Route 9 Corridor Study in Wellesley

A report produced by the Central Transportation Planning Staff for the Massachusetts Highway Department

Route 9 Corridor Study in Wellesley

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EXECUTIVE SUMMARY

BACKGROUND AND OBJECTIVES

This study was initiated at the request of the Massachusetts Highway Department, as one component in the town of Wellesley's permitting process for the reuse of the former MassHighway Depot site on Route 9. The site is located on the north side of Route 9, just west of the I-95 (Route 128)/Route 9 interchange. It is currently the corporate headquarters of Harvard Pilgrim Health Care.

The goals of this study are to evaluate the intersections and interchanges along Route 9 in Wellesley and develop improvement options for addressing congestion, safety, and accessibility problems in the corridor. This study aims to present sufficient information about conditions along the Route 9 corridor to allow informed judgments about the most desirable strategies to advance. Such strategies may become future projects, to be designed and implemented by MassHighway, the town, and/or others. Integral part of the study is to develop these strategies in conjunction with town officials and MassHighway.

OVERVIEW OF STUDY AREA

Route 9 in Wellesley has two travel lanes in each direction, with 8- to 10-foot shoulders along most of its length. It operates as a divided highway, with median guardrail-type barriers along its entire length except for a short section at Kingsbury Street, where a grass median is provided. Openings in the median occur at intervals, to allow left turns and U-turns. At the locations where these median barrier breaks occur, and at signalized intersections where turns are permitted, additional turning lanes are provided. The longest segment without opportunities to make left turns or U-turns occurs between Route 16 and Cedar Street (almost 1.5 miles in the eastbound direction). The second-longest segment occurs between Kingsbury Street and Grantland Road (about 0.8 miles in the eastbound direction).

As Route 9 in Wellesley is a divided highway but not a limited-access highway, many abutter sites have driveways with direct access onto Route 9, although most of these allow right turn movements only. Many of these driveways represent the only access available for their sites' users.

The posted travel speed on Route 9 in Wellesley ranges from 35 to 50 mph. These speeds are not typically sustained during the hours of peak travel on Route 9, because there are high volumes of traffic and substantial queues at the signalized intersections.

EXISTING CONDITIONS

During the AM peak hour, particularly in the sharp peak of the AM eastbound direction, there is not much room for additional growth in traffic throughput. Therefore, future measurements of peak-hour traffic in this direction are likely to continue to show volumes in the range of 2,700–2,800 vehicles per hour as a practical maximum, even if increased activity leads to growth in overall traffic demand. Additional traffic demand will most likely be experienced as an expansion of the duration of the peak hour, rather than as a significant increase in peak-hour volumes. The PM westbound direction may continue to show some peak-hour volume growth, because it is more spread out than the AM peak. The most readily observable trend toward traffic growth is occurring during the midday and off-peak hours. Growth during these hours may be partially attributable to commuter travel; it is probably more directly related to school, shopping, and personal-business trips.

The level-of-service analyses of the signalized intersections generally shows that the main-line flows receive most of the signal "green time," with delays experienced primarily by side-street traffic trying to turn onto or cross Route 9. Queue analysis for Route 9 traffic at these intersections indicates that long vehicle queues or platoons tend to develop that move along Route 9 from signal to signal. In the case of the unsignalized intersections, the locations where the predominant or only movement from the side street is a right turn operate at generally adequate levels of service. Exceptions to this are: the intersection of Grantland Road and the service road (Worcester Street) with Route 9 eastbound; and the William Street intersection, especially during the PM peak hour. At unsignalized locations where vehicles on Route 9 make left turns, those vehicles can experience very long waits for gaps in the opposing traffic. This is noted particularly at the two U-turn bays on both sides of the Kingsbury Street, where turning demand is high enough and acceptable gaps for vehicles few enough that long queues develop during peak periods.

The crash database shows that a total of 954 crashes occurred on or near Route 9 in Wellesley during the three-year period from 1994 through 1996. Many of these crashes are concentrated at the interchanges and intersections that were the focus of this study, with the Route 128 interchange and the Route 16 interchange together accounting for approximately one-third of the crashes. Different types of vehicular crashes do suggest different classes of solutions. For example, locations where angle-type collisions are frequent may be improved by clearer signing, improved sight distance, installing traffic signals, or providing signal improvements such as exclusive turning phases or more reasonable timings. Locations characterized by rear-end collisions may benefit from improved sight distance, better advance warning of signals or queued conditions downstream, and improved signal sight lines.

IMPROVEMENT CONCEPTS

The results of the existing-conditions analysis led to the selection of eight problem locations for which improvement concepts were developed in this study: the intersections of Route 9 with Overbrook Drive, Weston Road, Oak/Westgate streets, Kingsbury Street, Grantland Road, Oakland Street, Cedar Street, and William Street. The improvement concepts are presented in detail for each problem location in chapter 3, along with a summary of the location's existing-conditions analysis. In the descriptions of the concepts, the objective is

clearly stated, any impact on safety or on ease of access to properties is defined, and any land-takings required are described.

This study examined both short- and long-term improvement concepts (that is, both concepts that could be implemented relatively quickly and more extensive modifications that would take relatively long to implement), and combination of those approaches. During the development of the improvement concepts, MassHighway and the town of Wellesley reviewed them in their preliminary stages, and the issues they raised were addressed. Some of the concepts also reflect input given by citizens at three public meetings, one when the study was introduced and two when the concepts chosen to be the recommendations of the study were presented.

RECOMMENDATIONS

The improvements that were recommended by this study for implementation are described in detail in chapter 4. They are summarized below and in Table ES-1 and Figure ES-1.

Overbrook Drive Intersection

The main recommended improvement for the Overbrook Drive intersection is to interconnect its traffic signal with the signal at the intersection of Route 9 with Oak Street in Natick. The objectives of this modification are to improve traffic operations on Route 9 by reducing delays and stops, and to reduce rear-end crashes. MassHighway is studying the Oak Street intersection for traffic and safety improvements. Treating the two intersections as a system rather than individual intersections would be advantageous. Additional recommended modifications include lengthening the Route 9 eastbound left-turn bay at Overbrook Drive to accommodate at least five vehicles and improving the drainage at the intersection. Implementing the recommendations would not require any land-takings or have any adverse impacts on the environment. Construction costs, which include interconnections, new signal equipment at Overbrook Drive, lengthening of the eastbound Route 9 left-turn bay, drainage improvements, and maintenance of traffic flow during construction, are estimated at $300,000.

Weston Road Interchange

The recommended improvement for the Weston Road interchange is to replace this substandard facility with a modern diamond interchange. A diamond interchange would significant improve traffic operations and safety at this location and reduce the congestion on the eastbound on- and off-ramp. Part of the improvement concept is to signalize the ramp–Weston Road intersections and enhance signs, to further improve safety and traffic operations. Reductions in congestion at the ramp–Weston Road intersections would be one of the benefits. This concept includes major modifications that would require land-takings and relocation of driveway access, possibly encroaching on the Overbrook Reservation. Construction costs, including building a new bridge, replacing ramps, installing new traffic signals, installing new guide and directional signs, maintaining traffic flow during construction, and providing other equipment, would be high; they are estimated in the range of $8 million.

TABLE ES-1
Estimated Construction Costs of Recommended Improvements

Intersection or Interchange	Recommended Improvement	Estimated Cost
Overbrook Drive	Interconnect traffic signals at Overbrook Drive in Wellesley and Oak Street in Natick	$300,000
Weston Road	Replace interchange with a new standard diamond interchange	8,000,000
Oak/Westgate Streets	Close median break with a locked gate or mountable raised median	50,000
Kingsbury Street	Signalize the U-turn bays on both sides of the Kingsbury Street intersection	500,000
Grantland Road	Close Grantland Road access to Route 9 and lengthen Route 9 eastbound on-ramp	100,000
Oakland Street	Improve signs on the Route 9 westbound approach and monitor results	50,000
Cedar Street	Replace interchange with a new diamond interchange	10,000,000
William Street	Prohibit right turns from Route 9 onto William Street, widen acceleration area west of William Street to provide a separate right-turn lane onto Route 128 northbound, and signalize three nearby intersections in Newton.	2,000,000
	Total Cost	**$21,000,000**

Oak and Westgate Streets Intersection

The recommended improvement for the Oak and Westgate streets intersection closes the median break in Route 9 with a locked gate or a bituminous mountable median, allowing only right turns from Oak and Westgate streets and thus eliminating vehicle conflicts involving unprotected left turns. The locked gate or mountable median would be closed at all times except for emergency uses. Closing the median would not affect accessibility severely, as the U-turn bays on both sides of the Kingsbury Street intersection would be signalized; protected turns would then be available in less than one-half mile in either direction (at Kingsbury Street and at Weston Road). At a minimum, the U-turn bays on both sides of the Kingsbury Street intersection would need to be signalized first in order to make this concept a reasonable alternative. No land-takings would be required for this improvement concept, and there would be no adverse environmental impacts. Very minor traffic disruptions would be expected during construction, the cost of which is estimated at $50,000.

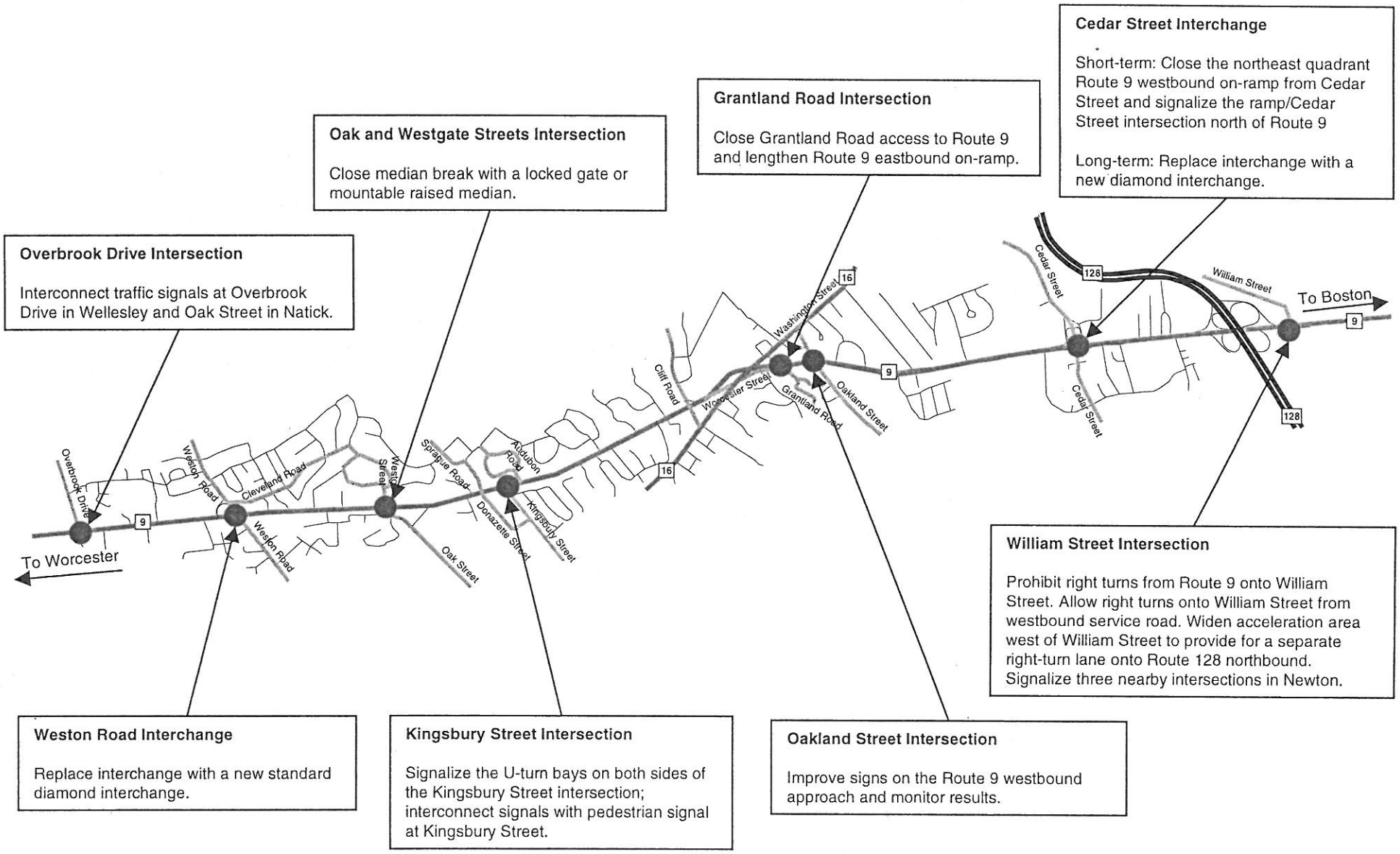


FIGURE ES-1
Route 9 Corridor Study in Wellesley: Recommended Improvements

Kingsbury Street Intersection

The improvement recommended for the Kingsbury Street intersection is to signalize the U-turn bays located on both sides of the intersection to allow safe, protected turns. This would increase the safety of traffic operations without adding a third lane in either direction of Route 9 and without any land-takings. The existing pedestrian traffic signal at the Kingsbury Street intersection would be retained, as would the two through lanes in both directions of Route 9. The Kingsbury Street approach would remain right-turn only. The proposed traffic signals would be coordinated with the Kingsbury Street pedestrian signal to improve traffic operations and pedestrian safety. No negative environmental impacts would result from the recommended improvement. Moderate traffic disruptions would be expected during construction, the cost of which is estimated at $500,000, including the new traffic signals.

Grantland Road Intersection

The improvements recommended for the Grantland Road intersection is to close Grantland Road access to Route 9. This concept has more safety and operational benefits but it also affects emergency delivery services and some opposition was expressed at the public meetings to this improvement concept. Closing Grantland Road would resolve the vehicular conflicts at this intersection, eliminate the stop sign at the Worcester Street approach that drivers do not comply with, and prevent cut-through traffic from using Grantland Road. However, this measure would affect delivery of emergency services and lacks space for a cul-de-sac to allow drivers to turn around and change direction. The one-way ramp near Grantland Road intersection should be examined if it can be realigned and moved towards Route 9 to create more space for the cul-de-sac for Grantland Road. Moderate traffic disruptions would be expected during construction, the cost of which is estimated at $100,000.

Oakland Street Intersection

The improvement recommended for the Oakland Street intersection is to provide better warning signs for motorists heading westbound on Route 9. New warning signs would be installed or existing signs modified to increase awareness of the upcoming traffic signal at Oakland Street. These improvements would have no impact on traffic delays or accessibility; however, they would be expected to improve safety. No land-takings would be involved and no adverse impacts on the environment would be expected. Construction costs would be minor, estimated at under $50,000, including improving signs and monitoring results.

Cedar Street Interchange

The short-term improvements recommended for the Cedar Street interchange is to close the northeast quadrant Route 9 westbound on-ramp from Cedar Street and signalize the ramp/Cedar Street intersection north of Route 9. This concept improves safety for the Route 9 westbound traffic by eliminating the short weave under the bridge by closing the northeast quadrant Route 9 westbound on-ramp from Cedar Street. Additional modifications include coordinating the traffic signals to improve traffic operations, modifying the ramp in the northwest quadrant for use by the westbound traffic, and lengthening the westbound on-ramp in the northwest quadrant. This concept has significant safety benefits but minimal reduction in

traffic delays. The proposed improvements would affect accessibility for the businesses in the northeast quadrant, as the ramp in that quadrant would serve only traffic exiting Route 9 onto Cedar Street northbound. The proposed improvements would impact water resources and includes modifications that would impact accessibility through relocation of access to some properties in the northeast quadrant. Moderate to major traffic disruption would be expected during construction, the cost of which is estimated at $750,000, including signal installation and equipment, modifying the northeast and northwest quadrant ramps, and improved signs. The short-term recommendations for the Cedar Street interchange should be considered only when the long-term recommendations are expected to take a long time to implement.

The long-term improvements recommended for the Cedar Street interchange is to replace the existing antiquated half-cloverleaf interchange with a modern full-diamond interchange and, possibly, to shift Route 9 to the north to create a frontage road on the southerly side for accessing businesses and properties in the southwest and southeast quadrants. It would require the construction of a new bridge to handle Cedar Street traffic and access to the businesses located in this area. Part of the concept is to signalize the ramp/Cedar Street intersection on the north side of Route 9 and coordinate it with the south-side signal to improve traffic operations and safety. The modifications would improve traffic operations and safety on the ramps, Cedar Street, and Route 9. The modifications would eliminate the weave under the bridge involving Route 9 westbound traffic. This alternative would require land-takings, would impact water resources, and includes modifications that would impact accessibility through relocation of access to some properties in the northeast quadrant. Construction costs, including building a new bridge, replacing ramps, installing a new traffic signal, providing other equipment, and maintaining traffic flow during construction would be high; they are estimated in the range of $10 million.

William Street Intersection

The recommended improvements at William Street include not only improvements at the William Street intersection and in the immediate vicinity, but also improvements that address traffic operations and safety problems at three of the intersections in Newton that were examined, as some of the traffic headed for Wellesley Office Park uses those intersections. The recommended measures are:

1. Prohibit right turns from Route 9 onto William Street.
2. Channel traffic into and out of William Street by constructing a traffic island.
3. Widen the acceleration area west of William Street to provide a separate right-turn lane onto Route 128 northbound.
4. Install and modify signs on Route 9 westbound to guide motorists to William Street.
5. Signalize the intersection of Ellis Street at Route 9 eastbound service road in Newton.
6. Signalize the intersection of Ellis Street/Quinobequin Road at Route 9 westbound service road in Newton and add a left-turn bay to the northbound approach.
7. Signalize the intersection of Chestnut Street at Route 9 westbound service road in Newton and add a left-turn bay to the northbound approach.

Prohibition of right turns from Route 9 would improve safety at the William Street intersection, as it removes one of the weaving movements in this vicinity. It would require that

traffic from Route 9 westbound destined for William Street exit at Chestnut Street and use the service road. Because of the additional traffic resulting from this diversion, signalization of the three intersections in Newton is recommended, to address congestion, queues, and safety. Widening the acceleration area on Route 9 west of William Street and constructing the traffic island would provide a separate right-turn lane onto the Route 128 northbound on-ramp. The idea is to channel the William Street traffic that is headed for Route 128 northbound so that it remains off of Route 9, in effect providing a two-lane on-ramp that would merge into a single traffic lane before entering Route 128, with one lane serving Route 9 traffic and the other serving William Street traffic. The widening would improve traffic operations and safety by providing additional space for the complex weaving movements and thus reducing vehicle conflicts. The proposed improvements would require land-takings, possibly encroaching on Wellesley Office Park. Construction is estimated to cost approximately $2 million including geometric improvements, widening, installing new signals, installing new signs, and maintaining traffic flow during construction.

1. BACKGROUND AND OBJECTIVES

This study was initiated at the request of the Massachusetts Highway Department, as one component in the town of Wellesley's permitting process for the reuse of the former MassHighway Depot site on Route 9. The site is located on the north side of Route 9, just west of the I-95 (Route 128)/Route 9 interchange. It is currently the corporate headquarters of Harvard Pilgrim Health Care. Redesign of the existing driveway serving the site; include modifying Route 9 to provide improved control of turning traffic, as part of the permitting process at this location.

The present study is based in part on an earlier study, completed by the Central Transportation Planning Staff in 1992. The earlier effort was a multiyear corridor planning study which covered the length of Route 9 from I-95 (Route 128) in Wellesley to I-495 in Southborough. It included an intensive examination of Route 9 traffic volumes and operations within the "Golden Triangle" area, identified as the section between Route 30 in Framingham and Lake Cochituate in Natick. It also analyzed operations at critical locations in the Route 9 corridor in Wellesley and Southborough and in Framingham and Natick outside the Golden Triangle area; the study's analysis of these locations, less intensive than in the Golden Triangle and focusing exclusively on traffic volume–related issues, may be characterized as follows. It evaluated traffic volumes in the base year 1987 using level-of-service techniques, and used a traffic model with factored peak-hour volumes to estimate the likely change in conditions in years 1995 and 2010. It recommended types of improvement strategies that might be investigated for particular locations. It did not investigate the physical feasibility of such measures or address design beyond presenting preliminary concepts at the level of sketches.

The study's recommendations were reviewed internally but never finalized or officially released. Several of its recommendations have advanced in the years since 1992, most notably proposals for improvements at the Cedar Street interchange, and concepts for a redesign of the Oak Street intersection in Natick, just west of the Wellesley town line. Other recommendations, while they appeared reasonable from a traffic efficiency viewpoint, may have been infeasible for physical or other reasons.

Figure 1-1 illustrates the section of Route 9 that is the focus of the present study. The goals of this study are:

1. To reevaluate the intersections and interchanges along Route 9 in Wellesley, updating traffic information where necessary through new and recent counts.

2. To identify which of the improvement ideas identified earlier still make sense.

3. To investigate additional improvement options that might be considered in addition to, or in place of, the options analyzed in the earlier analysis.

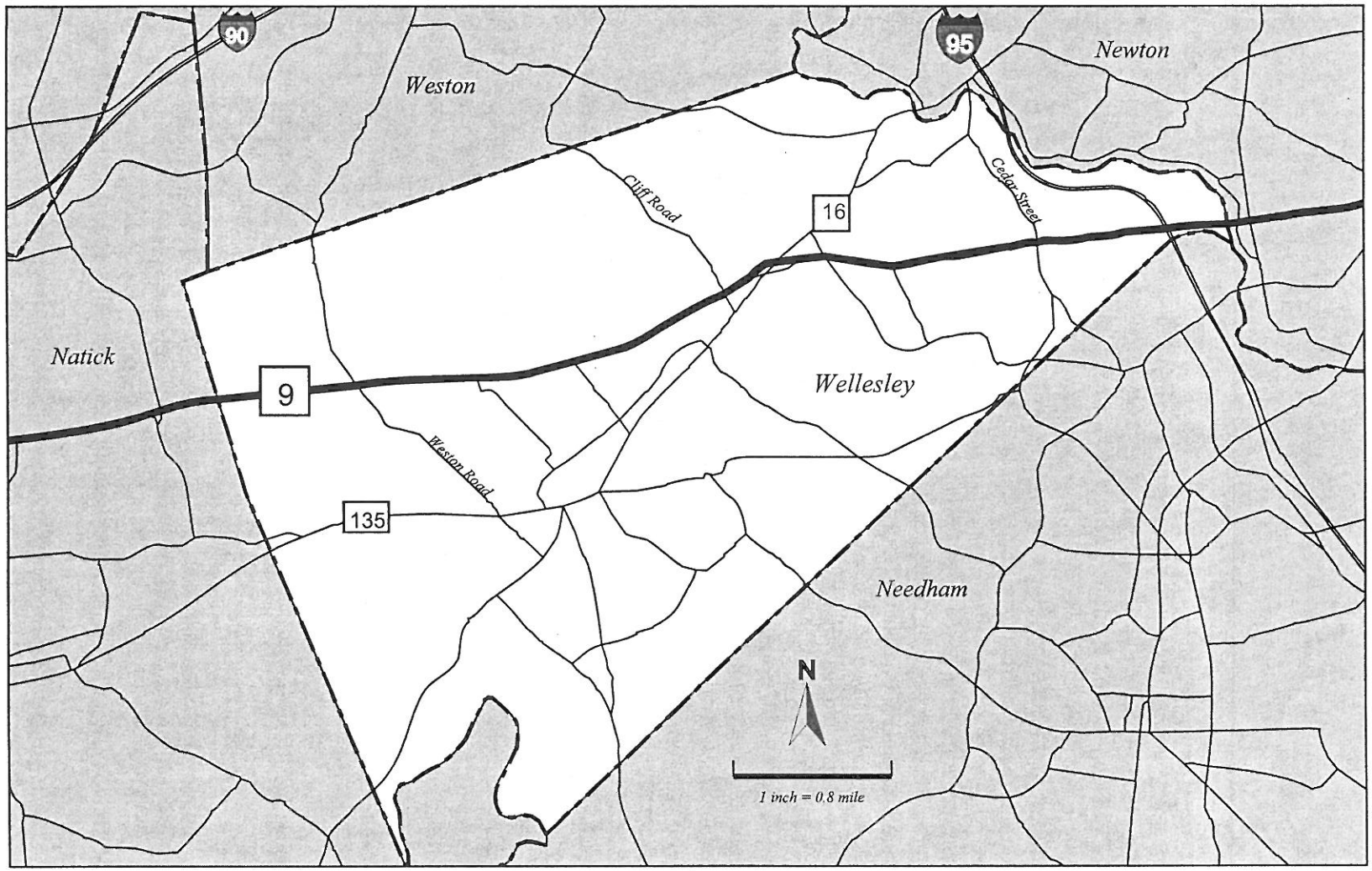


FIGURE 1-1
Route 9 in Wellesley

This study goes beyond the earlier effort in several respects:

1. It includes a preliminary review of physical opportunities and constraints pertaining to improvement options, although at a planning level, short of conceptual engineering design.

2. It includes a review of crash data along the Route 9 corridor in Wellesley based on the Registry of Motor Vehicles files.

3. It takes note of ongoing and proposed developments in and near the Route 9 corridor and discusses traffic growth trends and their implications for this corridor.

The study aims to present sufficient information about conditions along the Route 9 corridor to allow informed judgments about the most desirable strategies to advance. Such strategies may become future projects, to be designed and implemented by MassHighway, the town, and/or others.

This report is organized into five sections: an executive summary and four chapters. The following chapter documents the existing conditions. The third chapter describes the various concepts developed to address problems at the locations studied. The fourth and final chapter presents recommendations of this study and the process to be followed to implement any of the recommendations. Appendix A consists of the minutes of the three public meetings that were held as part of this study. Appendices B, C, and D contain crash information and level-of-service data for, respectively, existing conditions and conditions after implementation of improvements.

2 EXISTING CONDITIONS

This chapter presents an overview of the study area and discusses the existing geometry and general conditions at locations of prime interest, traffic volume data, existing levels of service, crash data, and the opportunities for turning traffic.

2.1 OVERVIEW OF STUDY AREA

Route 9 in Wellesley has two travel lanes in each direction, with 8- to 10-foot shoulders along most of its length. It operates as a divided highway, with median guardrail-type barriers along its entire length, except for a short section at Kingsbury Street, where a grass median is provided. Openings in the median occur at intervals, to allow left turns and U-turns. At the locations where these median barrier breaks occur, and at signalized intersections where turns are permitted, additional turning lanes are provided. The posted travel speed on Route 9 in Wellesley ranges from 35 to 50 mph. These speeds are not typically sustained during the hours of peak travel on Route 9, because there are high volumes of traffic and substantial queues at the signalized intersections.

2.2 GEOMETRY AND INTRODUCTORY DISCUSSION OF CONDITIONS

In this discussion, the corridor is divided into four sections:

1. Natick/Wellesley Line to Mansfield Road
2. Mansfield Road to Shaw Road
3. Shaw Road to Emerson Road
4. Emerson Road to the Wellesley/Newton Line

2.2.1 From Natick/Wellesley Line to Mansfield Road

The most westerly section of Route 9 within Wellesley includes two traffic signals, one at Overbrook Drive and a pedestrian-actuated signal near St. James's Church, east of Lexington Road, and one interchange, which is at Weston Road (Figure 2-1).

The first traffic signal within this section of Route 9 is located at the T intersection with Overbrook Drive, just east of the Natick/Wellesley town line. At this location, left/U-turn lanes facilitate turns for both eastbound and westbound Route 9 traffic. There is a pedestrian crosswalk from the former Sozio's site on the northwest corner of the intersection to the south side of Route 9 in front of the car dealership. Overbrook Drive is itself a primarily residential street, providing access to residential neighborhoods north of Route 9.

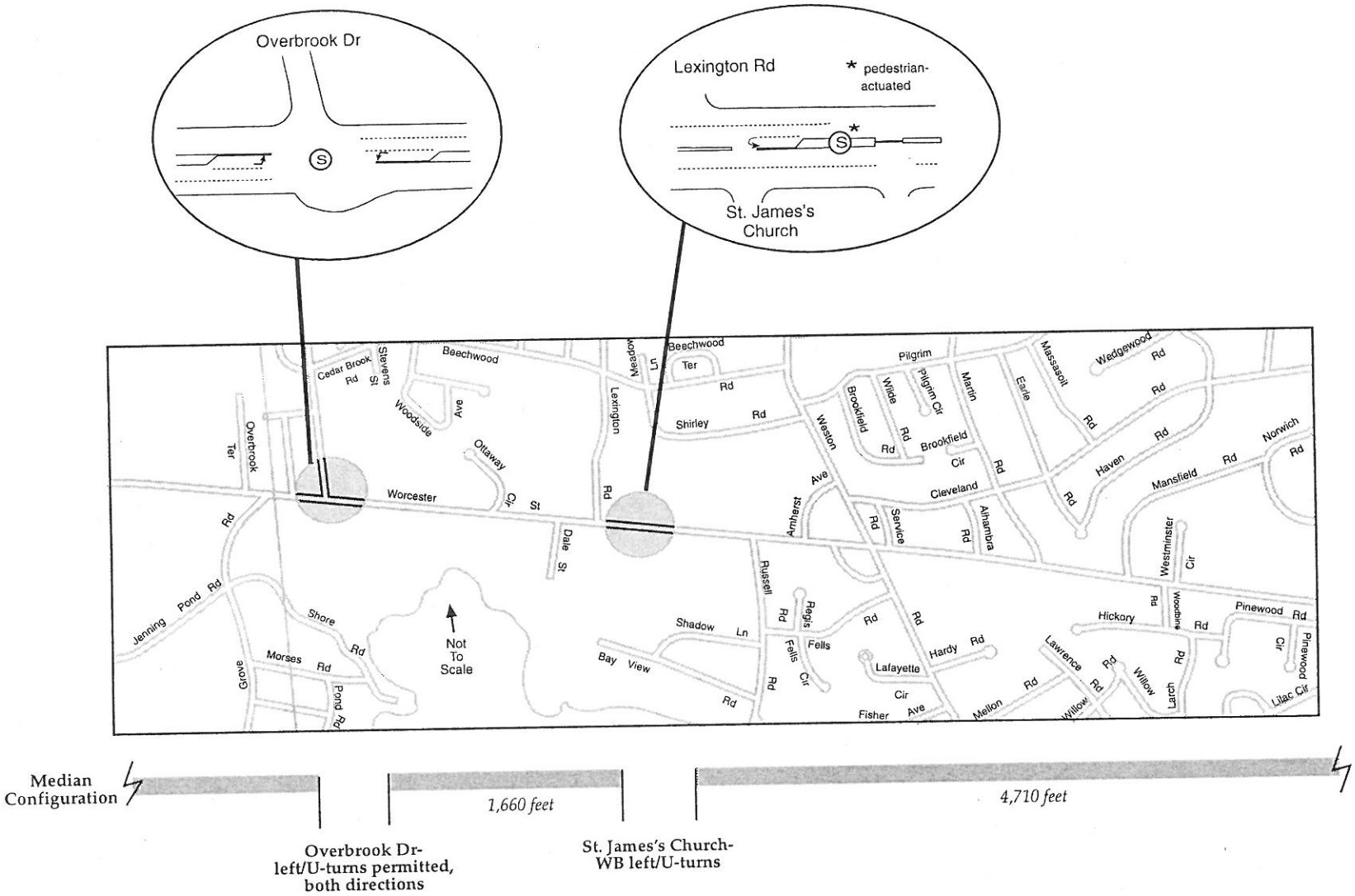


FIGURE 2-1
Route 9: Natick/Wellesley Line
to Mansfield Road

A development proposal is currently under review for a commercial site located adjacent to the Shell Station on the northeast corner of the intersection, with driveway access on Route 9 and on Overbrook Drive. No major modifications to Route 9 itself are proposed in conjunction with this development plan. In addition, a bank has been proposed for the former Sozio's site; no details are currently available on the proposed access plan for this use.

Overbrook Drive is located approximately 1,700 feet east of the intersection of Route 9 with Oak Street, within Natick. The Oak Street intersection—configured as a complex signalized rotary—is recognized as a major local bottleneck, which causes westbound traffic backups extending into Wellesley. MassHighway is exploring improvements to this location.

The second traffic signal, operated as a pedestrian-only signal, is located close to the median break in front of St. James's Church, near Lexington Road. A westbound left/U-turn lane is provided at this location, providing access to the church parking lot and allowing U-turns from Route 9 westbound to eastbound. Approximately 300 feet east of the median break, there is a pedestrian crosswalk across Route 9, with a median refuge area and pedestrian-actuated signal. This crosswalk primarily serves church-related traffic, as does an additional gated median break located approximately 70 feet east of the crosswalk. This second median break is available only to traffic exiting the church parking lot and turning left onto Route 9 westbound on Sunday mornings following church services. The controlled gate is closed at all other times, and is supervised by a police detail during its hours of being open each week. The primary median break, which is always open, does not appear to be heavily used by U-turning traffic, based on observations during recent traffic counts.

The grade-separated interchange at Weston Road provides separate ramps for traffic entering and exiting the westbound side of Route 9 from Weston Road northbound and southbound. Traffic entering and exiting Route 9 eastbound uses a single ramp system located in the southwest quadrant, creating an unsignalized T intersection with Weston Road. The ramps at Weston Road are of old-fashioned design, with tight curves, limited sight distance, limited acceleration/deceleration lanes, little separation between opposing entering and exiting traffic, and access driveways to homes and businesses located directly on the ramps. A stop sign controls entry to Route 9 from the eastbound on-ramp.

All other intersections along Route 9 in this section consist of residential streets that create right-in/right-out T intersections with Route 9. On the north side, Lexington Road, Alhambra Road, and Martin Road are interconnected with other neighborhood streets, which allow alternative access to residents. Only Overbrook Terrace and Ottaway Circle are cul-de-sacs which have no other access apart from their intersections with Route 9. On the south side, Grove Road and Russell Road are interconnected with the local street network; only Dale Street, adjacent to the St. James's Church lot, is a residential cul-de-sac.

2.2.2 From Mansfield Road to Shaw Road

This section includes only one traffic signal: a pedestrian-actuated signal at Kingsbury Street. Median U-turn openings are provided east and west of the Kingsbury Street intersection, and at the intersection of Oak and Westgate streets with Route 9 (Figure 2-2).

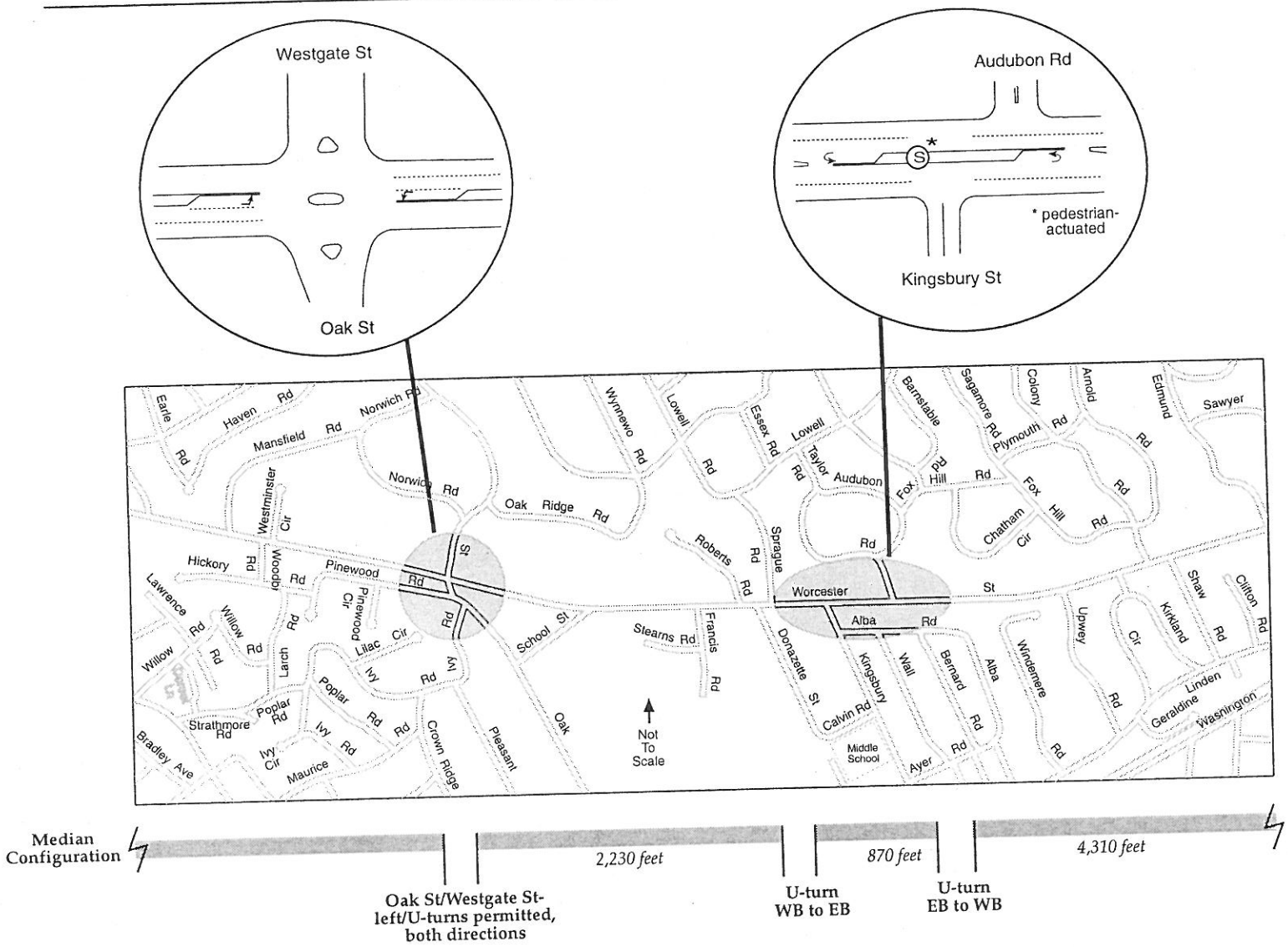


FIGURE 2-2
Route 9: Mansfield Road to Shaw Road

Route 9 at Oak and Westgate Streets is an unsignalized intersection with channelizing islands in the median that serve mainly to separate eastbound and westbound left turns and U-turns. Exclusive left/U-turn lanes are also provided in both directions on Route 9. Both Oak and Westgate Streets are governed by stop signs, and signs indicate that only right turns are permitted from these streets onto Route 9. There is no physical barrier preventing traffic from crossing the median or turning the "wrong way" onto Route 9 (i.e., westbound from Oak Street; eastbound from Westgate). Only one or two vehicles were observed to attempt these prohibited movements during recent counts. The posted speed limit in this section of Route 9 is 50 mph

Kingsbury Street intersects Route 9 at a point where the Route 9 right-of-way is wide enough for a grass median. A pedestrian refuge area is located within this median, and the traffic signal at this location is pedestrian-actuated only. The Wellesley Middle School is located on Kingsbury Street south of the intersection; many of the pedestrians and vehicles within the intersection are going to and from the school.

There is no median break for vehicles at Kingsbury Street itself—vehicular turns between Route 9 westbound and Kingsbury Street are accomplished via the U-turn bays located on either side of Kingsbury Street. Vehicles waiting to make U-turns experience long delays at both locations, because of steady Route 9 traffic. Informal observations noted an average delay time of 65 seconds[1] during the peak 15 minutes, with some vehicles delayed as long as 2+ minutes. During the morning (7:15-8:00), a school crossing guard is on duty at the pedestrian crossing, stopping traffic on Route 9. Such stoppages frequently provide the only opportunity for vehicles turning from Route 9 westbound to eastbound to exit, because Route 9 eastbound vehicles are slowing down in anticipation of the stop at the crosswalk. A very high proportion of vehicles making this U-turn during the morning peak period (over 80 percent) will immediately change lanes to turn right into Kingsbury Street, toward the School.

Because of lengthy delays, vehicle queues frequently spill beyond the ends of the U-turn bays onto the general-purpose Route 9 lanes. This is especially noteworthy in the westbound direction (i.e., vehicles turning from Route 9 westbound to eastbound), in both AM and PM peak periods. It also occurs in the opposite direction, however (vehicles turning from Route 9 eastbound to westbound.). Queues of up to nine vehicles were observed in the westbound U-turn bay (turning into Route 9 eastbound).

With the exception of the Route 9 intersection with Oak and Westgate streets, all intersections in this section of Route 9 operate as T intersections, allowing right-turn entry and exit only to and from Route 9. Old Colony Road, Audubon Road, Sprague Road, Oak Street, and Mansfield Road all provide access to Route 9 for the network of residential streets north of Route 9. These streets are all interconnected, so that alternate Route 9 access would still be available to these neighborhoods if one or more of these streets were no longer available as a connection. Only Roberts Road and Westminster Circle are residential cul-de-sacs on the north side, having access only via Route 9.

Similarly, south of Route 9, Woodbine Road, Oak and School Streets, Donazette Street, Kingsbury Street, Upwey Road, Kirkland Circle, and Shaw Road are interconnected via Linden

[1] Per stopped vehicle.

Street, which parallels Route 16 north of the railroad right-of-way. Only Stearns Road and Francis Road are cul-de-sacs with access solely via Route 9.

2.2.3 From Shaw Road to Emerson Road

This section includes the interchange of Route 9 with Route 16 (Washington Street), and signalized intersections at Worcester Street and Oakland Street. In addition, a single two-way ramp at Cliff Road serves traffic entering and exiting westbound Route 9 only. A parallel service road exists on the north side of Route 9 just east of Oakland Street, providing access to several residential streets. Unsignalized intersections in this section include, on the south side, Rockland Street and Kimlo Road west of Route 16, and Grantland Road, Standish Road, and Mulhern Lane east of the Route 16 interchange. On the north side, unsignalized intersections include Edmunds Road and Bradford Road (Figure 2-3).

Route 9 crosses over Cliff Road approximately 500 feet west of the Route 9 intersection with Worcester Street. A two-way on-off ramp of substandard design currently permits access to and from Route 9 westbound at this location; no access is provided to or from Route 9 eastbound. The ramp is controlled by stop signs on both Route 9 and Cliff Road. Sight distance is extremely limited at the point where this ramp meets Route 9, primarily because of Route 9's horizontal and vertical curvature, and because of a stone wall that impedes the view of oncoming traffic.

Route 16 crosses over Route 9 at Wellesley Hills Square, and connections are provided between the two roadways via several ramps and short connector roads. On the eastbound side, traffic exits Route 9 at its signalized intersection with Worcester Street directly in front of the Wellesley Fire Station. Worcester Street is a short two-way street, with sidewalks and on-street parking on both sides, which also connects with Route 16 at a signalized intersection.[2]

To enter Route 9 in the eastbound direction, traffic can make a right turn from Worcester Street onto Route 9 or can use the eastbound on-ramp located farther along Route 16 (Figure 2-4). This ramp, located on the old Route 9 alignment, now meets Route 9 at the point where Grantland Road, a residential street, also intersects with Route 9. Currently, Grantland Road has the right-of-way, with stop signs located both at the end of the on-ramp and at the Grantland Road approach to Route 9—an unorthodox and confusing arrangement.

On the westbound side of Route 9, traffic exits the highway at an off-ramp, which divides, into two separate traffic roadways serving Route 16 eastbound and westbound. At the top of the ramp, traffic headed for Route 16 westbound is controlled by a traffic signal, which permits only left turn movements from the ramp. The off-ramp represents the only exit from Route 9 westbound within the interchange: no left turn is permitted from Route 9 westbound at Worcester Street, in front of the fire station.

[2] "Worcester Street" at this location is actually the original alignment of Route 9, which is also known as Worcester Street for most of its length. On its original alignment, Worcester Street crossed Route 16 at-grade at this location and continued along the two-way service road which today serves as the eastbound on-ramp to Route 9.

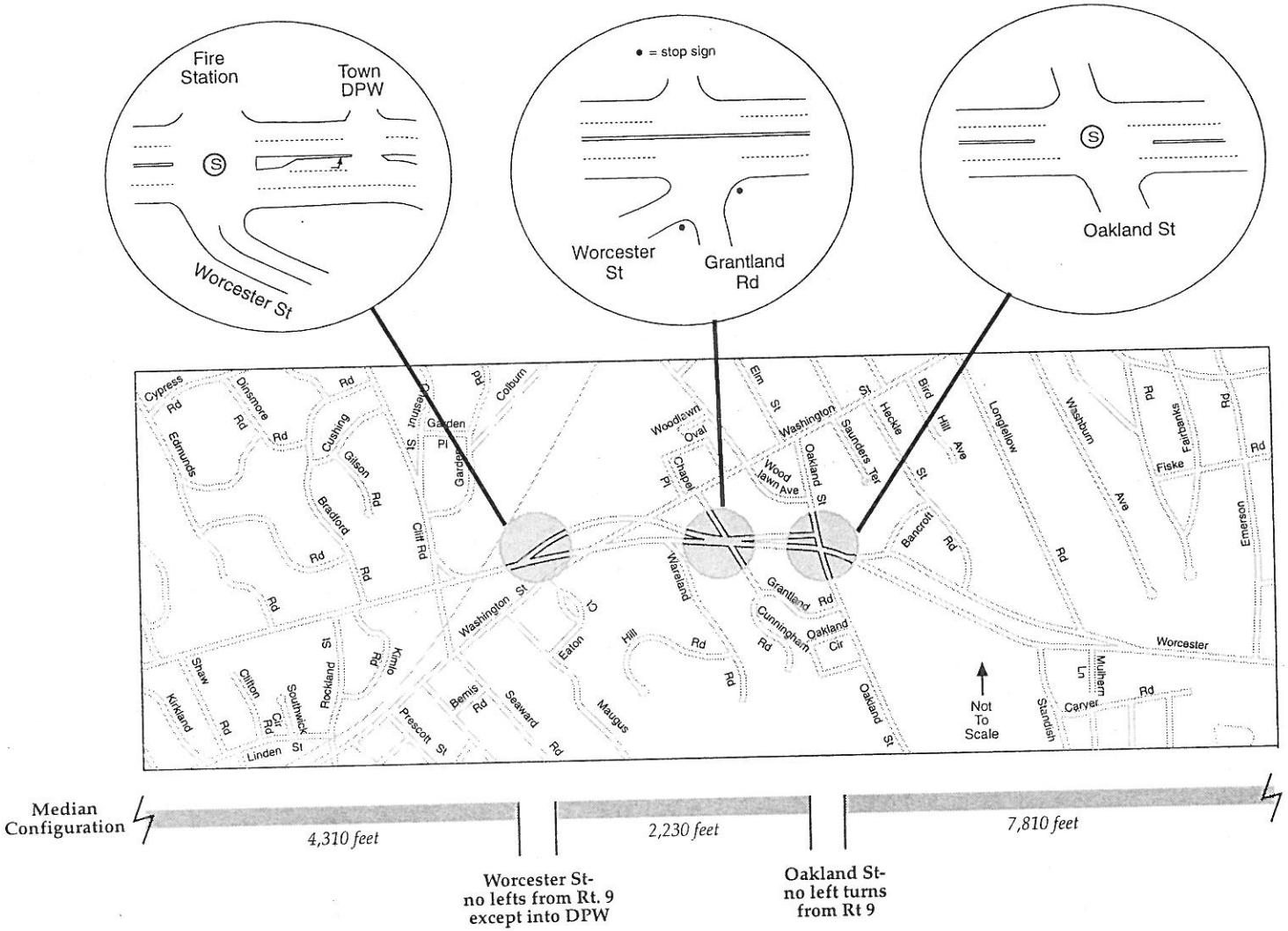


FIGURE 2-3
Route 9: Shaw Road to Emerson Road

Traffic may enter Route 9 westbound from Route 16 at two locations: from the westbound on-ramp located directly across Route 16 from the westbound off-ramp, and from Worcester Street at the signalized intersection in front of the fire station. The westbound on-ramp is a wide access roadway with a stop sign at its terminus on Route 9. The ramp also provides direct access to the town of Wellesley public works department facility and fire station; both located adjacent to the point where the ramp meets Route 9. Currently, traffic may only enter the ramp from Route 16 westbound: no left turns are currently permitted from Route 16 eastbound onto the ramp (Figure 2-4).

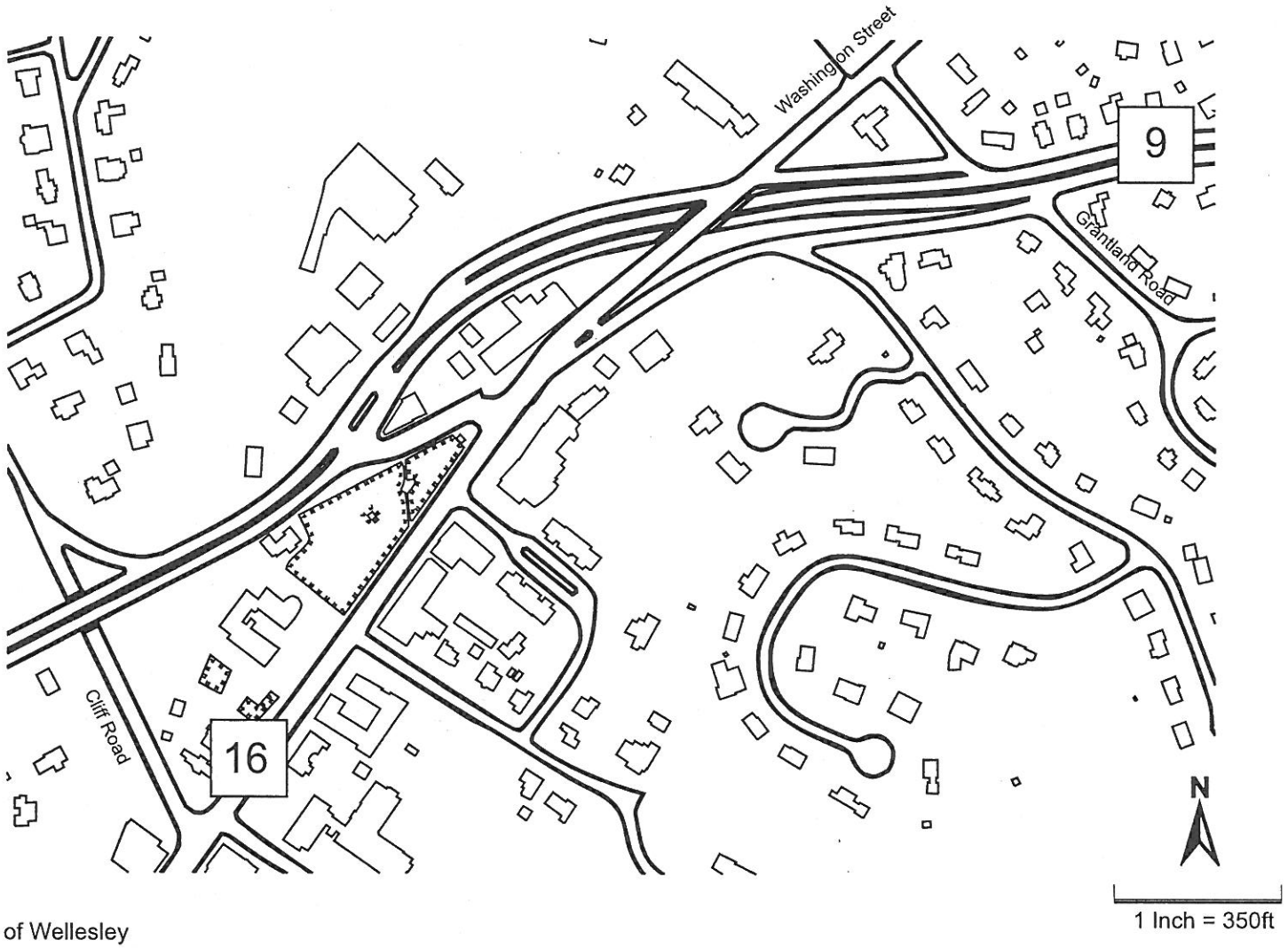
MassHighway is currently designing modifications to the Route 16 bridge over Route 9, as part of a rehabilitation project. In addition to bridge modifications, MassHighway is examining reconfigurations of the connections within the interchange, in an effort to improve safety. The proposal which has received most attention over the past several years would close the median in front of the fire station/public works buildings to all but emergency vehicles, and would modify the existing traffic signal to operate only by emergency vehicle preemption. If such a median closing were to occur, Route 16 traffic coming from west of Worcester Street would no longer be able to use Worcester Street to get to Route 9 westbound. Therefore, provision would need to be made at the westbound Route 9 on-ramp for entering left turns from Route 16, a move currently prohibited. This proposal is currently under review by MassHighway and town officials. Local objections have been raised to closing the Route 9 median, and the resulting relocation of access for traffic associated with the public works department to Woodlawn Road; as well as to the proposals advanced for modifications to the westbound on-ramp to Route 9.

The intersection of Route 9 and Oakland Street is the only signalized intersection within this section. It is a fully actuated signal, with no left turns permitted from Route 9 in either direction and right turns permitted from Route 9 only in the eastbound direction. All turns are permitted from both Oakland Street approaches. The intersection is located just west of a hill crest, so that sight distance is limited by vertical geometry as one approaches the intersection from the east. An illuminated sign is located about 700 feet east of the intersection, warning approaching vehicles of the upcoming traffic signal.

Other intersections located within this section of Route 9 are unsignalized T intersections which permit access in and out for right turns only. These include Standish Road, Rockland Street, and Kimlo and Shaw roads on the south side, and Bradford and Edmunds roads on the north side of Route 9. They are all predominantly residential streets, although Rockland Road does provide through connections to Washington Street (Route 16).

2.2.4 From Emerson Road to Wellesley/Newton Line

The easternmost section of Route 9 in Wellesley includes the interchanges of Route 9 with Cedar Street and I-95 (Route 128), and a signalized intersection at the driveway serving the Harvard Pilgrim site. Unsignalized intersections are located along Route 9 at several primarily residential streets. Lexington Road is a residential street that meets Route 9 in an unsignalized intersection. Hastings Street is a residential street which intersects the eastbound off-ramp at Cedar Street; at present, jersey barriers are used to block access to Hastings Street



Mapping courtesy of Wellesley

FIGURE 2-4

Route 9/Route 16 Interchange

from Route 9, except for a small number of commercial abutters. Other intersecting streets include Minuteman Lane, Harris Avenue, Maple Road, and Lantern Lane on the north side, and Burke Lane, Willow Street, and Dearborn Street on the south side (Figure 2-5).

The Cedar Street interchange is a full-service interchange of old-fashioned design, half cloverleaf-type, half diamond-type (Figure 2-6). On the northerly side, the curvature of the loop ramps falls short of current standards, and the existing provision for acceleration and deceleration is inadequate at all ramps. The westbound on- and off-ramps come together as undivided roadways, which also accommodate curb cuts serving abutting existing land uses. On the southerly side, the eastbound off- and on-ramps are one-way roadways at the point where they meet Route 9; both become two-way roadways beyond the Route 9 diverge/merge, also serving abutting land uses with access directly on the ramps. A traffic signal at the intersection of the ramps and Cedar Street was recently upgraded, and minor geometric improvements were made to the ramps. This intersection serves high volumes of existing traffic. Exclusive left-turn lanes are provided on both Cedar Street approaches and on the eastbound off-ramp approach.

The I-95 (Route 128) interchange with Route 9 is a full cloverleaf interchange that carries heavy volumes on all ramps during peak traffic periods. The Route 9 ramps are shorter and their curves are sharper than modern design standards would permit. Opportunities for modifying these ramps to conform more closely to modern standards are limited by the constrained right-of-way and the proximity of buildings on both the east and west sides of I-95.

On the west side of I-95, the southbound off-ramp is located very close to the signalized intersection at the new Harvard Pilgrim site driveway. Large numbers of vehicles traveling from Route 9 westbound, as well as from the I-95 southbound ramp, are destined for the driveway of the Sun Life office complex, located on the south side of Route 9 just east of the signalized intersection. A formalized jug-handle-type roadway is provided within the Harvard Pilgrim site, as part of its own driveway, accessible to traffic bound for Sun Life through a westbound exclusive right-turn lane on Route 9 (Figure 2-7). In addition, a protected U-turn lane will be provided in the westbound direction for use by Sun Life traffic coming from Route 9 westbound. This turning lane will also be available for use as a left-turn lane by this traffic in the event that the existing Sun Life access driveway is relocated to the signalized intersection sometime in the future.

In addition to the improvements to accommodate traffic turning into Sun Life, three through lanes will be provided on Route 9 in both the eastbound and westbound directions to serve general traffic. An exclusive left-turn lane will also be provided in the eastbound direction.

On the east side of I-95, the diverge of the on-ramp from Route 9 westbound to I-95 northbound is located only 240 feet from William Street, which serves as the entrance to the Wellesley Office Park. The geometry in the westbound direction is further complicated by the existence, just east of the office park entrance, of the Route 9 bridge over Chestnut Street, Ellis Street, and the Charles River in Newton. Vehicles traveling westbound on the bridge toward either the I-95 (Route 128) ramps or William Street traverse a downgrade, and weave with traffic entering Route 9 westbound from the Chestnut Street ramp.

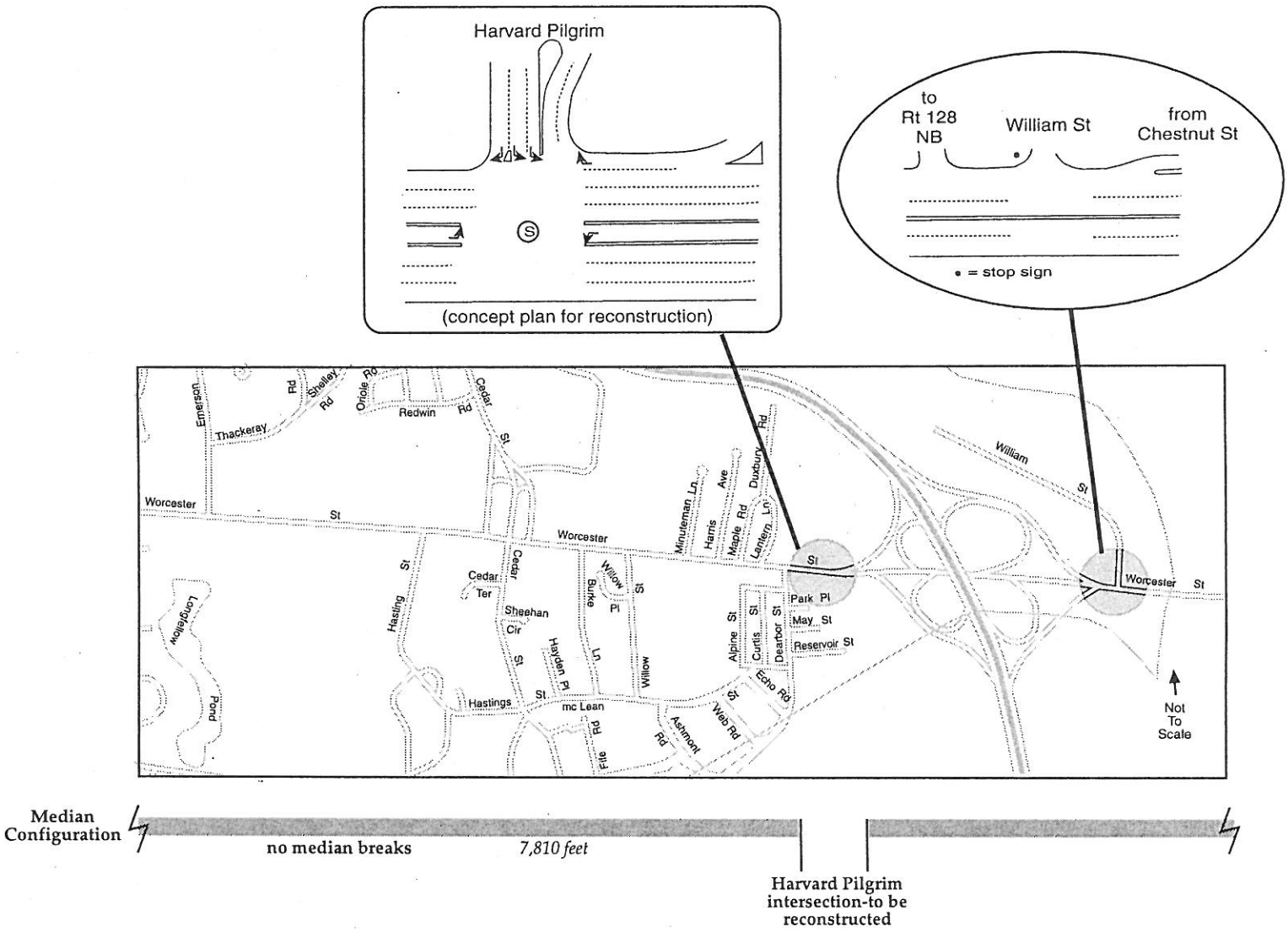
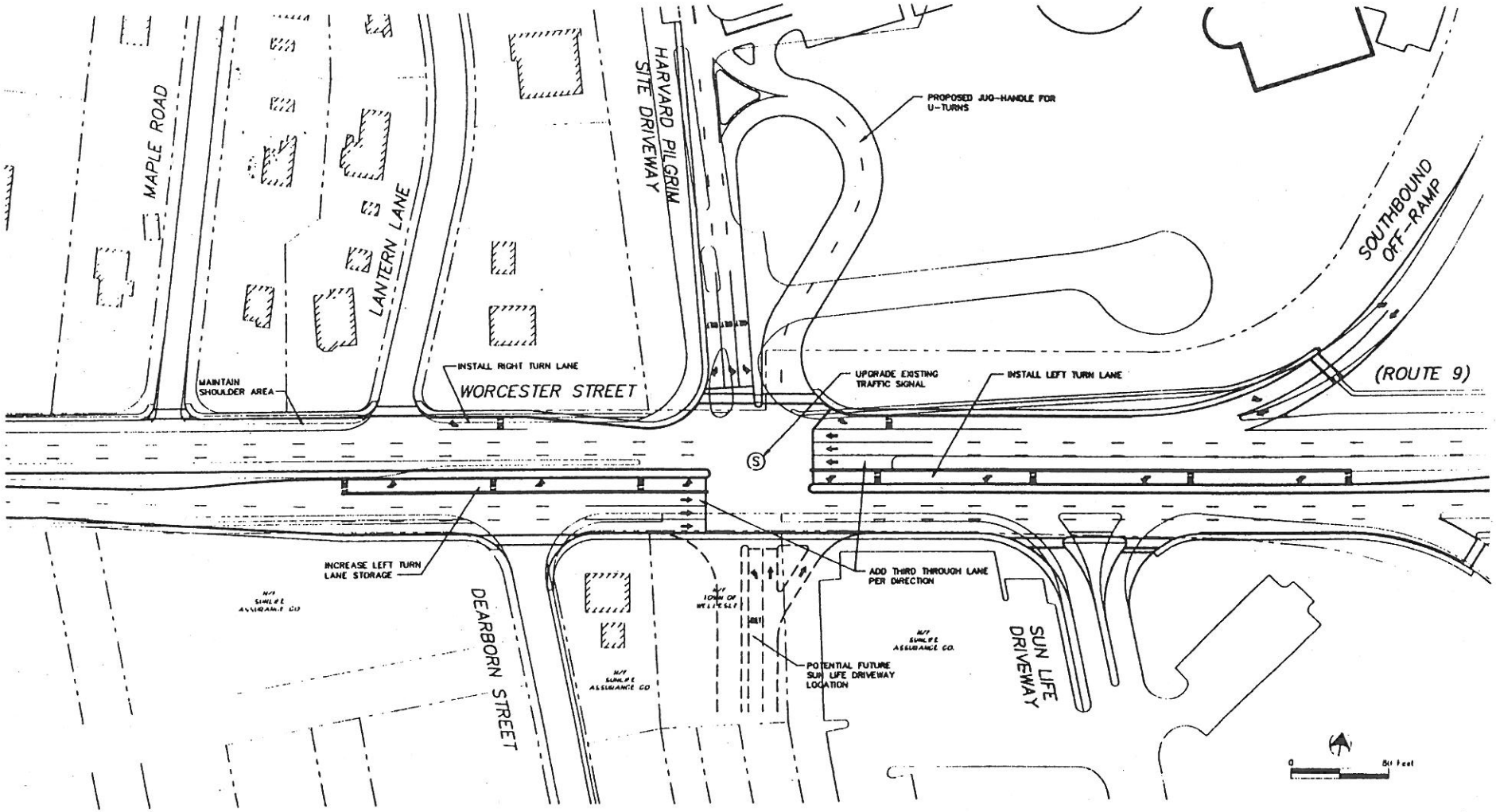


FIGURE 2-5
Route 9: Emerson Road
to Wellesley/Newton Line

Mapping courtesy of Wellesley GIS

FIGURE 2-6
Cedar Street Interchange



(Source: RD Vanasse & Associates)

FIGURE 2-7
Newly Reconstructed Harvard Pilgrim Driveway

It has also been noted that eastbound Route 9 traffic regularly backs up into Wellesley from the intersection of Route 9 and Woodward/Eliot Streets in Newton, particularly during morning peak travel hours. This location is a signalized intersection, with two through lanes and an exclusive left-turn lane on each Route 9 approach.

Apart from the interchanges and signalized intersection, other residential streets on the north side of Route 9 function as cul-de-sac streets, with no access or egress except via Route 9. Route 9 access for these streets is right-turn-in, right-turn-out only, so that all vehicles must enter/exit in the westbound direction. The first opportunities to reverse direction, for traffic headed to and from Route 9 eastbound, occur at the Cedar Street interchange and the signalized intersection at the new Harvard Pilgrim site, respectively. The traffic signal at this location creates gaps for vehicles exiting Minuteman Drive and the other residential streets onto Route 9 westbound. Emerson Road is a residential street, which provides right-turn in/right-turn out access to Route 9 via an unsignalized intersection.

The residential streets on the south side of Route 9 are similarly restricted to right-in/right-out access to and from Route 9 eastbound; they are also connected with Cedar Street, and can use this street to access Route 9 westbound.

2.3 TRAFFIC VOLUMES AND LEVELS OF SERVICE

Available traffic count data for Route 9 in Wellesley was assembled from a number of sources:

1. Traffic studies performed as part of permitting requirements for the Harvard Pilgrim site near I-95 (Route 128)[3] and the CEA site (formerly Chin's Village) near Overbrook Drive.[4]
2. Traffic analyses performed in conjunction with functional redesign of the Route 9/Route 16 interchange, 1994 and 1997.[5]
3. Traffic counts performed by MassHighway for its traffic count database.

In addition, new traffic counts were undertaken at a limited number of locations during May 1998. Previous and current counts were synthesized and compared to examine patterns of consistency and growth over time. The new counts included:

1. Partial turning movement counts at several intersections along Route 9:
   Oakland Street (turns only)

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[3] *Traffic Impact and Access Study, Harvard Pilgrim Health Care at Wellesley Gateway*, prepared for Wellesley Gateway LLC by Robert D. Vanasse & Associates (EOEA #10963), February 13, 1997.

[4] *Technical Traffic Report—CEA Wellesley Trust*, prepared by Rizzo Associates (EOEA#11352), September 1997.

[5] *Functional Design Report, Route 9 and Route 16, Wellesley*, prepared for MassHighway Department Traffic Operations Division by Louis Berger & Associates, March 1994; *Preliminary Traffic Study for Route 16 (Washington St.) over Route 9*, prepared for MassHighway Department by Pare Engineering Corporation, December 23, 1997.

Cliff Road (turns only)
Rockland Street (Route 9 plus turns)
Old Colony Road (Route 9 plus turns)
Kingsbury Street (turns only)
Oak/Westgate Streets (turns only)
Lexington Road (turns only)

2. A new 24-hour automatic traffic recorder count on Route 9 east of Overbrook Drive.

Figures 2-8 to 2-10 compare historic 24-hour eastbound and westbound traffic on Route 9 from previous years' counts at several locations within the study area. The graph shows unadjusted volumes averaged over a two- to three-day count period in each case. These figures illustrate a consistency in terms of peaking patterns in each direction. They further illustrate that during the daily peak hour, particularly in the sharp peak of the AM eastbound direction, there is not much room for additional growth in traffic throughput. Therefore, future measurements of peak-hour traffic in this direction are likely to continue to show volumes in the range of 2,700–2,800 vehicle per hour as a practical maximum, even if increased activity leads to growth in overall traffic demand. Additional traffic demand will most likely be experienced as an expansion of the duration of the peak hour, rather than as a significant increase in peak-hour volumes.

The PM westbound direction may continue to show peak-hour volume growth, because it is a more diffuse peak, not as sharp or as high as the AM peak. The most readily observable trend toward traffic growth is occurring during the midday and off-peak hours. Growth during these hours may be partially attributable to commuter travel; it is probably more directly related to school, shopping, and personal-business trips.

Figures 2-11a–c show current (1998) AM and PM peak-hour traffic volumes on Route 9 in Wellesley based on new counts and updates of earlier counts. Table 2-1 compares these updated volumes with the 1987 count-based volumes and future projections contained in the 1992 corridor study. Effectively, there is little observable difference between currently measured peak-hour volumes, and those observed in 1987 during the previous study; and growth in peak-hour traffic has not reached levels projected in that study. The most plausible reason for this is the little or no excess capacity is left on Route 9 during the single peak hour in the morning and, to a lesser extent, the evening. Additional growth may occur on Route 9, but it is likely to be manifested in the expansion of peak hour–like conditions across a longer period, rather than an increase in the intensity of the single hour. Thus, it is not likely that future counts will show additional peak-hour growth unless roadway capacity is expanded.

Level-of-service (LOS) analysis was applied to all locations where traffic volumes are available. In Table 2-2 the results are summarized, and compared with those from the earlier study. It is worth noting that the 1987 analyses were performed with an earlier version of the Highway Capacity Manual analysis methodology. That methodology was updated in 1994; the changes in methodology may result in minor changes in level of service.

The level-of-service results at signalized intersections generally show adequate operation in terms of peak-hour signal-timing efficiency. The results tend to reflect the fact that traffic is

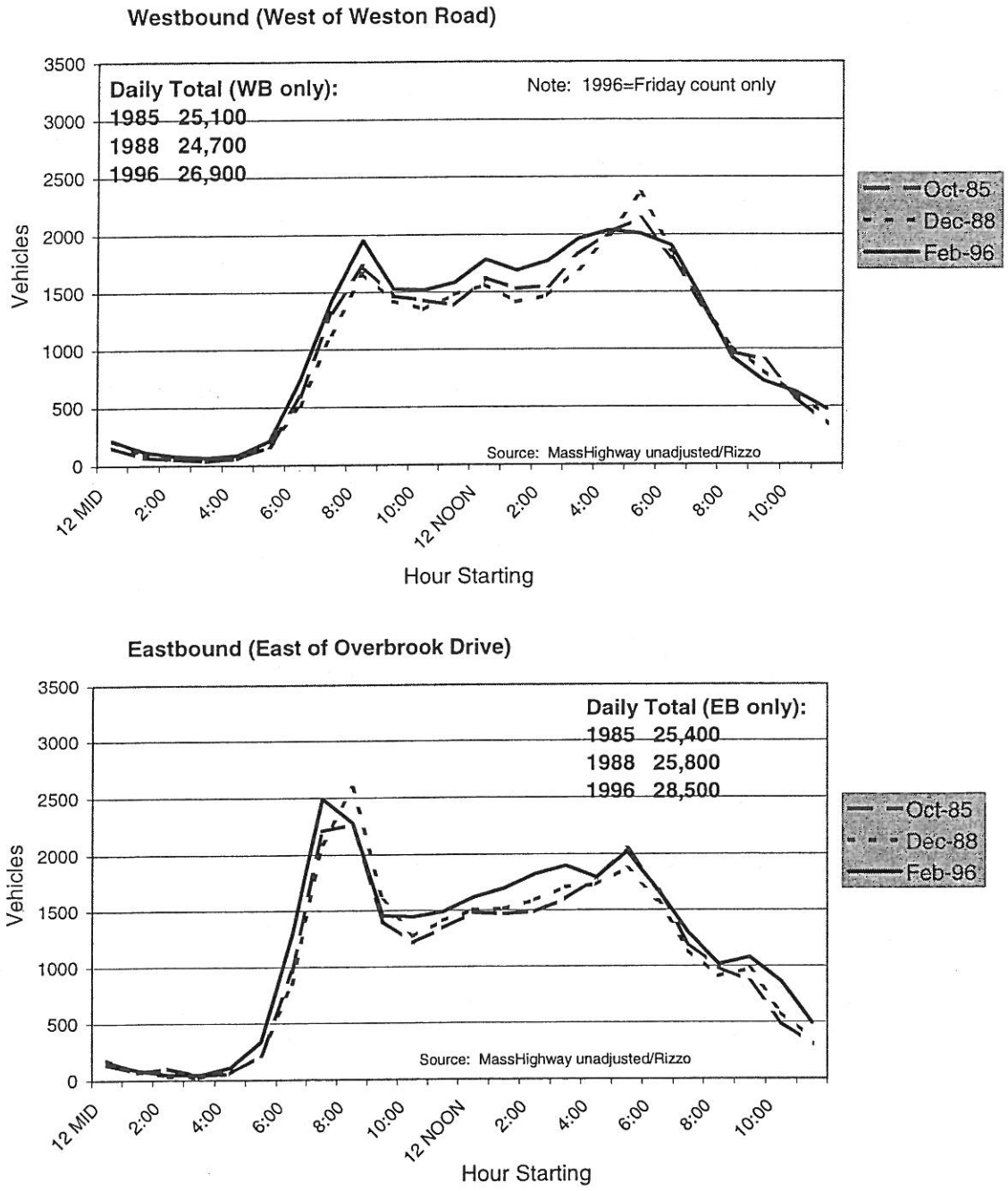
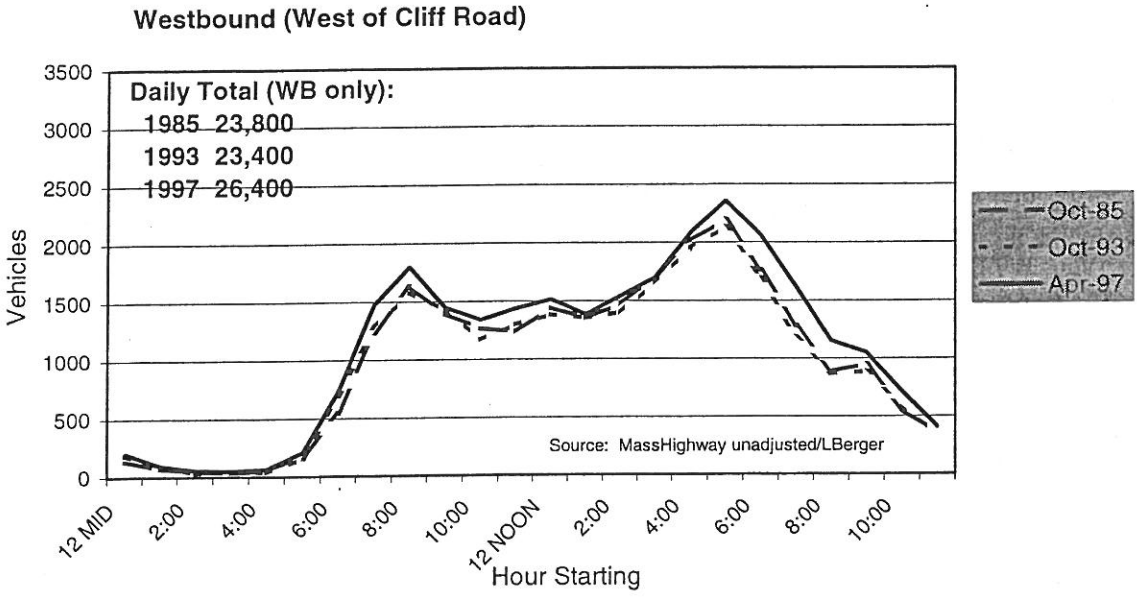


FIGURE 2-8
Historic Traffic Counts:
Route 9 West of Weston Road/East of Overbrook Drive



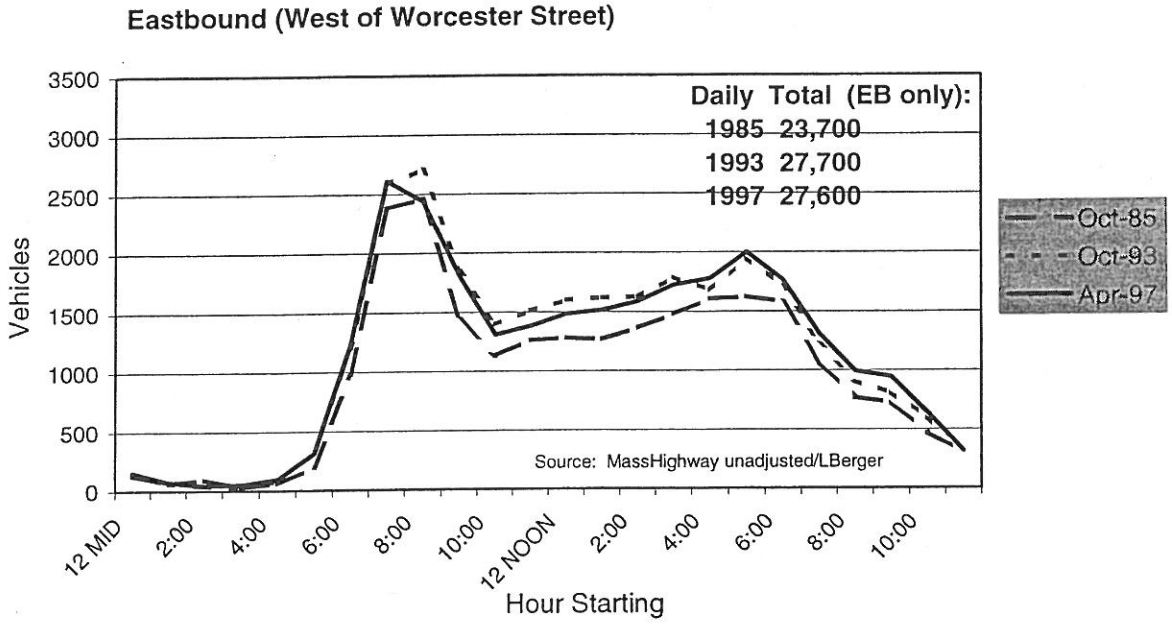
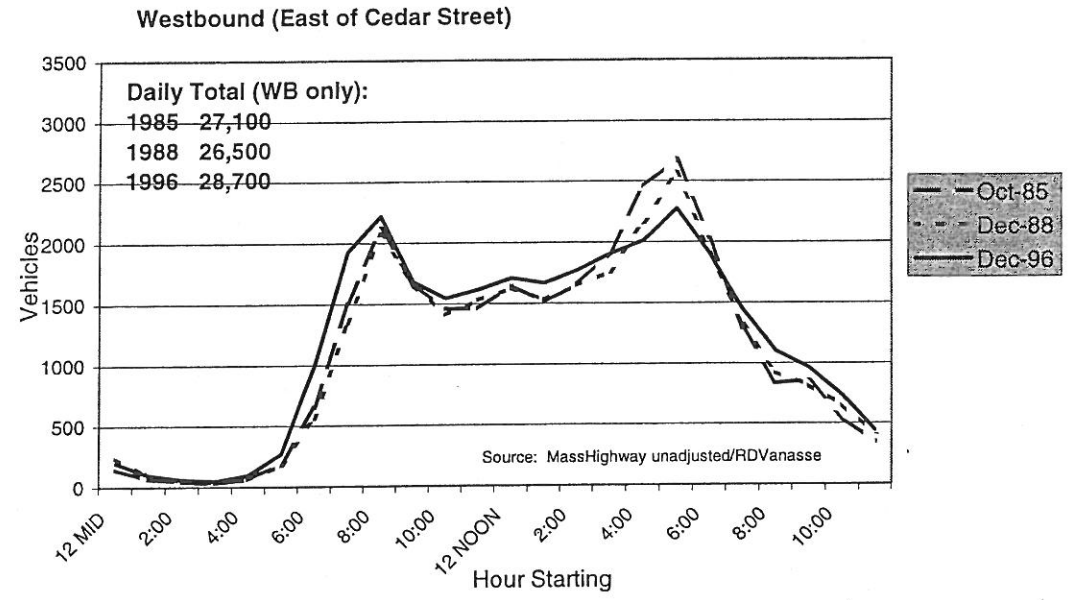


FIGURE 2-9
Historic Traffic Counts:
Route 9 West of Cliff Road/West of Worcester Street



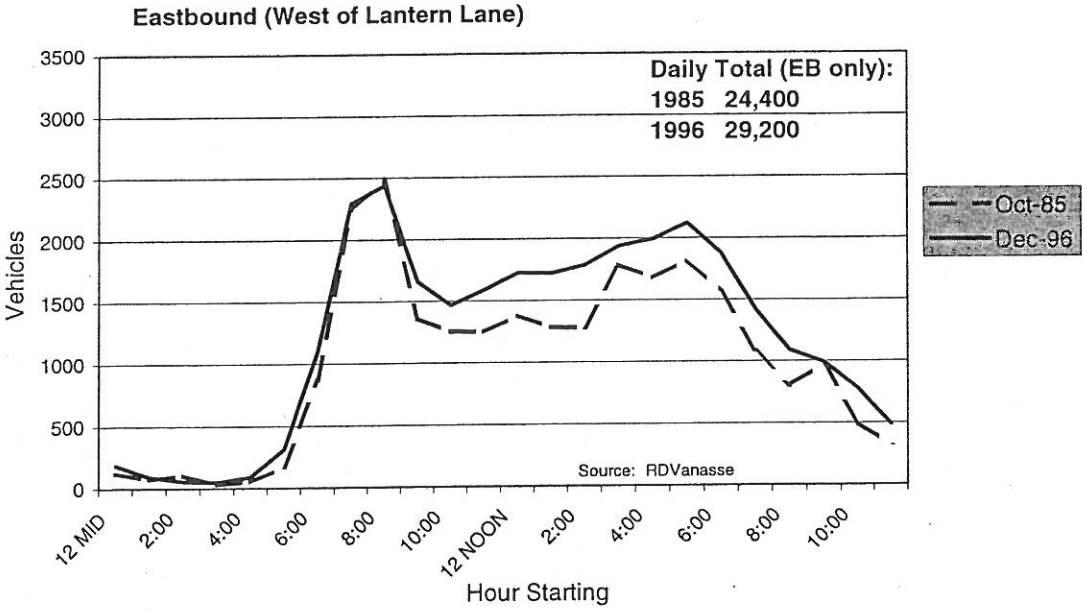
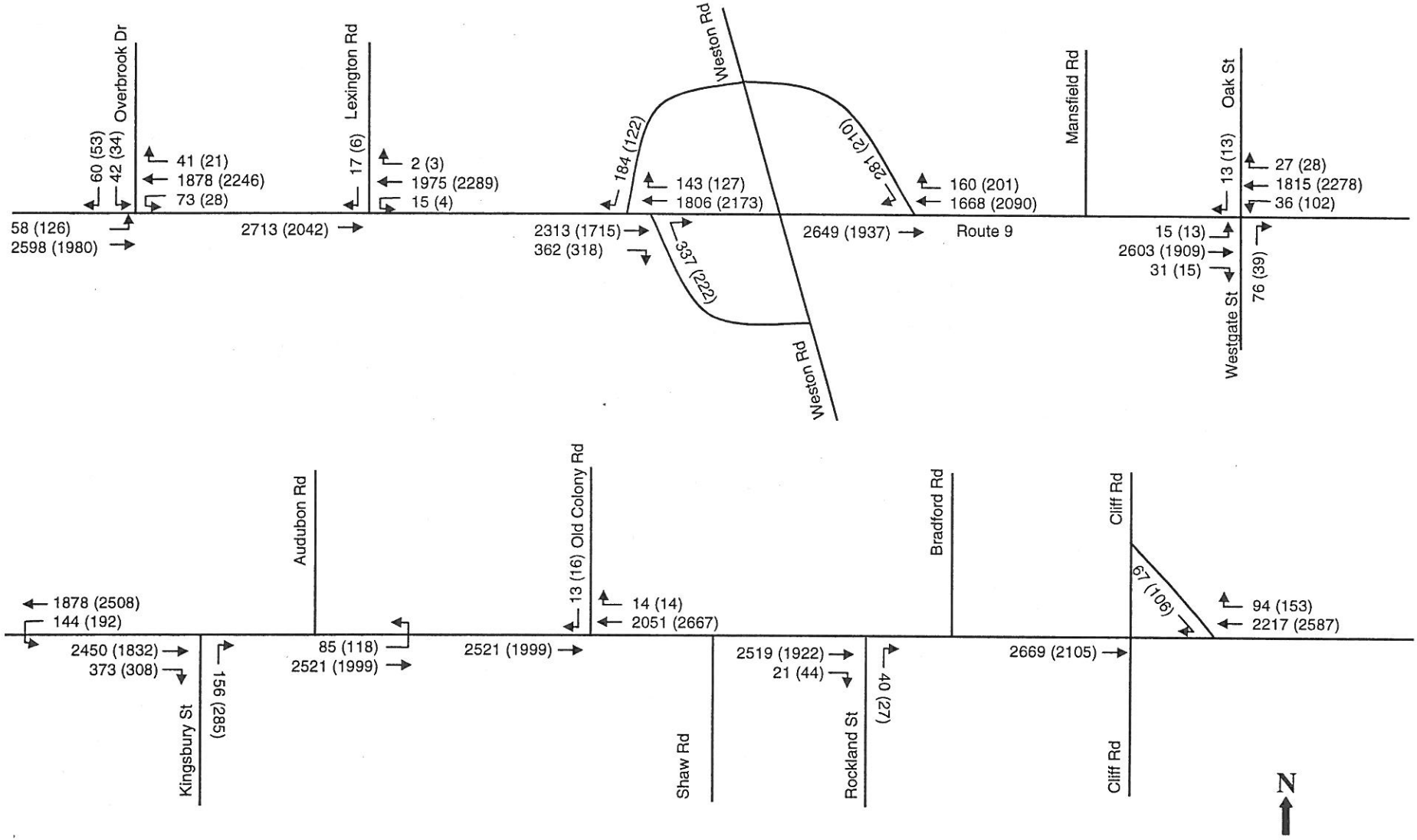


FIGURE 2-10
Historic Traffic Counts:
Route 9 East of Cedar Street/West of Lantern Lane



NOT TO SCALE
XX = AM Peak Hour
(XX) = PM Peak Hour

FIGURE 2-11a
Existing (1998) Traffic Volumes
Overbrook Drive to Cliff Road

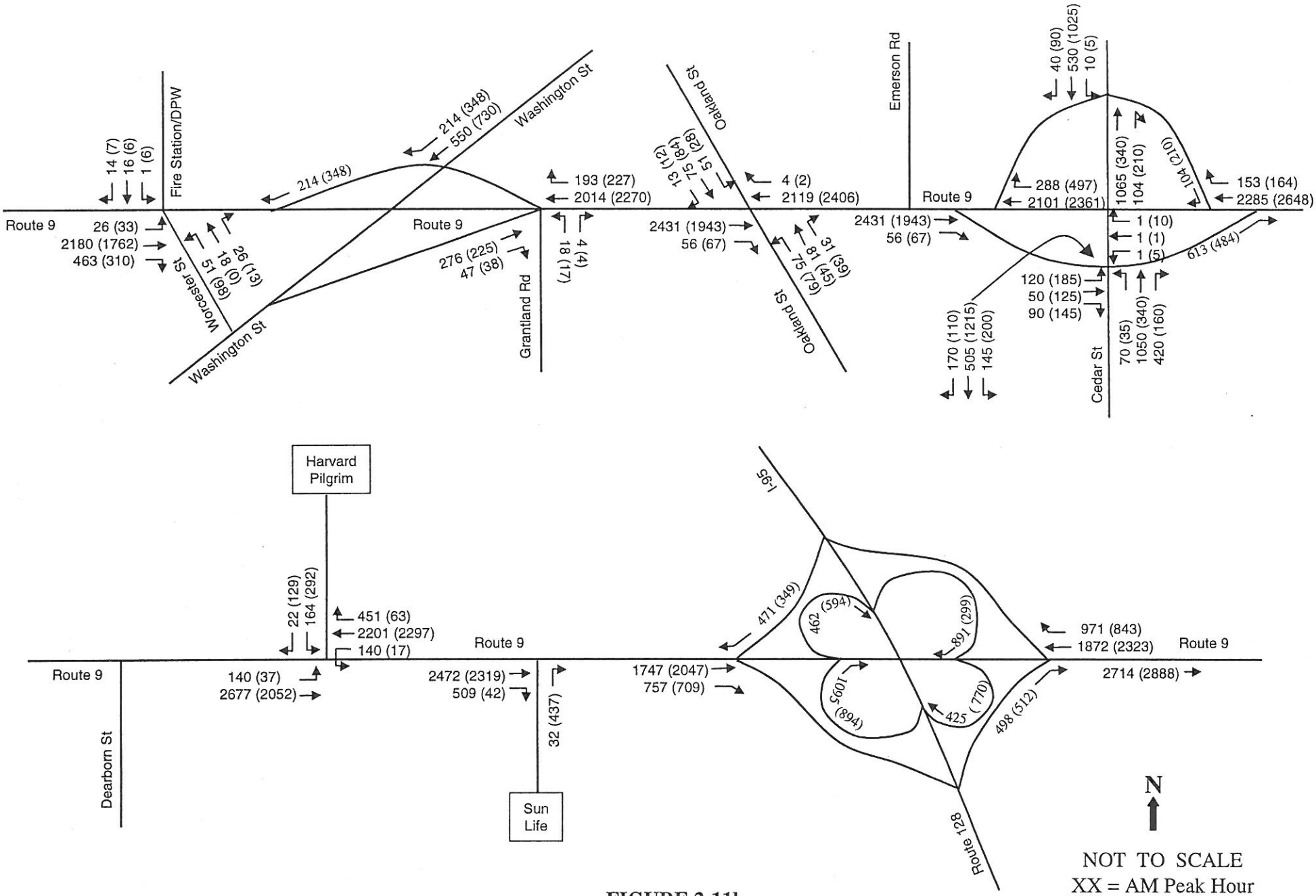
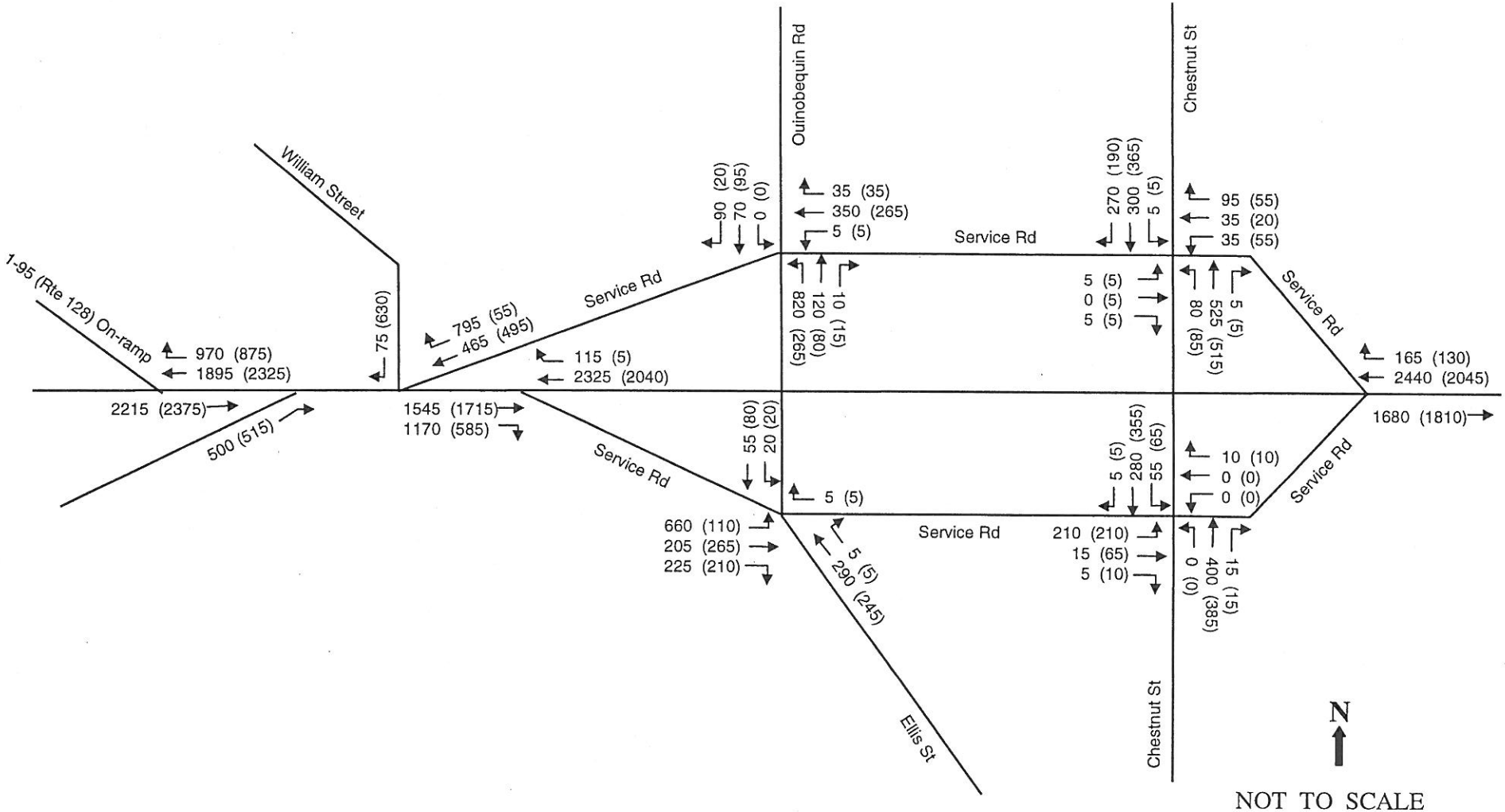


FIGURE 2-11b
Existing (1998) Traffic Volumes
Worcester Street to I-95/Route 128 Interchange



NOT TO SCALE
XX = AM Peak Hour
(XX) = PM Peak Hour

FIGURE 2-11c
Existing (1998) Traffic Volumes
William Street to Chestnut Street

TABLE 2-1
Peak Hour Traffic Volume Growth, 1987–98

	Sum of Vehicles Entering Intersection, PM Peak Hour				
Route 9 at:	**1987 Actual[Ψ]**	**1995 Projected[Ψ]**	**% Growth (from 1987)**	**1998 Actual[φ]**	**% Growth (from 1987)**
Overbrook Drive	4791	5390	12.5%	4488	0
Oak/Westgate	4317	4857	12.5%	4397	1.9%
Kingsbury Street	4646	5179	11.5%	4922	5.9%
Worcester Street	4847	5397	11.3%	4801	0
Oakland Street	4441	5040	13.5%	4705	5.9%

[Ψ]Source: *The Route 9 Corridor: Wellesley, Natick, Framingham, Southborough*, CTPS, September 1992.
[φ]Source: Current traffic counts and adjusted recent counts

self-regulating to some extent along Route 9: that is, delays at upstream signalized intersections tend to result in metered peak-direction flows of vehicles, which, once released by a green light, then arrive in bunches at downstream intersections. At these downstream intersections, the main-line flows receive most of the signal "green time," with delays experienced primarily by side-street traffic trying to turn onto or cross Route 9. These individual side-street movements may operate at low levels of service, but tend to involve small numbers of vehicles. This is true, for example, for left turns from Overbrook Road to Route 9 eastbound and for movements from Worcester Street to Route 9 in both directions. Queue analysis for Route 9 traffic at these intersections indicates that long vehicle queues or platoons tend to develop that move along Route 9 from signal to signal. The Route 9 queue analysis is summarized in Table 2-3.

Analysis was also performed at unsignalized intersections along Route 9 within Wellesley (Table 2-4). Not surprisingly, locations where the predominant or only movement is a right turn out of a minor street operate at generally adequate levels of service (typically C-D range). Exceptions to this are observed at the intersection of Grantland Road and the Route 16 service road (Worcester Street) with Route 9 eastbound, and at William Street, especially during the PM peak hour. The unsignalized level of service analysis methodology does not adequately capture the complex geometry of the circumstances at either of these intersections; therefore, the poor quality of operation at these two intersections may be underestimated by these analyses.

At locations where the predominant movements include left turns across Route 9 traffic, operations are typically at level of service F, indicating very long waits for gaps to service emerging vehicles. This is noted particularly at the two U-turn slots near Kingsbury Street, where turning demand is high enough, and acceptable gaps for vehicles few enough, that long queues develop during peak

TABLE 2-2
Level-of-Service Analysis at Signalized Intersections

		1998 Existing Conditions				1987 Base Conditions[Ψ]	
		AM Peak Hour		PM Peak Hour		PM Peak Hour	
Route 9 at:	**Movement**	**LOS**	**Delay (sec)**	**LOS**	**Delay (sec)**	**LOS**	**Delay (sec)**
Overbrook Drive	Route 9 eastbound L	D	29	D	31	F	
	Route 9 eastbound T	D	33	B	11	B	
	Route 9 westbound L	D	32	B	11	D	
	Route 9 westbound TR	B	7	C	17	C	
	Overbrook Drive southbound LR	E	47	D	31	F	
	Overall	C	22	B	15	C	20
Fire Station	Route 9 eastbound L	D	35	D	29	F	
	Route 9 eastbound TR	C	18	A	3	A	
	Route 9 westbound TR	D	27	D	33	B	
	Worcester Street northbound LTR	D	29	F	65	F	
	Fire Station southbound LR	C	25	D	27	C	
	Overall	C	22	C	21	B	9
Oakland Street	Route 9 eastbound TR	D	31	B	9	--	
	Route 9 westbound TR	B	9	D	29	--	
	Oakland Street northbound LTR	D	25	C	21	--	
	Oakland Street southbound LTR	C	20	C	18	--	
	Overall	C	21	C	20	B	(n/a)

Shading denotes unacceptable delay
L = Left turns, T = Through movements, R = Right turns
[Ψ]Calculated using 1994 Highway Capacity Software, version 2.g.
[φ]Calculated using CINCH based on 1985 Highway Capacity Manual; results not comparable to 1994 Highway Capacity Software.
[χ]Assumed improvements include 3 through lanes each way with turning lanes.
(n/a) = not available.

TABLE 2-3
Average Queue Lengths at Route 9 Signalized Intersections with Existing Traffic Volumes*

Signalized	AM Peak Hour		PM Peak Hour	
Intersection	Route 9 EB	Route 9 WB	Route 9 EB	Route 9 WB
1. Overbrook Road	1,250 ft.	490 ft.	670 ft.	890 ft.
2. Fire Station	1,070 ft.	980 ft.	360 ft.	1,410 ft.
3. Oakland Street	1,100 ft.	570 ft.	600 ft.	1,100 ft.
4. Harvard Pilgrim	670 ft.	450 ft.	440 ft.	540 ft.

*2 lanes each way except at Harvard Pilgrim (3 lanes each way)

periods. The level-of-service methodology yields 95th-percentile queue lengths[6] on the order of 15–19 vehicles during the predominant peak periods for each U-turn direction.

While the longest queue observed during the data-gathering period was 9 vehicles, it is not unreasonable to expect that queue lengths of more than 10 vehicles may occur. At some locations, the difficulties experienced by vehicles turning right onto Route 9, or vehicles trying to make U-turns across the median, may be ameliorated by the existence of an upstream traffic signal. The signal stops main-street traffic, creating periodic interruptions in flow downstream. These interruptions become gaps or intervals that can be used by vehicles at downstream driveways or intersections to enter or cross Route 9 before the next traffic platoon is released by the signal. This effect presently occurs just east of Overbrook Road for eastbound traffic, benefiting driveways and streets on the south side of Route 9. It also occurs just west of the signal at the Harvard Pilgrim site, benefiting Minuteman Lane and other driveways on the north side of Route 9.

Finally, level of service analysis was applied at the three interchanges located along Route 9 in Wellesley. Because Route 9 speeds are lower than freeway speeds, and because the Weston Road and Cedar Street interchange ramps do not exhibit the geometric characteristics of modern-design freeway ramps, ramp analysis was not appropriate at these two locations. Instead, the junctions of the Weston and Cedar on- and off-ramps with Route 9 were analyzed as unsignalized intersections. Standard freeway ramp analysis procedures were applied to the I-95 (Route 128) ramps.

[6] The vehicle 95th-percentile queue length is the length likely to be exceeded no more than 5 percent of the time, given the defined flow conditions. This value typically provides guidance to engineers designing left-turn storage areas, although it is not interpreted as a standard. The queue-length analysis is based on procedures described in the 1994 *Highway Capacity Manual* (Transportation Research Board, Special Report 209) and reported as a standard output from the Highway Capacity Software analysis method for unsignalized intersections.

TABLE 2-4
Level-of-Service Analysis at Unsignalized Intersections

		1998 Existing Conditions				1987 Base Conditions[Ψ]
		AM Peak Hour		PM Peak Hour		PM Peak Hour
Location	Movement	LOS	Delay (sec)	LOS	Delay (sec)	LOS
Lexington Road	Southbound R	B	9	C	11	
Oak/Westgate Street	Northbound R	C	19	B	10	
	Southbound R	B	8	C	11	
	Eastbound L	D	25	F	51	E
	Westbound L	F	166	F	95	F
U-turn West of Kingsbury Street	Westbound U-turn	F	*	F	*	F
Kingsbury Street	Northbound R	F	47	F	59	
U-turn East of Kingsbury Street	Eastbound U-turn	F	73	F	*	F
Old Colony Road	Southbound R	B	10	C	15	
Rockland Street	Northbound R	C	15	B	9	
Cliff Road	Southbound R	C	14	D	26	
Grantland Road	service road	F	67	C	19	
	Grantland Road northbound	F	67	C	19	
	Worcester Street eastbound	F	67	C	19	
Williams Street	Southbound R	D	22	F	*	

Shading denotes unacceptable delay
L = Left turns, T = Through movements, R = Right turns
[Ψ] Performed only at selected unsignalized intersections.
* Very long delay exceeding 3 minutes

The results of the level-of-service analysis at the interchanges are summarized in Table 2-5. Several ramp intersections function at low service levels, particularly those on the eastbound side of Route 9 at both Weston Road and Cedar Street. At the I-95 (Route 128) interchange, the analysis yields results in the C/D range, suggesting adequate operation at the Route 9 level of the ramp connections. However, the limitations of this analysis should be noted: Route 9 does not operate as a freeway, even in the area close to the I-95 (Route 128) interchange. In particular, the proximity of the Harvard Pilgrim, Sun Life, and William Street driveways and their interaction with ramp operations are not directly reflected in the procedures used for the analysis.

2.4 CRASH ANALYSIS

Data on crash incidence within the segment of Route 9 studied were obtained from Massachusetts Registry of Motor Vehicles (RMV) records for the three most recent years available (1994 through 1996). These data were derived from crash report records submitted by municipal police departments, the Massachusetts State Police, and other sources. They represent a comprehensive source of information on reported crashes in the Route 9 corridor.
The data obtained were address-matched, geo-located using ArcInfo, and categorized by type. Tables 2-6 and 2-7 and Figures 2-12a and 2-12b summarize the results of the crash inventory.

The database shows a total of 954 crashes on or near Route 9 in Wellesley during the three-year period. Many of these crashes are concentrated at the interchanges and intersections that were the focus of this study, with the I-95 (Route 128) interchange and the Route 16 (Washington Street) interchange together accounting for approximately one-third of the crashes.

Because of limitations in the way locations are identified, the interchange crash totals may overestimate the number of crashes that occur on Route 9 itself or its ramps. For example, it is difficult to separate out those crashes that occurred on the main I-95 (Route 128) roadway close to Route 9 ramps from those that occurred on Route 9 eastbound or westbound in this area. I-95 (Route 128) narrows from four to three travel lanes in each direction immediately south of Route 9; so a large number of rear-end collisions involving southbound vehicles might not be unexpected here. Unfortunately, the crash records maintained by the RMV do not allow for a finer breakdown of crash locations than the identification of closest intersection or interchange.

The crash data for the study-area interchange/intersection locations at which the crash total over three years was 20 or more will be discussed below (one intersection that was eventually selected for development of improvement concepts, Oak/Westgate Streets, is not included, as the crash total was eight). Tables B1 through B9, in Appendix B, present additional information at each of these locations. Preliminary to discussing individual intersections, the following remarks and observations should be made.

Evaluation of the frequencies and types of crashes provides clues for improving safety at particular locations. There are automatic approaches for dealing with different types of vehicular crashes, but some types of problems do suggest certain classes of solutions. For example, situations or locations where angle-type collisions are frequent may be improved by

TABLE 2-5
Level of Service Analysis at Interchanges[Ψ]

		1998 Existing Conditions			
		AM Peak Hour		PM Peak Hour	
Location	**Movement**	**LOS**	**Delay (sec)**	**LOS**	**Delay (sec)**
Route 9 Ramps at Weston Road	Westbound on-ramp – West side[#]	C	17	C	18
	Westbound on-ramp – East side[#]	D	26	E	33
	Eastbound on-ramp[#]	F	256	D	24
Weston Road/Ramp Junction (North side)	Weston Road northbound	A	5	A	4
	Weston Road southbound	B	6	B	5
	Eastbound ramp	F	46	F	122
	Westbound ramp/Cleveland Road	F	229	E	37
Weston Road/Ramp Junction (South side)	Weston Road northbound	B	5	A	5
	Eastbound ramp	F	*	F	229
Route 9 ramps at Cedar Street	Westbound– West side[#]	C	13	D	26
	Westbound – East side[#]	C	19	F	93
	Eastbound[#]	F	*	F	87
Cedar Street/Ramp Junction (North side)	Eastbound ramp	B	9.2	F	*
Cedar Street/Ramp Junction (South side)	Cedar Street northbound	F	*	B	10
	Cedar Street southbound	B	13	B	5
	Eastbound ramp	C	24	F	*
	Westbound ramp	C	17	F	*
I-95/Route 128 ramps at Route 9	Westbound – West side	C	--[ϕ]	C	--[ϕ]
	Westbound – East side	C	--[ϕ]	C	--[ϕ]
	Eastbound – West side	C	--[ϕ]	D	--[ϕ]
	Eastbound – East side	C	--[ϕ]	C	--[ϕ]

Shading denotes unacceptable delay
L = Left turns, T = Through movements, R = Right turns
[#]Limited or no acceleration lanes; therefore, analyzed as unsignalized intersections.
[Ψ]No direct comparison possible with 1987 results because of differences in analysis methodology; I-95/Route 128 not analyzed in earlier report.
[ϕ]Not applicable for ramp analysis.

TABLE 2-6
Number of Recorded Crashes at Selected Intersections, by Year

	Number of Crashes[Ψ]			
	Year			
Route 9 at:	**1994**	**1995**	**1996**	**TOTAL**
Route 128	48	57	60	165
Route 16	41	53	63	157
Weston Road	18	19	22	59
Kingsbury Street	8	13	28	49
Cedar Street	22	8	14	44
Oakland Street	10	12	12	34
Grantland Road	4	12	7	23
Overbrook Drive	2	13	6	21
Audubon Road	2	2	6	10
William Street	6	3	11	20
Oak/Westgate Street	2	2	4	8
Lexington Road	2	2	2	6
Dearborn Street	2	1	2	5
TOTAL	**167**	**197**	**237**	**601**

[Ψ]Source: Mass. Registry of Motor Vehicle data, from CTPS GIS.

clearer signing, simplified geometry, improved sight distance, installing traffic signals, or providing signal improvements such as exclusive turning phases or more reasonable timings. Locations characterized by rear-end collisions may benefit from improved sight distance, better advance warning of signals or queued conditions downstream, and improved signal sight lines. Where collisions occur on ramps or driveway approaches entering congested roadways, providing longer acceleration areas may permit easier entry. Also, traffic signalization strategies may be used to create gaps for minor-street traffic to enter the highway at regular intervals. However, the matching of solution approaches with particular problems must be done on a location-by-location basis, and the only certain way of ascertaining whether a particular approach will have a measurable effect on safety is to try it.

Table 2-8 presents estimated crash rates, calculated as a function of the total volume of traffic served at individual intersections and expressed as number of crashes per million entering vehicles. At one time, the state maintained a list of statewide average crash rates, which provided a benchmark for evaluating crash experience at particular locations compared with statewide levels. These rates are no longer maintained. However, the calculation of crash rates weighted by traffic volumes still provides a reasonable basis for comparing different locations' crash experience weighted by exposure.

weighted by traffic volumes still provides a reasonable basis for comparing different locations' crash experience weighted by exposure.

TABLE 2-7
Total Recorded Crashes in Study Area, by Type (1994–1996)[Ψ]

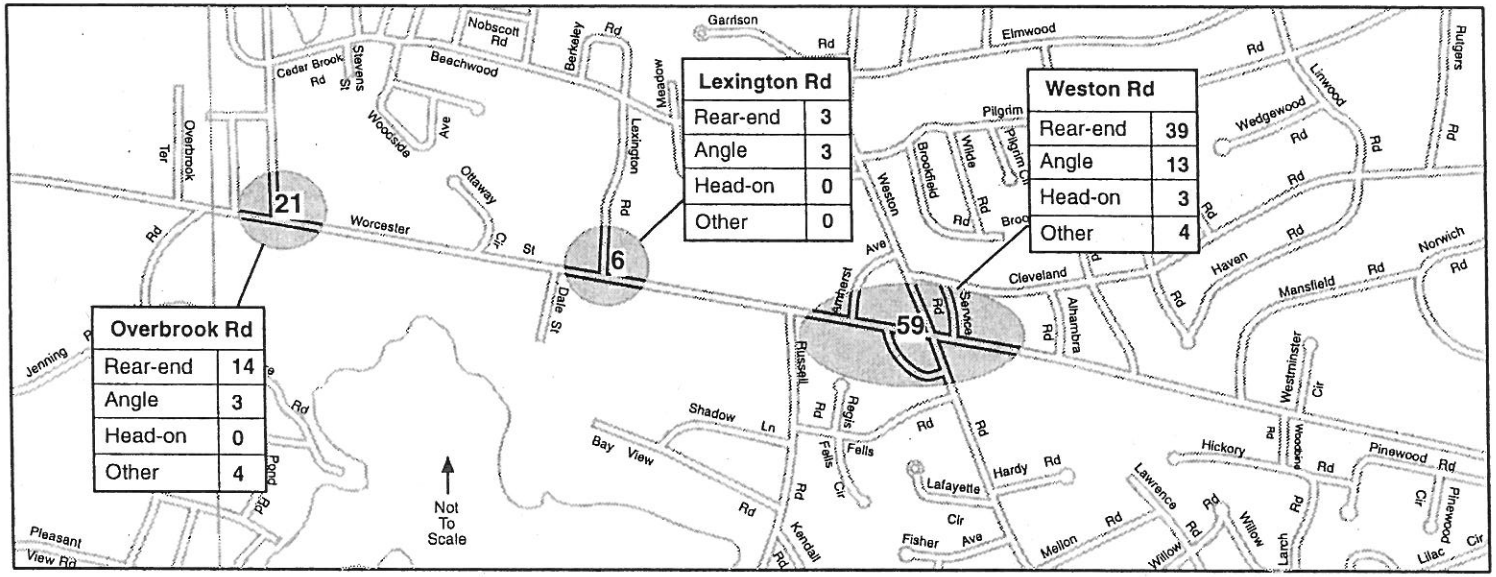
Collision Category	Number	% of Total
Rear-end collision	552	58%
Angle collision	233	24%
Head-on collision	14	1%
Other/not recorded	155	16%
TOTAL	**954**	
Severity Class	**Number**	**% of Total**
Fatal	1	0%
Hospital	20	2%
Other injury	305	32%
Prop. damage	628	66%
TOTAL	**954**	

[Ψ]Source: Mass. Registry of Motor Vehicle data, from CTPS GIS.

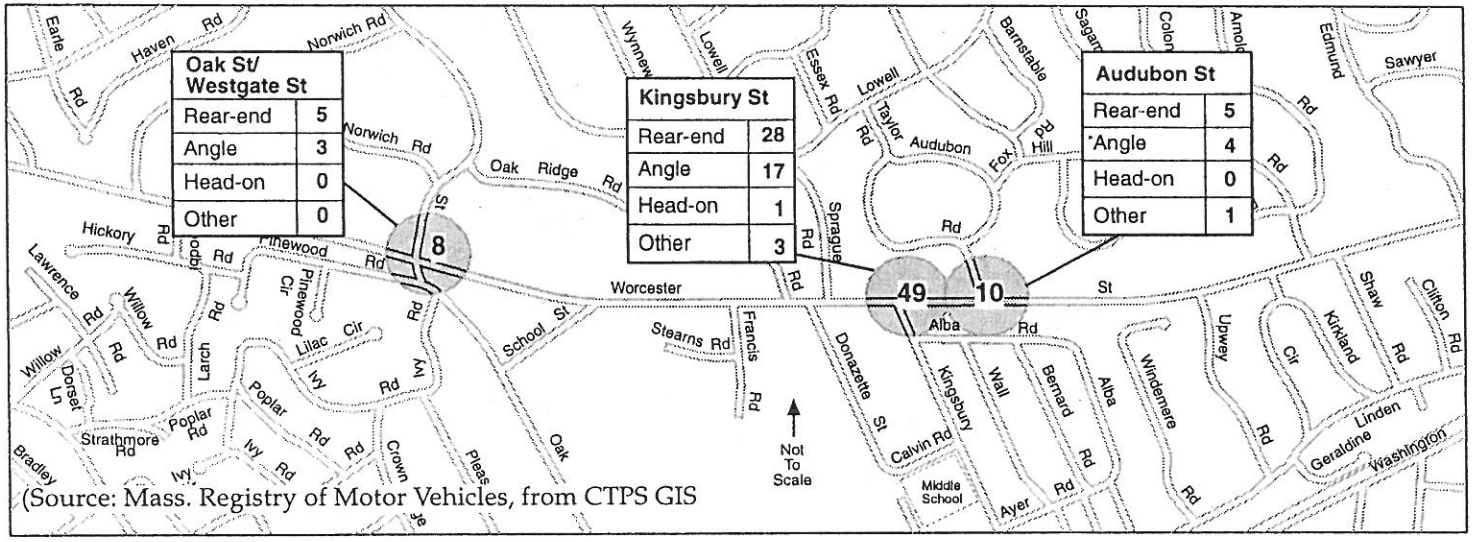
Based on this ranking, the Route 9/Route 16 interchange area was identified as the highest crash location in the study area, followed by the I-95 (Route 128) interchange area and the Weston Road interchange. It is not surprising that these interchange locations should have higher crash incidence than simple intersections: each interchange effectively represents at least three or four separate "intersections" handling large volumes of traffic. This is particularly true at the I-95 (Route 128) and Route 16 (Washington Street) interchange areas, both of which handle many complex movements.

The signalized intersections in this corridor did not appear to fare badly when their crash experience was examined in terms of traffic volume exposure. Oakland Street crashes may be attributable in large part to sight distance limitations which give rise to rear-end collisions; while the data for the Overbrook Road intersection suggest it may not experience crashes at a level which is out-of-scale for this type of intersection. The unsignalized intersections at Kingsbury Street, including the U-turns, and at Grantland Road appeared to be locations where design improvements might yield significant benefits in terms of crash reductions. In the following series of discussion of individual intersections, the intersections are in descending order of total number of crashes.

Route 9: Overbrook Drive to Mansfield Road



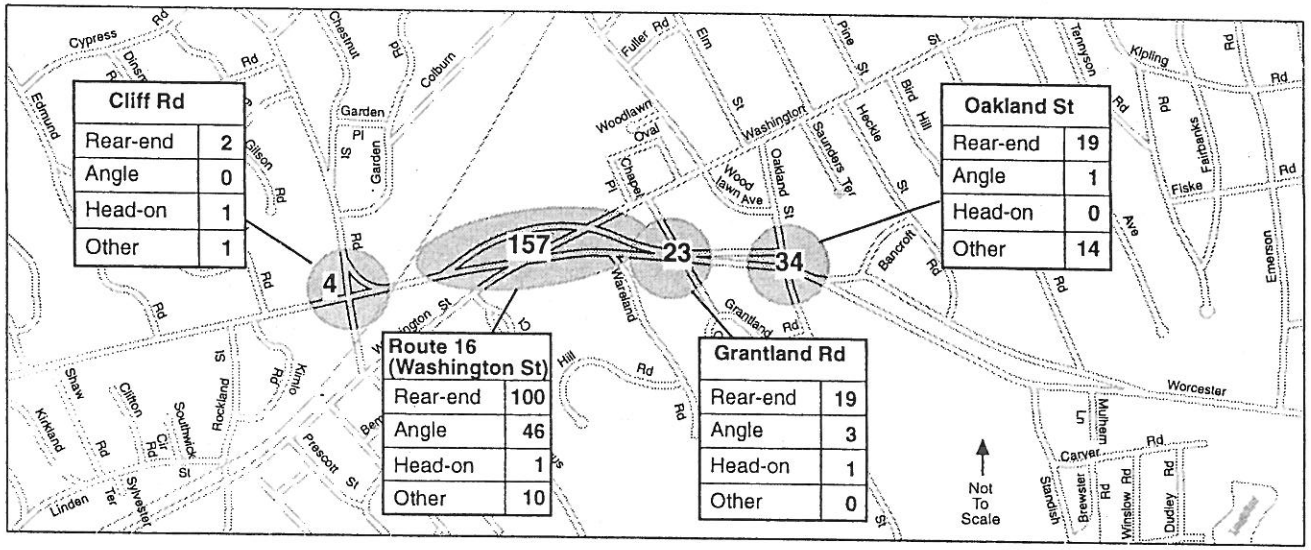
Route 9: Mansfield Road to Old Colony Road



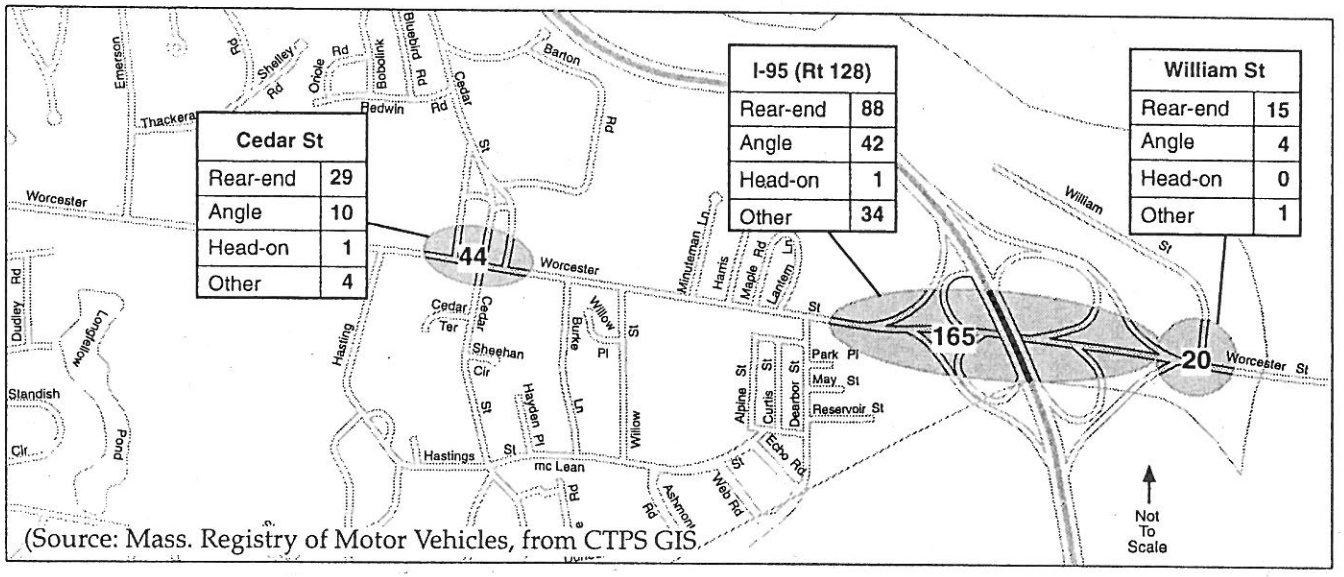
(Source: Mass. Registry of Motor Vehicles, from CTPS GIS

FIGURE 2-12a
Total Traffic Crashes at Intersections/Interchanges, 1994-96:
Overbrook Drive to Old Colony

Route 9: Shaw Road to Emerson Road



Route 9: Emerson Road to William Street



(Source: Mass. Registry of Motor Vehicles, from CTPS GIS.)

FIGURE 2-12b
Total Traffic Crashes at Intersections/Interchanges, 1994-96:
Shaw Road to William Street

TABLE 2-8
Crash per Million Annual Entering Vehicles (1994-96)

Route 9 at:	Location Category	Crash Rate
Worcester Street (Route 16)	I	2.58
I-95 (Route 128)	I	1.86
Weston Road	I	1.02
Kingsbury Street	U	.89
Grantland Road	U	.82
Cedar Street	I	.69
Oakland Street	S	.63
William Street	U	.48
Overbrook Road	S	.40

I = Interchange
S = Signalized intersection
U = Unsignalized intersection

2.4.1 I-95 (Route 128) Interchange

As discussed above, it was unclear how many of the 165 crashes identified at the location "Route 9 and I-95 (Route 128)" were related to interchange operations. However, from the directional data recorded in the crash statistics, over one-third of the crashes recorded in this area (59 of 165) involved two or more vehicles traveling southbound, most likely on I-95 (Route 128). An additional 33 crashes involved two or more vehicles traveling northbound, again most likely on I-95 (Route 128). A comparatively small number involved pairs of vehicles traveling either eastbound or westbound (18 in each direction), and therefore likely to be located on Route 9 itself.

As can be seen in Figure 2-12b, rear-end collisions were by far the most common in this area, with angle collisions making up fewer than half the number of rear-end crashes. Rear-end collisions on Route 9 at this location may be attributable to unexpected vehicle queues extending back from downstream traffic signals, as well as to vehicle queues on the Route 9 ramps awaiting gaps in Route 9 traffic.

2.4.2 Route 16 (Washington Street)

Like the I-95 (Route 128) interchange area, this interchange comprises a number of different traffic intersection locations with different characteristics. Of the 157 crashes reported in this general area:

- 100, or 64 percent, were rear-end collisions; 46, or 29 percent, were angle collisions.
- 7 involved pedestrians.
- 73, or 46 percent, occurred at a traffic signal (it is not clear how many were at the signal in front of the fire station), while 13 occurred at stop or yield signs.
- 8 involved vehicles which hit roadside objects, including a guardrail, signpost, utility pole, or other object.
- 66 involved two or more vehicles traveling eastbound; while 55 involved two or more vehicles traveling westbound.

Vehicle queues at the Route 9 traffic signal, unexpected by approaching motorists, especially in the eastbound direction in the morning, probably contribute the greatest share of crashes recorded at this location; sight distance limitations, the grade and resulting high speeds on the eastbound approach, and the lack of warning signage are probably factors here. In addition, Worcester Street, connecting Route 9 with Route 16, is a short two-way street with parking and sidewalks on both sides which stores vehicle queues waiting at the Route 16 traffic signal in a single lane. Because several hundred vehicles typically enter Worcester Street from Route 9 during both peak hours (over 400 were noted in the PM peak hour), Worcester Street regularly backs up as far as, or into, the Route 9 eastbound approach, a condition conducive to rear-end collisions.

2.4.3 Weston Road

Like the I-95 and Route 16 interchanges, the Weston Road interchange contains numerous potential conflict points for vehicles and it is difficult to pinpoint the locations and specific causes of crashes from the summary crash database. As at those other two interchanges, the greatest number of crashes were rear-end collisions. Twenty of the 59 crashes involved two or more eastbound vehicles; 22 occurred at stop-sign-controlled locations. At least 13 involved turning vehicles, while 12 vehicles were reported to be "slowing down or stopping" when the crash occurred. Three of the crashes here, involved pedestrians—but these may have occurred off Route 9 itself, in the vicinity of the small commercial establishments at the base of the westbound on- and off-ramps.

The limited sight distance, steep ramp grades, and interaction with driveways on the eastbound on- and off-ramps are likely contributing factors in crashes at this location. On the westbound side, confusing channelization, and activity at the driveway/parking area for the Fells Market and other establishments, may contribute to crashes as well.

2.4.4 Kingsbury Street

Of the 49 crashes recorded at this location, 35 percent or 17, were angle collisions. Of the total, 32 crashes involved at least one eastbound vehicle; 24 of these involved two or more vehicles both reported as traveling eastbound. Eastbound vehicles also accounted for most of the angle collisions at this location; these vehicles probably included a number which turned into the eastbound roadway using the U-turn bay, then tried to change lanes in a short distance in order to turn right into Kingsbury Street. In contrast, most of the crashes in which westbound vehicles

were involved were rear-end collisions. In 11 of the total crashes, vehicles hit roadside objects (guardrail, curbing, etc.).

2.4.5 Cedar Street

As at the other locations, the greatest number of crashes reported here were rear-end collisions. Slightly more crashes occurred in the eastbound direction (20), than in the westbound direction (14). Nine of the reported crashes occurred at stop signs, including 4 in which vehicle queues on ramps caused rear-end crashes at a stop sign. It is worth noting that total crashes at Cedar Street did decline in 1995 and 1996, compared with 1994, suggesting that the improvements made here in recent years may have had some crash reduction benefit.

2.4.6 Oakland Street

Of the 34 crashes that occurred in the vicinity of the Route 9/Oakland Street intersection, almost 60 percent (20) were in the westbound direction. Rear-end crashes comprised just over half the total (19), while 16 crashes involved vehicles hitting roadside objects, including utility poles, guard rail, curbing, or the stone walls on both sides of Route 9. Limited sight distances associated with curvature in both horizontal and vertical geometry are clearly key factors in crash incidence here.

2.4.7 Grantland Road

The proportion of rear-end crashes at this location is 83 percent of the three-year total of 23 crashes, with all but two involving eastbound vehicles. The intersection of two minor streets at the entrance to Route 9 eastbound, with two stop signs, is a confusing situation for motorists; the poor sight distance and limited acceleration area on Route 9 eastbound itself are probable contributors to crash incidence here.

2.4.8 Overbrook Road

Two-thirds of the 21 reported crashes at this intersection involved westbound vehicles, and two-thirds were rear-end collisions. Only two crashes involved turning vehicles; in one, a vehicle turning right from Route 9 onto Overbrook hit a parked car.

2.4.9 William Street

Virtually all crashes reported at this location involved vehicles headed westbound on Route 9, or southbound—presumably the latter are vehicles exiting the Wellesley Office Park driveway. Of the 20 total crashes, 15 were reported as rear-end collisions. It appears that 7 of these involved only Route 9 westbound vehicles; they may be associated with the long steep grade of Route 9 at this location, and changes in vehicle speeds close to ramp entry decision points. The remainder of the rear-end crashes probably involved at least one vehicle entering or exiting William Street, or vehicles on the ramp from Chestnut Street. The structure of the database does not permit more precise identification of these movements.

2.5 OPPORTUNITIES FOR TURNING TRAFFIC

As Route 9 in Wellesley is a divided highway but not a limited-access highway, many abutter sites have driveways with direct access onto Route 9, although most of these allow right-turn movements only. Many of these driveways represent the only access available for their sites' users. Route 9 provides cross-median access at a limited number of locations, as listed in Table 2-9. These opportunities for cross-median access (left turns, U-turns, and direct crossing traffic) include a mix of interchange ramps, at-grade signalized intersections, and unsignalized left/U-turn median openings.

The longest segment without opportunities to make left turns or U-turns occurs between Route 16 and the Cedar Street interchange (almost 1.5 miles in the eastbound direction). The second-longest segment occurs between Kingsbury Street and the Grantland Road intersection, (about 4,300 feet in the eastbound direction). To our knowledge, there are no guidelines suggesting maximum desirable lengths of unbroken medians. It is usually recommended that the number of allowed median breaks be limited to the extent possible without severely impeding access, for reasons of safety as well as traffic progression on relatively high-speed roadways such as Route 9.

The highest volumes of cross-median movements were observed at the Kingsbury Street U-turns in both directions (118 eastbound, 192 westbound), and at Overbrook Road in the eastbound direction (126). All of these volumes were observed during the PM peak hour. Cross-median movements cannot be easily distinguished at interchange locations, because they are included in total ramp volumes; but it is not unreasonable to expect that reasonably high proportions of U-turning or left-turning traffic also use the Weston Road and Cedar Street interchanges to make these moves. This would generally represent an acceptable use of interchange ramps; in these cases, however, it must be considered that the existing ramps are of old-fashioned and substandard design. Likewise, U-turns at Overbrook Road generally appear to operate safely because of the existing traffic signal, although they do result in delays to through traffic.

The U-turn operations at Kingsbury Street involve high volumes of turning traffic, and high volumes and speeds of opposing Route 9 traffic. Recent crash history suggests that the Kingsbury Street U-turns warrant improved control, through geometric changes, signalization, or other means. In addition, the intersection of Oak and Westgate Streets with Route 9 may also be a candidate for improved controls.

TABLE 2-9
Distances between Successive Opportunities to Cross Route 9 Median

Cross-Street	Distance Between Opportunities, ft.	Left Turn or U-Turn Possible? Eastbound Direction	Westbound Direction		
Oak Street, Natick		Yes	Yes		
	1,750				
Overbrook Drive		Yes	Yes		
	1,660				
St. James' Church		--	Yes		
	1,570				
Weston Road		Yes	Yes		Interchange*
	3,030				
Oak/Westgate Street		Yes	Yes		
	2,230				
WB to EB U-turn/ Kingsbury Street		--	Yes		
	870				
EB to WB U-turn/ Kingsbury Street		Yes	--		
	3,810				
Cliff Road		--	--		
	490			B	
Route 16/Fire Station		Yes	--		Interchange*
	1,460				
Grantland Road/WB off		--	Yes		Interchange*
	730		A		
Oakland Street		--	--	C	
	5,450				
Cedar Street		Yes	Yes		Interchange*
	2,180				
Harvard Pilgrim		Yes	Yes		
	3,200				
Chestnut Street, Newton		Yes	Yes		Interchange*

* Turns via ramps (or local streets functioning as ramps)

A, B, C = 1st, 2nd, 3rd longest intervals between median openings

3 DEVELOPMENT OF IMPROVEMENT CONCEPTS

The results of the existing-conditions analysis led to the selection of eight problem locations for which improvement concepts would be developed in this study. The locations are the intersection of Route 9 with:

- Overbrook Drive
- Weston Road
- Oak/Westgate streets
- Kingsbury Street
- Grantland Road
- Oakland Street
- Cedar Street
- William Street

This chapter presents the improvement concepts that were developed to address the congestion and safety problems at the problem locations. For each location the results of the existing conditions analysis are given and the improvement concepts are described. For each improvement concept, the objective is clearly stated, any impact on safety or on ease of access to properties is defined, and any land-takings required are described.

During the development of the improvement concepts, MassHighway and the town of Wellesley reviewed them in their preliminary stages, and the issues they raised were addressed. Some of the concepts presented in this chapter also reflect input given by citizens at three public meetings, one at which the study was introduced and two at which the concepts chosen to be the recommendations of the study were presented (minutes of the meetings are provided as Appendix A of this report).

3.1 OVERBROOK DRIVE INTERSECTION

At this location, the existing-conditions analysis indicates that both eastbound and westbound Route 9 traffic operates at acceptable levels of service, LOS D or better. However, Overbrook Drive's southbound left- and right-turn traffic operates only at LOS E or worse during the AM peak hour. During the three-year period 1994–96, 21 traffic crashes occurred at this intersection. The two improvement concepts developed for this intersection are described below. The traffic volumes projected to result from each concept are given in Figure 3-1.

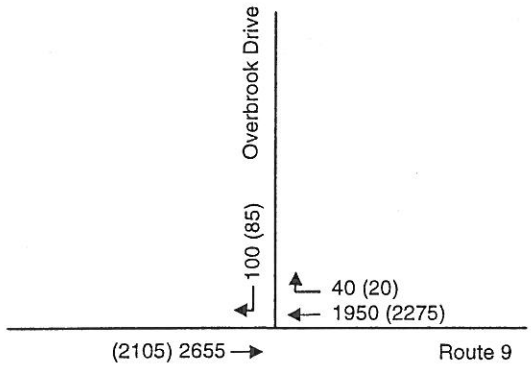
3.1.1 Concept 1 – Remove Traffic Signal and Close Median

One of the improvement concepts investigated for this intersection is to remove the existing traffic signal and close the median opening. The objective of this modification is to improve traffic operations and safety at this location by eliminating left turns from both Route 9 and Overbrook Drive. With this modification, only right turns would be permitted from Overbrook Drive to Route 9 westbound. Former left-turn traffic from Overbrook Drive would

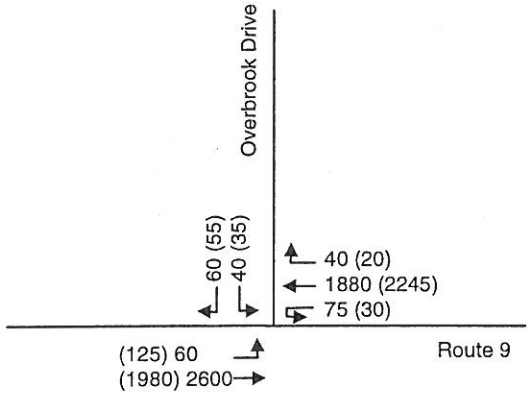
N

NOT TO SCALE

XX = AM Peak Hour
(XX) = PM Peak Hour



Concept 1–Remove Traffic Signal and Close Median



Concept 2 – Interconnect Traffic Signals at Overbrook Drive in Wellesley and Oak Street in Natick

FIGURE 3-1
Overbrook Drive Intersection: Projected Traffic Volumes After Implementation of Improvement Concepts (Existing [1998] Demand Assumed)

have to travel west to Oak Street in Natick to go eastbound on Route 9. Also, former Route 9 eastbound left-turners and westbound U-turns would have to turn at Weston Road or Oak Street.

Closing the median would significantly reduce accessibility for the abutting properties on Route 9. The Oak Street intersection is already congested, operating at LOS F; rerouting additional traffic through it would worsen the existing conditions. The nearest turn point, Weston Road, is three quarters of a mile to the east, an interchange of substandard design, and a high-crash location. Although this concept would reduce delay on Route 9, its impact on Overbrook Drive would be undesirable, considering the detours (which create more delay) and reduced accessibility.

This modification would improve traffic operations on Route 9, reducing delay by eliminating interruptions of its traffic. The right turns from Overbrook Drive would operate at an acceptable level of service (LOS C) during the peak hours (Table 3-1). The impact of this modification on safety would be beneficial, as two-thirds of the crashes at this location were rear-end collisions, a common type of crash at congested signalized intersections. However, the detours and accessibility disadvantages would most likely outweigh the advantages of this concept, especially if Weston Road and/or Oak Street were not improved first.

Implementing this concept would not require any land-takings. It would not have any adverse impacts on the environment, because the suggested modification affects only the turning movements, which form a small proportion of the Route 9 traffic. Construction costs, which include closing the median, removing the signal equipment, installing new stop signs at the Overbrook Drive's approach, and maintenance of traffic flow during construction, are estimated at $50,000.

3.1.2 Concept 2 – Interconnect Traffic Signals at Overbrook Drive in Wellesley and Oak Street in Natick

Another improvement concept developed for Overbrook Drive intersection is to interconnect the traffic signal at Overbrook Drive in Wellesley with the signal at Oak Street in Natick (Figure 3-2). The objective of this modification is to improve traffic operations on Route 9 by reducing delays and stops. MassHighway is studying the Oak Street intersection for traffic and safety improvements. These two intersections are less than 2000 feet apart. Treating them as a system rather than individual intersections would be advantageous. Additional modifications include lengthening the Route 9 eastbound left-turn bay at Overbrook Drive to accommodate at least five vehicles and improving the drainage at the intersection.

The impact of these modifications on safety would be beneficial; as traffic on Route 9 would be stopped less frequently, rear-end collisions would be reduced. Lengthening the eastbound Route 9 left-turn bay would prevent its traffic queue from extending into the main travel lanes. With traffic sensors, signal coordination, and improved signal timings, traffic operations at this intersection would be more efficient and acceptable (LOS D or better) during the peak hours.

TABLE 3-1
Level of Service Analysis at Overbrook Drive Intersection
After Implementation of Improvement Concepts
(Existing [1998] Travel Demand Assumed)

		AM Peak Hour		PM Peak Hour	
Concept	**Movement**	**LOS**	**Delay (sec)**	**LOS**	**Delay (sec)**
1 – Close median break	Overbrook Dr southbound R	C	12	C	16
	Overall	A	1	A	1
2 – Interconnect traffic signals at Overbrook Drive in Wellesley and Oak Street in Natick	Rte 9 eastbound L	D	35	D	30
	Rte 9 eastbound T	C	16	B	10
	Rte 9 westbound L	D	30	C	23
	Rte 9 westbound T	A	4	B	9
	Overbrook southbound LTR	D	36	D	32
	Overall	B	12	B	10

L = Left turns, T = Through movements, R = Right turns

Implementing this concept would not require any land-takings or have any adverse impacts on the environment. Construction costs, which include interconnections, new signal equipment at Overbrook Drive, lengthening of the eastbound Route 9 left-turn bay, drainage improvements, and maintenance of traffic flow during construction, are estimated at $300,000.

3.2 WESTON ROAD INTERCHANGE

This grade-separated interchange provides access to and from Route 9. Two separate ramps (located in the northeast and northwest quadrants) are provided for accessing Route 9 on the westbound side from Weston Road northbound and southbound. Traffic entering and exiting Route 9 eastbound uses a single ramp located in the southwest quadrant. Stop signs control entry to Route 9 from the eastbound on-ramp as well as entry to Weston Road from the eastbound off-ramp. The existing-conditions analysis indicates that the eastbound-side ramp has a poor level of service (LOS F) during the AM peak hour. The westbound-side ramps operate fairly well (LOS D or better). All of the ramps have short deceleration and acceleration lanes, tight curves, and limited sight distance. This interchange has the third-highest crash total in the study corridor (59 crashes during 1994–96) and the third-highest crash rate (1.02 per million entering vehicles). The improvements investigated to address traffic operations and safety at this interchange are described below. The projected traffic volumes for each of the concepts investigated are given in Figure 3-3.

3.2.1 Concept 1 – Improve Signing on Weston Road Approaches to the Ramps

This concept is to improve signing on Weston Road, particularly on the approaches to the ramps, and eliminate visual obstructions to improve sight distances. The intent is to improve safety. The ramp entrances and exits that can be confusing for drivers would be clearly identified with directional and guide signs.

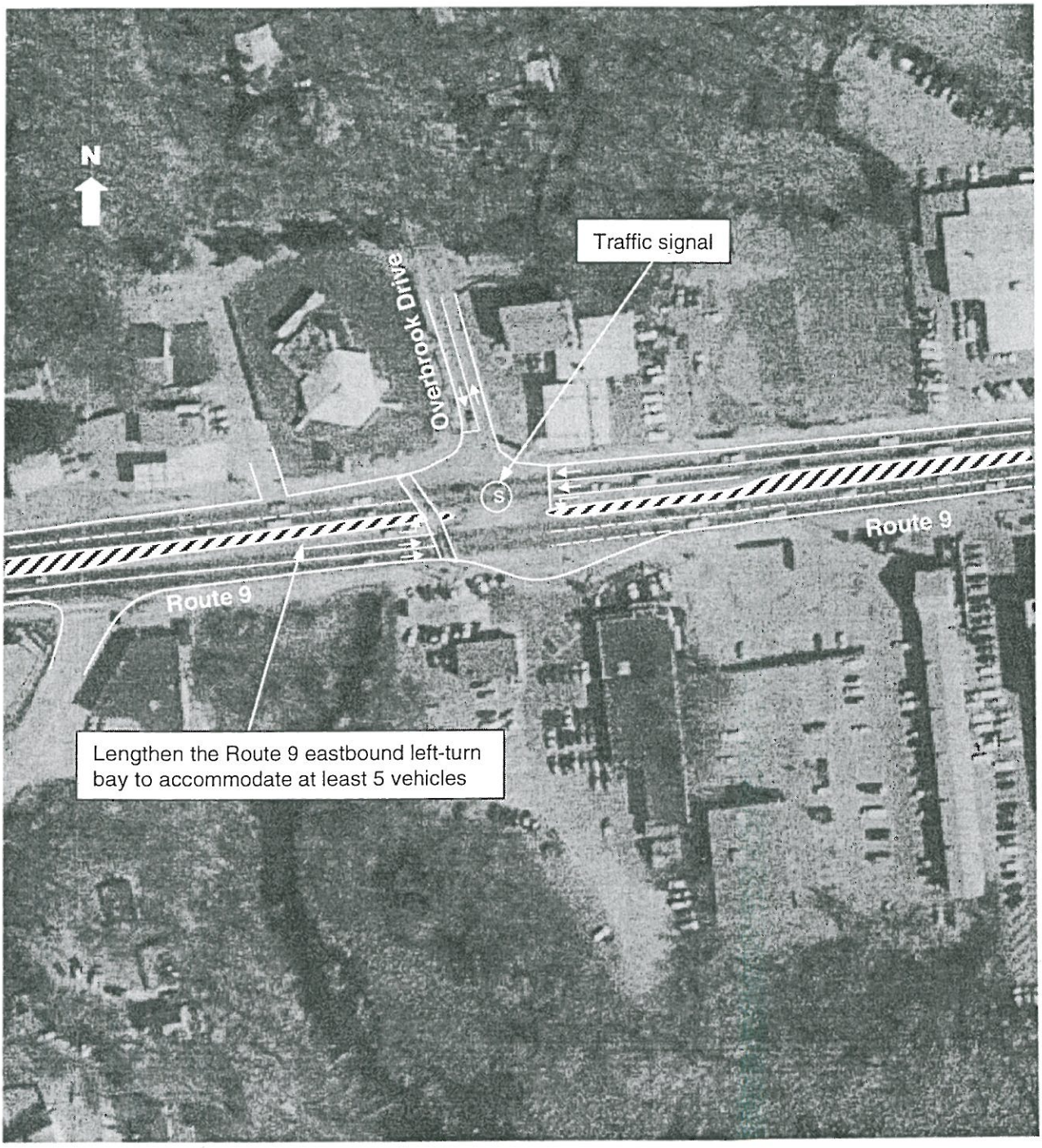
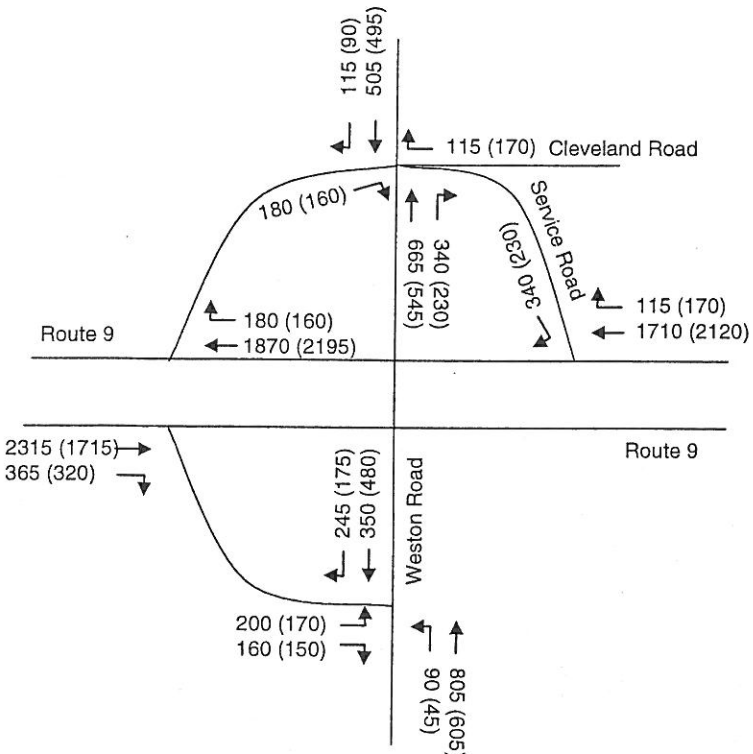
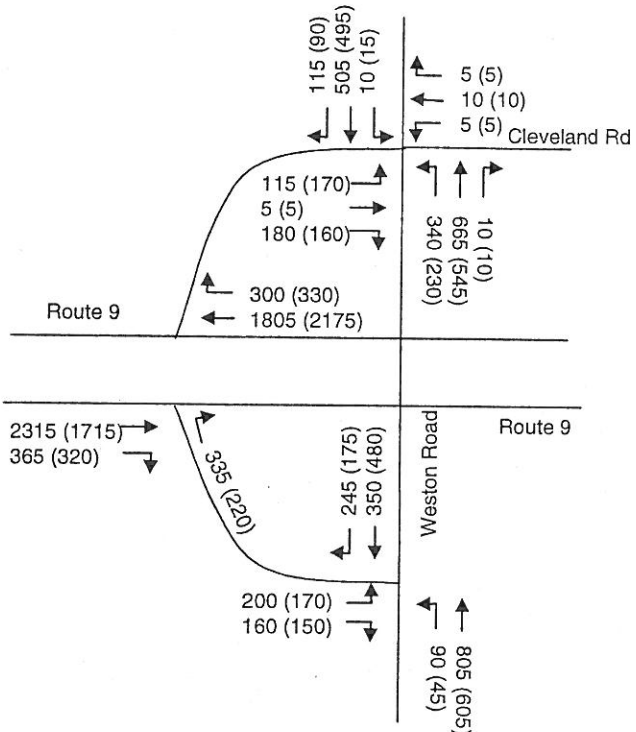


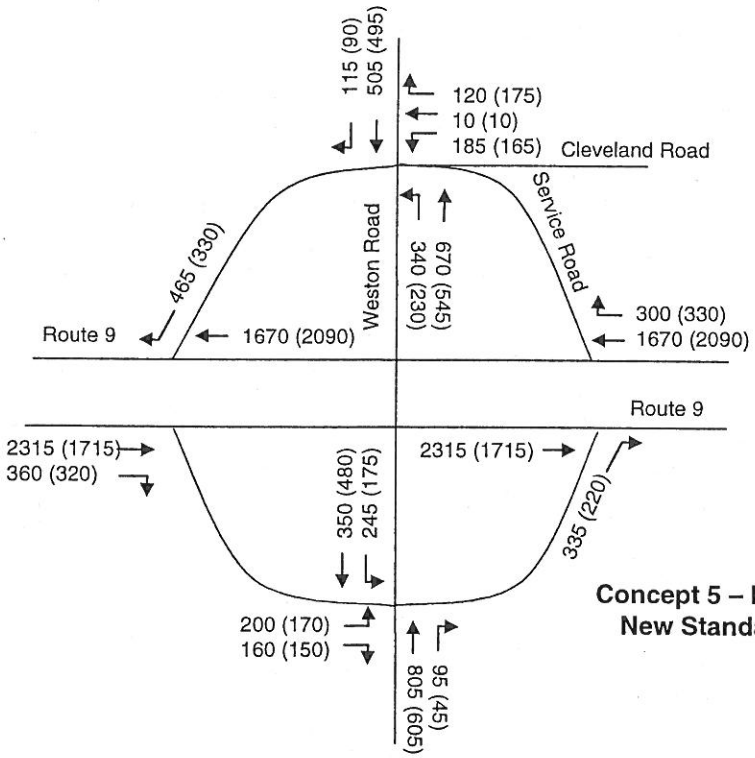
FIGURE 3-2
Overbrook Drive Intersection
Concept 2 - Interconnect Traffic Signals at Overbrook Drive in Wellesley and Oak Street in Natick



Concept 3 – Redesign Channelization and Install Traffic Signal



Concept 4 – Reconstruct Northwest Quadrant Ramp to Handle All Movements



N

NOT TO SCALE

XX = AM Peak Hour
(XX) = PM Peak Hour

Concept 5 – Replace Interchange with a New Standard Diamond Interchange

FIGURE 3-3
Weston Road Interchange: Projected Traffic Volumes After Implementation of Improvement Concepts (Existing [1998] Demand Assumed)

The modifications that are proposed in this concept would not reduce delay and would not impact accessibility in this vicinity. However, they would have a beneficial impact on traffic safety. No land-takings would be required for these modifications, and they would be expected to have no adverse impacts on the environment. The construction cost is estimated at around $50,000, including removing obstructions that block sight distance, installing new road signs, and maintaining traffic flow during construction.

3.2.2 Concept 2 – Convert Cleveland Road Approach at Service Road (Ramp) to Serve Westbound Traffic Only

This concept resolves the existing vehicular conflict between traffic exiting Route 9 via the service road (ramp) in the northeast quadrant and Cleveland Road eastbound traffic. The proposed improvement would prohibit eastbound traffic from entering Cleveland Road eastbound from service road. This would be accomplished through installation of a half closure and "DO NOT ENTER" signs as shown in Figure 3-4. Cleveland Road would remain a two-lane, two-way roadway except that its approach at the service road would serve westbound traffic only; the approach would be controlled by a stop sign. The service road, which handles exiting and entering Route 9 traffic, would be the major road and would remain uncontrolled.

The prohibition affects mostly Weston Road traffic that is headed for Cleveland Road eastbound. This traffic, to access Cleveland Road would have to turn at Pilgrim and Elmwood roads and use the internal street network. With the proposed modifications, traffic safety at the Cleveland Road intersection would be improved. The projected LOS for the intersection is A, a desirable one (Table 3-2). The modifications are not expected to affect emergency response times, as they would allow emergency vehicles to enter Cleveland Road from Weston Road or the service road. There would be no environmental impacts except for the extra vehicle-miles of travel resulting from the reduced access to eastbound Cleveland Road. The modifications would improve traffic safety at the Cleveland and service road intersection by eliminating the vehicular conflicts. The cost of the improvements is estimated at $50,000.

3.2.3 Concept 3 – Redesign Channelization and Install Traffic Signal

This concept is primarily to redesign and signalize the ramp–Weston Road intersection north of Route 9 without taking property from or affecting access to residential or commercial properties (Figure 3-5). Under this concept, both approaches of Weston Road would be widened to accommodate free right-turns onto the ramps. The northeast quadrant ramp would serve traffic exiting Route 9 to Weston Road northbound and Weston Road northbound traffic headed for Route 9 westbound. Similarly, the northwest quadrant ramp would serve traffic exiting Route 9 to Weston Road southbound as well Weston Road southbound traffic headed for Route 9 westbound. The proposed signal would operate satisfactorily, at LOS B or better (Table 3-2).

Additional modifications include widening the southbound approach of the ramp–Weston Road intersection south of Route 9 to accommodate free right turns onto the on-ramp. Improved signs clearly identifying the ramp entrances and exits on Weston Road and Route 9 are recommended. This concept's modifications would not affect businesses in the neighborhood but would require land taking encroaching on the boundaries of the Overbrook Reservation. The

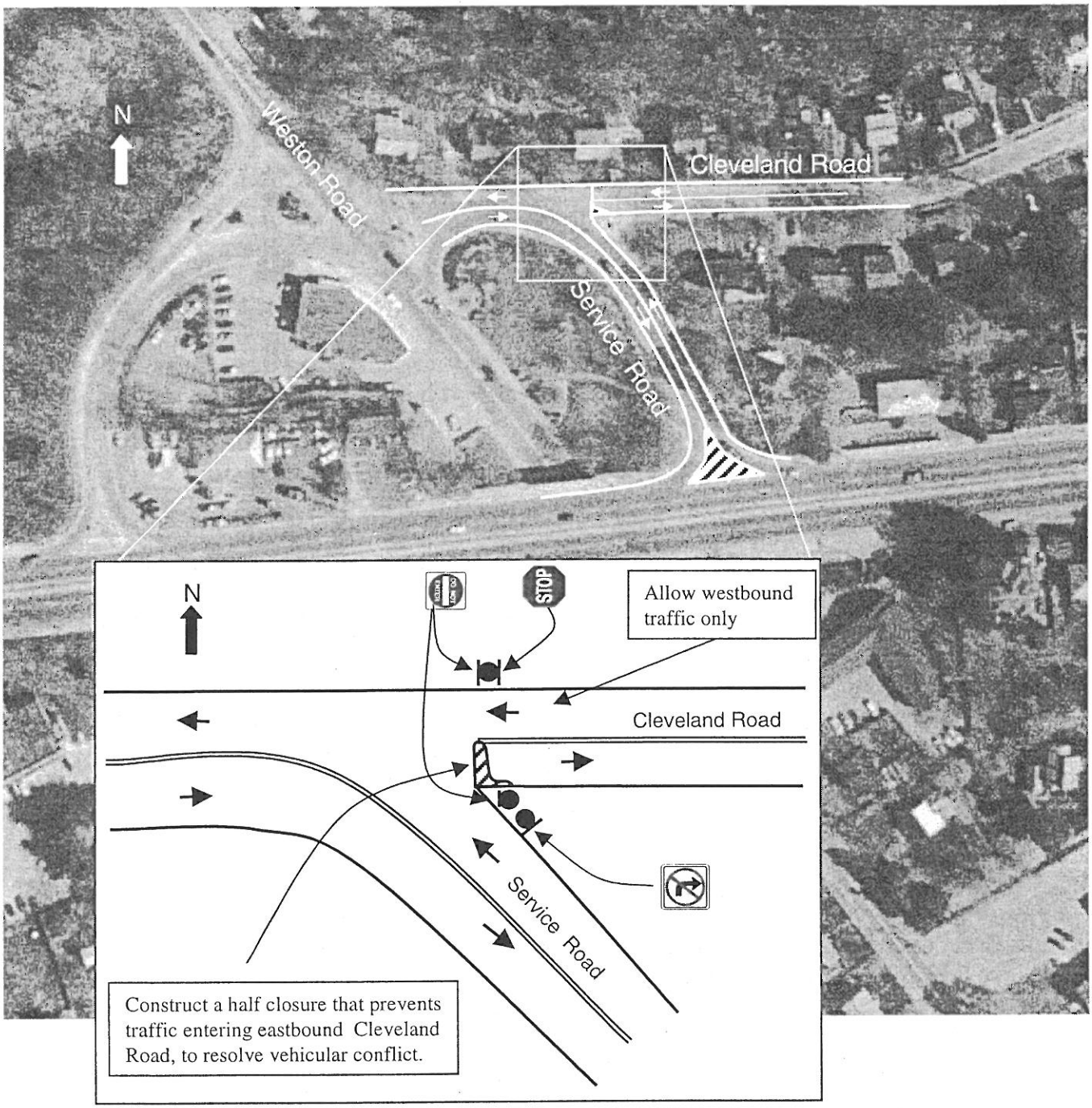


FIGURE 3-4
Weston Road Interchange
Concept 2 - Convert Cleveland Road Approach at Service Road (Ramp) to Serve Westbound Traffic Only

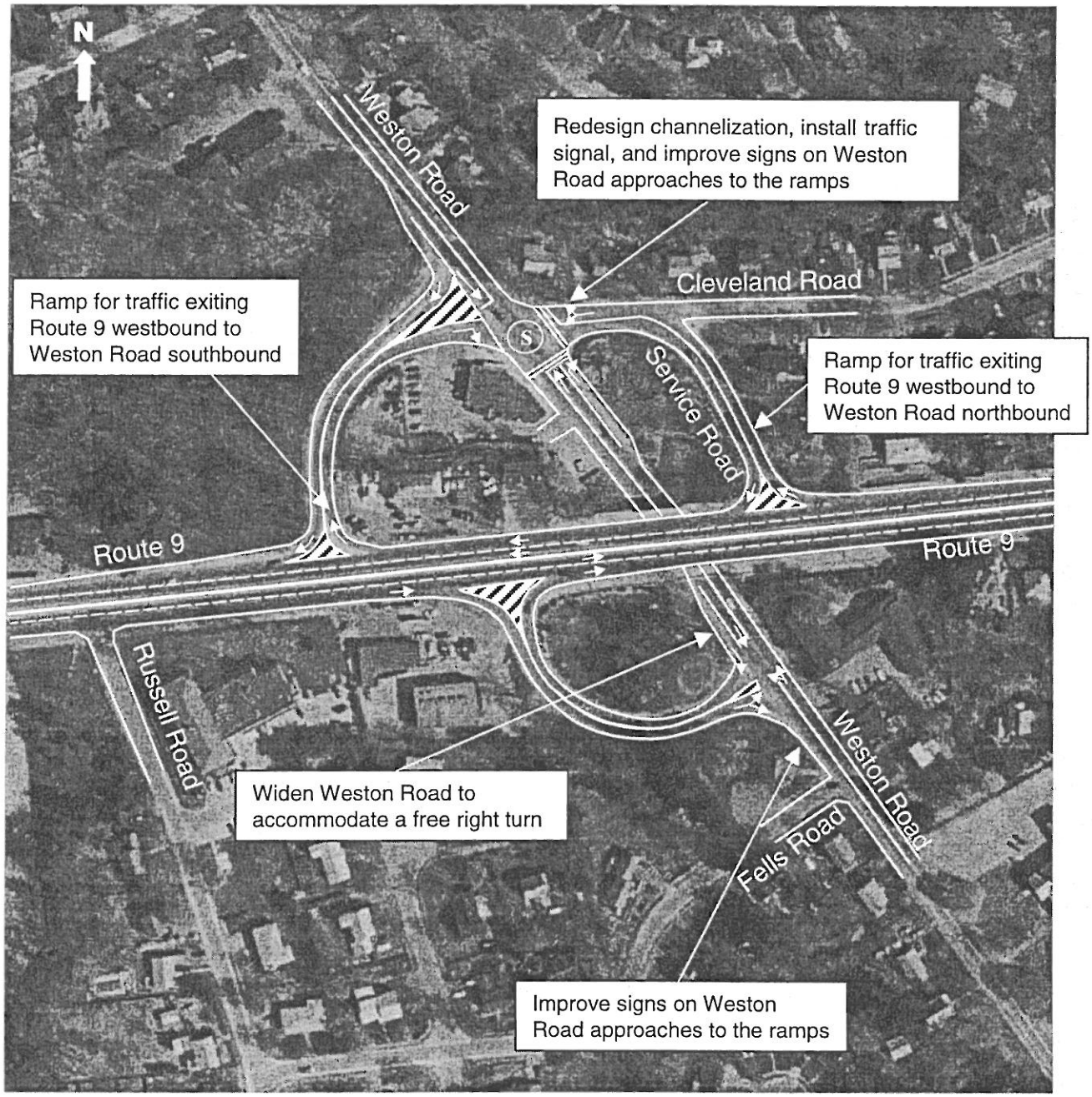


FIGURE 3-5
Weston Road Interchange
Concept 3 - Redesign Channelization and Install Traffic Signal

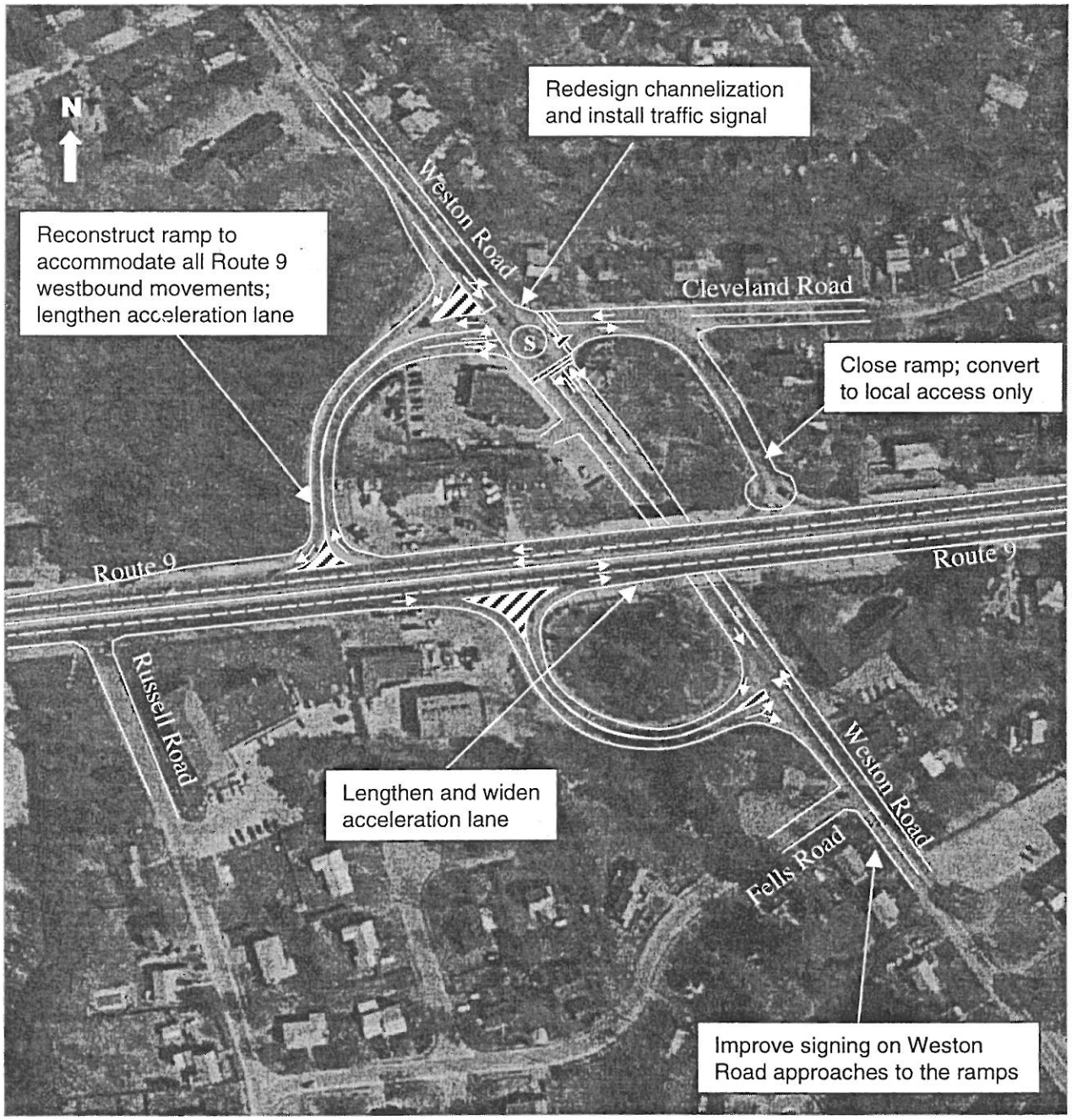


FIGURE 3-6
Weston Road Interchange
Concept 4 - Reconstruct Northwest-Quadrant Ramp to Handle All Westbound Movements

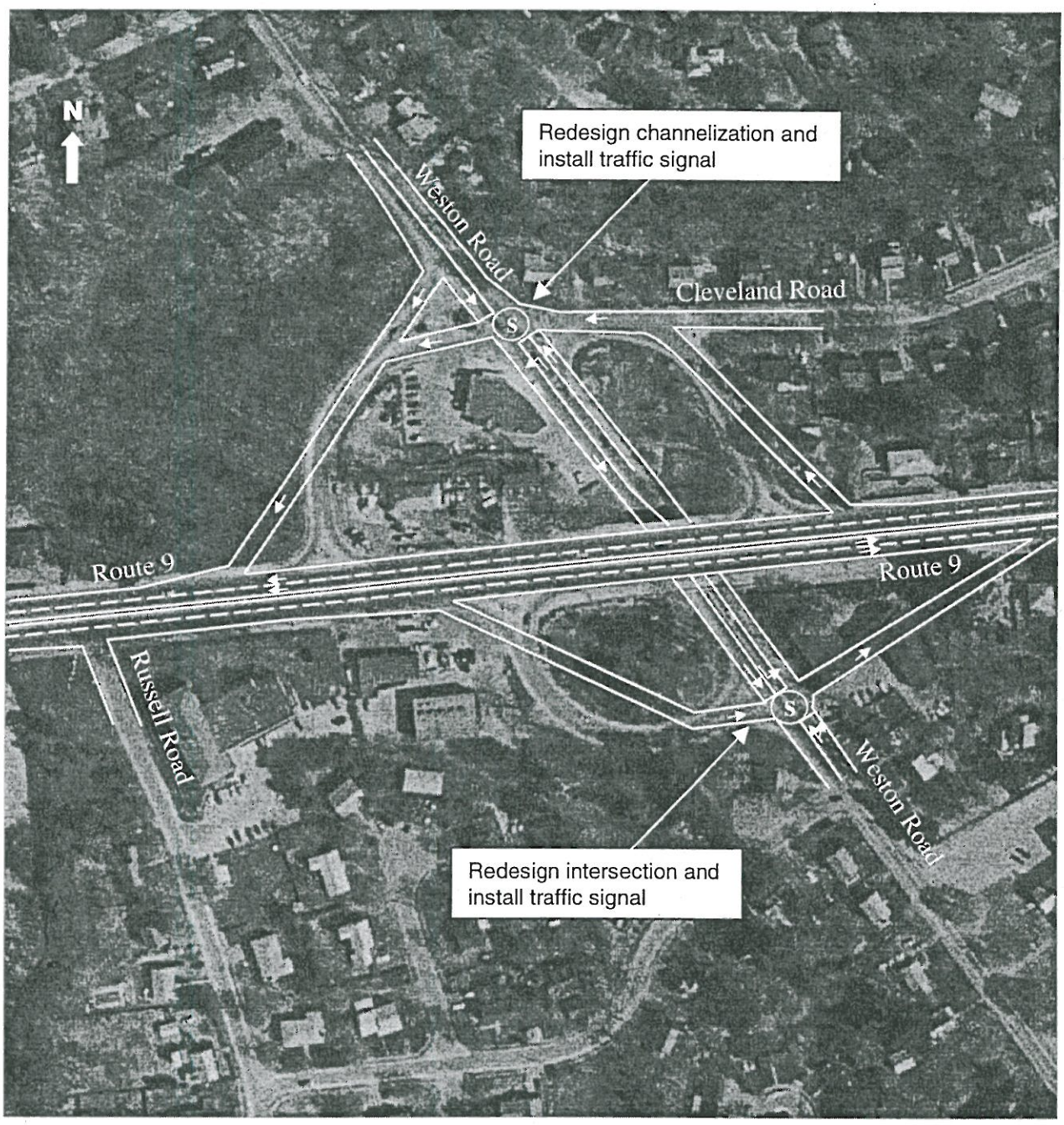


FIGURE 3-7
Weston Road Interchange
Concept 5 - Replace Interchange with a New Standard Diamond Interchange

These modifications enhance accessibility, as both U-turn capabilities are maintained and full-protection signal control is given to the high-volume left-turns and U-turns. If only two through lanes are maintained each way on Route 9, this concept results in poor levels of service at the intersection: LOS F and LOS D for the AM and PM peak hours, respectively (Table 3-4). Installing a right-turn bay in addition to the two through lanes in the eastbound direction improves the LOS to B for both peak hours. The signal installations would potentially result in a significant improvement in safety by reducing angle collisions through protection of left turns and U-turns.

No land-takings are required for these modifications (this may not be true if an eastbound right-turn bay is included), and there would be no negative environmental impacts if improvements remain within the existing right-of-way. Potential traffic disruptions during construction, including detours, lane shifting, and reduced speed, are one of the issues associated with this concept. Construction costs are estimated to be on the order of $500,000, including intersection geometric improvements, the new traffic signal, and relocation of both U-turn bays.

3.4.3 Concept 3 – Install Traffic Signal, Widen Route 9, and Relocate Both U-Turn Bays to a Redesigned Kingsbury Street Intersection

This improvement concept is similar to Concept 2, except that U-turns and left turns are allowed in both directions of Route 9 at the intersection with Kingsbury Street. One benefit of this concept is that it would provide for safer U-turns and left turns at a single location (Figure 3-12). Because most of the existing U-turn traffic is accessing Kingsbury Street, including school-related traffic to and from the Wellesley Middle School, installing a signal at this location to serve all U-turns and left turns would eliminate the existing complex maneuvers.

Also, by providing protected turns, it would enhance accessibility and could significantly reduce angle collisions. Kingsbury Street's approach might need to be widened to accommodate these improvements. The existing median U-turns would be removed, limiting access to Audubon Road: eastbound Route 9 traffic, to access Audubon Road, would have to make a U-turn at Kingsbury Street, proceed westbound on Route 9, turn right onto Sprague Road, and follow the internal street network to Audubon. The median of Audubon Road will have to be opened at its entrance with Route 9 to allow residents access to both sides. Another shortcoming of this concept is that during peak periods, right turns from Audubon Road would not be able to access the left-turn bay for turning onto Kingsbury Street or Route 9 eastbound due to the short transition distance and queuing traffic. Also students of the Wellesley Middle School would have to cross seven lanes on Route 9, which is undesirable.

Installing a signal at this intersection, and maintaining an acceptable LOS would require widening Route 9 in each direction to provide three through lanes and a left-turn bay. The lanes would taper off to two lanes about 200 feet away. With this design, the intersection would operate at LOS C during the AM peak and LOS D during the PM peak (Table 3-4). It should be mentioned that the intersection would operate at a poor LOS (F) during the AM peak hour if a left-turn bay and only two through lanes were provided in each direction on Route 9.

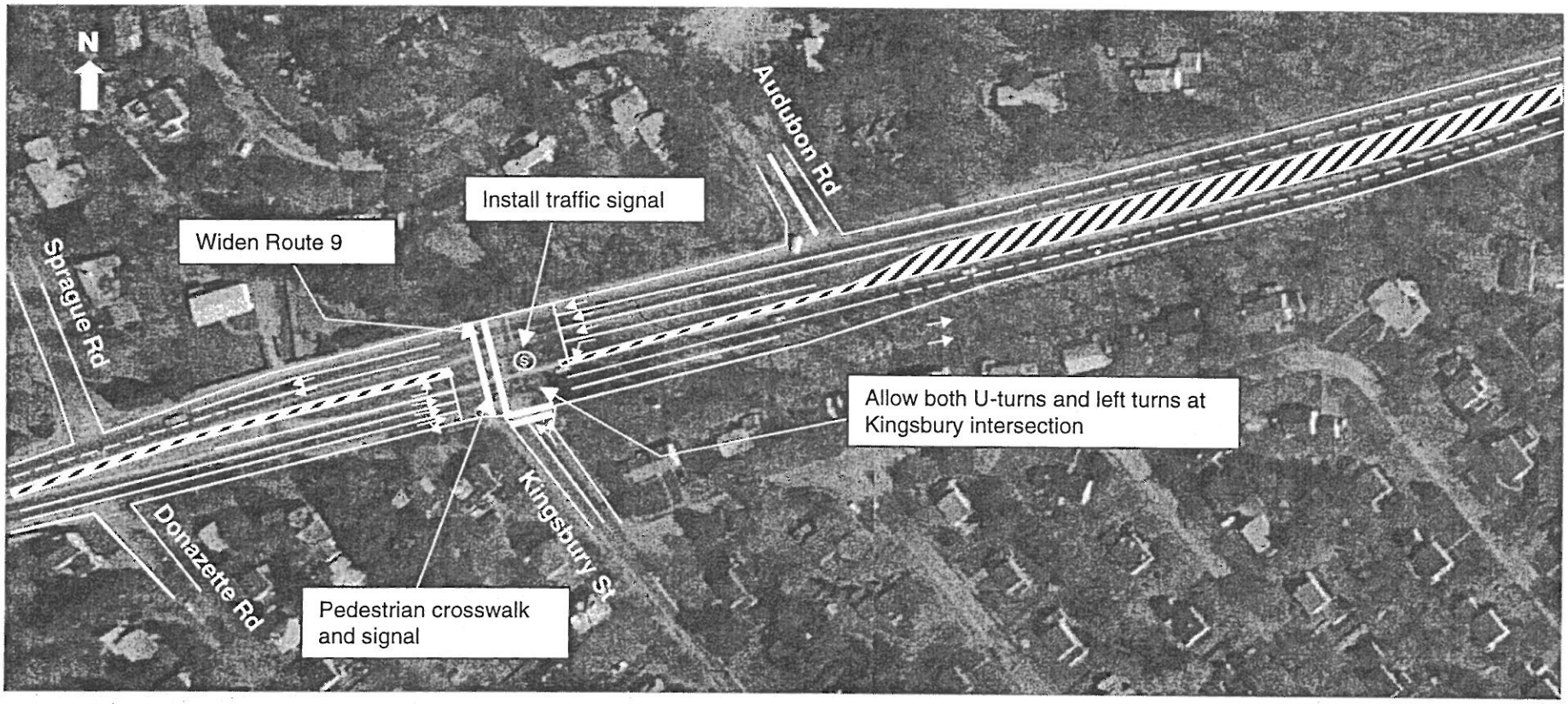


FIGURE 3-12
Kingsbury Street Intersection
Concept 3 - Install Traffic Signal, Widen Route 9, and Relocate Both U-turn Bays to a Redesigned Kingsbury Street Intersection

This improvement would require some land-takings. Environmental impacts include reduced buffer and frontage for the abutting properties. Similar traffic disruptions to those of Concept 2 are associated with this concept. Construction costs, including intersection geometric improvements, the new traffic signal, and relocation of both U-turn bays, are estimated in the range of $500,000–$750,000.

3.4.4 Concept 4 – Signalize the U-Turn Bays on Both Sides of Kingsbury Street

The concept would signalize the U-turn bays located on both sides of the Kingsbury Street intersection, allowing safe, fully protected turns (Figure 3-13). This would increase the safety of traffic operations without adding a third lane in either direction of Route 9 and without any land-takings. The existing pedestrian traffic signal at the Kingsbury Street intersection would be retained, as would be the two through lanes in both directions of Route 9. The Kingsbury Street approach would remain right-turn only. The proposed traffic signals would be coordinated with the pedestrian signal at the Kingsbury Street intersection to improve traffic operations and pedestrian safety.

During the AM and PM peak hours, traffic would operate satisfactorily: LOS D or better. No land-taking would be required, and no negative environmental impacts would result. Moderate traffic disruptions would be expected during construction, the cost of which is estimated at $500,000, including the new traffic signals.

3.5 GRANTLAND ROAD INTERSECTION

The existing-conditions analysis indicates that Grantland Road right turns operate at an undesirable LOS F during the AM and PM peak hours. The service road (Worcester Street) also operates at LOS F during the AM peak, but during the PM peak it operates well, at LOS C. There were a total of 23 crashes at this intersection in the three-year period 1994–96. The improvement concepts developed for this intersection and the vicinity are described below; the projected traffic volumes are shown in Figure 3-14.

3.5.1 Concept 1 – Close Grantland Road Access to Route 9 and Lengthen Route 9 Eastbound On-Ramp

This concept calls for the following modifications: (1) close Grantland Road access to Route 9 and (2) lengthen the Route 9 eastbound on-ramp (Figure 3-15). The objective is to improve both safety and traffic operations. The concept would eliminate the vehicular conflict point at the intersection of Grantland Road and the Worcester Street on-ramp, provide better sight distance, and create a longer acceleration lane for the on-ramp traffic. It would also eliminate the cut-through traffic using Grantland Road to access Oakland Street and the Massachusetts Bay Community College.

These modifications would impact accessibility for Grantland Road residents. These motorists would have to reroute to Oakland Street, east of Grantland Road, to access Route 9. Closing Grantland Road would affect emergency delivery services. It would also require construction of a cul-de-sac at the end of Grantland Road for turning around. There is no space

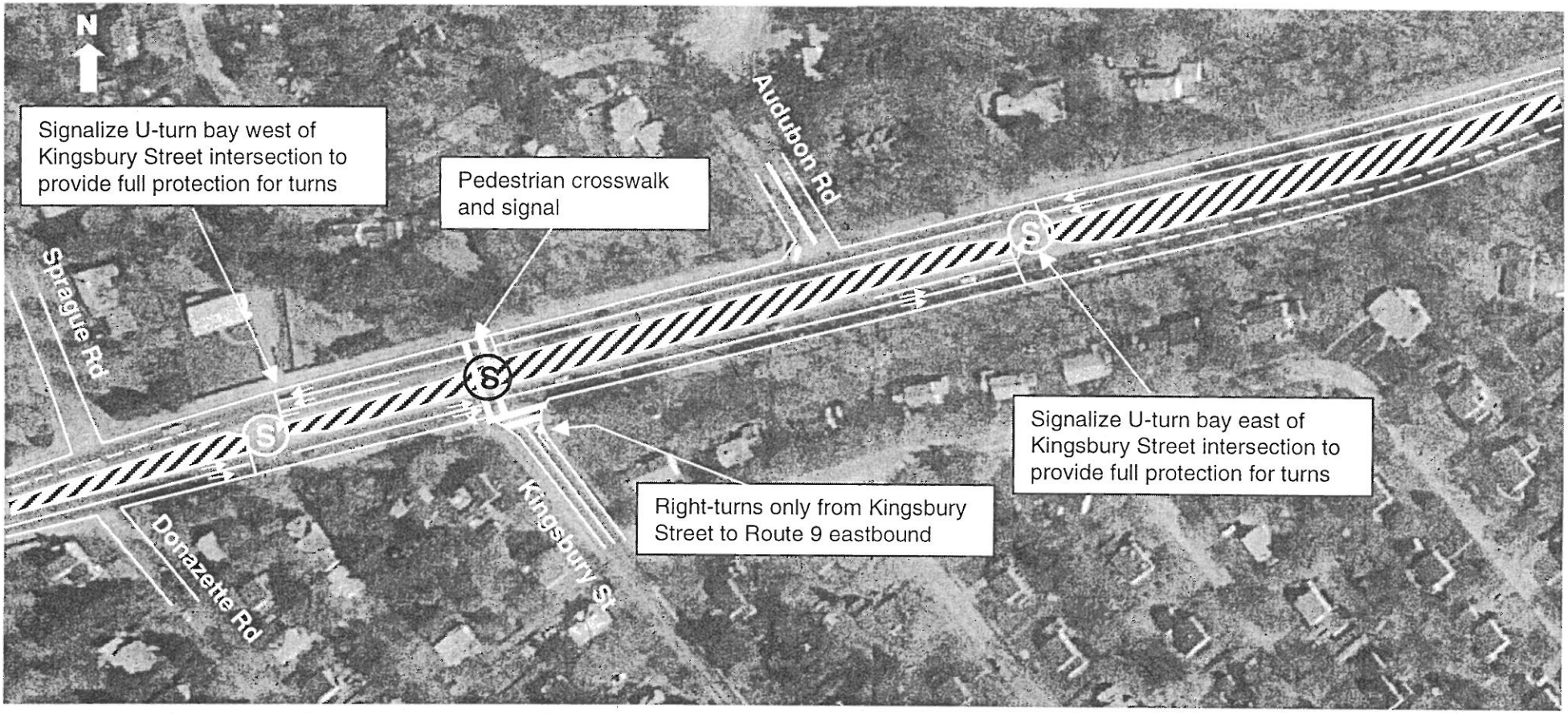
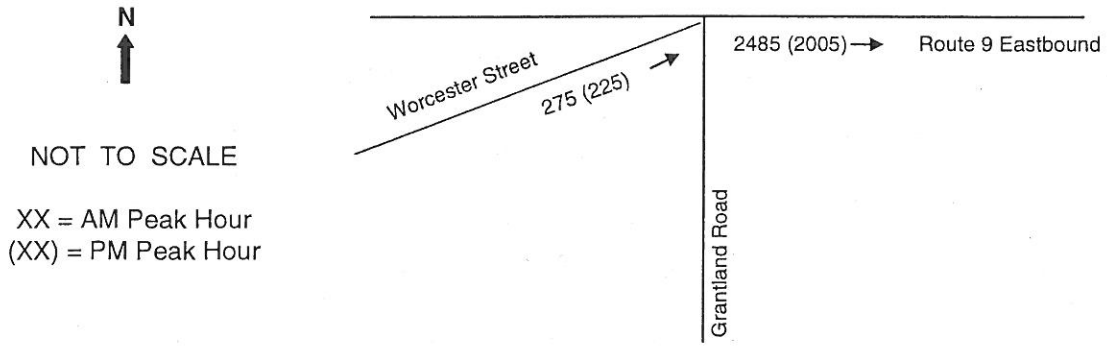
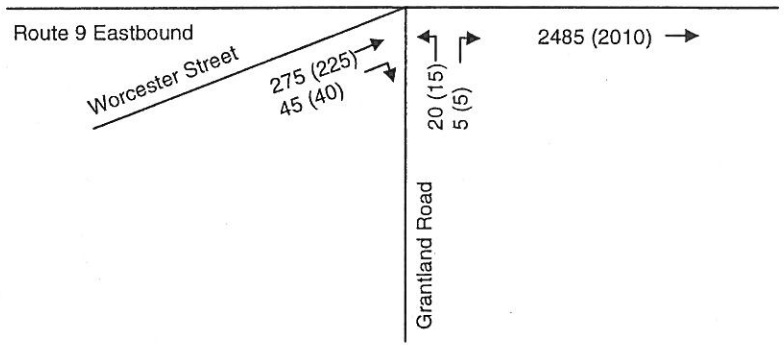


FIGURE 3-13
Kingsbury Street Intersection
Concept 4 - Signalize the U-Turn Bays Located on Both Sides of Kingsbury Street Intersection



Concept 1 – Close Grantland Road Access to Route 9 and Lengthen Route 9 Eastbound On-Ramp



Concept 2 – Lengthen Route 9 Eastbound On-Ramp and Make Geometric Improvements

FIGURE 3-14
Grantland Road Intersection: Projected Traffic Volumes After Implementation of Improvement Concepts (Existing [1998] Demand Assumed

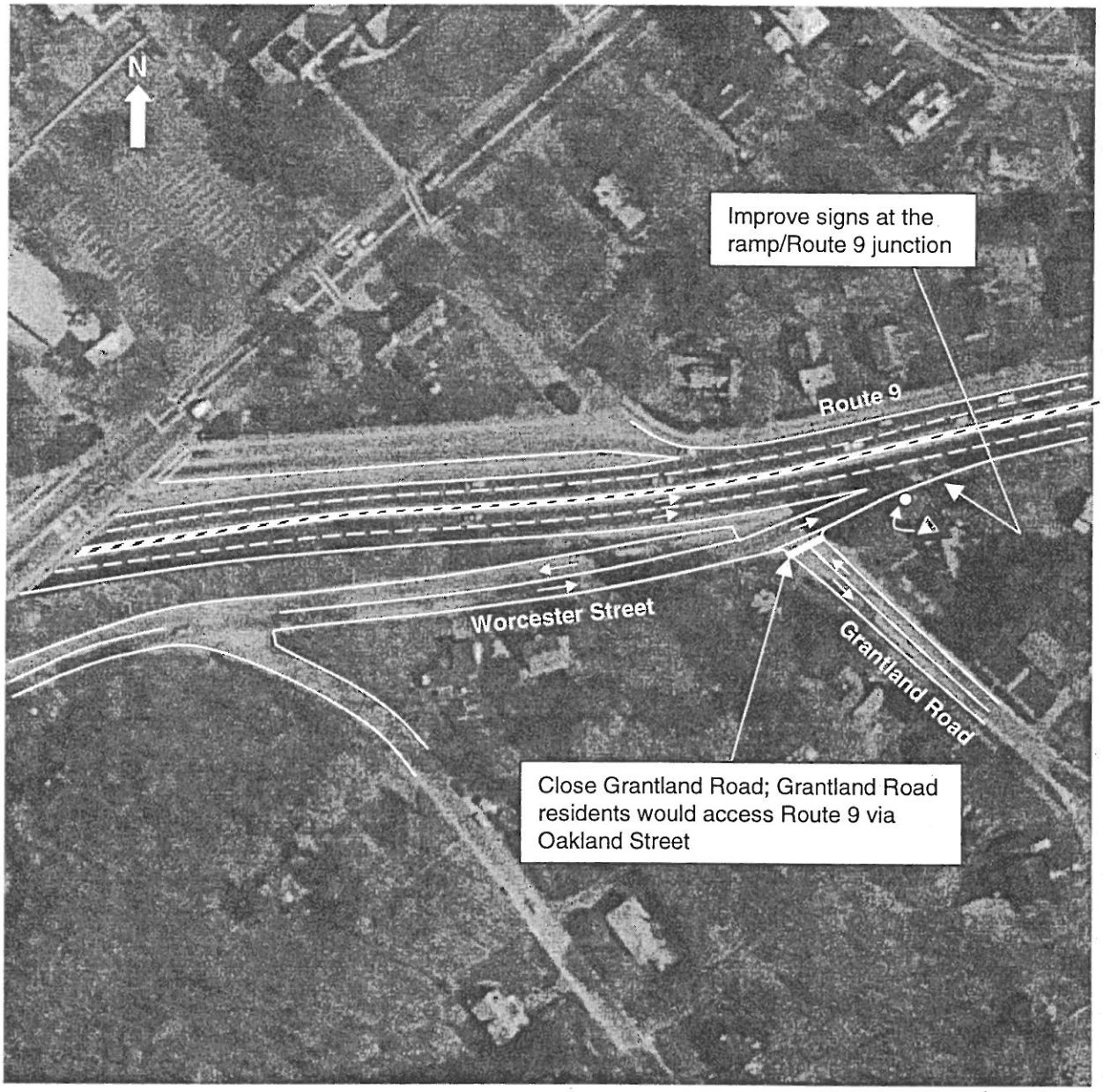


FIGURE 3-15
Grantland Road Intersection
Concept 1 - Close Grantland Road Access to Route 9 and Lengthen Route 9 Eastbound On-Ramp

available for building this cul-de-sac at the end of Grantland Road. The one-way ramp near Grantland Road intersection should be examined if it can be realigned and moved towards Route 9 to create more space for the cul-de-sac for Grantland Road. Traffic operations would improve significantly as a result of these modifications: during the AM and PM peak hours, traffic would operate at LOS E and LOS C, respectively. Safety benefits could be realized from these modifications through reduced potential for vehicle conflicts and improved sight distance.

These modifications would require land-taking east of Grantland Road for implementation and would reduce the frontage to residential buildings in that area. The environmental impacts of the lengthening would include noise from moving vehicles and the increased travel distance associated with rerouting Grantland Road traffic. Construction would involve minimal traffic disruption and detouring, and the estimated cost is $100,000 or less, including closing Grantland Road, lengthening the on-ramp, and providing pavement marking and signing.

3.5.2 Concept 2 – Lengthen Route 9 Eastbound On-Ramp and Make Geometric Improvements

This concept calls for the following modifications: lengthen the Route 9 eastbound on-ramp and make geometric improvements at the Grantland Road and Worcester Street intersection (Figure 3-16). The objective is to improve both safety and traffic operations. The improvements would create a longer acceleration lane and improve signing for the on-ramp traffic. A yield sign is proposed at the on-ramp entrance to Route 9 eastbound. The existing stop signs and flashing red beacon would be retained. Additional modifications would provide traffic islands and pavement markings at the approaches of Grantland Road and Worcester Street to channel traffic and resolve vehicular conflict.

These modifications would not impact accessibility for Grantland Road residents. Traffic operations would improve significantly as a result of these modifications, but there would be no impact on traffic delays. Safety benefits could be realized from these modifications through reduced potential for vehicle conflict.

The modifications would require land-taking and environmental impacts similar to that of Concept 1 for implementation. Construction would involve minimal traffic disruption and detouring, and the estimated cost is $100,000 or less, including geometric improvements, lengthening the on-ramp, and providing pavement marking and signing.

3.6 OAKLAND STREET INTERSECTION

The analysis of existing conditions indicates that this intersection is operating well (LOS C) during the peak hours. The worst movements (Route 9 eastbound and westbound through traffic) operate at LOS D. Notwithstanding good levels of service, there were a total of 34 crashes at this intersection in the three-year period 1994–96. The improvements developed for this intersection primarily address safety problems rather than capacity and are described below. The traffic volumes under each of the concepts would be the same as the existing volumes, which are given in Chapter 2.

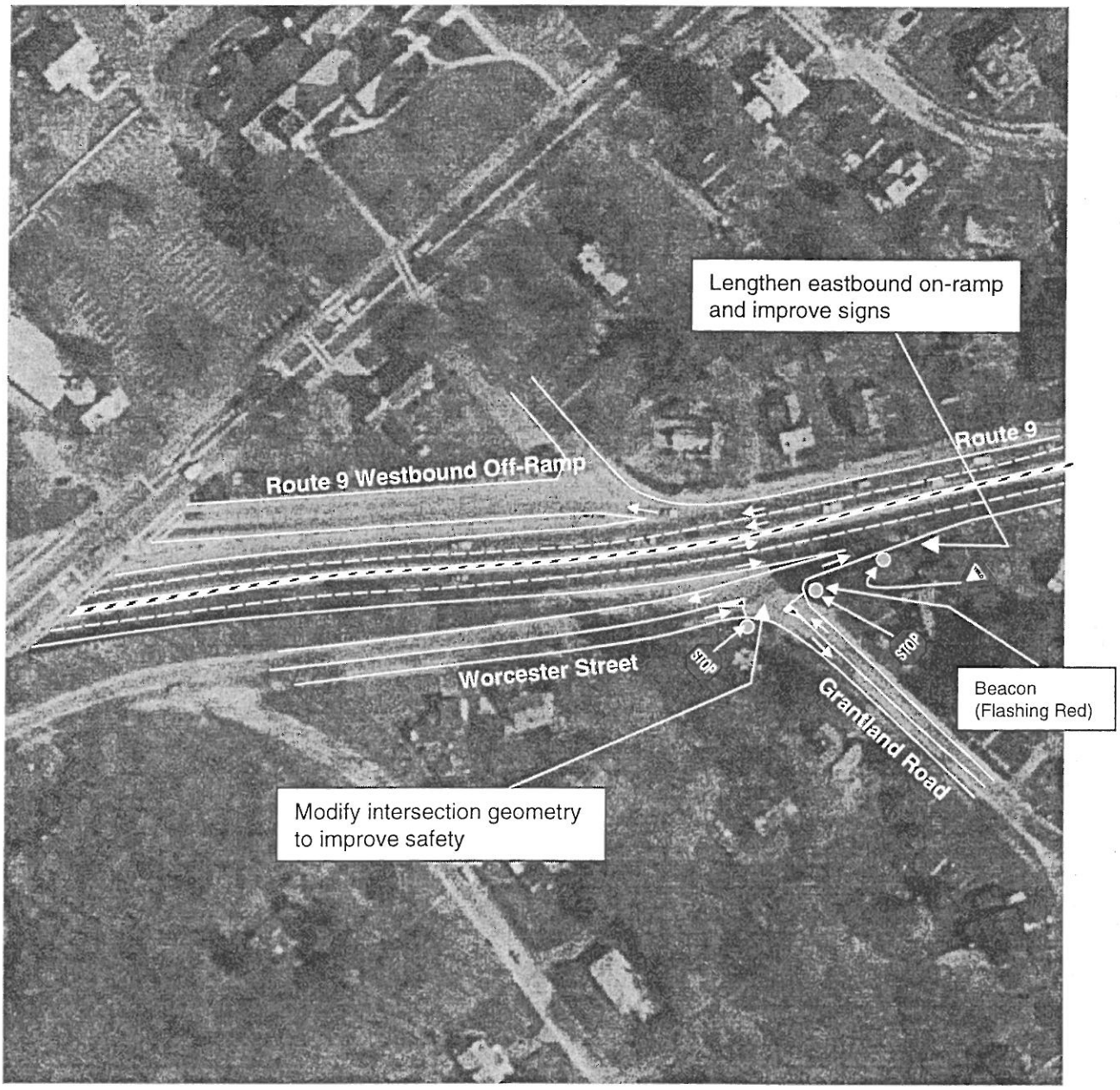


FIGURE 3-16
Grantland Road Intersection
Concept 2 - Lengthen Route 9 Eastbound On-Ramp and Make Geometric Changes

3.6.1 Concept 1 – Close Median and Remove Signal

This concept, which the objective of which is to improve safety, would eliminate the existing traffic signal and close the median opening. With this modification, only right turns would be permitted from Oakland Street to Route 9 westbound and eastbound. Former left-turn traffic from Oakland Street northbound would have to travel east to Cedar Street to go westbound on Route 9. Former left-turn traffic from Oakland Street southbound would have to travel west to Washington Street (Route 16) to go eastbound on Route 9.

This modification would significantly reduce accessibility for the abutting properties on Route 9. The nearest turning point for Oakland Street northbound left-turn traffic, Cedar Street, is over a mile to the east and is an interchange of substandard design and a high-crash location. The nearest turning point for Oakland Street southbound left-turn traffic, Washington Street, is about a quarter of a mile to the west. Therefore, although this concept would reduce delay on Route 9, its impact on Oakland Street would be undesirable.

This modification would improve traffic operations on Route 9, reducing delay by eliminating interruptions of its traffic. The right turns from Oakland Street would operate at an acceptable LOS (C) during the peak hours. The impact of this modification on safety would be beneficial, as over 50 percent of the crashes at this location were rear-end collisions, a common type of crash at congested signalized intersections. However, the accessibility disadvantage would most likely outweigh the advantages of this concept, especially if the Cedar Street interchange and Route 16 interchange were not improved first.

Implementing this concept would not require any land-takings; it would not have any adverse impacts on the environment, because the suggested modification affects only the turning movements, which form a small proportion of the Route 9 traffic. Construction costs, which include closing the median, removing the signal equipment, installing new stop signs at Oakland Street's approaches, and maintenance of traffic flow during construction, are estimated at $50,000.

3.6.2 Concept 2 – Improve and Monitor Signs at the Route 9 Westbound Approach

The objective of this concept is to improve safety for westbound Route 9 motorists approaching the intersection (Figure 3-17). It would consist of the installation of new warning signs or modification of existing signs to provide better coordination with the traffic signal at Oakland Street. The improvements would have to be monitored to assess their performance over time and to make changes when necessary.

These improvements would have no impact on traffic delays or accessibility; however, they would be expected to improve safety. No land-takings would be involved and no adverse impacts on the environment would be expected. Construction costs would be minor, estimated at under $50,000, including improving signs and monitoring results. The impact on traffic flow during construction would be expected to be negligible.

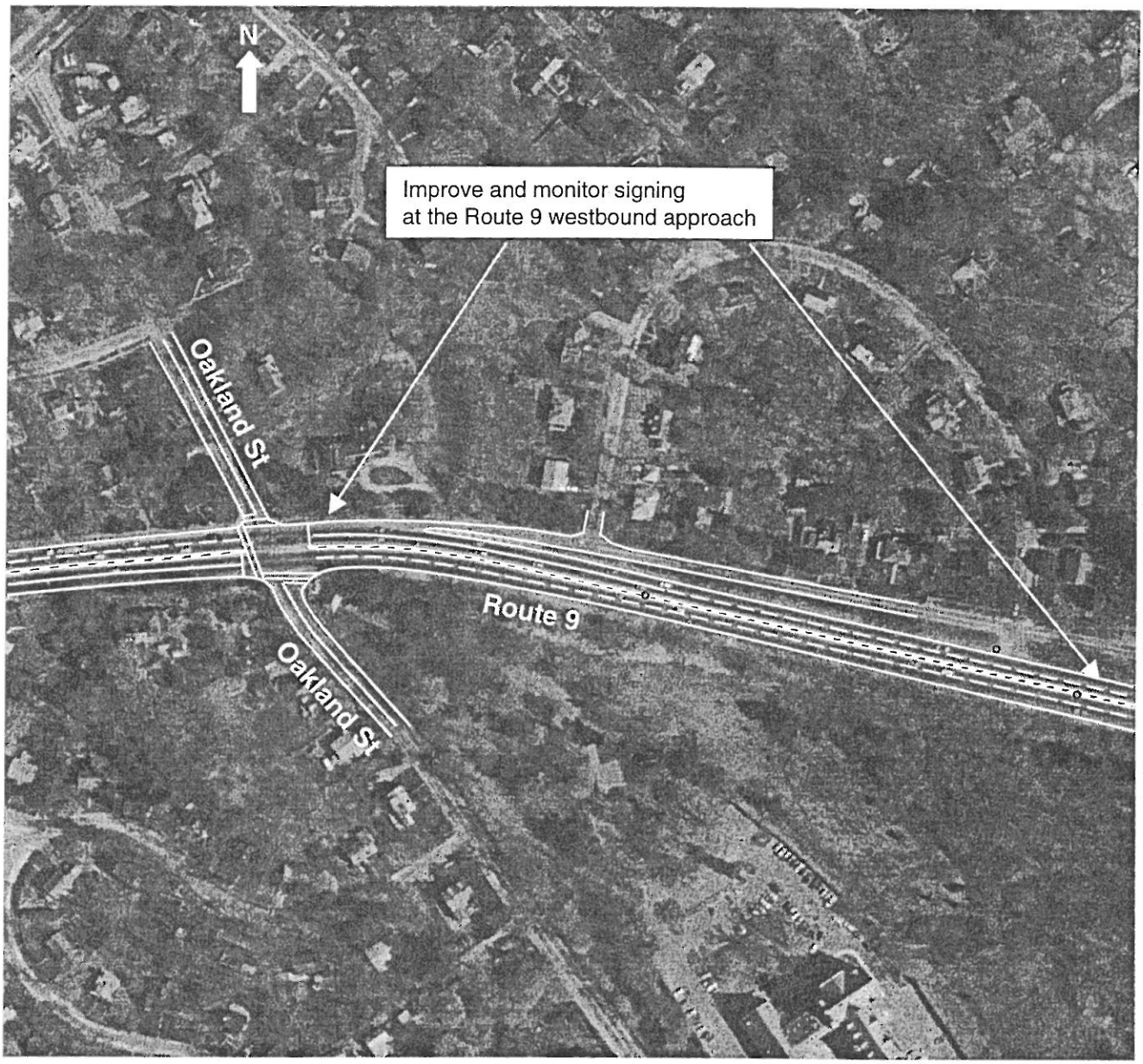


FIGURE 3-17
Oakland Street Intersection
Concept 2 - Improve and Monitor Signs at the Route 9 Westbound Approach

3.7 CEDAR STREET INTERCHANGE

In the three-year period 1994–96, 44 crashes occurred at this interchange, making it a high-crash location. Three improvement concepts were investigated to address the problems at this interchange and are described below. Figure 3-18 shows the traffic volumes projected under each of the concepts.

3.7.1 Concept 1 - Close the Northeast Quadrant Route 9 Westbound On-Ramp from Cedar Street and Signalize the Ramp/Cedar Street Intersection North of Route 9

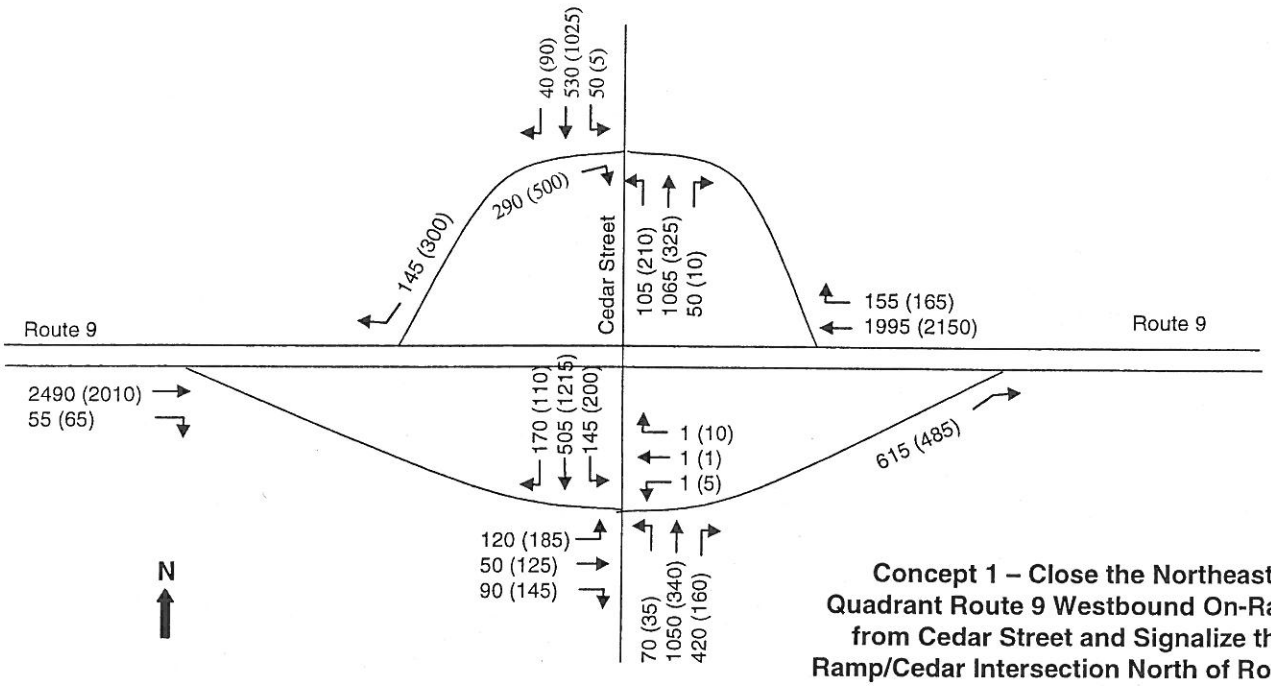
The objective of this short-term concept (that is, one that could be implemented relatively quickly) for the Cedar Street interchange (Figure 3-19) is to improve safety for Route 9 westbound traffic by eliminating the short weave under the bridge by closing the northeast quadrant Route 9 westbound on-ramp from Cedar Street. The improvements include by signalizing the ramp/Cedar Street intersection north of Route 9 and coordinating the traffic signals to improve traffic operations and modifying the ramp in the northwest quadrant for use by the westbound traffic. Additional modifications include lengthening the westbound on-ramp in the northwest quadrant.

This concept has significant safety benefits but minimal reduction in traffic delays. The projected levels of service for both traffic signals on Cedar Street are unacceptable (LOS E or worse during the PM peak hour, Table 3-5). These improvements would affect accessibility for the businesses in the northeast quadrant, as the ramp in that quadrant would serve only traffic exiting Route 9 onto Cedar Street northbound. Access to Barton Road would be retained.

There would be some environmental impacts resulting from pavement widening within the Rosemary Brook aquifer, near the existing town well. Moderate to major traffic disruption would be expected during construction, the cost of which is estimated at $750,000, including signal installation and equipment, modifying the northeast quadrant ramp, and improved signs.

3.7.2 Concept 2 – Replace Interchange with a New Diamond Interchange

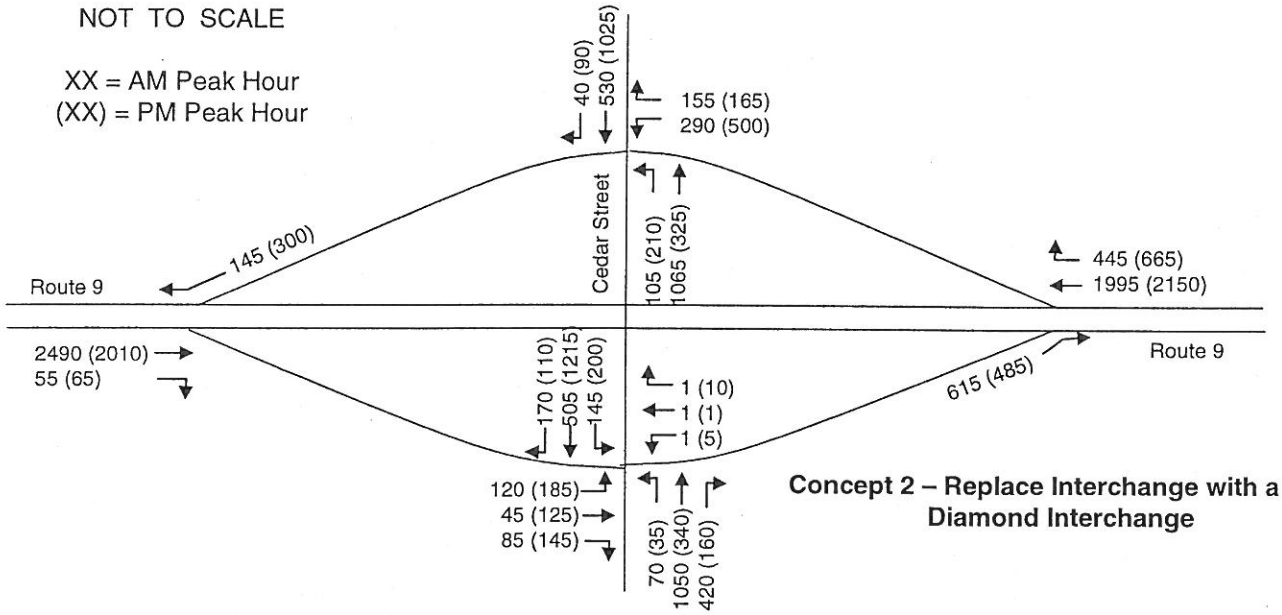
This concept, construction of a diamond interchange (Figure 3-20) and, possibly, that Route 9 be shifted to the north, is a long-term alternative (that is, it would take relatively long to implement). The objective is to improve safety and traffic operations. It would include a frontage road on the southerly side for accessing businesses and properties in the southwest and southeast quadrants. It would require the construction of a new bridge to handle Cedar Street traffic and access to the businesses located in this area. It would replace the antiquated ramp geometry on the westbound side with modern, diamond-type ramps that meet the state design standards, and widen the bridge over Route 9. Part of this concept is to signalize the ramp–Cedar Street intersection on the north side of Route 9 and coordinate it with the south-side signal to improve traffic operations and safety. The modifications would improve traffic operations and safety on the ramps, Cedar Street, and Route 9. It eliminates the short weave under the bridge involving Route 9 westbound traffic. The proposed signalized intersection on the north side would operate at LOS C with a five-lane bridge and at LOS F with a four-lane bridge.



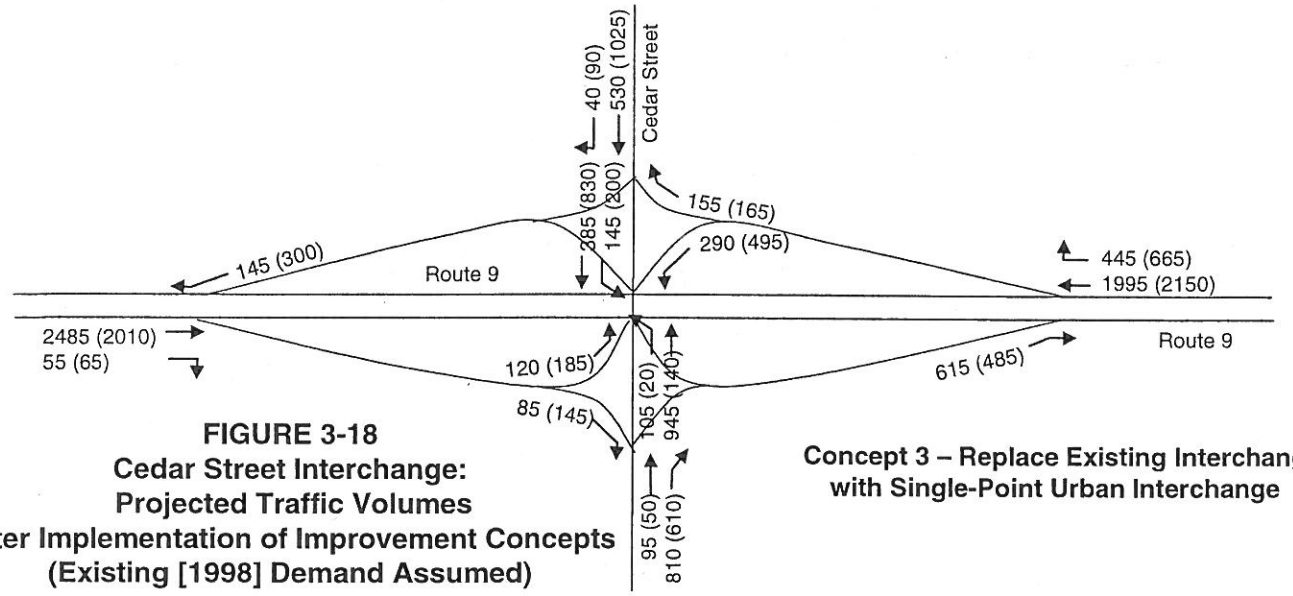
Concept 1 – Close the Northeast Quadrant Route 9 Westbound On-Ramp from Cedar Street and Signalize the Ramp/Cedar Intersection North of Route 9

NOT TO SCALE

XX = AM Peak Hour
(XX) = PM Peak Hour



Concept 2 – Replace Interchange with a New Diamond Interchange



Concept 3 – Replace Existing Interchange with Single-Point Urban Interchange

FIGURE 3-18
Cedar Street Interchange:
Projected Traffic Volumes
After Implementation of Improvement Concepts
(Existing [1998] Demand Assumed)

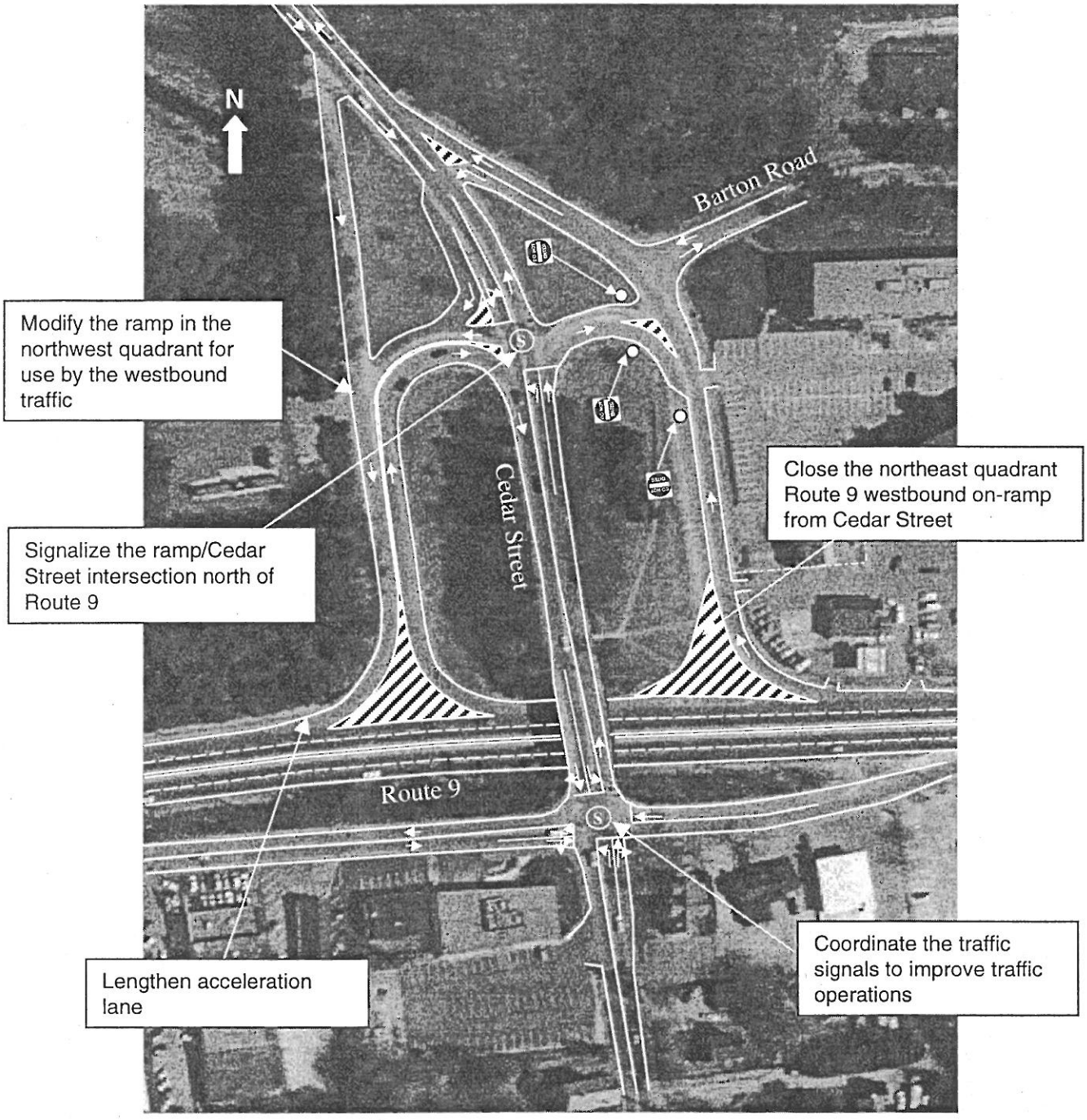


FIGURE 3-19
Cedar Street Interchange
Concept 1 - Close the Northeast Quadrant
Route 9 Westbound On-Ramp from Cedar Street

TABLE 3-5
Level of Service Analysis at Cedar Street Interchange

Concept	Movement	AM Peak Hour LOS	AM Peak Hour Delay (sec)	PM Peak Hour LOS	PM Peak Hour Delay (sec)
1 – Close the northeast quadrant route 9 westbound on-ramp from Cedar Street and signalize the ramp/Cedar Street intersection north of Route 9	*South-side intersection*				
	Cedar St northbound L	A	3	A	4
	Cedar St northbound T	F	108	B	9
	Cedar St southbound L	E	48	A	4
	Cedar St southbound T	A	5	F	78
	Ramp westbound LTR	D	29	C	22
	Overall	F	69	E	52
	North-side intersection				
	Cedar St northbound L	A	3	D	39
	Cedar St northbound T	A	5	B	12
	Cedar St southbound T	A	5	E	48
	Ramp eastbound LTR	A	5	D	36
	Overall	A	5	D	35
2 – Replace Interchange with a New Diamond Interchange (Five-lane bridge)	*South-side intersection*				
	Cedar St northbound L	A	5	A	5
	Cedar St northbound T	B	13	A	5
	Cedar St southbound L	C	22	A	5
	Cedar St southbound T	A	5	B	13
	Ramp westbound LTR	B	10	B	11
	Ramp eastbound L	C	22	C	18
	Ramp eastbound TR	A	5	B	14
	Overall	B	12	B	12
	North-side intersection				
	Cedar St northbound L	A	2	B	11
	Cedar St northbound T	A	4	B	14
	Cedar St southbound TR	A	5	C	18
	Ramp westbound LR	D	32	D	37
	Overall	B	9	C	22
3 – Replace existing interchange with a single point urban interchange (Five-lane bridge)	Ramp westbound LR	D	26	C	22
	Ramp eastbound LR	C	21	C	20
	Cedar St northbound L	D	27	D	25
	Cedar St northbound T	B	6	B	9
	Cedar St southbound L	D	38	C	24
	Cedar St southbound T	A	4	B	11
	Overall	B	11	C	16

L = Left turns, T = Through movements, R = Right turns
Note: Shading denotes unacceptable delay

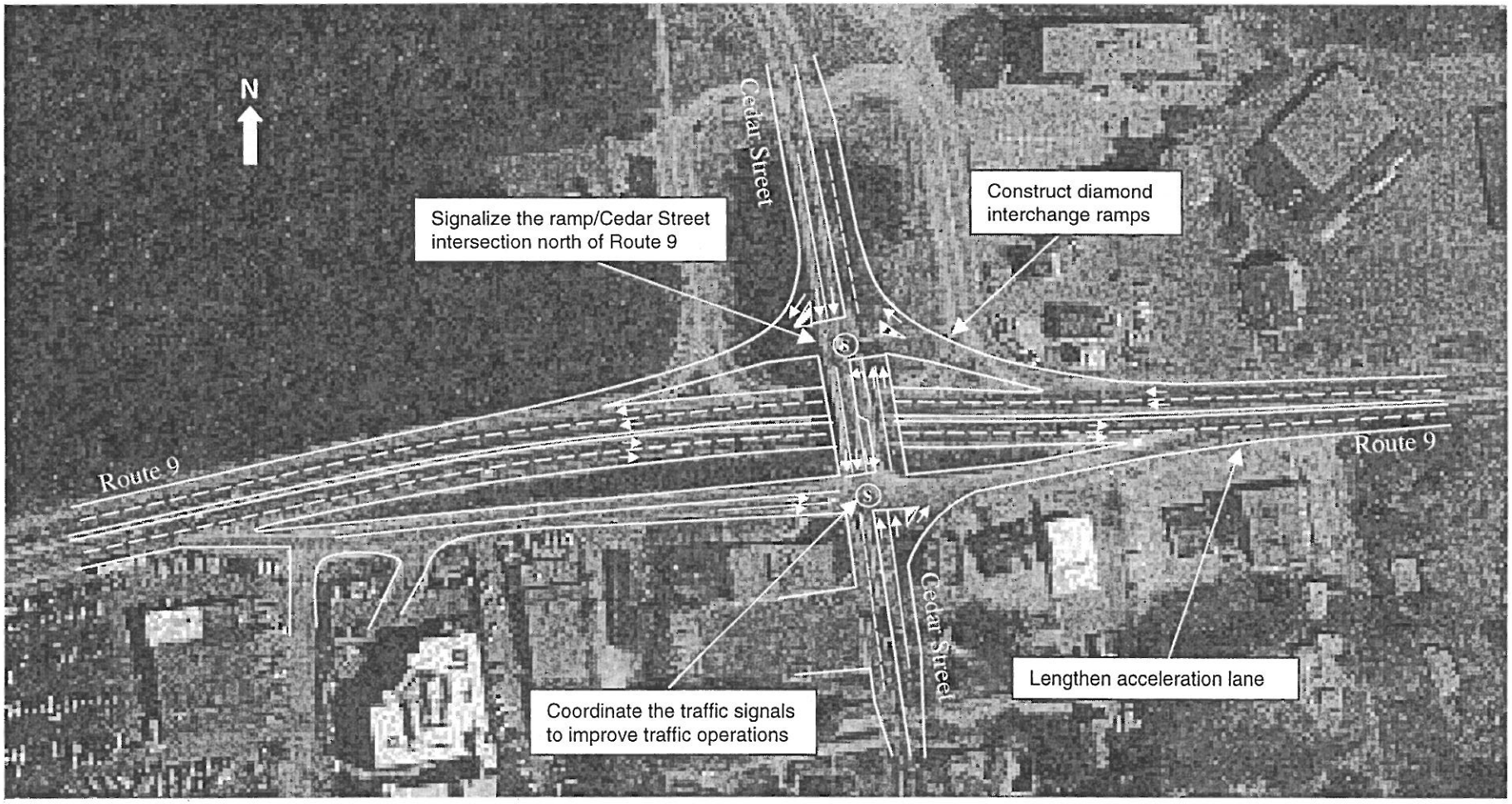


FIGURE 3-20
Cedar Street Interchange
Concept 2 - Replace Interchange with a New Diamond Interchange

This alternative would require land-takings and would impact water resources and parklands. Some measures would need to be taken to minimize the impacts on water resources and any other environmental impacts such as on wetlands. This concept includes major modifications that would impact accessibility. Some businesses' properties in the northeast quadrant would have to be taken and driveway access for others relocated. Construction costs, including building a new bridge, replacing ramps, and installing a new traffic signal and other equipment, would be high; they are estimated in the range of $10 million or more. Traffic disruption during construction would include major traffic diversions and delays for both Route 9 and Cedar Street traffic.

3.7.3 Concept 3 – Replace Existing Interchange with an Overpass Single-Point Urban Interchange

This concept, construction of an overpass single-point urban interchange (SPUI) is a long-term alternative. The objective of this concept is similar to that of Concept 2. The single-point urban interchange (SPUI) is a relatively new type of diamond interchange that offers improved traffic-carrying ability, safer operation, and reduced right-of-way needs under certain conditions when compared with other interchange configurations. The distinguishing feature of this interchange is the convergence of all through and left-turning movements into a single signalized intersection area. The advantage of this feature is that all intersecting movements can be served by a single signal, with at most one stop being required to pass through the interchange. A traditional diamond interchange requires two signals, one on each side of the highway.

This long-term alternative would increase intersection capacity and would separate ramp traffic from traffic accessing businesses in the southwest and southeast quadrants. With an overpass SPUI, the intersection would operate at LOS D or better, assuming a five-lane bridge. The lane configuration and assignments would be as shown in Figure 3-21. Traffic operations and safety, both on the ramps and in the intersection, would be improved greatly. Access to businesses would be more circuitous with these modifications and include traversing a signal. On the east side, some land-takings and relocation of some driveway access to businesses would be required and would impact water resources and parklands.

The cost of construction and its impact on traffic flow are similar to those of Concept 2. Construction costs, including building a new bridge, replacing ramps, installing a new traffic signal and equipment, relocating driveways for businesses, and improving access, would be high; they are estimated in the range of $15 million or more.

3.8 WILLIAM STREET INTERSECTION

In the three-year period 1994–96, 20 crashes occurred at this intersection. Virtually all of these crashes involved vehicles headed westbound on Route 9 or headed, according to the records, "southbound"—presumably the latter were vehicles exiting Wellesley Office Park. Analysis of the existing conditions indicates that William Street has an undesirable LOS (F) during the PM peak hour. During the AM peak, it operates at LOS D. The problems at this location are:

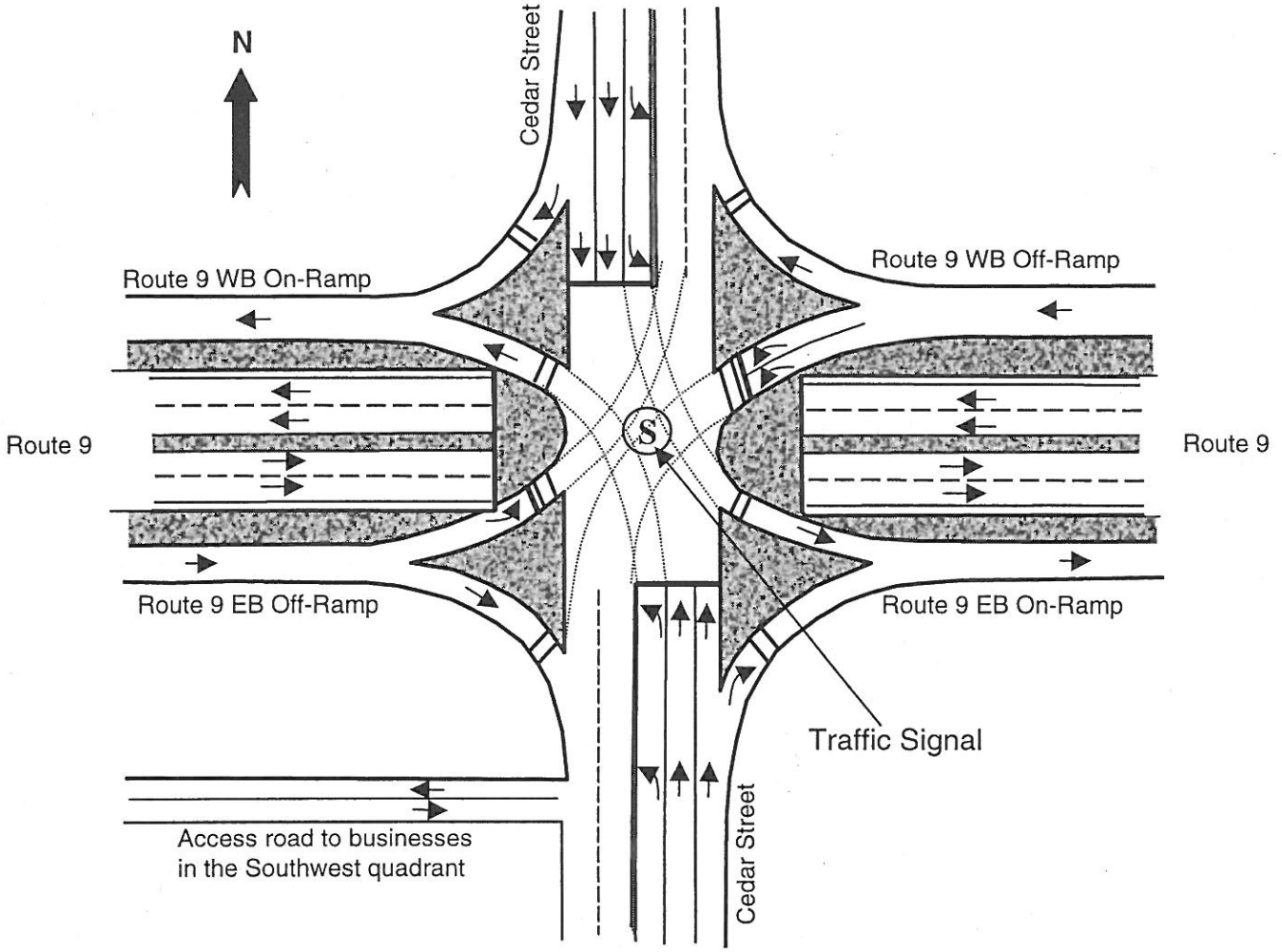


FIGURE 3-21
Cedar Street Interchange
Concept 3 - Overpass Single-Point Urban Interchange

1. The weaving conflicts of traffic movements coming from Route 9 westbound and the westbound, on-ramp, entering William Street or destined for the Route 128 northbound on-ramp or Route 9 westbound.

2. Similar weaving and merging difficulties involving traffic exiting William Street and traffic entering Route 9 westbound, both traffic streams having the option of entering Route 128 northbound or proceeding on Route 9 westbound.

3. Traffic congestion during the PM peak hour.

Three improvement concepts were investigated to address the problems at this interchange and are described below. Figure 3-22 shows the traffic volumes projected under each of the concepts.

3.8.1 Concept 1 – Formalize Current Temporary Arrangement and Improve Signs on Route 9 Westbound

There is currently a temporary arrangement consisting of police details and traffic cone devices to channel traffic from William Street and to separate it from Route 9 through traffic and right turns entering William Street. This concept would formalize the current arrangements with permanent physical modifications: barriers, curbs, and paint stripes (Figure 3-23). Additional modification includes the installation of new signs or modifying existing signs to warn motorists of the upcoming William Street intersection. The segment where signs should be improved extends from William Street eastward along Route 9 to the westbound off-ramp.

These modifications would provide safety levels similar to those of the police-controlled situation. They would not affect accessibility, impact the environment, or require any land-takings. There would be no impact on traffic delay. The construction process would have a minor to moderate impact on traffic flow. The estimated cost of construction is approximately $50,000, including barriers, curbing, and pavement markings.

3.8.2 Concept 2 – Prohibit Right Turns from Route 9 onto William Street

The purpose of this modification would be to eliminate one weaving movement in the section of Route 9 between the Ellis Street/Quinobequin Road on-ramp and William Street. The modification consists of prohibiting, through installation of a raised physical barrier, right turns from Route 9 onto William Street (Figure 3-24). The recommendations include not only improvements at the William Street intersection and in the immediate vicinity, but also improvements that address traffic operations and safety problems at three of the intersections in Newton that were examined, as some of the traffic headed for Wellesley Office Park uses those intersections. The recommended improvements are:

1. Prohibit right turns from Route 9 onto William Street.

2. Channel traffic into and out of William Street by constructing a traffic island (formalizing the channelization currently effected by the police detail).

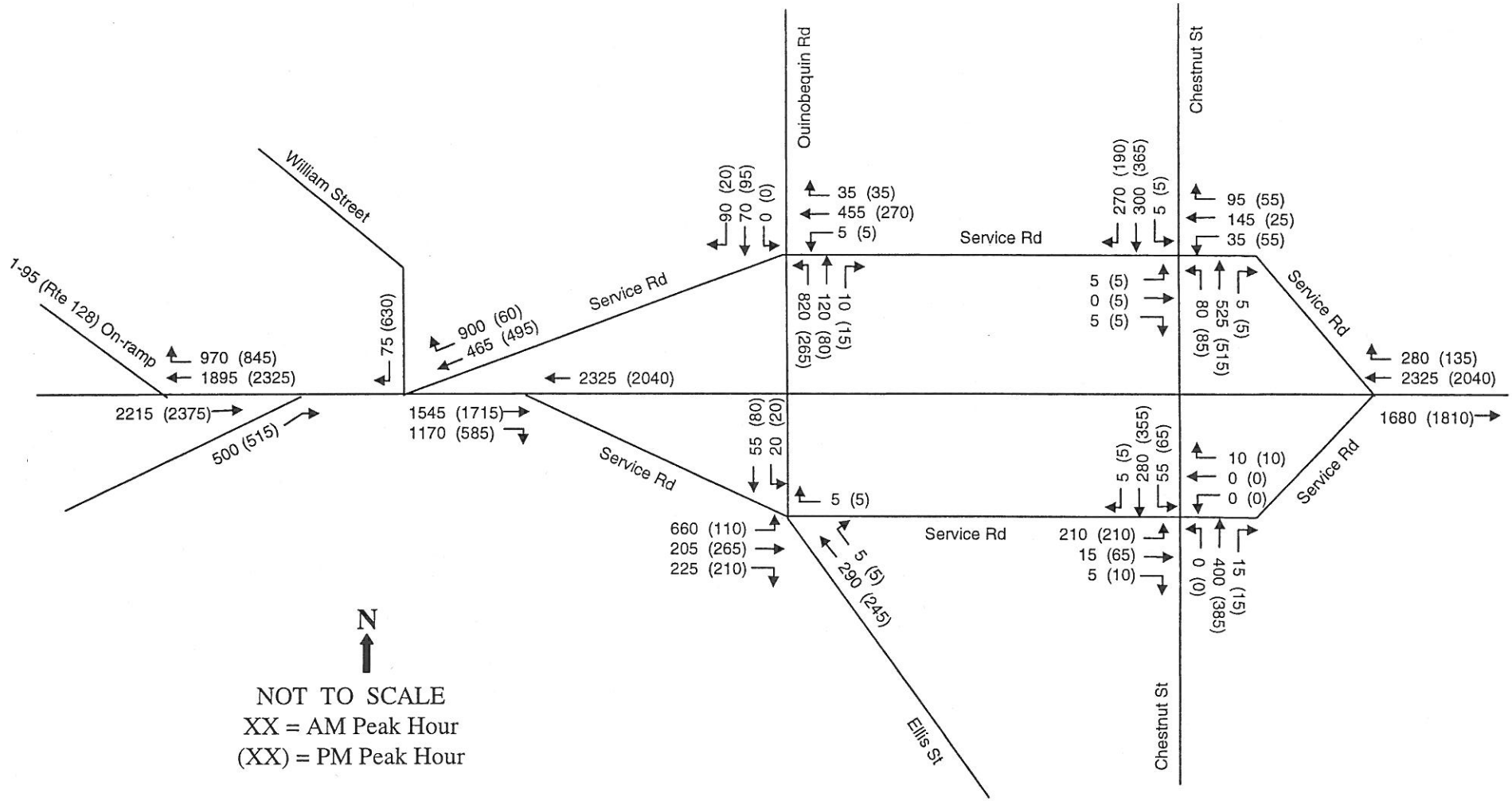


FIGURE 3-22
William Street and Nearby Intersections: Projected Traffic Volumes
After Implementation of Improvement Concepts
(Existing [1998] Demand Assumed)

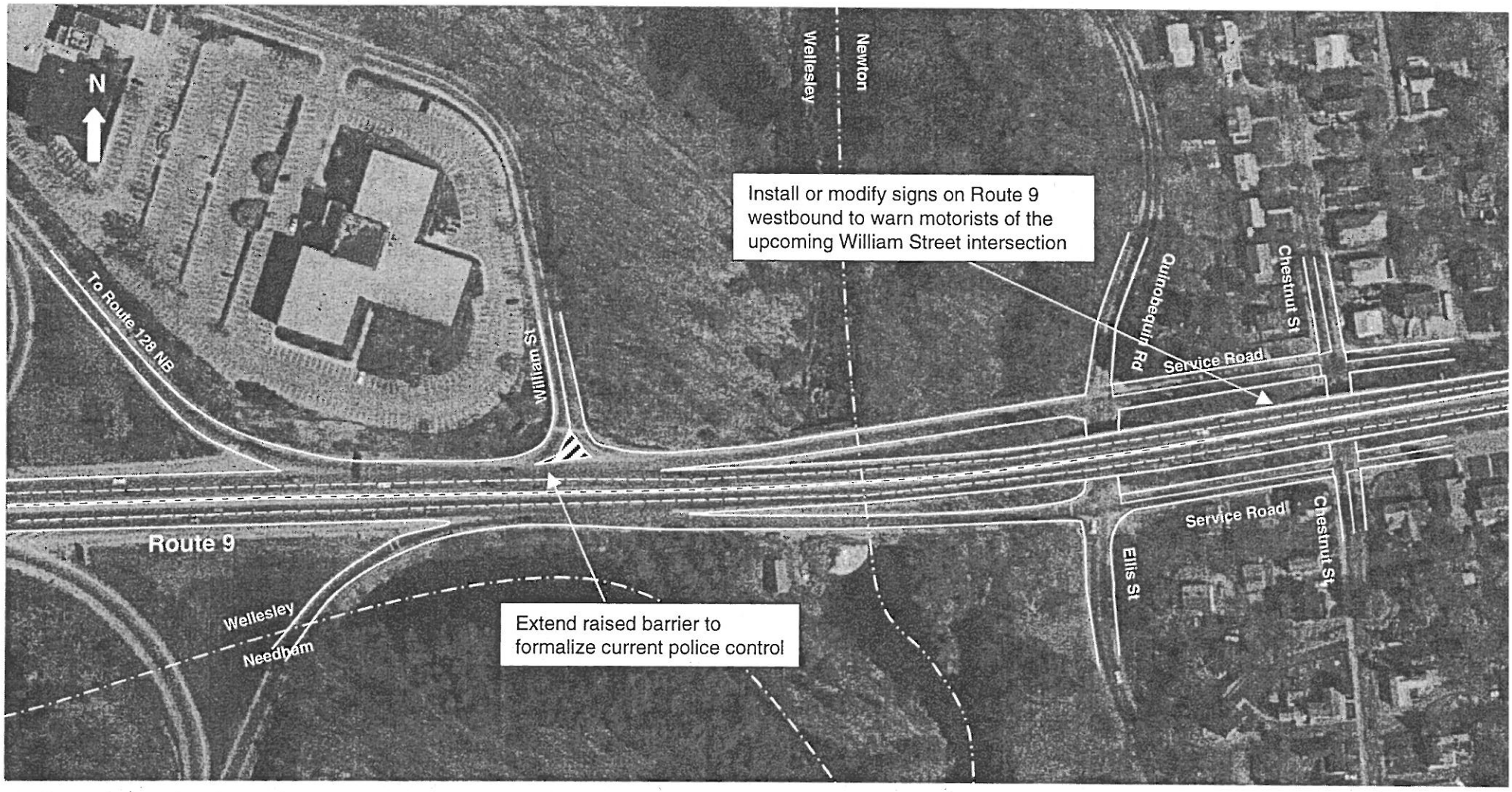


FIGURE 3-23
William Street Intersection
Concept 1- Formalize Current Temporary Arrangement and Improve Signs on Route 9 Westbound

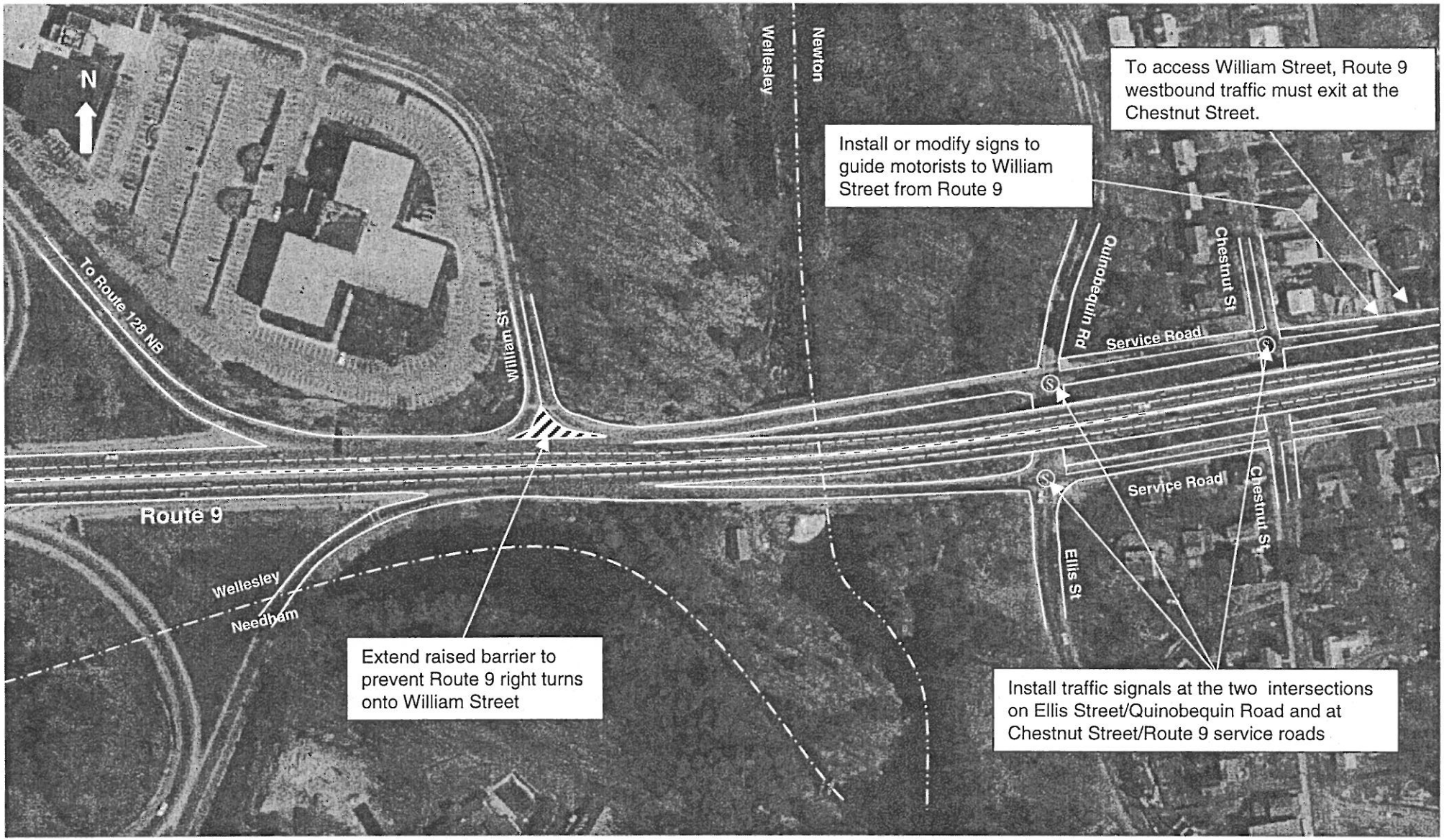


FIGURE 3-24
William Street Intersection
Concept 2 - Prohibit Right Turns from Route 9 onto William Street

3. Install and modify signs on Route 9 westbound to guide motorists to William Street.

4. Signalize intersection of Ellis Street at Route 9 eastbound service road.

5. Signalize intersection of Ellis Street/Quinobequin Road at Route 9 westbound service road and add a left-turn bay to the northbound approach.

6. Signalize intersection of Chestnut Street at Route 9 westbound service road and add a left-turn bay to the northbound approach.

The prohibition of right turns from Route 9 onto William Street would require that traffic from Route 9 westbound destined for William Street exit at Chestnut Street and use the off-ramp. It is because of the additional ramp traffic resulting from the diversion that CTPS recommends that the three intersections in Newton be signalized, to address congestion and queues.

The Newton intersections would operate at acceptable levels of service (LOS D or better), except for the eastbound ramp movement at the Chestnut Street intersection south of Route 9, which would operate at LOS F during the PM peak hour. The projected delays and levels of service after implementation of the proposed improvements are shown in Table 3-6. The left-turn bays would enhance traffic operations for Chestnut and Ellis streets' northbound through traffic as well as providing protected/permitted left turns onto the westbound on-ramp. The traffic signals would also improve safety at the intersections, which presently suffer from poor sight distance. Elimination of right turns from Route 9 would improve safety at the William Street intersection, as it removes one of the weaving movements.

No land-takings would be required. The construction cost is estimated at approximately $1 million, including geometric improvements, signalization and signage. The construction process would have a moderate impact on traffic flow on Route 9 and at the affected intersections.

3.8.3 Concept 3–Widen Acceleration Area West of William Street to Provide a Separate Right-Turn Lane onto Route 128 Northbound

This concept calls for widening the acceleration area west of William Street to provide a separate right-turn lane onto the Route 128 on-ramp. The idea is to channel the William Street traffic that is headed for Route 128 so that it stays off of Route 9, in effect providing a two-lane on-ramp to Route 128 with one lane serving Route 9 traffic and the other serving William Street traffic. The two lanes would merge into a single traffic lane before entering Route 128 (Figure 3-25).

The modification would improve traffic operations and safety by providing additional area for the complex weaving movements and thus reducing vehicle conflicts. It would reduce traffic delay at William Street, which would operate at LOS D. This concept would require land-takings, possibly including encroachment on Wellesley Office Park. It would have moderate environmental impacts associated with road widening. Construction is estimated to cost approximately $1.5 million and would have some impact on traffic flow through lane shifting and rerouting.

TABLE 3-6
Level of Service Analysis at William Street and Newton Intersections

Concept	Movement	AM Peak Hour LOS	AM Peak Hour Delay (sec)	PM Peak our LOS	PM Peak our Delay (sec)
Concept 2 – Prohibit right turns from Route 9 onto William Street	*Ellis Street @ Route 9 eastbound service road*				
	Ramp eastbound L	B	11	B	16
	Ramp eastbound T	B	10	C	22
	Ellis St northbound T	B	20	A	7
	Ellis St southbound T	C	25	A	1
	Service Rd westbound LR	A	1	A	1
	Ellis Street /Quinobequin Road at Route 9 westbound service road				
	Ellis St northbound L	B	18	B	19
	Ellis St northbound T	B	17	B	18
	Quinobequin Rd southbound T	D	38	D	40
	Service Rd westbound LTR	D	47	D	37
	Chestnut Street at Route 9 westbound service road north of Route 9				
	Chestnut St northbound L	A	5	A	2
	Chestnut St northbound T	A	6	A	4
	Chestnut St southbound T	B	12	A	8
	Service Rd eastbound LTR	B	15	B	10
	Service Rd westbound LTR	D	36	B	12
	Chestnut Street @ Route 9 eastbound service road south of Route 9, unsignalized				
	Chestnut St northbound LTR	A	3	A	3
	Chestnut St southbound LTR	A	4	A	4
	Service Rd eastbound LTR	D	21	F	81
	Service Rd westbound LTR	C	11	C	15

Notes: L = Left turns, T = Through movements, R = Right turns

- *Shading denotes unacceptable delay.*
- *William Street is excluded because the proposed improvements require its traffic to yield and merge with Route 9 westbound traffic.*

3.9 SUMMARY

All of the improvement concepts are summarized in Tables 3-7 through 3-14. Each table summarizes a location's modifications, the objective of the improvements, and the impacts, if any, on accessibility, delay, safety, and the environment. It also notes any land-takings, the estimated construction costs, and any impacts of construction on traffic flow.

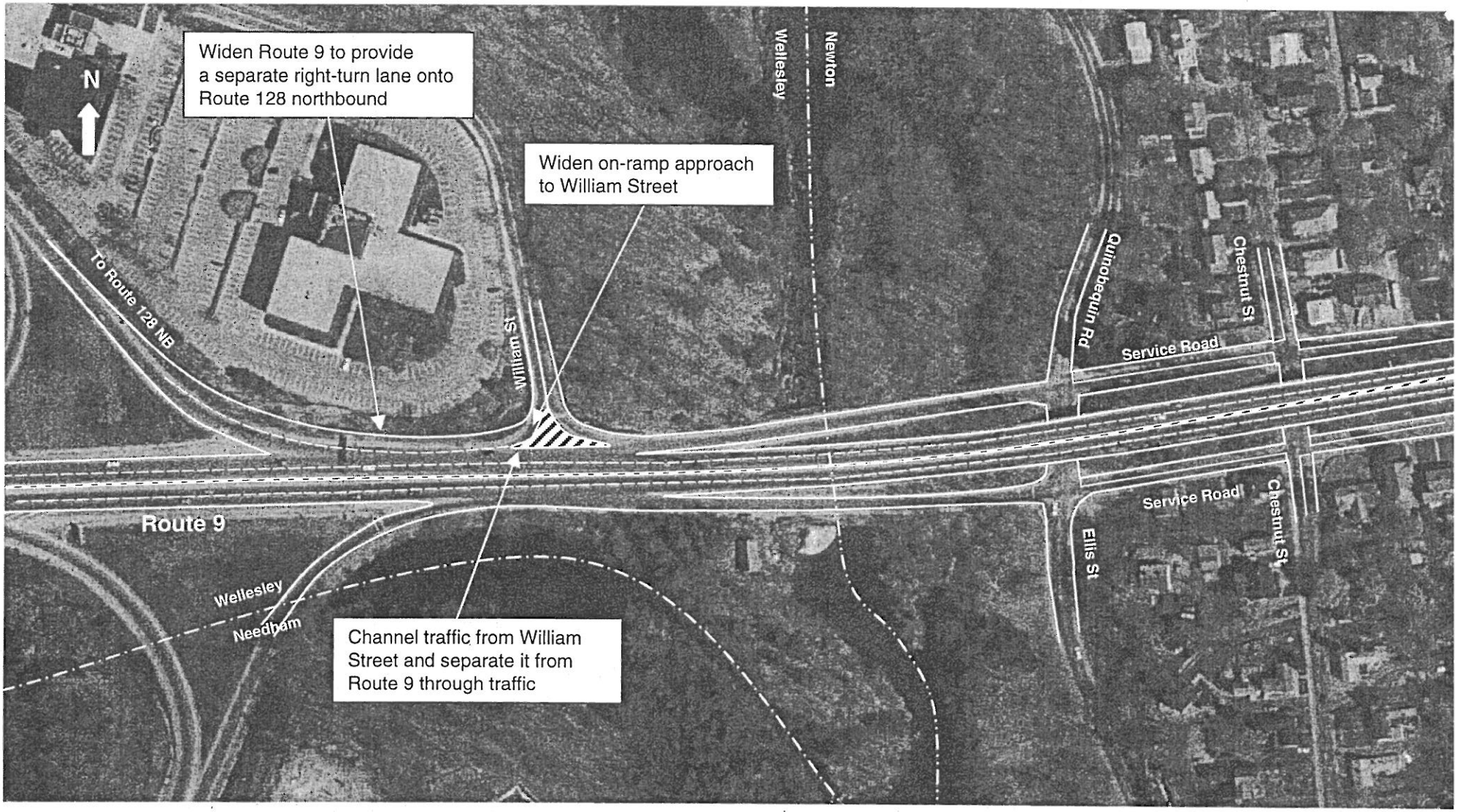


FIGURE 3-25
William Street Intersection
Concept 3 - Widen Acceleration Area West of William Street to Provide a Separate Right-Turn Lane onto Route 128 Northbound

TABLE 3-7
Overbrook Drive Intersection: Improvement Concepts

Concept #	Modification	Purpose/Objective	Impacts					Estimated Construction Costs[1]/Traffic Disruption
			Accessibility	Level of Service/Delays	Safety	Land-Takings	Environment	
1	Remove signal and close median.	Improve traffic operations and safety by eliminating left turns and diversions from Route 9 eastbound to Overbrook Drive.	Would require Overbrook Drive traffic and local commercial traffic to travel west to Oak Street, Natick, to go eastbound on Route 9; significant reduction in accessibility for abutting properties. Also, next opportunity for eastbound left-turners is Weston Road, a less desirable location.	Delays reduced by eliminating signalized intersection, but traffic rerouting also creates delays for abutters.	Reduction in rear-end collisions at Overbrook Drive intersection.	None required.	No impact, except for increased vehicle-miles of travel (VMT) added by rerouting Overbrook Drive and other turning traffic.	**Estimated Cost:** $50,000, including signal removal, closing median, and installing signs. **Traffic Disruption:** Minor.
2	Interconnect traffic signals at Overbrook Drive in Wellesley and Oak Street in Natick.	Reduce delays and number of stops.	None.	Delays and stops reduced by signal coordination; there is no traffic rerouting to create additional delay for abutters.	Reduction in rear-end collisions, as vehicles are stopped less frequently.	None required.	No impact.	**Estimated Cost:** $300,000, including interconnection equipment, drainage, and lengthening of the eastbound left-turn bay. **Traffic Disruption:** Moderate.

[1]The estimated cost given is for construction only, exclusive of any land-taking.

TABLE 3-8
Weston Road Interchange: Improvement Concepts

Concept #	Modification	Purpose/Objective	Impacts					Estimated Construction Costs[1]/Traffic Disruption
			Accessibility	Level of Service/Delays	Safety	Land-Takings	Environment	
1	Improve signing on Weston Road approaches to ramps; eliminate visual obstructions.	Improve safety by eliminating existing confusion through clear identification of ramp entrances/exits with directional and guide signs.	No impact.	No impact.	Minor improvement.	None required.	No impact.	**Estimated Cost:** $50,000, including improved signs and removal of visual obstructions. **Traffic Disruption:** Very minor.
2	Convert Cleveland Road approach at Service Road to serve westbound traffic only by installing a half closure.	Resolve the existing vehicular conflict between traffic exiting Route 9 via Service Road and Cleveland Road eastbound traffic.	Would require Cleveland Road eastbound traffic to use Pilgrim Road or Elmwood Road to access Cleveland Road.	Improved traffic operations on Service Road.	Improvement in safety through eliminating the existing vehicular conflict.	None required.	No impact, except for vehicle-miles of travel added by rerouting Cleveland Road eastbound traffic.	**Estimated Cost:** $50,000, including installation of a half closure and improved signs. **Traffic Disruption:** Very minor.
3	Redesign channelization and install traffic signal.	Improve traffic operations and safety by eliminating left-turn movements.	Would require Cleveland Road eastbound traffic and westbound lefts to use the internal street system to access Weston Road.	Reduction in traffic delays, through providing free right turns onto Route 9.	Improvement in safety through eliminating unprotected left turns.	Encroaching on the boundaries of the Overbrook Reservation.	Significant encroachment on the Overbrook Reservation.	**Estimated Cost:** $750,000, including ramp reconstruction, intersection improvements, new signal, and signs. **Traffic Disruption:** Moderate
4	Reconstruct northwest-quadrant ramp to handle all westbound movements.	Discontinue use of substandard ramp to eliminate undesirable exit/entrance without taking property or eliminating residential access.	Improved access to residences adjacent to ramp, because of safer approach.	Concentration of movements in one quadrant would require signalization at the Weston Road junction, resulting in better LOS. Reduction in traffic delays if exclusive left-turn lanes are provided.	Major improvement if ramps were upgraded to modern standards, and the ramp Weston Road junction is signalized.	Encroachment Overbrook Reservation adjacent to ramp.	Significant impacts on Overbrook Reservation and Boulder Brook.	**Estimated Cost:** $1–2 million, including new intersection, ramp reconstruction, improved signs, and converting ramp in the northeast quadrant to local access only. **Traffic Disruption:** Traffic diversions during construction.
5	Replace existing interchange with a new standard diamond interchange.	Discontinue use of substandard ramp to eliminate undesirable exit/entrance.	Would impact accessibility; Reduced access to abutting properties.	LOS would improve to D at the ramp-Weston Road junctions, if left-turn bays were provided on Weston Road.	Major improvement if protected left turns were provided at the ramp-Weston Road junctions.	Significant land-takings and relocation of driveways.	Potentially unacceptable impacts on Overbrook Reservation.	**Estimated Cost:** $8 million including widening Route 9 bridge, new diamond interchange, and improved signs. **Traffic Disruption:** Traffic diversions during construction.

[1] The estimated cost given is for construction only, exclusive of any land-taking.

TABLE 3-9
Oak and Westgate Street Intersection: Improvement Concepts

Concept #	Modification	Purpose/Objective	Impacts					Estimated Construction Costs[1]/Traffic Disruption
			Accessibility	Level of Service/Delays	Safety	Land-Takings	Environment	
1	Close median break with a locked gate or mountable raised median.	Eliminate vehicle conflicts by preventing all median crossings except for emergency services.	Closing median would require Route 9 lefts to use Kingsbury Street or Weston Road to access Oak/Westgate streets.	Four-way uncontrolled intersection would be replaced with 2 T-intersections comparable to other Route 9 locations; both intersections will operate at LOS C.	Elimination of uncontrolled turning movements is safety benefit.	None required.	None, except for increased vehicle-miles of travel (VMT) associated with circuitous rerouting of turning vehicles.	**Estimated Cost:** $50,000 **Traffic Disruption:** Very minor.
2	Redesign as signalized intersection.	Improve traffic safety while retaining crossing opportunity.	Would improve accessibility by providing for all movements at all approaches.	Intersection delay is created for Route 9 through vehicles; signalized intersection operates at LOS F if two through lanes and a left-turn lane are provided each way on Route 9, at LOS D if three through lanes and a left-turn lane.	Safety is improved by providing full protection for U-turns and left-turns.	Minor land-taking probably required.	None.	**Estimated Cost:** $500,000, including signal installation and intersection geometric changes. **Traffic Disruption:** Moderate: Lane shifts, some detouring.

[1] The estimated cost given is for construction only; exclusive of any land-taking.

TABLE 3-10
Kingsbury Street Intersection: Improvement Concepts

Concept #	Modification	Purpose/Objective	Impacts					Estimated Construction Costs[1]/Traffic Disruption
			Accessibility	Level of Service/Delays	Safety	Land-takings	Environment	
1	Close median breaks for U-turn bays.	Eliminate difficult, unprotected U-turn conditions.	Closes only U-turn capability in this area. The nearest alternatives, at Oak/Westgate streets and Worcester Street at Fire Station, require detours of up to a mile that would significantly impact school-bound traffic.	Eliminates unprotected and uncontrolled U-turns, which operates at poor LOS (F).	Eliminates unprotected, uncontrolled U-turns, which experience relatively high crash incidence.	None required.	No impact, except for vehicle-miles of travel (VMT) added by rerouting U-turns.	**Estimated Cost:** $50,000, including closing the median U-turn bays and installing guide signs to direct motorists to Kingsbury Street. **Traffic Disruption:** Very minor.
2	Install traffic signal and relocate the westbound U-turn bay to Kingsbury Street intersection.	Provide for safer, protected U- and left turns into Kingsbury Street while staying within existing right-of-way.	Maintains U-turn capability while providing protection for highest-volume U-turns and left-turns; existing U-turn access to Audubon Road is maintained; Kingsbury Street approach remains right-turn-only.	Intersection would operate at LOS F if 2 through lanes were maintained each way on Route 9; would improve to LOS B if an exclusive right turn lane is added in the eastbound direction.	Significantly improves safety by reducing angle collisions through provision of protected U-turns and left turns.	None would be required if 2 through lanes were maintained; some land-takings if if an exclusive right turn lane is added in the eastbound direction.	No impact if improvements remain within existing right-of-way.	**Estimated Cost**: $500,000 or higher, including intersection improvements, new traffic signal, and relocation of the westbound U-turn bay. **Traffic Disruption:** Major construction detours and lane-shifting.
3	Install traffic signal, widen Route 9, and relocate both U-turn bays to a redesigned Kingsbury Street intersection.	Provide for safer U-turns and left turns at a single location in both directions.	Maintains U-turn capabilities while providing protection for all U- and left-turns; Audubon Road's median would need to be opened to allow access to both sides.	Intersection would operate at LOS F if 2 through lanes were maintained each way on Route 9; would improve to LOS D if 3 through lanes were provided.	Significantly improves safety by reducing angle collision through provision of protected U-turns and left turns.	None would be required if 2 through lanes were maintained; some land takings if 3 through lanes were provided.	No impact if improvements remain within existing right-of-way.	**Estimated Cost**: $750,000 or higher, including intersection improvements, new traffic signal, and relocation of the U-turn bays. **Traffic Disruption:** Major construction detours and lane-shifting.
4	Signalize the U-turn bays on both sides of the Kingsbury Street.	Provide for safer U-turns at both locations without land-taking.	Maintains present U-turn capabilities while providing protection.	Intersection would operate at LOS D if both signals were coordinated to reduce delay and stops.	Significantly improves safety by reducing angle collision through provision of protected U-turns and left turns.	None required.	No impact if improvements remain within existing right-of-way.	**Estimated Cost**: $500,000 or higher, including intersection improvements, new traffic signal, and relocation of the U-turn bays. **Traffic Disruption:** Major construction detours and lane-shifting.

[1] The estimated cost given is for construction only, exclusive of any land-taking.

TABLE 3-11
Grantland Road Intersection: Improvement Concepts

Concept #	Modification	Purpose/Objective	Impacts					Estimated Construction Costs[1]/Traffic Disruption
			Accessibility	Level of Service/Delays	Safety	Land-Takings	Environment	
1	Close Grantland Road access to Route 9 and lengthen Route 9 eastbound on-ramp.	Improve safety and traffic operations by eliminating vehicle conflict point, providing better sight distance, and creating longer acceleration lane for Route 9 on-ramp traffic.	Grantland Road residents rerouted to Oakland Street; affects emergency delivery services.	Improved LOS because of reduced volume.	Significant improvement in safety associated with reduced possibilities of vehicle conflict and improved ramp geometry.	Minimal land-taking would be required.	Minimal impact resulting from increased vehicle-miles of travel (VMT) from rerouting Grantland Road traffic.	**Estimated Cost:** $100,000, including closing Grantland Street and lengthening Route 9 eastbound on-ramp. **Traffic Disruption:** Very minor.
2	Lengthen Route 9 eastbound on-ramp and make geometric improvements.	Improve safety and traffic operations.	No impact.	No impact.	Significant improvement in safety associated with improved ramp geometry.	Minimal land-taking would be required.	No impact.	**Estimated Cost:** $100,000, including intersection geometric improvements and lengthening Route 9 eastbound on-ramp. **Traffic Disruption:** Very minor.

[1] The estimated cost given is for construction only; exclusive of any land-taking.

TABLE 3-12
Oakland Street Intersection: Improvement Concepts

Concept #	Modification	Purpose/Objective	Impacts					Construction Costs[1]/Traffic Disruption
			Accessibility	Level of Service/Delays	Safety	Land-Takings	Environment	
1	Close median and remove signal.	Improve safety by eliminating intersection.	Significant reduction in accessibility to abutting properties.	Reduced delay for Route 9 traffic; LOS C for Oakland Street right turns; increased travel times for rerouted traffic.	Reduction in rear-end collisions anticipated.	None required.	No impact.	**Estimated Cost**: $50,000. **Traffic Disruption:** Very minor.
2	Improve warning signs at Route 9 westbound approach and monitor performance.	Improve safety.	No impact.	No impact.	Improvement anticipated.	None required.	No impact.	**Estimated Cost**: $50,000, including improved signs and monitoring performance. **Traffic Disruption:** None.

[1] The estimated cost given is for construction only; exclusive of any land-taking.

TABLE 3-13
Cedar Street Interchange: Improvement Concepts

Concept #	Modification	Purpose/Objective	Impacts					Estimated Construction Costs[1]/Traffic Disruption
			Accessibility	Level of Service/Delays	Safety	Land-Takings	Environment	
1	Close the northeast quadrant Route 9 westbound on-ramp from Cedar Street and signalize the ramp/Cedar Street intersection north of Route 9.	Improve safety by eliminating the weave under the bridge.	Would impact access to businesses in the northeast quadrant as the ramp would serve only traffic exiting Route 9 onto Cedar Street northbound.	Would not reduce traffic delays at the interchange.	Potential safety benefits resulting from elimination of the weaving section under the bridge.	Encroachment on the boundaries of the Rosemary Brook Aquifer.	Some impact associated with pavement widening within Rosemary Brook Aquifer.	**Estimated Cost:** $750,000, including signal installation and equipment, modifying the northeast quadrant ramp, and improved signs. **Traffic Disruption:** Moderate.
2	Replace interchange with a new diamond interchange.	Improve traffic operations and safety.	Some businesses' properties in the northeast quadrant would be taken, others would require relocated access.	Traffic operations on the ramps as well as on Cedar Street would be improved. The proposed signalized intersection on the north side would operate at LOS D with a 5-lane bridge.	Significant safety benefits resulting from elimination of the weaving movements.	Relocations of driveways and potential land-takings encroaching on the boundaries of the Rosemary Brook Aquifer.	Potential impacts to water resources, parkland.	**Estimated Cost:** $10 million or more including a new bridge, replacing ramps, new signals, and other equipment. **Traffic Disruption:** Would require traffic diversion during construction.
3	Replace existing interchange with an overpass single-point urban (SPUI) interchange.	Improve traffic operations and safety, with reduced right-of-way needs compared to Concept 2.	Access to businesses would be more circuitous.	Traffic operations would be improved if a 5-lane bridge were provided.	Significant improvements resulting from the elimination of weaving movements.	Potentially significant, associated with relocating access to abutting properties.	Potential impacts to water resources, parkland.	**Estimated Cost:** $15 million or more, including a new bridge, replacing ramps, new signal, and other equipment. **Traffic Disruption:** Would require traffic diversion during construction.

[1] The estimated cost given is for construction only; exclusive of any land-taking.

TABLE 3-14
William Street Intersection: Improvement Concepts

Concept #	Modification	Purpose/Objective	Impacts					
			Accessibility	Level of Service/Delays	Safety	Land-takings	Environment	Estimated Construction Costs[1]/Traffic Disruption
1	Formalize current temporary arrangement, permanently improving channelization by extending barrier separation between Route 9 traffic and entering William Street traffic; improve signs on Route 9 westbound.	Permanently provide the safety level provided by the current temporary arrangement.	No change.	No impact.	Similar to current police-controlled situation.	None required.	No impact.	**Estimated Cost**: $50,000. **Traffic Disruption:** Minor.
2	Prohibit right turns from Route 9 into William Street	Eliminate one weaving movement in the section between Ellis/Quino-bequin on-ramp and William Street.	Route 9 westbound traffic destined for William Street must exit at Chestnut Street and use the service road.	Additional ramp traffic resulting from diversion requires three intersections in Newton to be signalized to address congestion and queues. The Newton intersections would operate at LOS D, except for the eastbound service road movements south of Route 9, which would operate at LOS F in the PM peak period.	Elimination of minor weaving movements and signalization of the Newton intersections would improve safety and traffic operations.	None required.	No impact.	**Estimated Cost**: $1 million, including intersection geometric and signalization improvements. **Traffic Disruption:** Moderate.
3	Widen acceleration area west of William Street to provide a separate right-turn lane onto Route 128 northbound.	Improve traffic operations and safety by channeling William Street traffic that is headed for Route 128 so that it stays off of Route 9—in effect providing a two-lane on-ramp to Route 128 northbound with one lane serving Route 9 traffic and the other serving William Street traffic.	Increased accessibility for William Street traffic headed for Routes 9 and 128.	Reduces traffic delay at William Street—which would operate at LOS D.	Significant improvement associated with reduced likelihood for vehicle conflict.	Possible minor encroachment on Wellesley Office Park.	Moderate impact associated with road widening.	**Estimated Cost**: $1.5 million (road to be widened into area of rock). **Traffic Disruption:** Major lane-shifting affecting Route 9 and William Street traffic.

[1] The estimated cost given is for construction only; exclusive of any land-taking.

4 RECOMMENDED IMPROVEMENTS AND IMPLEMENTATION PLAN

The improvements that are recommended by this study for implementation are identified and described in this chapter; summaries are given in Table 4-1 at the end of the chapter. For most of the locations, the recommendation is to implement one of the improvement concepts as it is described in chapter 3; the descriptions of these concepts that are provided in this chapter contain the same information as the descriptions in chapter 3, though, in some cases, recommendations regarding time frame have been added.

The roles of MassHighway, the town of Wellesley, and interested citizens in the development of the recommendations have been summarized at the beginning of chapter 3.

This chapter concludes with information on the implementation process.

4.1 OVERBROOK DRIVE INTERSECTION

Recommended Improvements: Concept 2–Interconnect Traffic Signals at Overbrook Drive in Wellesley and Oak Street in Natick

The recommended improvement for the Overbrook Drive intersection is Concept 2 (Figure 4-1), in which the traffic signals at Overbrook Drive in Wellesley and Oak Street in Natick would be interconnected.

The objective of this modification is to improve traffic operations on Route 9 by reducing delays and stops. MassHighway is studying the Oak Street intersection for traffic and safety improvements. These two intersections are less than 2000 feet apart. Treating them as a system rather than individual intersections would be advantageous. Additional modifications include lengthening the Route 9 eastbound left-turn bay at Overbrook Drive to accommodate at least five vehicles and improving the drainage at the intersection.

The impact of these modifications on safety would be beneficial; as traffic on Route 9 would be stopped less frequently, rear-end collisions would be reduced. Lengthening the eastbound Route 9 left-turn bay would prevent its traffic queue from extending into the main travel lanes. With traffic sensors, signal coordination, and improved signal timings, traffic operations at this intersection would be more efficient and acceptable (LOS D or better) during the peak hours.

Implementing this concept would not require any land-takings or have any adverse impacts on the environment. Construction costs, which include interconnections, new signal equipment at Overbrook Drive, lengthening of the eastbound Route 9 left-turn bay, drainage improvements, and maintenance of traffic flow during construction, are estimated at $300,000.

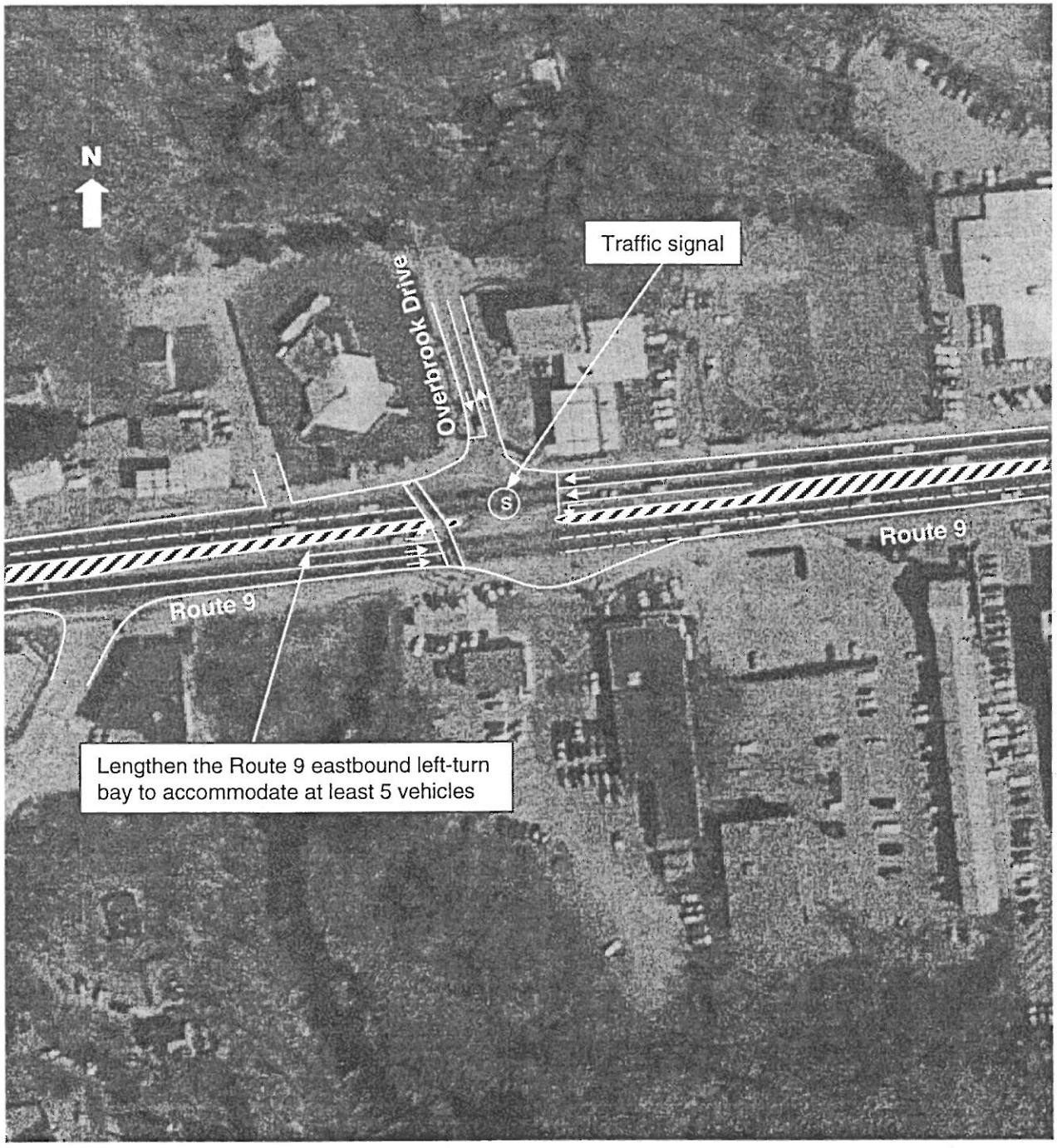


FIGURE 4-1
Overbrook Drive Intersection: Recommended Improvements
Concept 2 - Interconnect Traffic Signals at Overbrook Drive in Wellesley and Oak Street in Natick

4.2 WESTON ROAD INTERCHANGE

This study examined both short- and long-term improvement concepts for the Weston Road interchange, that is, both concepts that could be implemented relatively quickly and more extensive modifications that would take relatively long to implement. One possible option was to recommend implementation of both short-term improvements and long-term ones. At the public meetings, opposition was expressed to Concepts 2, 3, and 4 in both categories. It is nevertheless recommended that Concept 5, a long-term improvement, be implemented.

- **Recommended Short-Term Improvements: None**

  It is not recommended that any of the short-term (as defined above) options be implemented.

- **Recommended Long-Term Improvement: Concept 5 – Replace Interchange with a New Standard Diamond Interchange**

The Route 9 bridge over Weston Road is due for reconstruction in the near future. It is recommended that, when this reconstruction takes place, the existing, substandard interchange be replaced with a modern diamond interchange. The antiquated ramp geometry would be brought into conformance with design standards. Part of this concept is to signalize the ramp–Weston Road intersections, and install signs to improve traffic operations and safety. These modifications would improve traffic operations on the ramps as well as at the ramp–Weston Road intersections (Figure 4-2). A diamond interchange would significantly reduce the congestion on the eastbound on- and off-ramps and at the ramp-Weston Road intersection south of Route 9. The proposed signalized ramp–Weston Road intersections would operate at LOS D or better if a left-turn bay and a single through lane were provided at each intersection on Weston Road.

This concept includes major modifications that would impact accessibility. Some businesses and residential properties in all four quadrants would have to be taken and driveway access for others relocated. These land-takings and relocations of driveways would also impact water resources, especially the Overbrook Reservation. Construction costs, including building a new bridge, replacing ramps, and installing new traffic signals, new guide and directional signs, and other equipment, would be high; they are estimated in the range of $8 million or more. Traffic disruption during construction would include major traffic diversions and delays for both Route 9 and Weston Road traffic.

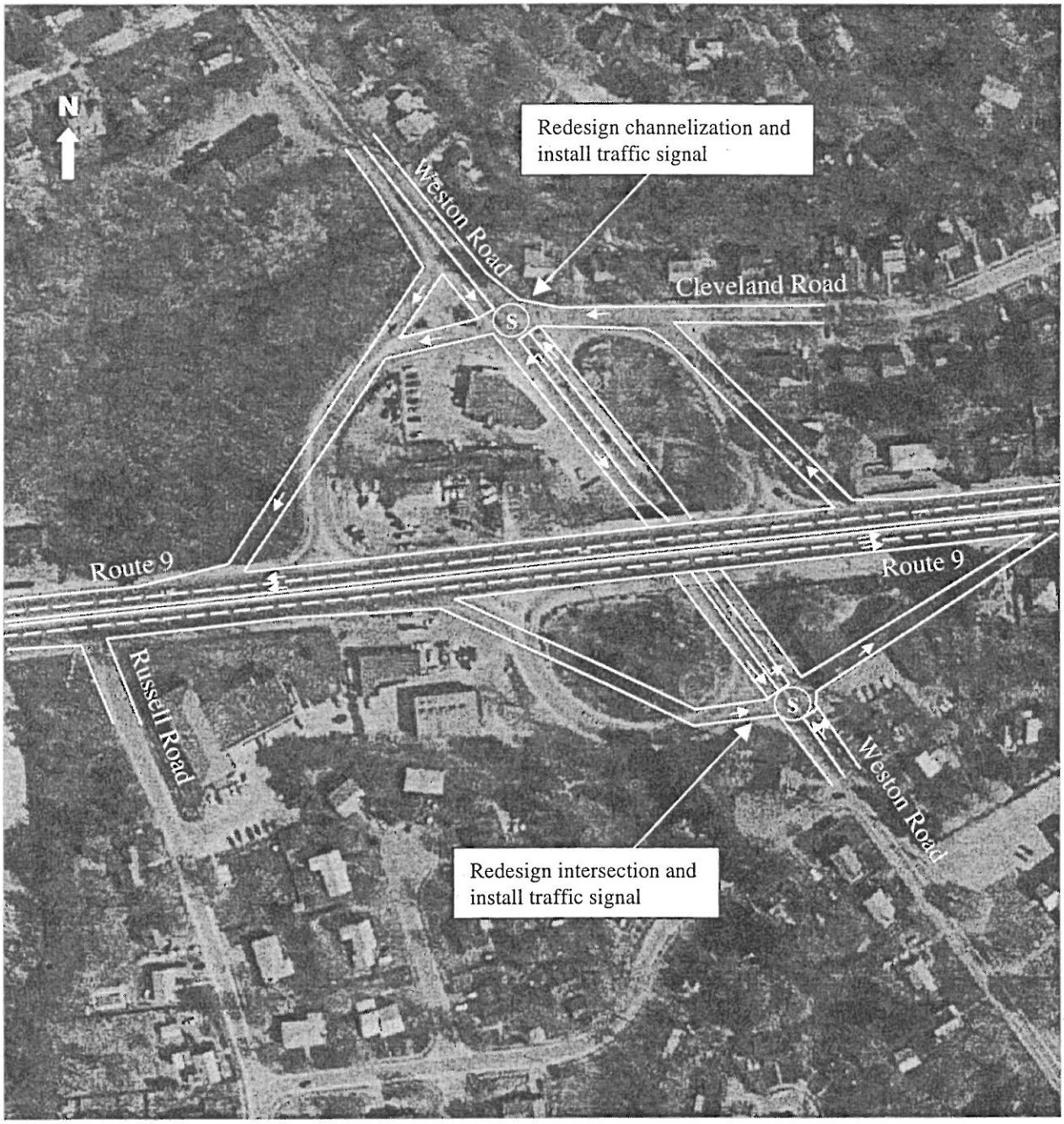


FIGURE 4-2
Weston Road Interchange: Recommended Improvements
Concept 5 - Replace Interchange with a New Standard Diamond Interchange

4.3 OAK AND WESTGATE STREETS INTERSECTION

Recommended Improvements: Concept 1 – Close Median Break with a Locked Gate or Mountable Raised Median

The recommended improvement closes the median break in Route 9 with a locked gate or a bituminous mountable median to eliminate vehicle conflicts involving unprotected left turns and allows only right turns from Oak and Westgate streets (Figure 4-3). The locked gate or mountable median would be closed at all times except for emergency uses.

Closing the median would not affect accessibility severely, as the U-turn bays on both sides of the Kingsbury Street intersection would be signalized; protected turns would then be available in less than one-half mile in either direction (at Kingsbury Street and at Weston Road). Current Route 9 eastbound lefts onto Westgate Street would have to proceed to the U-turn bay east of Kingsbury Street, then make a safe, protected turn there, proceed westbound on Route 9, and turn right onto Westgate Street. Current Route 9 westbound lefts onto Oak Street would have two options:

1. Make a safe, protected turn at the U-turn bay west of Kingsbury Street, proceed eastbound on Route 9, turn right onto Kingsbury Street, turn right onto Linden Street, and follow the internal street network to Oak Street.

2. Proceed westbound on Route 9 to access Weston Road southbound, and use the internal street network (Weston Road or Linden Street) to access Oak Street.

At a minimum, the U-turn bays on both sides of Kingsbury Street intersection would need to be signalized first in order to make this concept a reasonable alternative. The projected levels of service for the two T-intersections that would replace the existing two-way-stop-controlled intersection are acceptable, LOS C or better.

No land-taking would be required for this modification, and there would be no adverse environmental impacts, except for the extra vehicle-miles of travel resulting from the banned left turns. Very minor traffic disruptions would be expected during construction, the cost of which is estimated at $50,000.

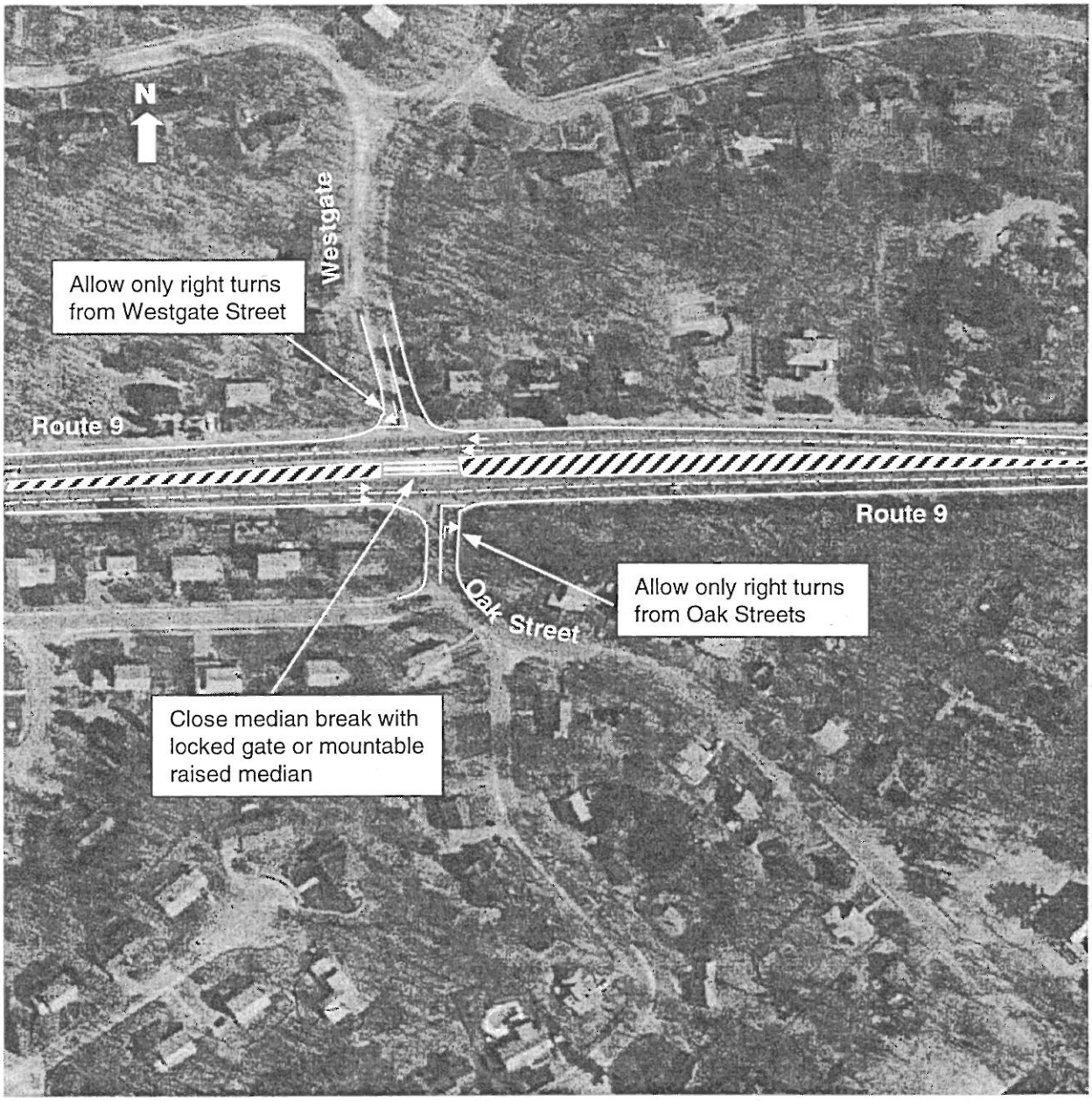


FIGURE 4-3
Oak/Westgate Streets Intersection: Recommended Improvements
Concept 1-Close Median Break with Locked Gate or Mountable Raised Median

4.4 KINGSBURY STREET INTERSECTION

Recommended Improvements: Concept 4–Signalize the U-Turn Bays on Both Sides of the Kingsbury Street Intersection

The improvement recommended for the Kingsbury Street intersection is Concept 4, in which the U-turn bays located on both sides of the intersection would be signalized to allow safe protected turns (Figure 4-4).

The concept would signalize the U-turn bays located on both sides of the Kingsbury Street intersection, allowing safe, fully protected turns. This would increase the safety of traffic operations without adding a third lane in either direction of Route 9 and without any land-takings. The existing pedestrian traffic signal at the Kingsbury Street intersection would be retained, as would be the two through lanes in both directions of Route 9. The Kingsbury Street approach would remain right-turn only. The proposed traffic signals would be coordinated with the pedestrian signal at the Kingsbury Street intersection to improve traffic operations and pedestrian safety.

During the AM and PM peak hours, traffic would operate satisfactorily: LOS D or better. No land-taking would be required, and no negative environmental impacts would result. Moderate traffic disruptions would be expected during construction, the cost of which is estimated at $500,000, including the new traffic signals.

4.5 GRANTLAND ROAD INTERSECTION

Recommended Improvements: Concept 1—Close Grantland Road Access to Route 9 and Lengthen Route 9 Eastbound On-Ramp

The improvements recommended for the Grantland Road intersection is to close the Grantland Road access to Route 9 and lengthen the Route 9 eastbound on-ramp. This concept has more safety and operational benefits but it also affects emergency delivery services and some opposition was expressed at the public meetings to this improvement concept.

Closing Grantland Road would resolve the vehicular conflicts at this intersection, eliminate the stop sign at the Worcester Street approach that drivers do not comply with, and prevent cut-through traffic from using Grantland Road. However, this measure would affect delivery of emergency services and lacks space for a cul-de-sac to allow drivers to turn around and change direction. The one-way ramp near Grantland Road intersection should be examined if it can be realigned and moved towards Route 9 to create more space for a cul-de-sac for Grantland Road. Moderate traffic disruptions would be expected during construction, the cost of which is estimated at $100,000.

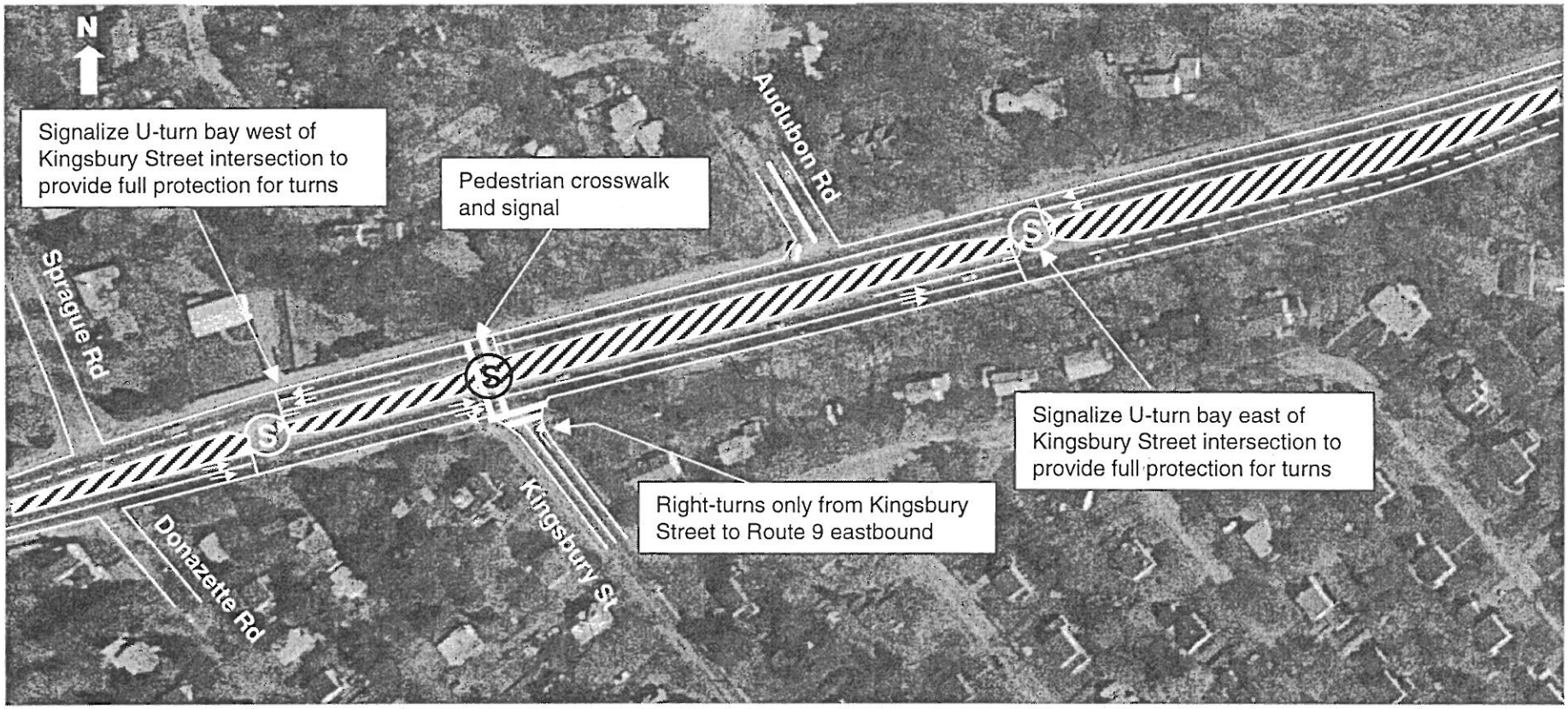


FIGURE 4-4
Kingsbury Street Intersection: Recommended Improvements
Concept 4 - Signalize the U-Turn Bays Located on Both Sides of Kingsbury Street Intersection

4.6 OAKLAND STREET INTERSECTION

Recommended Improvement: Concept 2 – Improve and Monitor Signs at the Route 9 Westbound Approach

The improvement recommended for the Oakland Street intersection is Concept 2, which would provide better warning signs for motorists heading westbound on Route 9 (Figure 4-5). New warning signs would be installed or existing signs modified to increase awareness of the upcoming traffic signal at Oakland Street.

These improvements would have no impact on traffic delays or accessibility; however, they would be expected to improve safety. No land-takings would be involved and no adverse impacts on the environment would be expected. Construction costs would be minor, estimated at under $50,000, including improving signage and monitoring results. The impact on traffic flow during construction would be expected to be negligible.

4.7 CEDAR STREET INTERCHANGE

This study examined one short-term improvement concept and two long-term improvement concepts for the Cedar Street interchange, that is one concept that could be implemented relatively quickly and two concepts involving more extensive modifications that would take relatively long to implement. One possible option was to recommend implementation of both short-term and long-term concepts.

Recommended Short-Term Improvements: Concept 1 – Close the Northeast Quadrant Route 9 Westbound On-Ramp from Cedar Street and Signalize the ramp/Cedar Street Intersection North of Route 9

The short-term improvements recommended for the Cedar Street interchange is to close the northeast quadrant Route 9 westbound on-ramp from Cedar Street and signalize the ramp/Cedar Street intersection north of Route 9. This concept improves safety for the Route 9 westbound traffic by eliminating the short weave under the bridge by closing the northeast quadrant Route 9 westbound on-ramp from Cedar Street. Additional modifications include coordinating the traffic signals to improve traffic operations, modifying the ramp in the northwest quadrant for use by the westbound traffic, and lengthening the westbound on-ramp in the northwest quadrant.

This concept has significant safety benefits but minimal reduction in traffic delays. The proposed improvements would affect accessibility for the businesses in the northeast quadrant, as the ramp in that quadrant would serve only traffic exiting Route 9 onto Cedar Street northbound. The proposed improvements would impact water resources and includes modifications that would impact accessibility through relocation of access to some properties in the northeast quadrant. Moderate to major traffic disruption would be expected during construction, the cost of which is estimated at $750,000, including signal installation and equipment, modifying the northeast and northwest quadrant ramps, and improved signs. The short-term recommendations for the Cedar

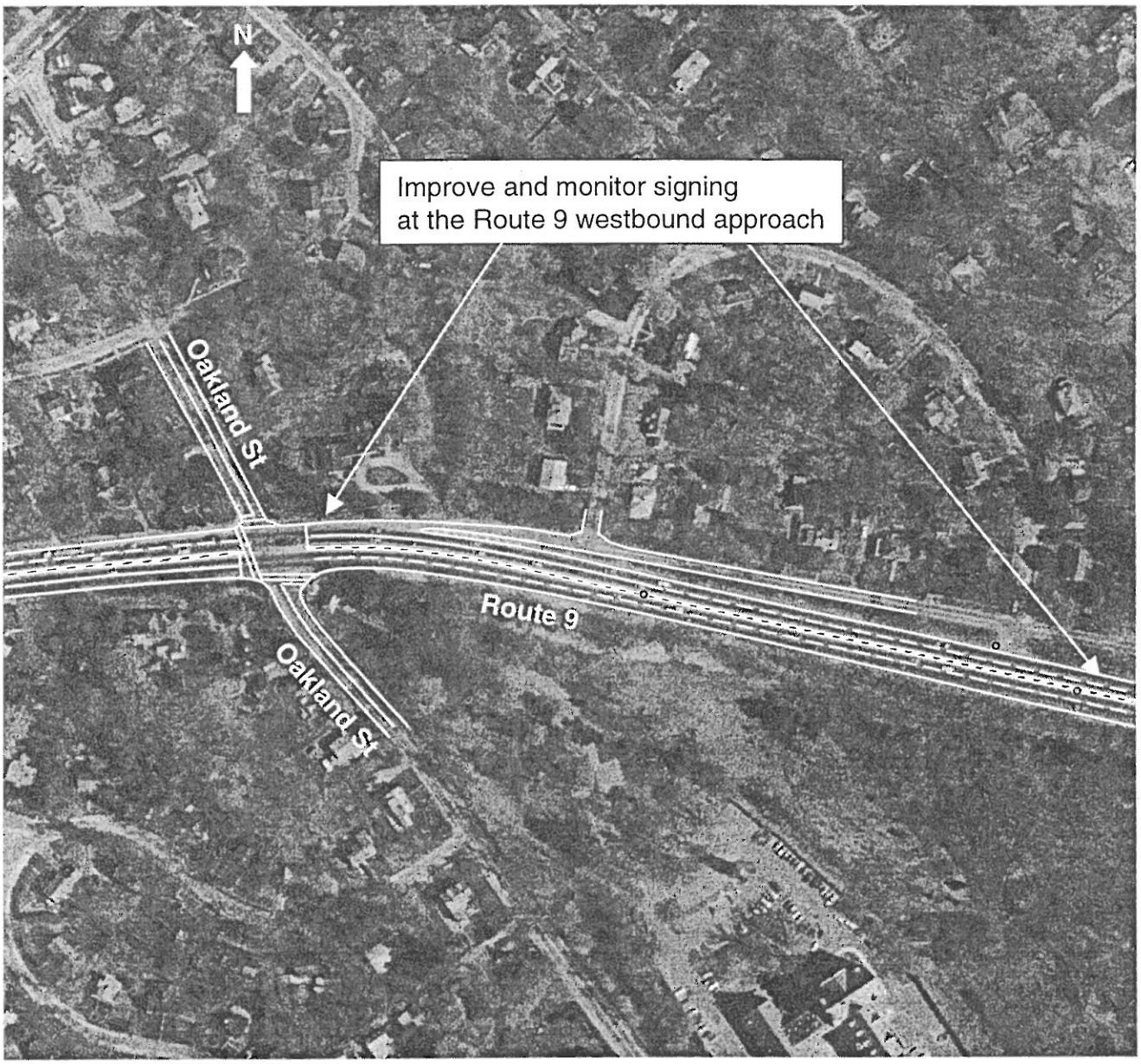


FIGURE 4-5
Oakland Street Intersection: Recommended Improvements
Concept 2 - Improve and Monitor Signs at the Route 9 Westbound Approach

Street interchange should be considered only when the long-term recommendations are expected to take a long time to implement.

Recommended Long-Term Improvements: Concept 2 – Replace Interchange with a New Diamond Interchange

The Cedar Street bridge over Route 9 is due for reconstruction in the near future. When this reconstruction takes place, it is recommended that the existing interchange be replaced with a modern diamond interchange and, possibly, that Route 9 be shifted to the north (Figure 4-6). The new interchange would include a frontage road on the southerly side for accessing businesses and properties in the southwest and southeast quadrants. It would require the construction of a new bridge to handle Cedar Street traffic and access to the businesses located in this area. It would replace the antiquated ramp geometry on the westbound side with modern, diamond-type ramps that meet the state design standards, and widen the bridge over Route 9. Part of this concept is to signalize the ramp–Cedar Street intersection on the north side of Route 9 and coordinate it with the south-side signal to improve traffic operations and safety. The modifications would improve traffic operations and safety on the ramps, Cedar Street, and Route 9. It eliminates the weave under the bridge involving Route 9 westbound traffic. The proposed signalized intersection on the north side would operate at LOS D with a 5-lane bridge and at LOS F with a 4-lane bridge.

This alternative would require land-takings and would impact water resources and parklands. Some measures would need to be taken to minimize the impacts on water resources and any other environmental impacts such as on wetlands. This concept includes major modifications that would impact accessibility. Some businesses' properties in the northeast quadrant would have to be taken and driveway access for others relocated. Construction costs, including building a new bridge, replacing ramps, and installing a new traffic signal and other equipment, would be high; they are estimated in the range of $5 million or more. Traffic disruption during construction would include major traffic diversions and delays for both Route 9 and Cedar Street traffic.

4.8 WILLIAM STREET INTERSECTION

Recommended Improvements: Combination of Concepts 2 and 3 – Prohibit Right Turns from Route 9 onto William Street and Widen Acceleration Area West of William Street to Provide a Separate Right-Turn Lane onto Route 128 Northbound.

The recommendation is to implement both Concept 2 and Concept 3 (Figure 4-7). These concepts include not only improvements at the William Street intersection and in the immediate vicinity, but also improvements that address traffic operations and safety problems at three of the intersections in Newton that were examined, as some of the traffic headed for Wellesley Office Park uses those intersections. The recommended measures are:

1. Prohibit right turns from Route 9 onto William Street.

2. Channel traffic into and out of William Street by constructing a traffic island.

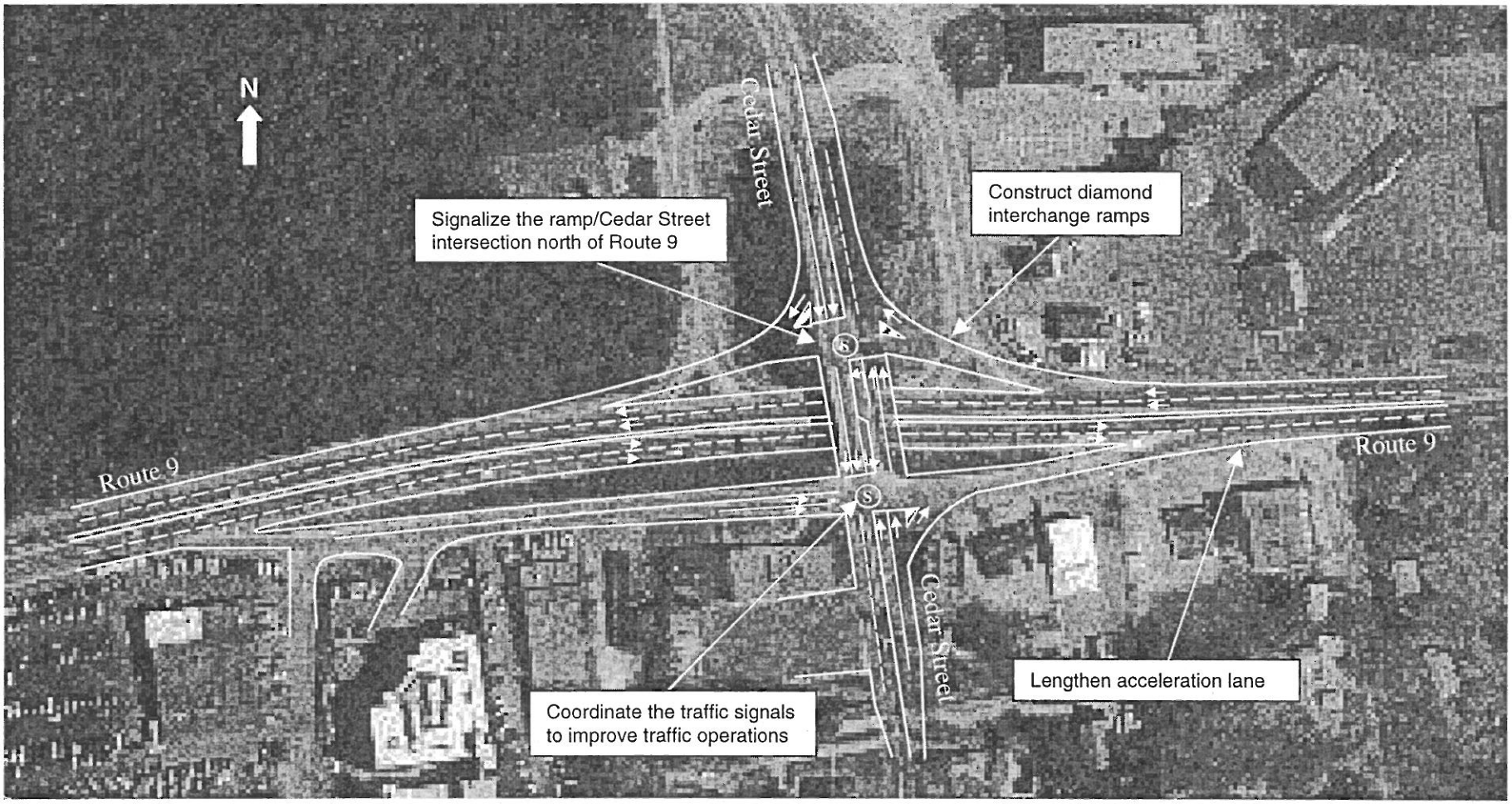


FIGURE 4-6
Cedar Street Interchange: Recommended Improvements
Concept 2 - Replace Interchange with a New Diamond Interchange

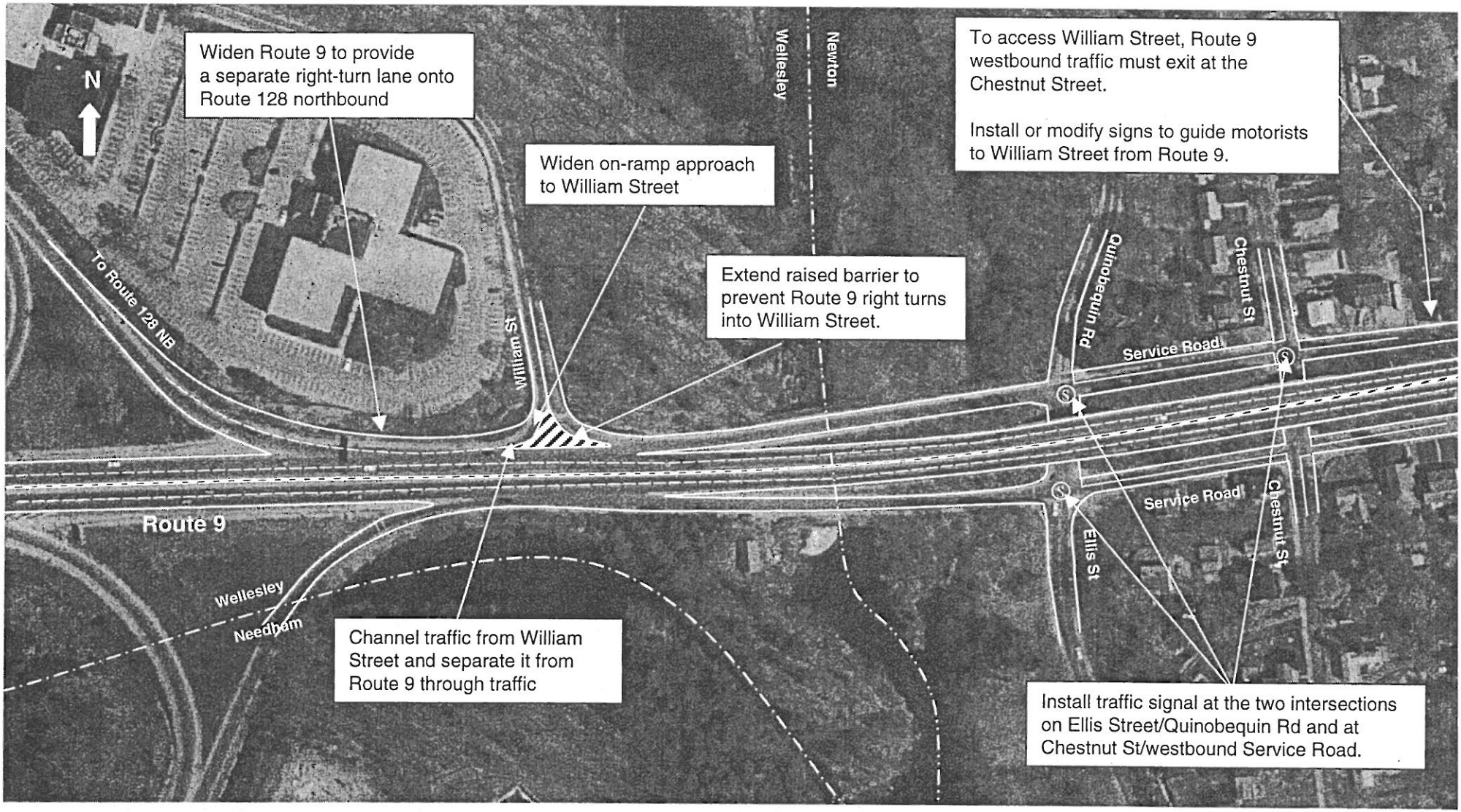


FIGURE 4-7
William Street and Nearby Intersection: Recommended Improvements
Combination of Concepts 2 and 3 - Prohibit Right-Turns from Route 9 onto William Street;
Widen Acceleration Area West of William Street to Provide a Separate Right-Turn Lane onto Route 128 Northbound

3. Widen the acceleration area west of William Street to provide a separate right-turn lane onto Route 128 northbound.

4. Install and modify signs on Route 9 westbound to guide motorists to William Street.

5. Signalize the intersection of Ellis Street at Route 9 eastbound service road in Newton.

6. Signalize the intersection of Ellis Street/Quinobequin Road at Route 9 westbound service road in Newton and add a left-turn bay to the northbound approach.

7. Signalize the intersection of Chestnut Street at Route 9 westbound service road in Newton and add a left-turn bay to the northbound approach.

Elimination of right turns from Route 9 would improve safety at the William Street intersection, as it removes one of the weaving movements in this vicinity (Route 9 right turns and Route 9 westbound on-ramp traffic). The prohibition of right turns would require that traffic from Route 9 westbound destined for William Street exit at Chestnut Street and use the service road.

It is because of the additional traffic resulting from the diversion that signalization of the three intersections in Newton is recommended, to address congestion and queues. The Newton intersections would operate at acceptable levels of service (LOS D or better), except for the eastbound service road movement at the Chestnut Street intersection south of Route 9. The left-turn bays would enhance traffic operations for Chestnut and Ellis streets' northbound through traffic as well as providing protected/permitted left turns onto the westbound on-ramp. The traffic signals would also improve safety at the intersections, which presently suffer from poor sight distance.

Widening the acceleration area on Route 9 west of William Street and constructing the traffic island would provide a separate right-turn lane onto the Route 128 northbound on-ramp. The idea is to channel the William Street traffic that is headed for Route 128 northbound so that it stays off of Route 9, in effect providing a two-lane on-ramp to Route 128 northbound, with one lane serving Route 9 traffic and the other serving William Street traffic. The two lanes would merge into a single traffic lane before entering Route 128 northbound. The modifications would improve traffic operations and safety by providing additional space for the complex weaving movements and thus reducing vehicle conflicts. The proposed improvements would require land-takings, possibly encroaching on Wellesley Office Park and traffic disruption during construction. Construction is estimated to cost approximately $2 million.

4.9 IMPLEMENTATION PROCESS

The town of Wellesley and the city of Newton may request that the Massachusetts Highway Department assist in the implementation of projects derived from this study. The process is as follows:[1]

[1] The above process assumes that none of the improvements requires environmental impact assessments.

1. The community must request in writing assistance from the Massachusetts Highway Department District 4 Director. The letter should include such information as why improvements are needed, a description of the proposed improvements, and the level of local support for the project. A copy of the letter should be sent to the Executive Secretary of the Boston Metropolitan Planning Organization (MPO) as well.

2. The District Office should investigate and review the request and possibly request a Project Justification Report. It is the responsibility of the community to prepare the report, if requested, and submit it to the District Office and the MPO.

3. At this point, the community should meet with the District Office and MPO to discuss the potential priority of the proposed project and plan the remaining steps to complete the process, including the need to hold an informational meeting to determine the degree of community support or opposition.

4. If the evaluation of the Project Justification Report is favorable and there is local support for the project, District Office will submit a favorable request to the Project Review Committee (PRC) of MassHighway. The PRC then determines whether the proposed project is eligible for federal and state highway funding then MassHighway notifies the community of the results.

5. Once the proposed project is approved, the community can request that the MPO place the project in the Transportation Improvement Program (TIP). The project must carry with it regional benefits and comply with the Regional Transportation Plan.

6. Once on the TIP, the community can prepare the necessary construction documents and depending on the complexity of the project, submittals may be required at the 25%, 75%, or 100% design phase.

7. MassHighway advertises and awards the project, and issues a notice to proceed to start construction.

Projects from this study can use funds from a variety of funding categories. It should be noted that many other projects compete for the same money; therefore, the priority of the project will determine if it is assigned to a funding category and programmed in the TIP. The funding categories for which the projects are eligible are:

- **National Highway System (NHS)** – Funds highway roads classified as principal arterial, interstate, and connectors to ports and intermodal facilities. Funds can be used for any type of improvement including new lanes, reconstruction, and resurfacing, and are based on 80% federal and 20% state share.

- **Non-Federal Aid (NFA)** - Funds construction, reconstruction, and improvement projects on roads and bridges in urban and rural areas.

- **Surface Transportation Program (STP)** - Funds projects chosen by states and localities on any roads that are not functionally classified as local or rural minor collectors.

- **STP Earmark (STP O)** - A portion of the STP funding earmarked for urban areas with a population over 200,000 for projects chosen by states and localities for any roads that are not functionally classified as local or rural minor collectors.

TABLE 4-1
Recommended Improvements

Intersection/ Interchange	Modification	Purpose/ Objective	Impacts					Estimated Construction Costs[1]/Traffic Disruption
			Accessibility	Level of Service/Delays	Safety	Land-Takings	Environment	
Overbrook Drive	Interconnect traffic signals at Overbrook Drive in Wellesley and Oak Street in Natick (Concept 2).	Reduce delays and number of stops.	None.	Delays and stops reduced by signal coordination; there is no traffic rerouting to create additional for abutters.	Reduce rear-end collisions, as vehicles are stopped less frequently.	None required.	No impact.	**Estimated Cost:** $300,000, including interconnection equipment, drainage, and lengthening of the eastbound left-turn bay. **Traffic Disruption:** Moderate.
Weston Road	Short term: None Long term: Replace existing interchange with a new standard diamond interchange (Concept 5).	Discontinue use of substandard ramp to eliminate undesirable exit/entrance.	Would impact accessibility; Reduced access to abutting properties.	LOS would improve to D at the ramp-Weston Road junctions, if left-turn bays were provided on Weston Road.	Major improvement if protected left turns were provided at the ramp-Weston Road junctions.	Significant land-takings and relocation of driveways.	Potentially unacceptable impacts on Overbrook Reservation.	**Estimated Cost:** $8 million including new bridge, new diamond interchange, and improved signs. **Traffic Disruption:** Traffic diversions during construction.
Oak and Westgate Streets	Close median break with a locked gate or mountable raised median (Concept 1).	Eliminate vehicle conflicts by preventing all median crossings except for emergency services.	Closing median would require Route 9 lefts to use Kingsbury Street or Weston Road to access Oak/Westgate streets.	Four-way uncontrolled intersection would be replaced with 2 T-intersections comparable to other Route 9 locations; both intersections will operate at LOS C.	Elimination of uncontrolled turning movements is safety benefit.	None required.	None, except for increased vehicle-miles of travel (VMT) associated with circuitous rerouting of turning vehicles	**Estimated Cost:** $50,000. **Traffic Disruption:** Very minor.
Kingsbury Street	Signalize the U-turn bays on both sides of the Kingsbury Street intersection (Concept 4).	Provide for safer U-turns at both locations without land-taking.	Maintains present U-turn capabilities while providing protection.	Intersection would operate at LOS D if both signals were coordinated to reduce delay and stops.	Significantly improves safety by reducing angle collisions through provision of protected U-turns and left turns.	None required.	No impact if improvements remain within existing right-of-way.	**Estimated Cost**: $500,000 or higher including intersection improvements, new traffic signal, and relocation of the U-turn bays. **Traffic Disruption:** Major construction detours and lane-shifting.

[1] The estimated cost given is for construction only; exclusive of any land-taking.

TABLE 4-1 (cont.)

Intersection	Modification	Purpose/ Objective	Impact					
			Accessibility	Level of Service/Delays	Safety	Land-Takings	Environment	Construction Costs[1]/Traffic Disruption
Grantland Road	Close Grantland Road access to Route 9 and lengthen Route 9 eastbound on-ramp.	Improve safety and traffic operations by eliminating vehicle conflict point, providing better sight distance, and creating longer acceleration lane for Route 9 on-ramp traffic.	Grantland Road residents rerouted to Oakland Street; affects emergency delivery services.	Improved LOS because of reduced volume.	Significant improvement in safety associated with reduced possibilities of vehicle conflict and improved ramp geometry.	Minimal land-taking would be required.	Minimal impact resulting from increased vehicle-miles of travel (VMT) from rerouting Grantland Road traffic.	**Estimated Cost:** $100,000, including closing Grantland Street and lengthening Route 9 eastbound on-ramp. **Traffic Disruption:** Very minor.
Oakland Street	Improve warning signs at Route 9 westbound approach and monitor. (Concept 2)	Improve safety.	No Impact.	No impact.	Improvement anticipated.	None required.	No impact.	**Estimated Cost:** $50,000. **Traffic Disruption:** None
Cedar Street	Short term: Close the northeast quadrant Route 9 westbound on-ramp from Cedar Street	Improve safety by eliminating the weave under the bridge.	Would impact access to businesses in the northeast quadrant as the ramp would serve only traffic exiting Route 9 onto Cedar Street northbound.	Would not reduce traffic delays at the interchange.	Potential safety benefits resulting from elimination of the weaving section under the bridge.	Encroachment on the boundaries of the Rosemary Brook Aquifer.	Some impact associated with pavement widening within Rosemary Brook Aquifer.	**Estimated Cost:** $750,000, including signal installation and equipment, modifying the northeast quadrant ramp, and improved signs. **Traffic Disruption:** Moderate.
	Long term: Replace interchange with a new diamond interchange (Concept 2).	Improve traffic operations and safety.	Some businesses' properties in the northeast quadrant would be taken, others would require relocated access.	Traffic operations on the ramps as well as on Cedar Street would be improved. The proposed signalized intersection on the north side would operate at LOS D with a 5-lane bridge.	Significant safety benefits resulting from elimination of the weaving movements.	Relocations of driveways and potential land-takings encroaching on the boundaries of the Rosemary Brook Aquifer.	Potential impacts to water resources, parkland.	**Estimated Cost:** $10 million or more, including a new bridge, replacing ramps, new signals and equipment. **Traffic Disruption:** Would require traffic diversion during construction.
William Street	Prohibit right turns from Route 9 onto William Street and widen acceleration area west of William Street to provide a separate right-turn lane onto Route 128 northbound (Concepts 2 and 3).	Eliminate one weaving movement in the section between Ellis/Quinobequin on-ramp and William Street. Channels William Street traffic that is headed for Route 128 so that it stays off of Route 9.	Require that Route 9 westbound traffic destined for William Street to exit at Chestnut Street and use the service road. Provides additional area for complex weaving movements	Additional ramp traffic resulting from diversion requires 3 intersections in Newton to be signalized to address congestion and queues. Improvements would reduce traffic delay at William Street and at the intersections in Newton.	Significant improvements in safety at William Street intersection, through elimination of one weaving movement and addition of space for other weaving movements, and at the Newton intersections, through signalization.	Possible encroachment on Wellesley Office Park	Moderate impact associated with road widening.	**Estimated Cost**: $2 million or more, including geometric modifications, signalization, and roadway widening (into area of rock) **Traffic Disruption:** Major lane shifting affecting Route 9 and William Street traffic

[1] The estimated cost given is for construction only; exclusive of any land-taking.