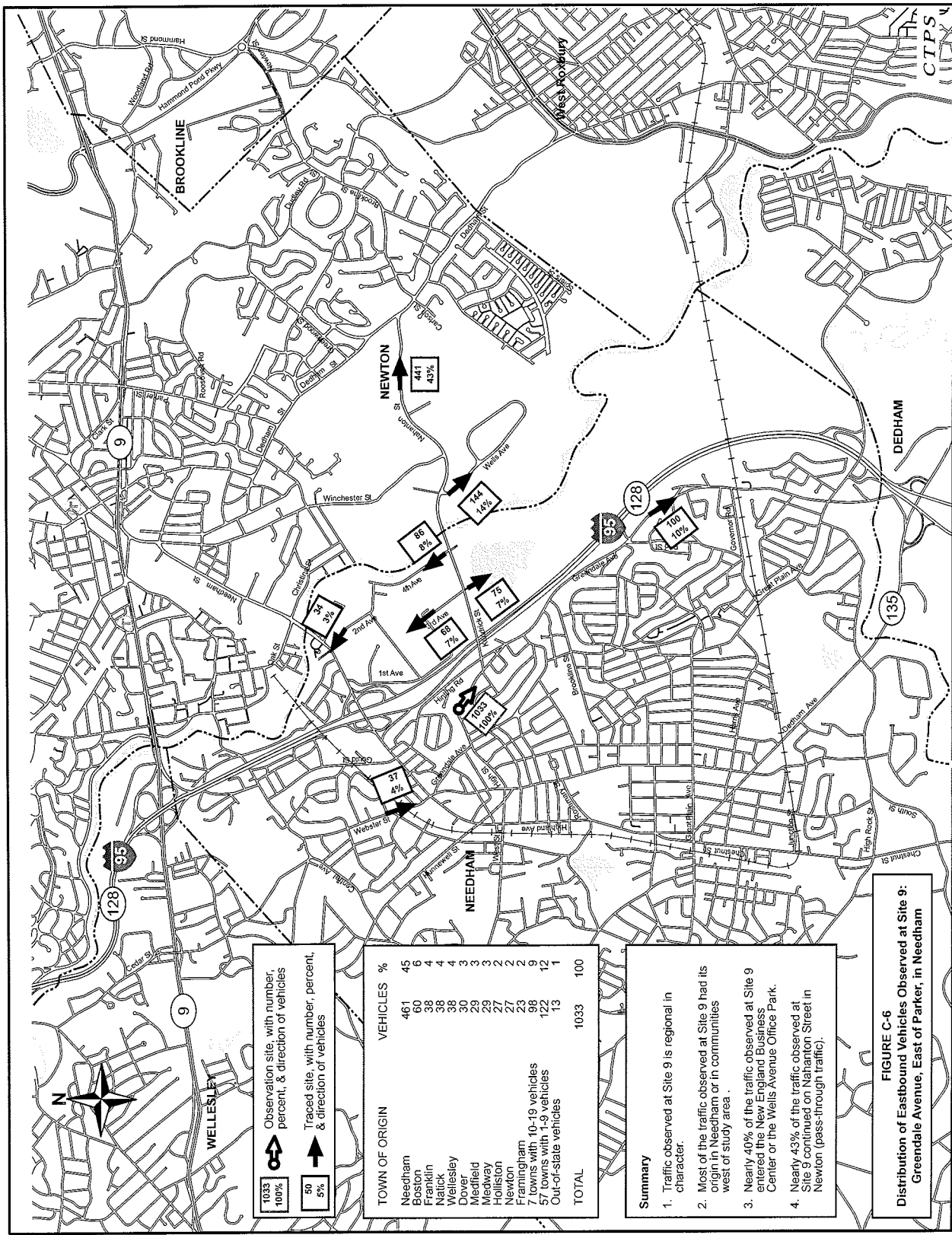
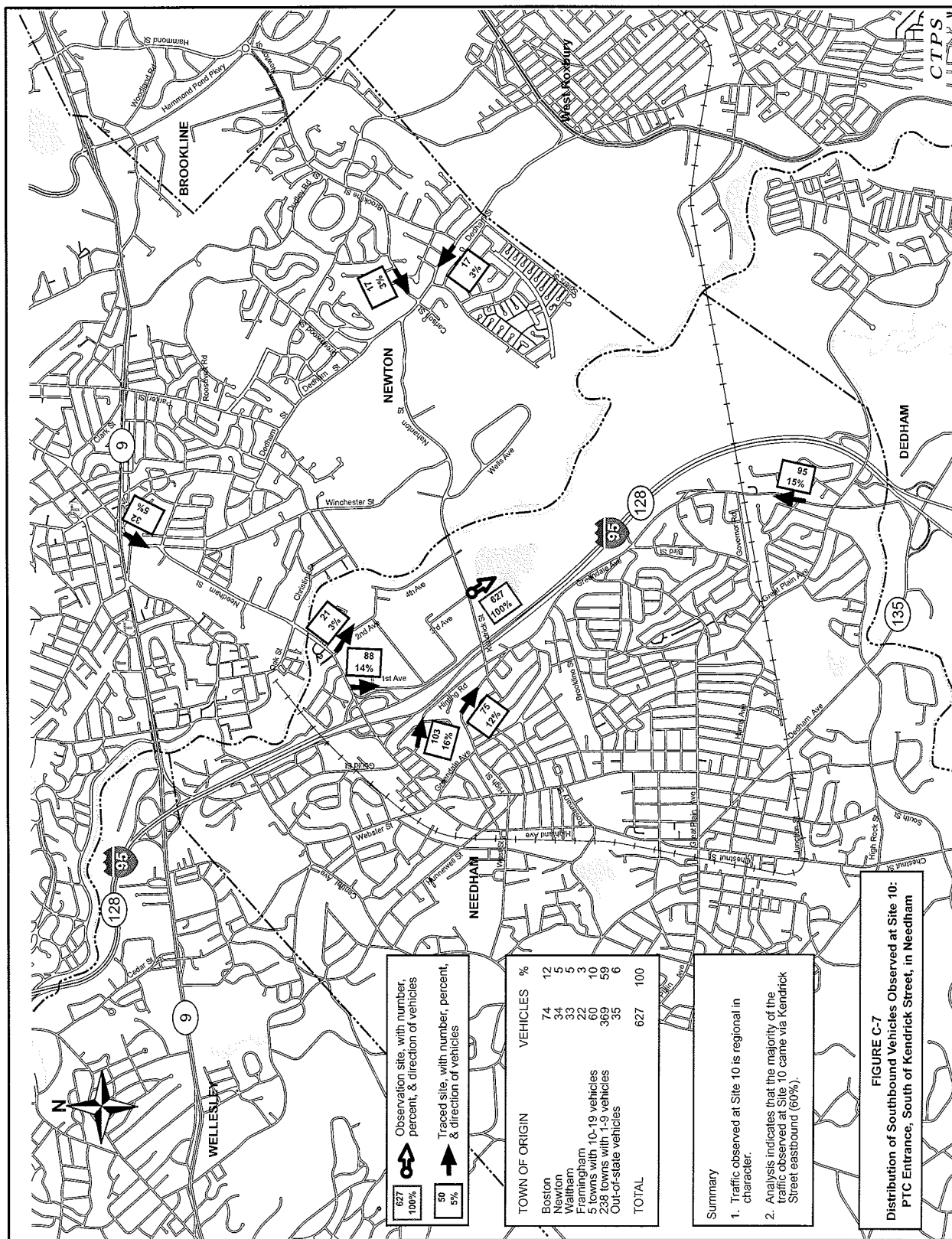


FIGURE C-6
Distribution of Eastbound Vehicles Observed at Site 9:
Greendale Avenue, East of Parker, in Needham



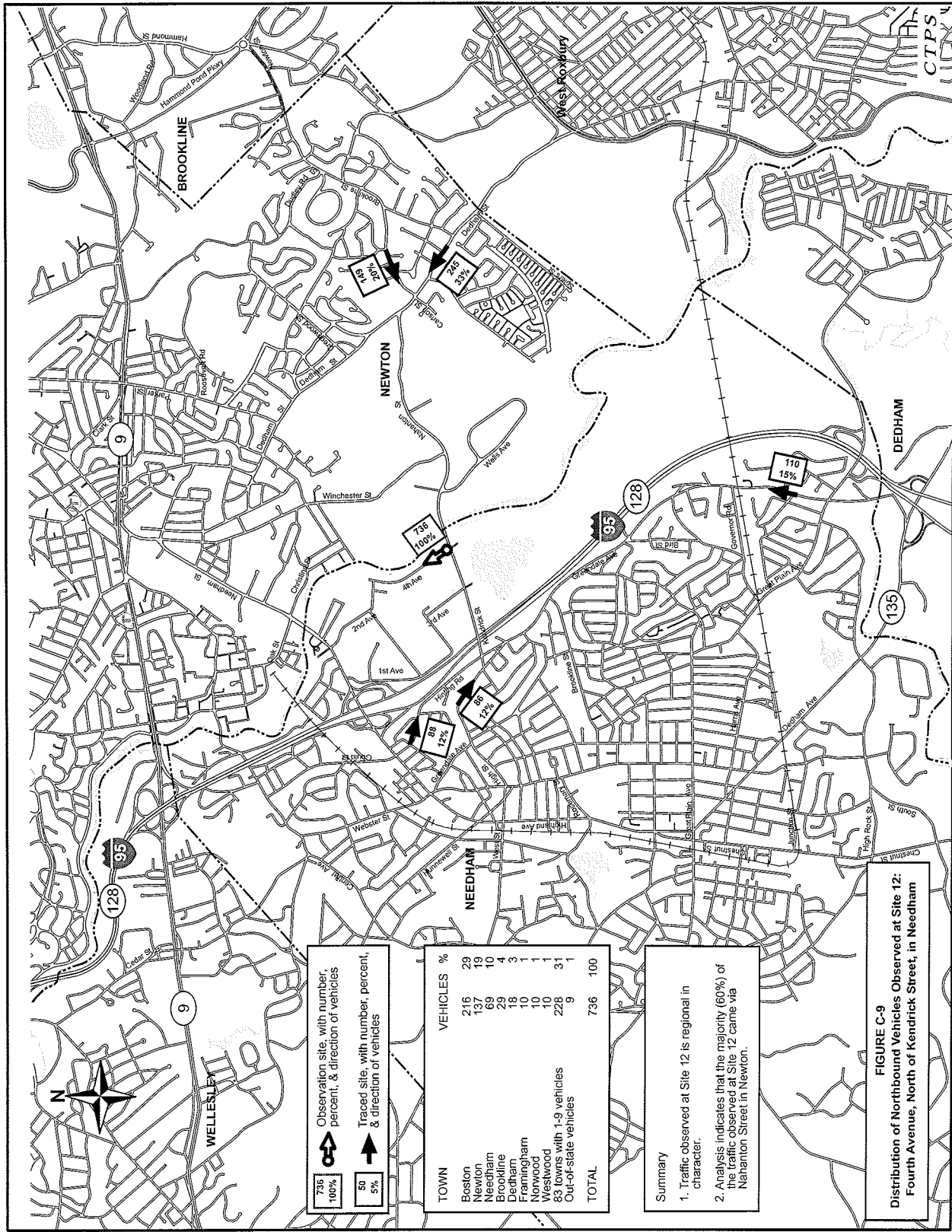


FIGURE C-9
Distribution of Northbound Vehicles Observed at Site 12:
Fourth Avenue, North of Kendrick Street, in Needham

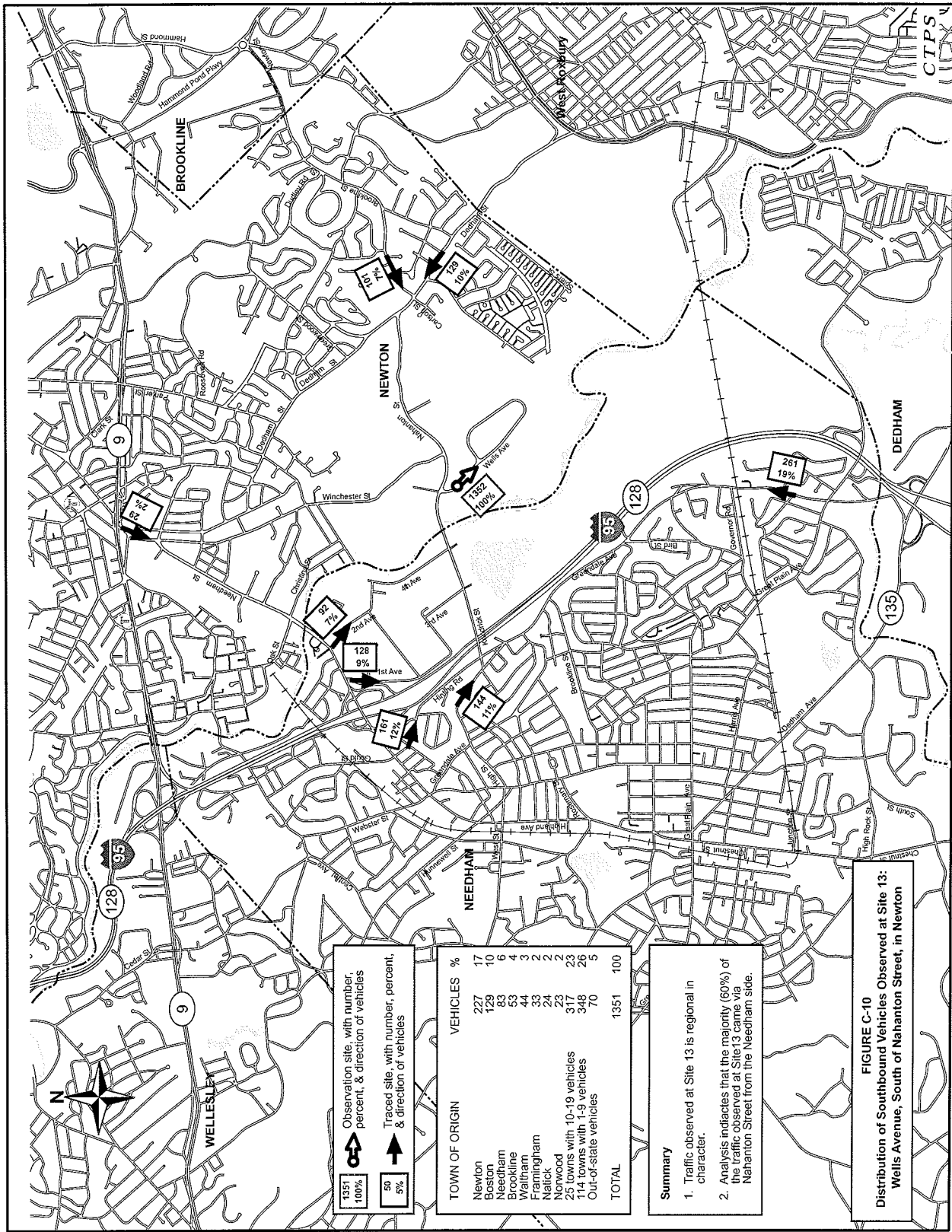
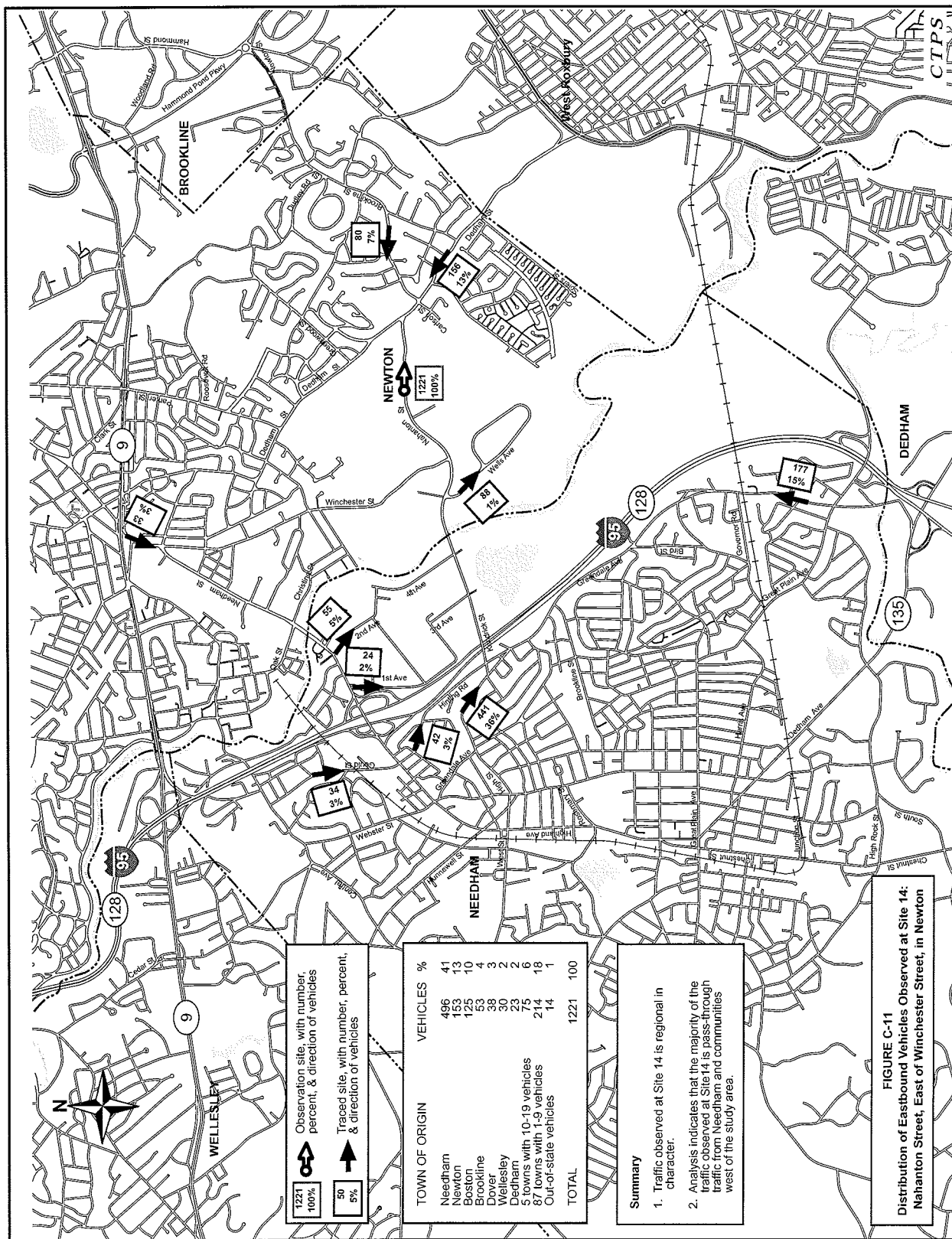
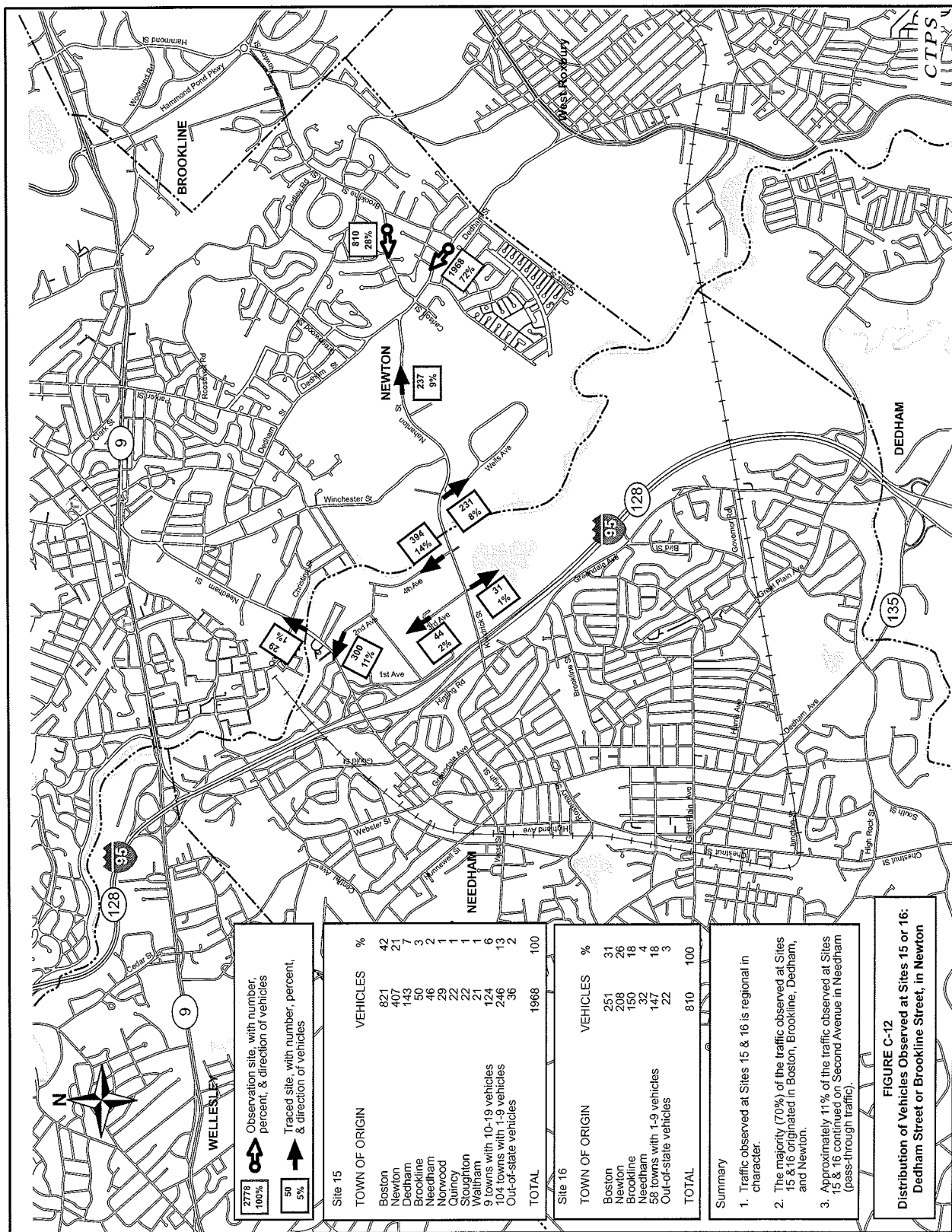


FIGURE C-10
Distribution of Southbound Vehicles Observed at Site 13:
Wells Avenue, South of Nahanton Street, in Newton





APPENDIX D

Comparison of Alternatives' Impacts on Traffic Volumes

D-1	No-Build Alternative: 2025 AM Peak Hour Traffic Volumes	D-15	Alternative 6: 2025 AM Peak Hour Traffic Increase/Decrease Compared to No-Build
D-2	No-Build Alternative: 2025 PM Peak Hour Traffic Volumes	D-16	Alternative 6: 2025 PM Peak Hour Traffic Increase/Decrease Compared to No-Build
D-3	No-Build Alternative: 2025 AM Traffic Increase/Decrease Compared to Calibrated 2002	D-17	Alternative 7: 2025 AM Peak Hour Traffic Increase/Decrease Compared to No-Build
D-4	No-Build Alternative: 2025 PM Traffic Increase/Decrease Compared to Calibrated 2002	D-18	Alternative 7: 2025 PM Peak Hour Traffic Increase/Decrease Compared to No-Build
D-5	Alternative 1: 2025 AM Peak Hour Traffic Increase/Decrease Compared to No-Build		
D-6	Alternative 1: 2025 PM Peak Hour Traffic Increase/Decrease Compared to No-Build		
D-7	Alternative 2: 2025 AM Peak Hour Traffic Increase/Decrease Compared to No-Build		
D-8	Alternative 2: 2025 PM Peak Hour Traffic Increase/Decrease Compared to No-Build		
D-9	Alternative 3: 2025 AM Peak Hour Traffic Increase/Decrease Compared to No-Build		
D-10	Alternative 3: 2025 PM Peak Hour Traffic Increase/Decrease Compared to No-Build		
D-11	Alternative 4: 2025 AM Peak Hour Traffic Increase/Decrease Compared to No-Build		
D-12	Alternative 4: 2025 PM Peak Hour Traffic Increase/Decrease Compared to No-Build		
D-13	Alternative 5: 2025 AM Peak Hour Traffic Increase/Decrease Compared to No-Build		
D-14	Alternative 5: 2025 PM Peak Hour Traffic Increase/Decrease Compared to No-Build		

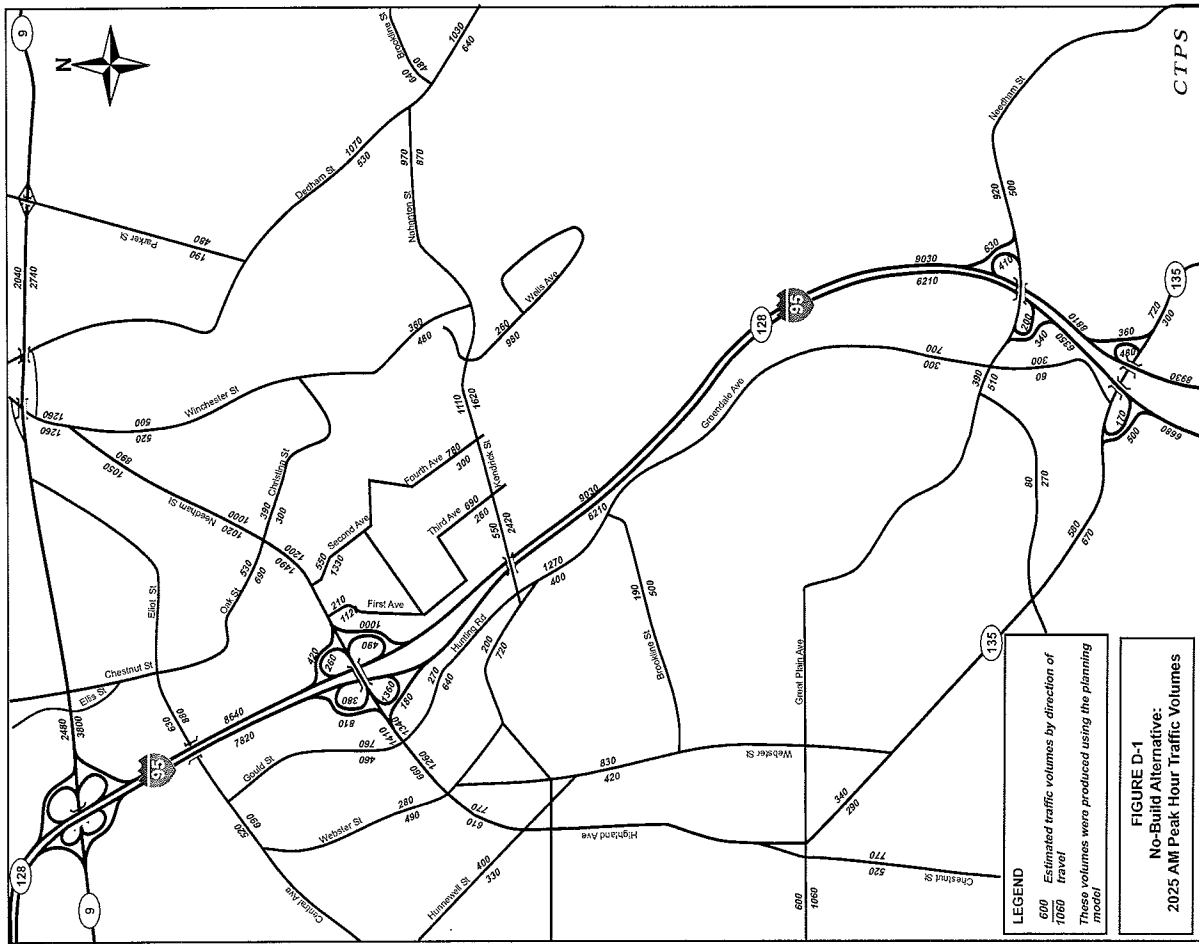


FIGURE D-1
No-Build Alternative:
2025 AM Peak Hour Traffic Volumes

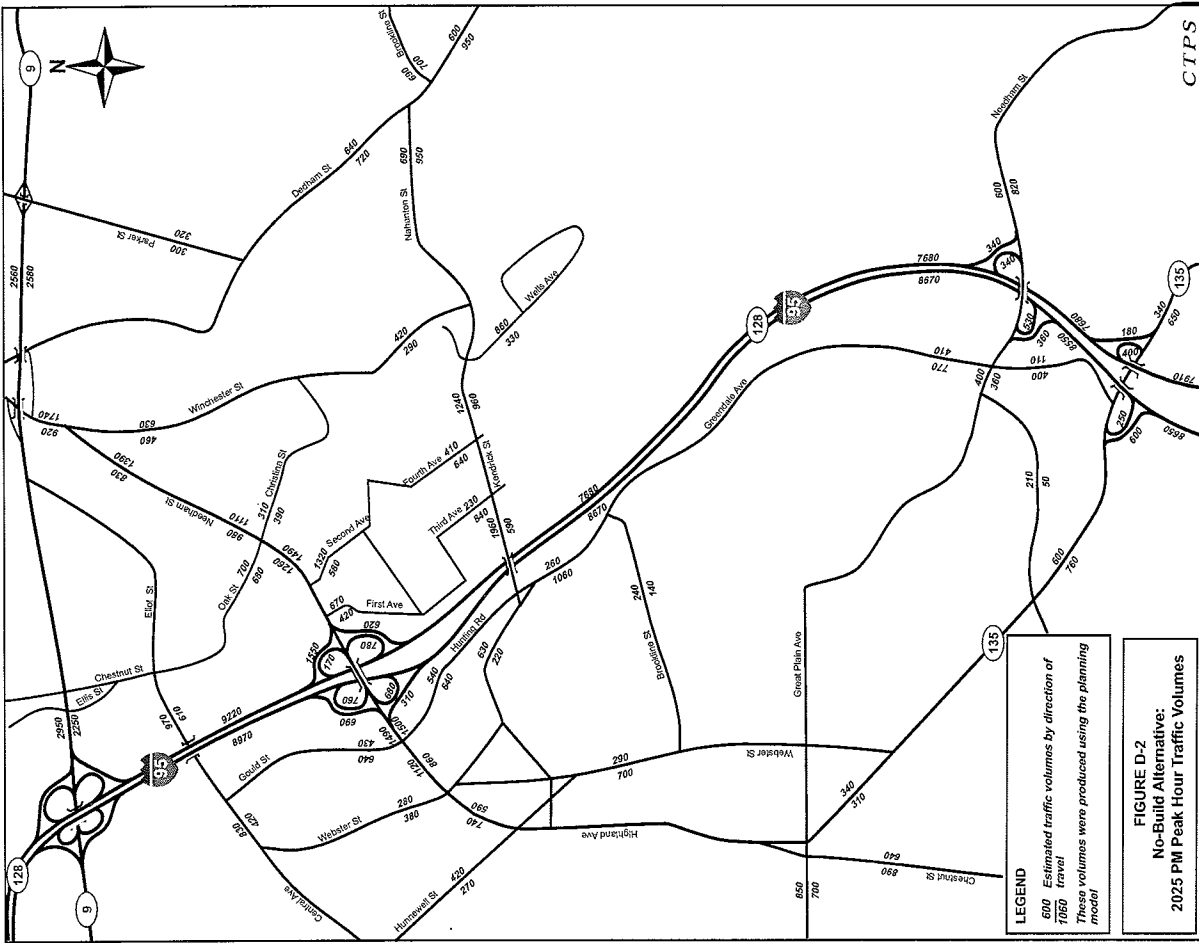
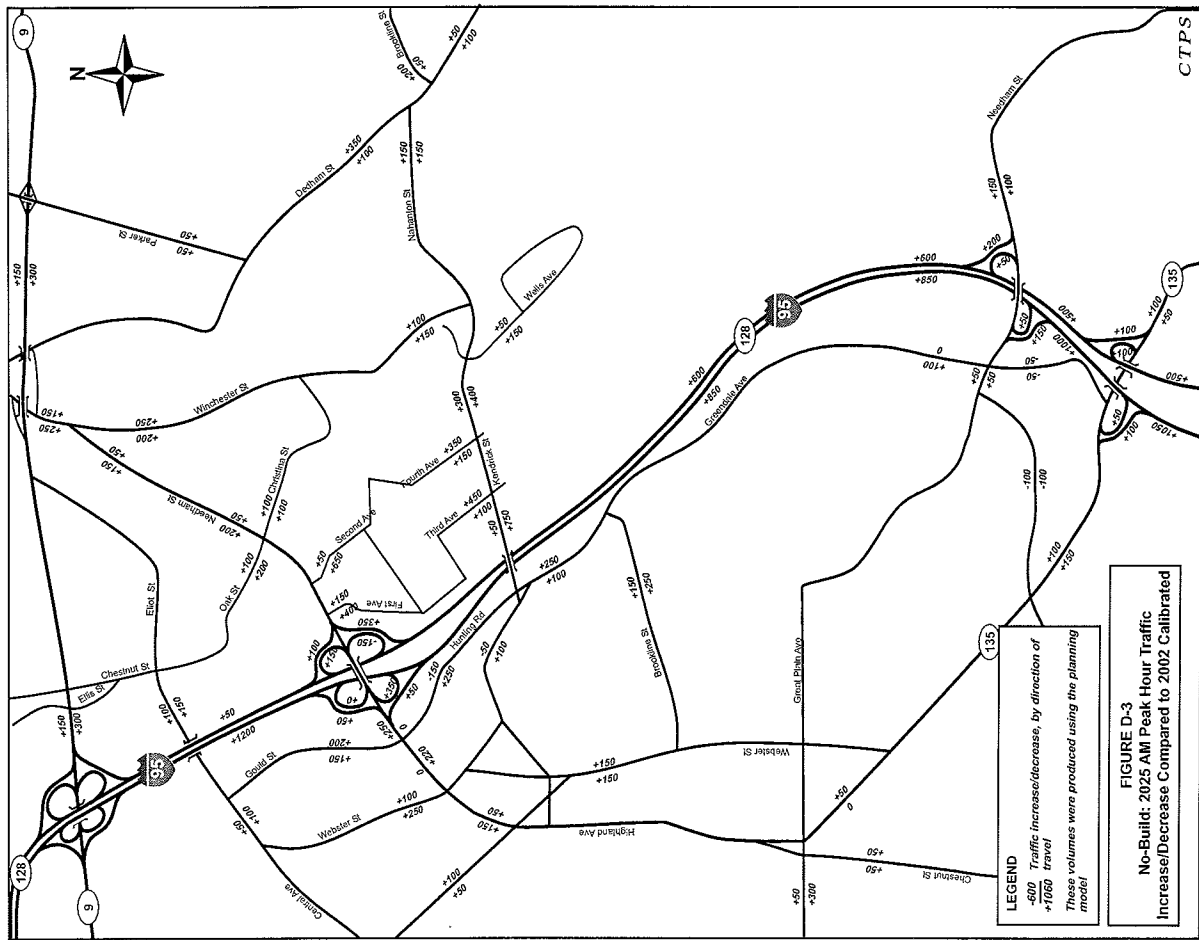
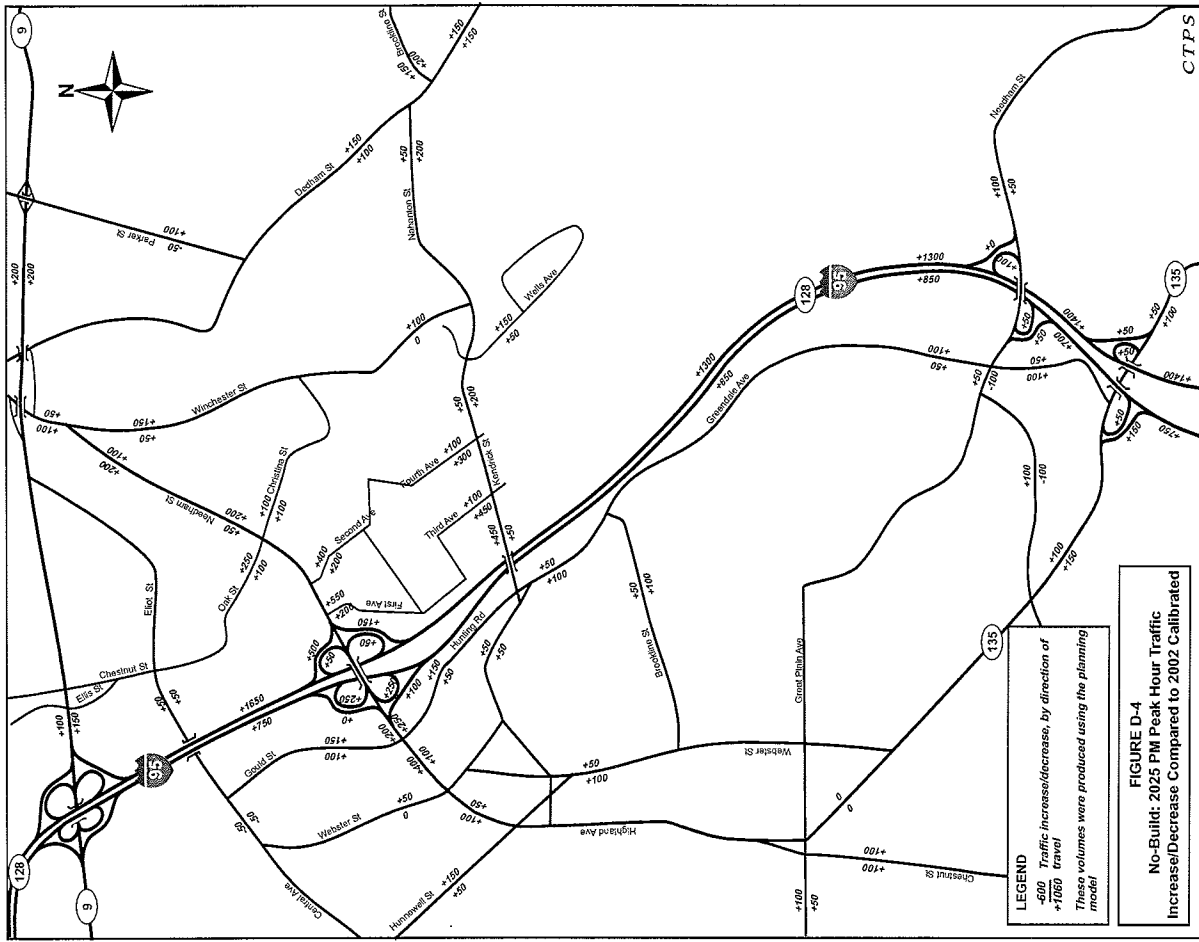
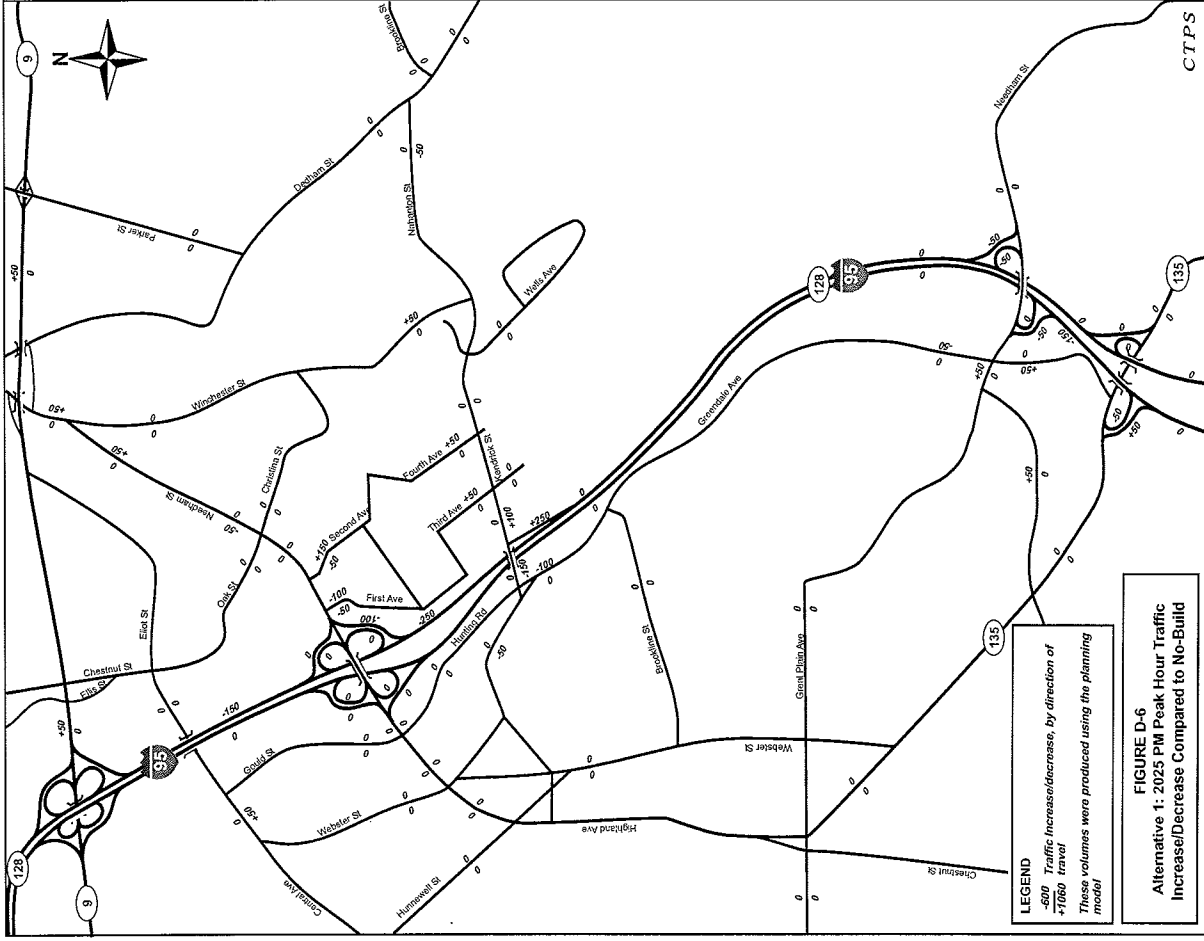
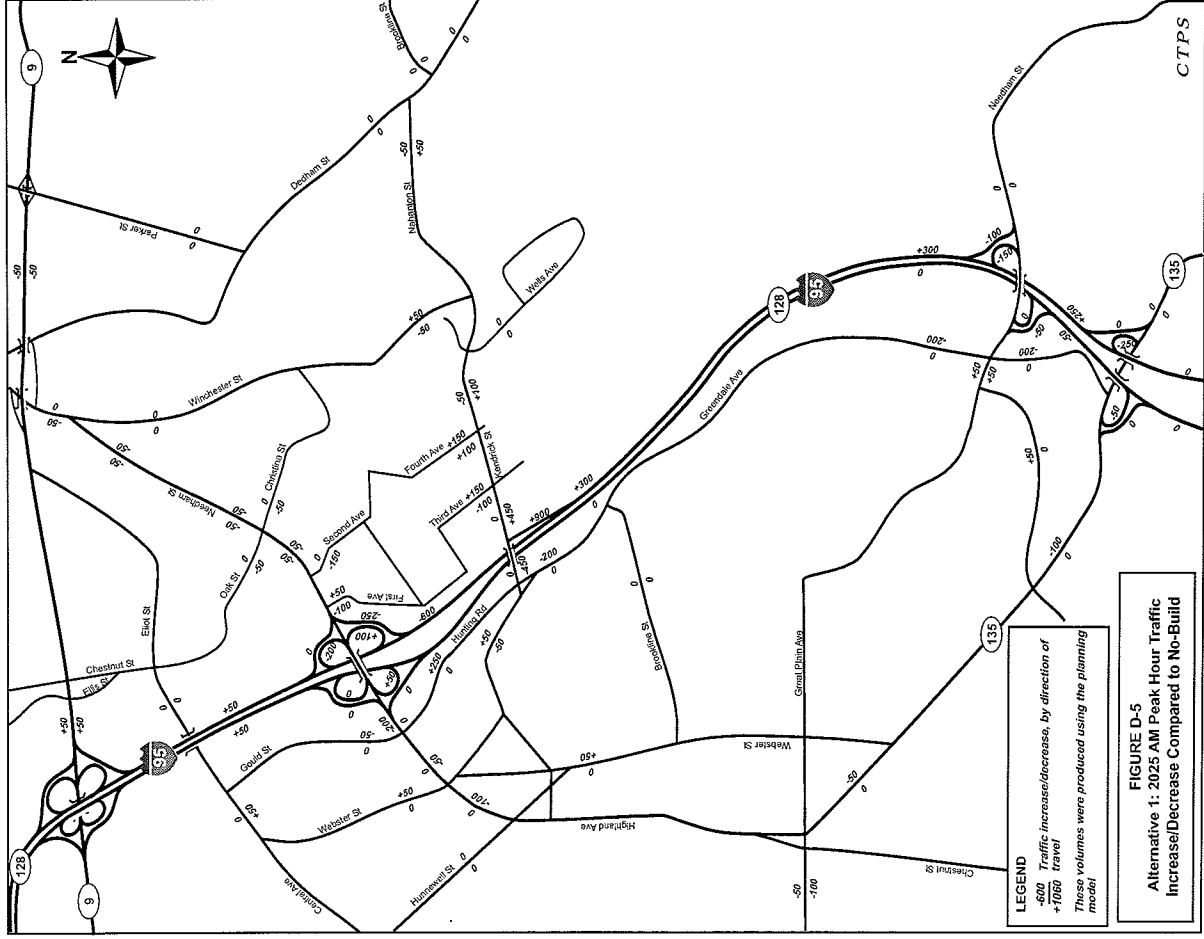
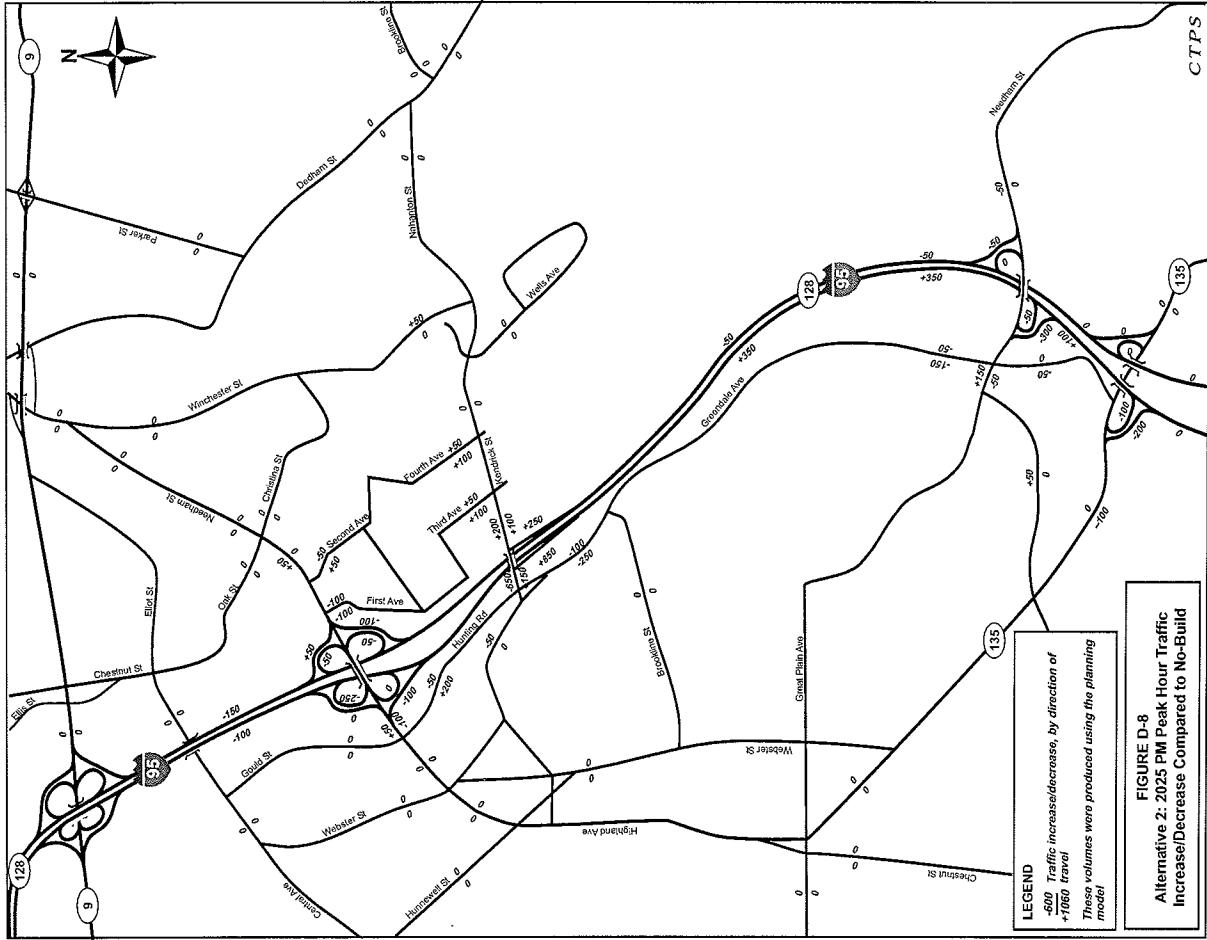
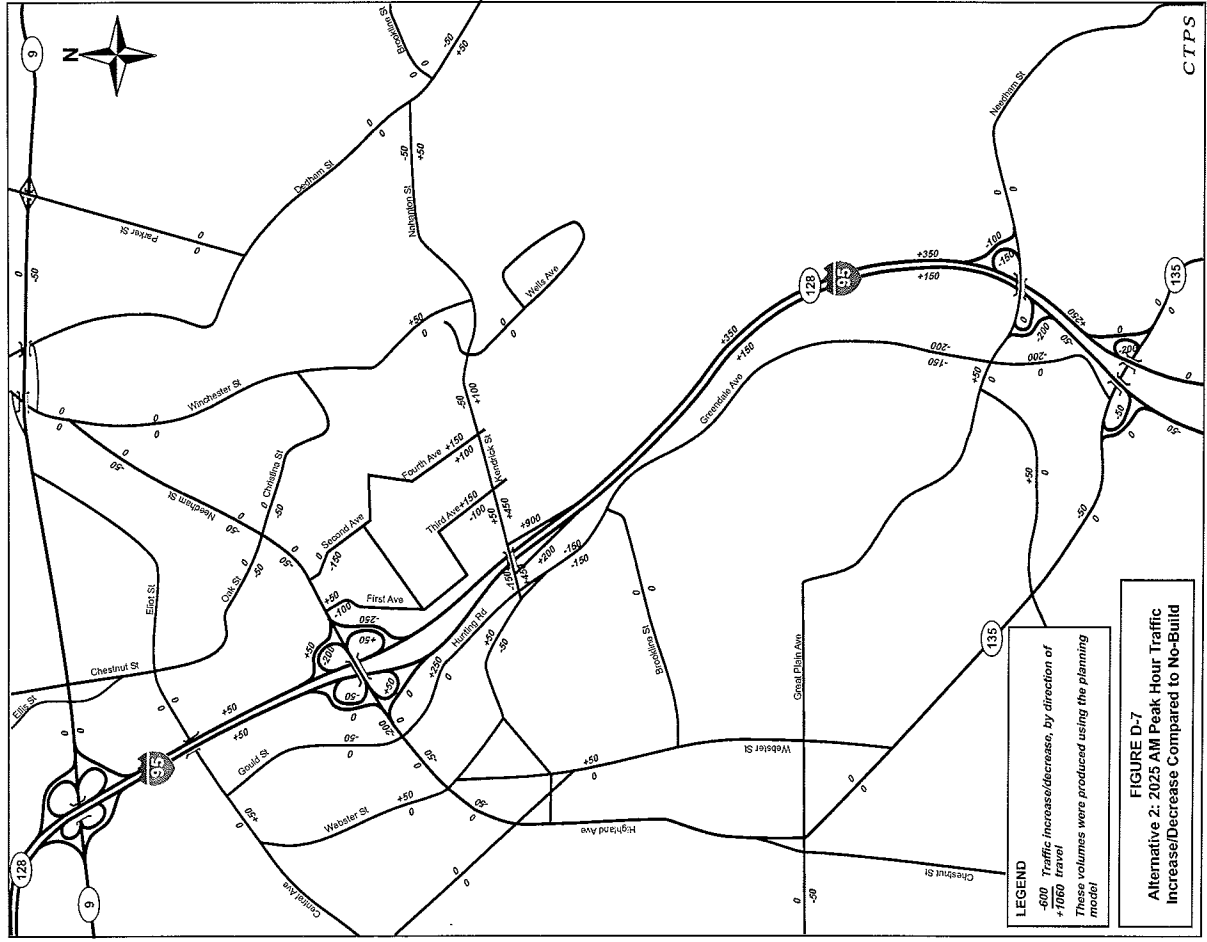
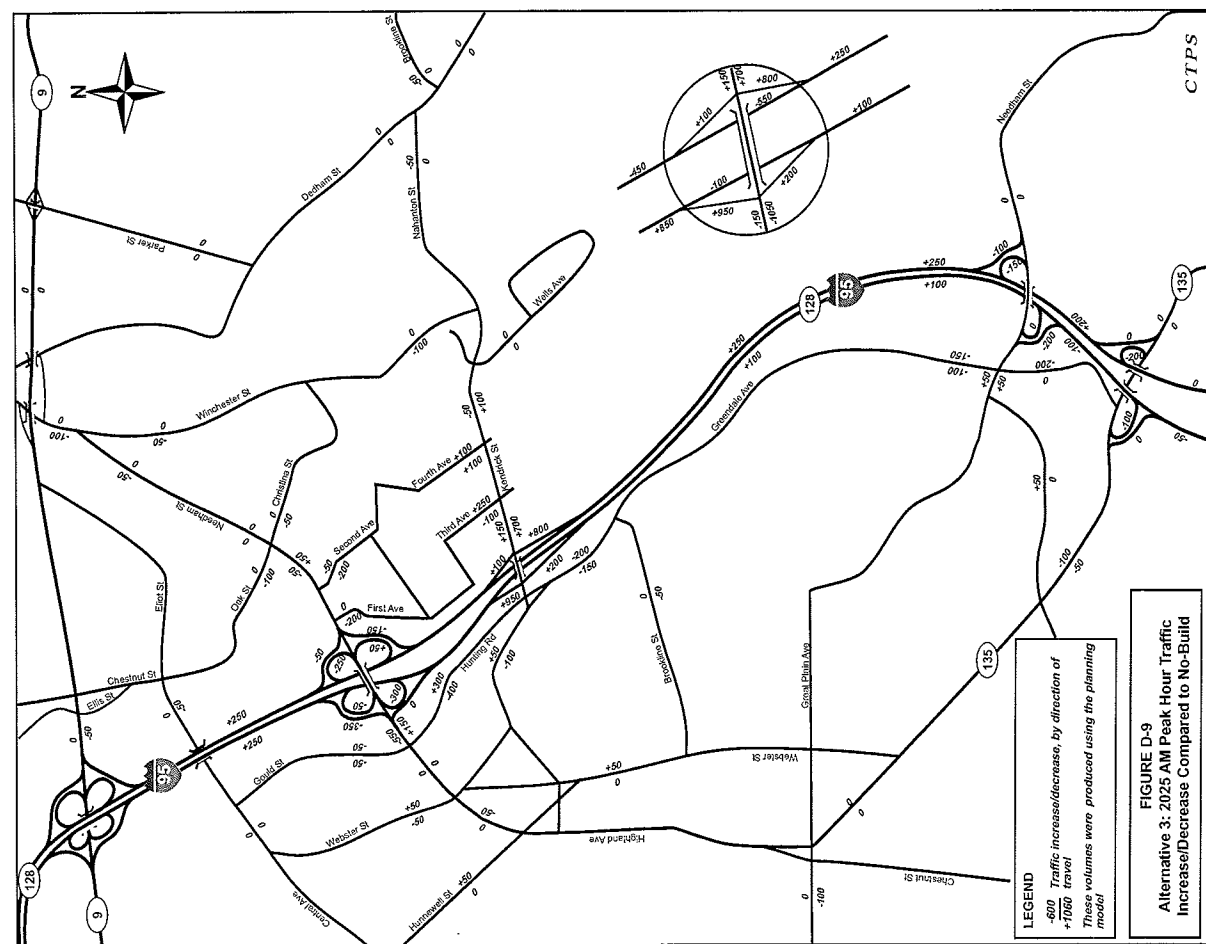
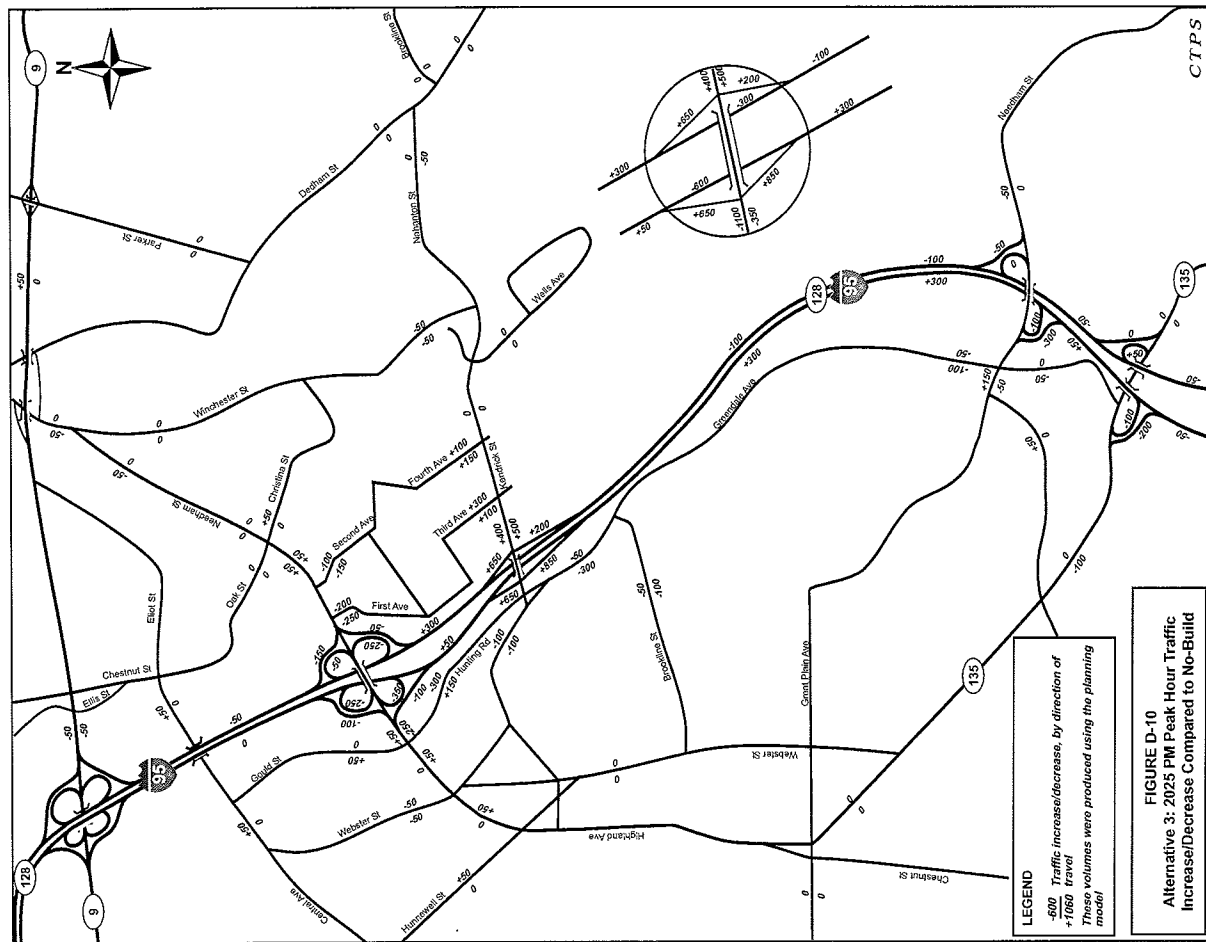


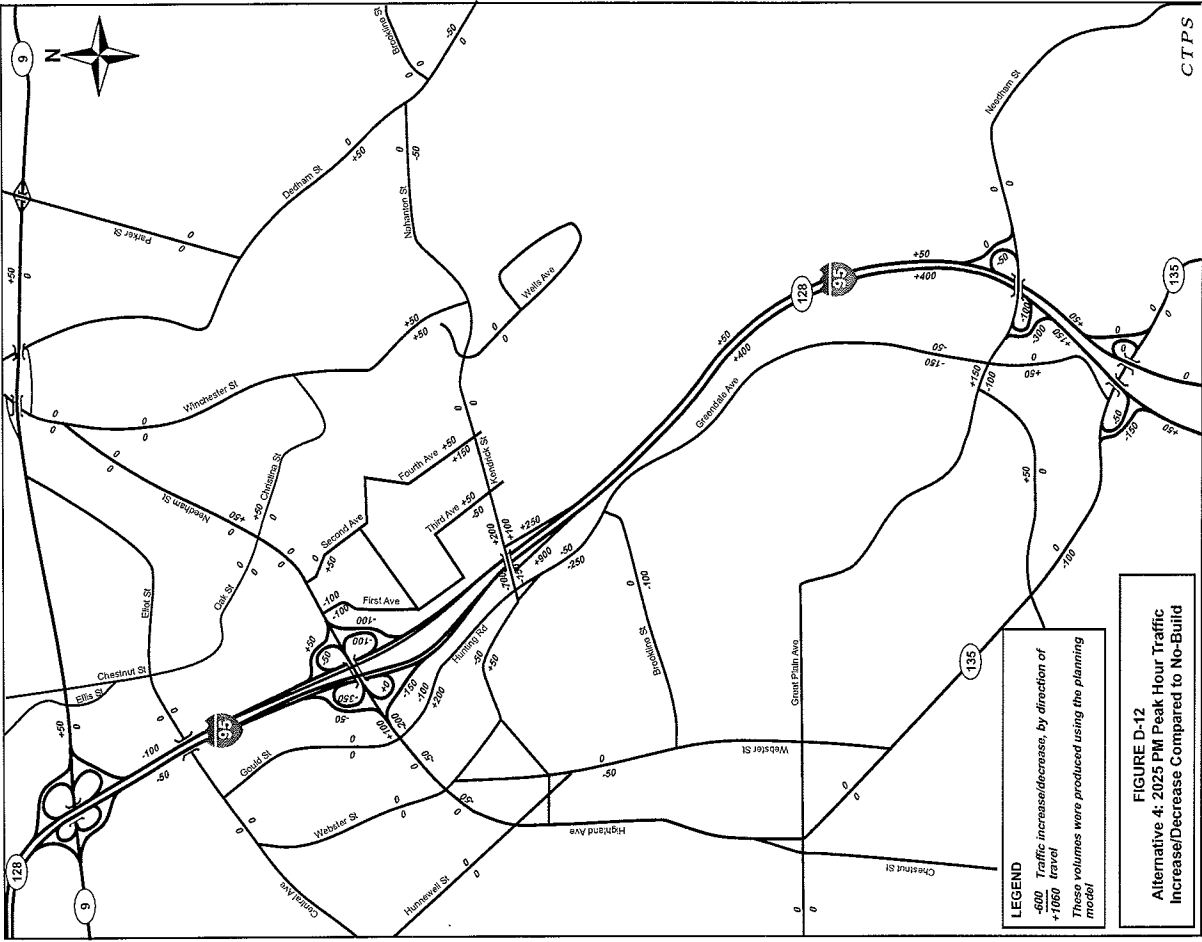
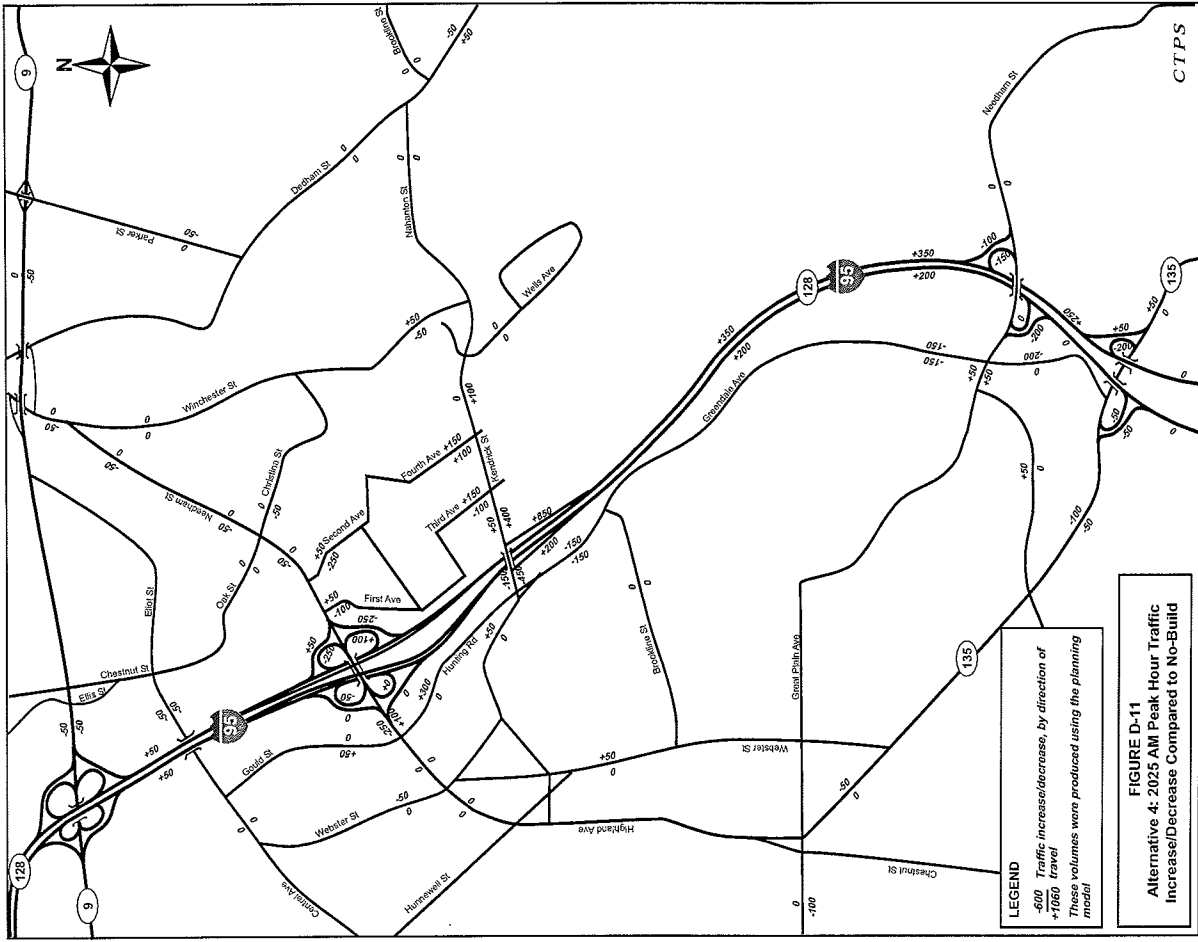
FIGURE D-2
No-Build Alternative:
2025 PM Peak Hour Traffic Volumes

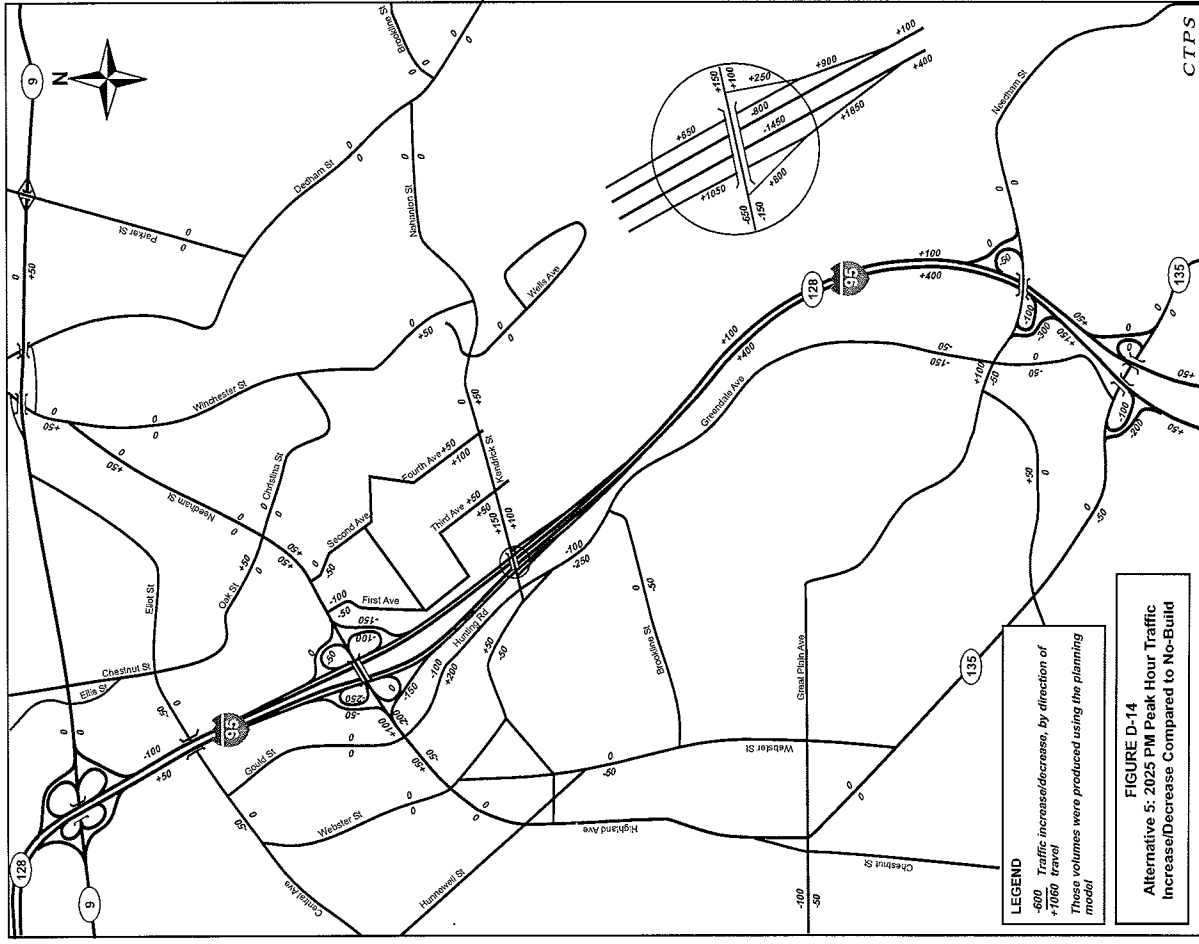
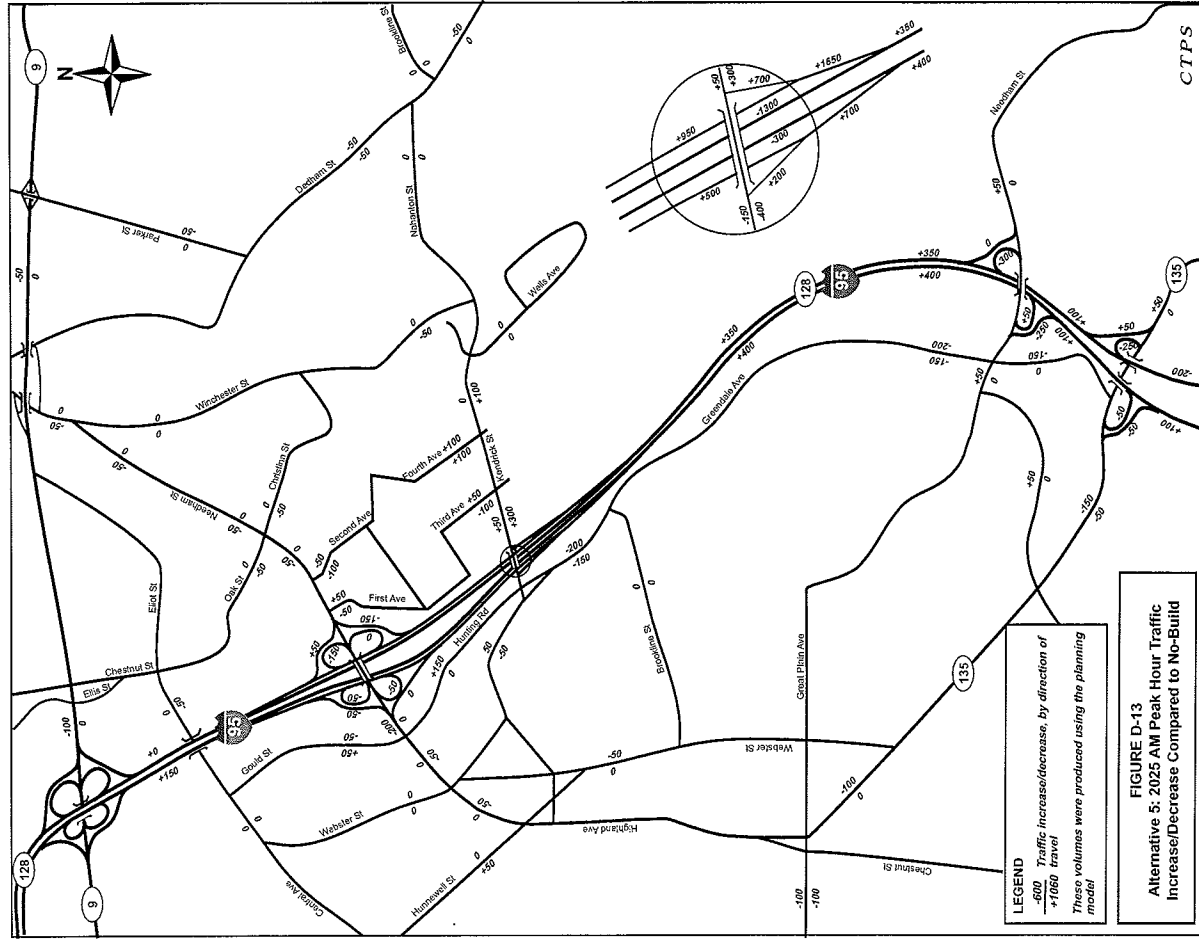


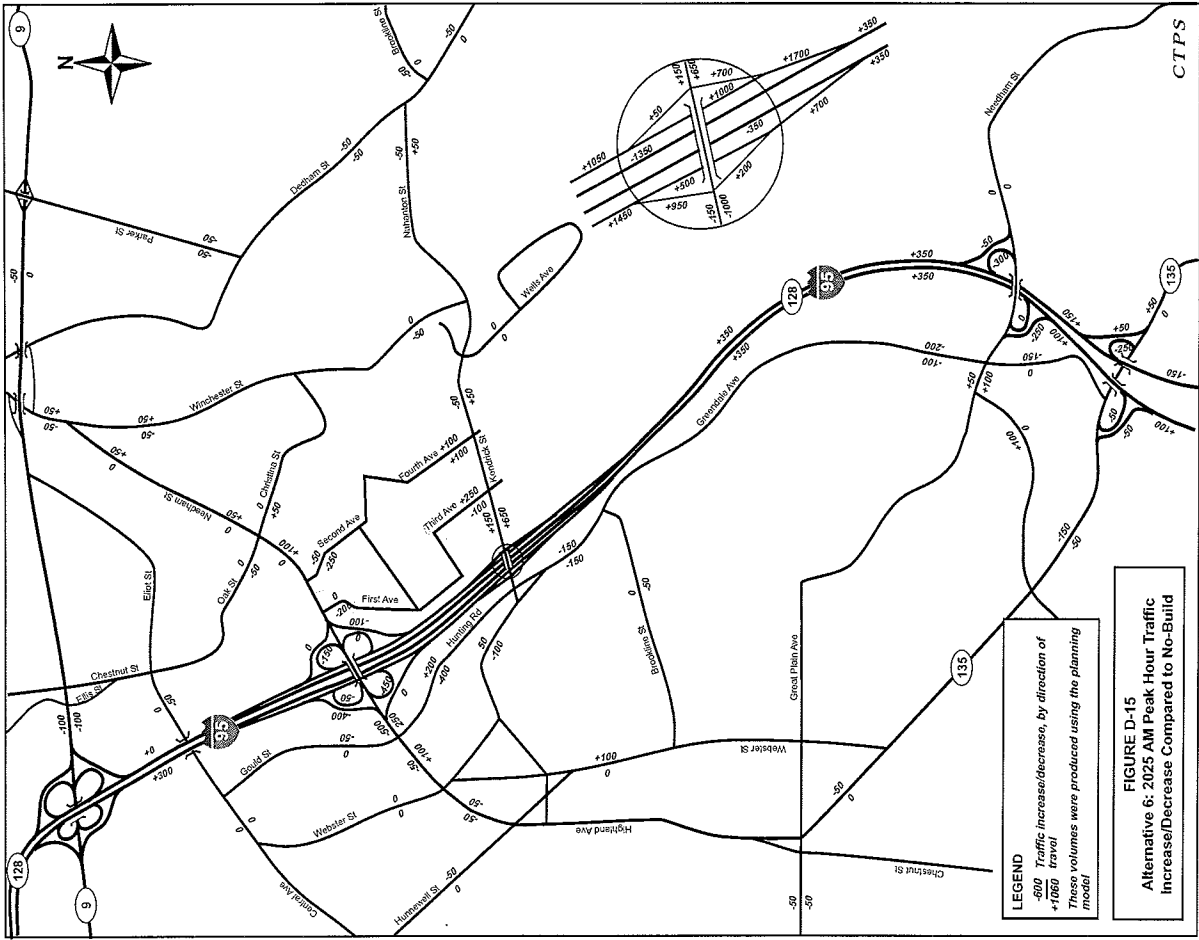
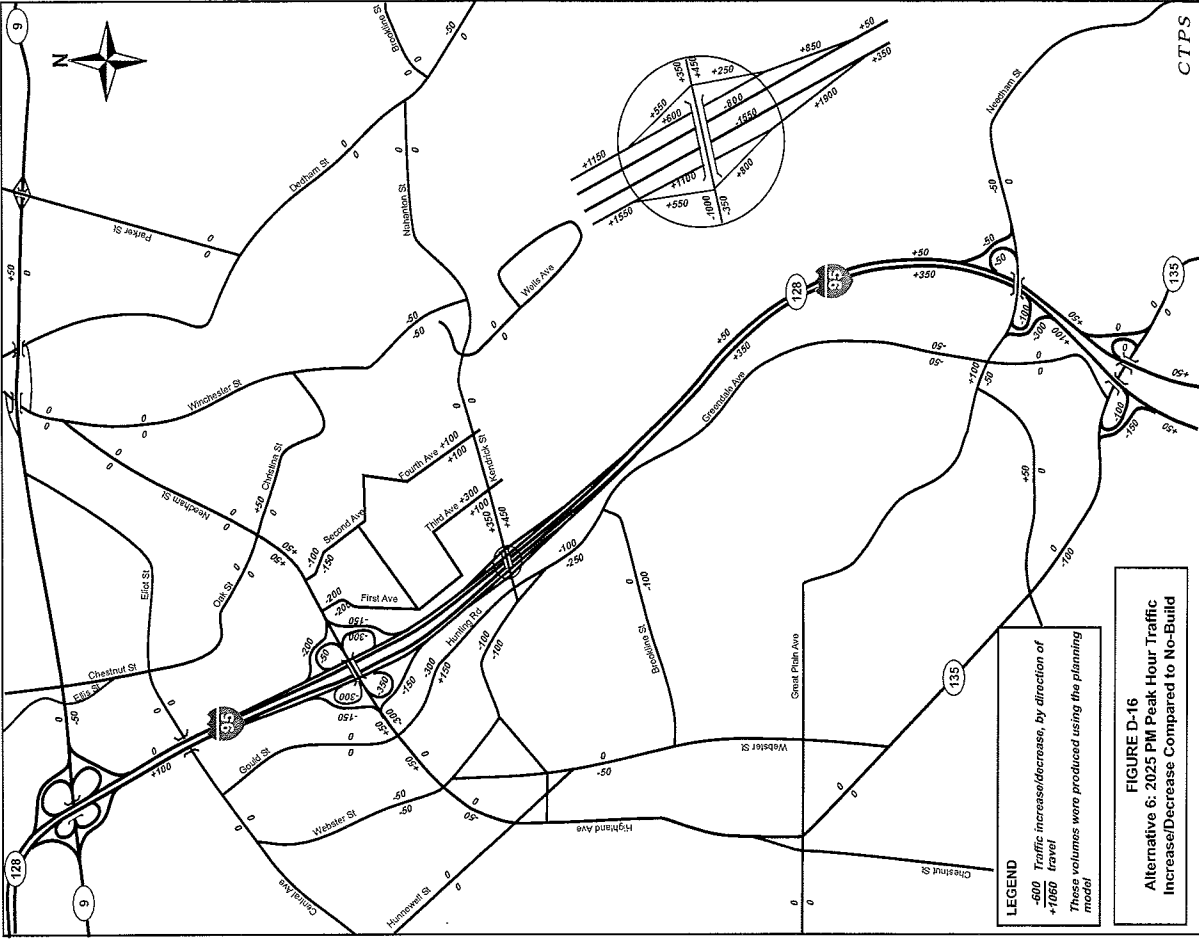












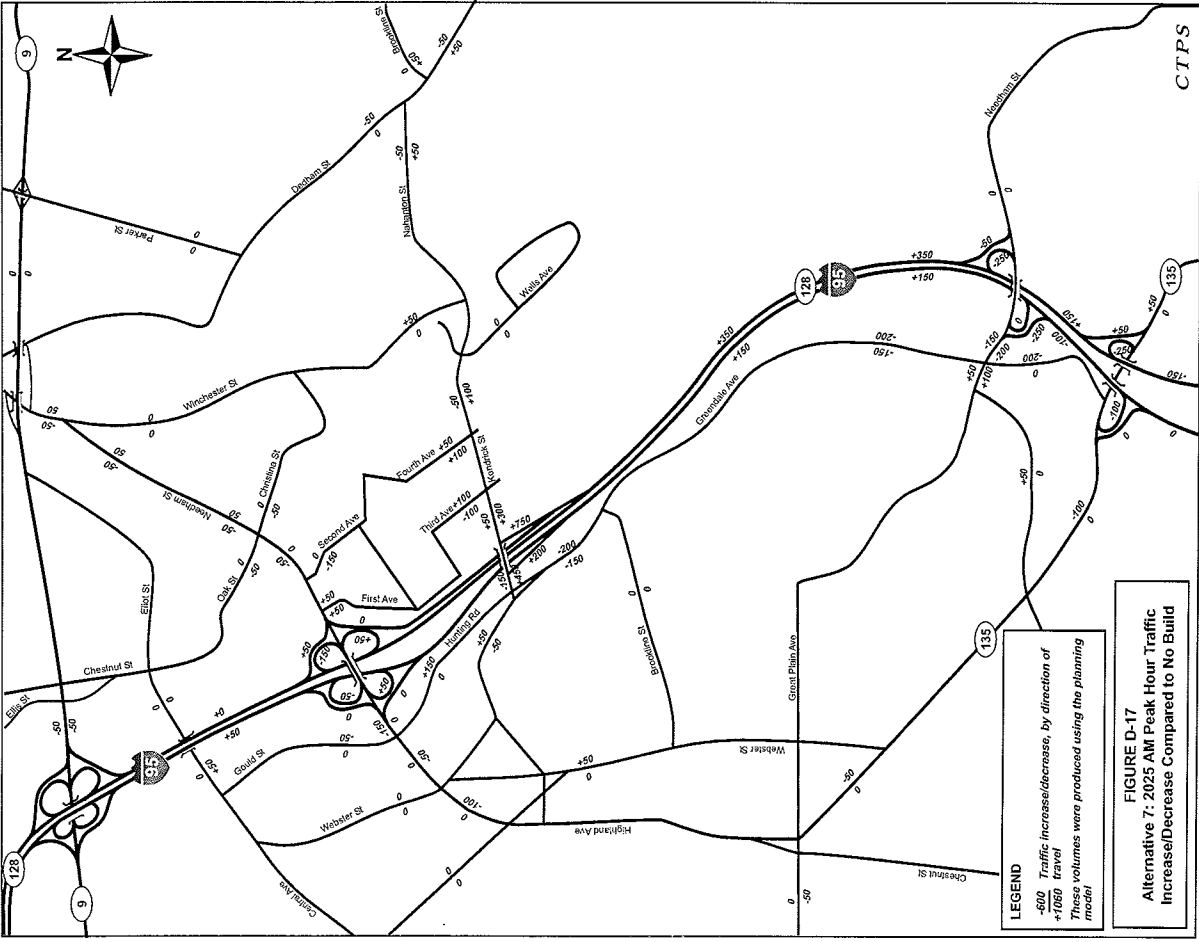


FIGURE D-17
Alternative 7: 2025 AM Peak Hour Traffic Increase/Decrease Compared to No Build

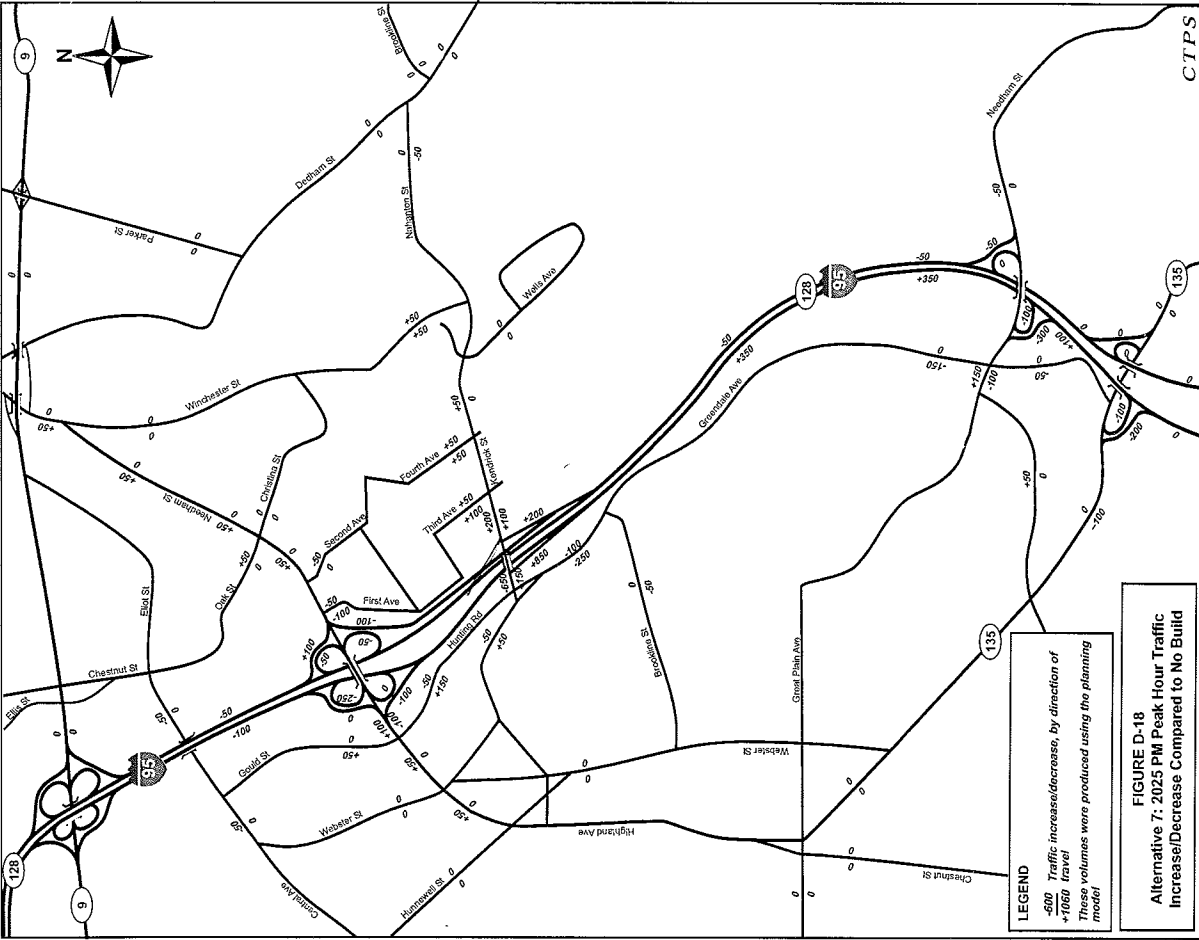


FIGURE D-18
Alternative 7: 2025 PM Peak Hour Traffic Increase/Decrease Compared to No Build