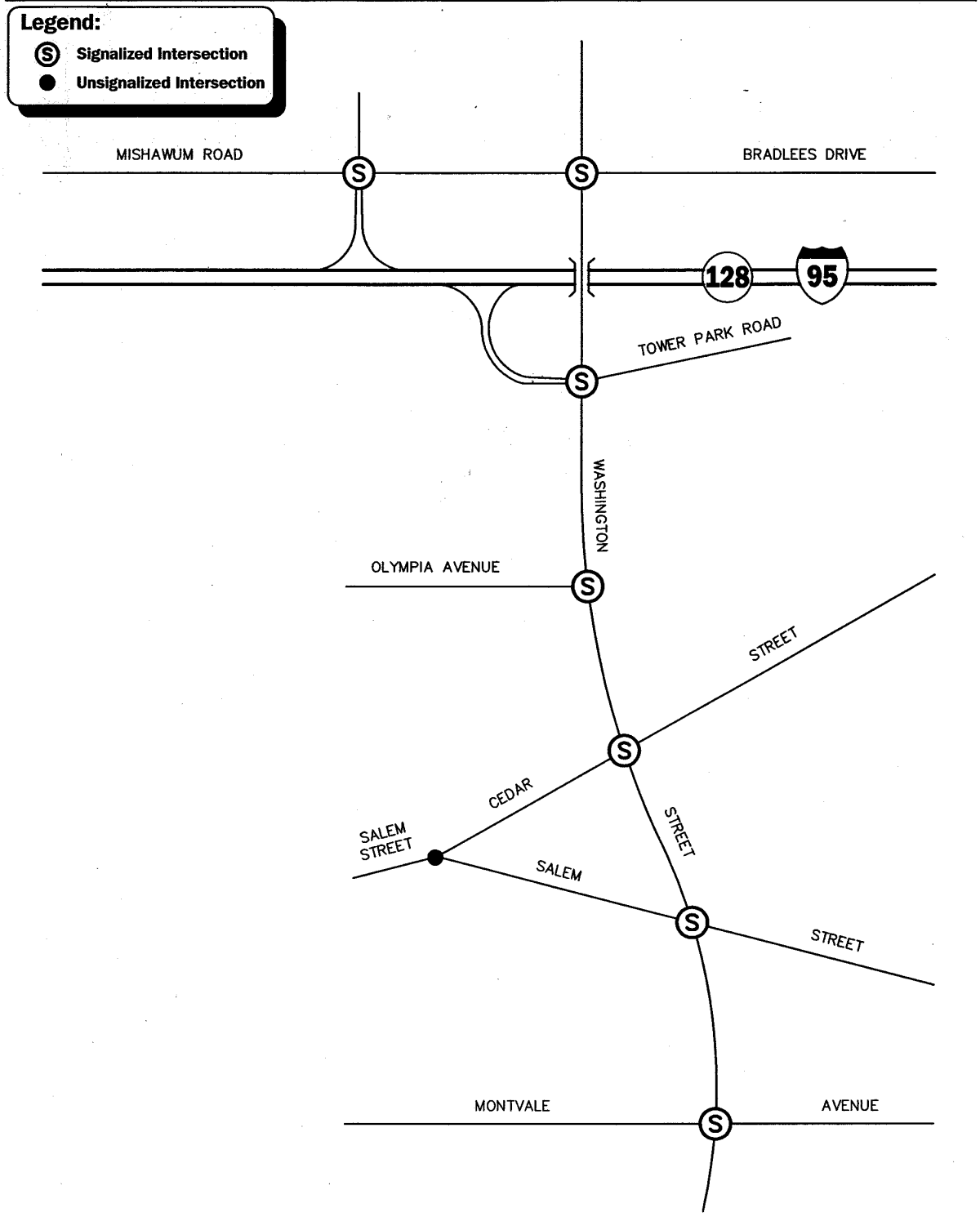
4. TRAFFIC ANALYSIS

In order to properly evaluate the potential land uses for each of the subject parcels, it was also critical to examine the capacity and issues related to the public infrastructure which serves the area encompassed by and surrounding the Superfund Site. To accomplish this task, ESS retained the firm of Vanasse & Associates, Inc. (VAI) to assess traffic capacity and congestion problems, and the capacity of infrastructure, most notably the capacity and related issues surrounding the water and sewage systems which serve the project site and its environs. However, based upon the analysis of land use trends and the limited additional build-out anticipated within the Wells G&H Area, it was determined at the onset that water and sewer systems had the capacity to absorb any likely additional development. A critical problem, however, was the traffic congestion which resulted from the limits of the capacity of Washington Street, and geometric problems related to moving traffic between the two major arteries. These traffic congestion problems must be considered when identfying the optimal land uses for the Advisory Committee's principal priority private development site, the W.R. Grace property located at 369 Washington Street. This section provides the VAi evaluation of traffic conditions along the Washington Street Corridor, and suggests traffic mitigation measures for incorporation in the overall recommendations.

Following the completion of the traffic review, the Advisory Committee discussed and endorsed two additional recommendations for the design and implementation of roadway improvements in the study area, beyond those considered by Vai. The first proposal, endorsed by the Committee, was for the widening of Washington Street between Salem Street and Route 128/95. The Woburn Engineering Department subsequently retained VAi to complete a conceptual plan for the widening proposal, in order to begin the process to submit the proposal to the Boston Metropolitan Planning Organization for inclusion in the regional Transportation Improvement Program (TIP).

The second proposal not specifically reviewed for its impact is the reconstruction and widening of the Washington Street- Route 128/95 Overpass. This project was included by the Massachusetts Highway Department in the initial conceptual design for the reconstruction of the Route 93/95 Interchange. However, this interchange design process is essentially starting over, as a result of substantial public opposition to the original conceptual plan. The Wells G&H Advisory Committee recommends that the upgrading of the Washington Street Overpass be included in any future design scheme for the interchange, if possible.

1. Preliminary Transportation Evaluation: The first step to be taken by VAI was the preliminary assessment of the existing transportation conditions on roadways and intersections surrounding the W.R. Grace property in Woburn, Massachusetts. This subsection documents existing transportation



Not To Scale

Figure 4.1

Study Area Intersections

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conditions within the study area, including identification of existing traffic constraints. Subsequent subsections evaluate future traffic conditions, including planned development and roadway improvements in the study area, and an evaluation of potential development scenarios for the project site.

a. Study Area Roadways: The study area for this transportation evaluation includes roadways and intersections likely to sustain some measurable impact from the redevelopment of the W.R. Grace site. Specifically, the study area includes portions of the Washington Street and Mishawum Road corridors, including critical intersections along these corridors. The study area intersections are depicted in Figure I and include:

- Washington Street at Mishawum Road
- Washington Street at I-95 northbound on-/off-ramp
- Washington Street at Olympia Avenue
- Washington Street at Cedar Street
- Washington Street at Salem Street
- Washington Street at Montvale Avenue
- Mishawum Road at I-95 southbound on/off-ramp and Commerce Way

A comprehensive field inventory of roadway and intersection geometrics was conducted in November, 2001. The field investigation consisted of an inventory of existing roadway and intersection geometry and traffic controls and travel speeds within the study area. Each of these elements is described below.

1) Washington Street: Washington Street is an urban arterial roadway that traverses the study area in a general north/south direction providing access to I-95/Route 128 at Interchange 36, as well as the towns of Reading and Winchester. North of Cedar Street, Washington Street is a four-lane roadway under State jurisdiction, varying in width from 40 to 60 feet with the directions of travel separated by a double-yellow centerline. South of Cedar Street, Washington Street is a two-lane roadway under local jurisdiction, varying in width from 33 to 42 feet, with the directions of travel separated by a single-yellow centerline between Cedar Street and Salem Street, and a double-yellow centerline south of Cedar Street. Marked shoulders are provided intermittently. Sidewalks are provided along the west side of Washington Street, north of Cedar Street, and along the east side from a point just north of Cedar Street. Land use along Washington Street, within the study area, consists of a mix of residential and commercial uses. The posted speed limit in the vicinity of the project site is 35 miles per hour (Mph).

2) Mishawum Road: Mishawum Road is a state maintained four-lane roadway that generally travels in an east-west orientation, between Washington Street in the east and Route 38 in the west. In the vicinity of the project area, two travel lanes are provided in each direction,

separated by a double-yellow centerline. The posted speed limit along Mishawum Road is 35 mph. Land use along the corridor is predominantly commercial, with some residential uses.

b. Study Area Intersections: The study area for this transportation evaluation includes intersections likely to sustain some measurable impact from the redevelopment of the W. R. Grace site. These are:

1) Mishawum Road at Commerce Way and I-95 Southbound On/Off-Ramps: Mishawum Road intersects Commerce Way and the I-95 southbom ramps to form a four-way, signalized intersection. This intersection is controlled by a four-phase, fully actuated traffic signal. Both the eastbound and westbound Mishawum Road approaches contain a shared through/ left-turn lane and a channelized right-turn lane. Both the southbound Commerce Way approach and the northbound exit ramp approach contain an exclusive left-turn lane, a shared through/ left-turn lane, an exclusive through lane, and a channelized right-turn lane. This intersection is under the jurisdiction of the Massachusetts Highway Department (MassHighway).

2) Washington Street at Mishawum Road: Washington Street meets Mishawum Road and a private driveway to form a four-way, signalized intersection. The traffic signal at this location operates as a three-phase, fully actuated traffic signal. The eastbound Mishawum Road approach contains an exclusive left-turn lane, a through lane, and a channelized right-turn lane. The westbound private drive approach provides a shared left-turn/through lane and a shared through/right-turn lane. Both the northbound and southbound Washington Street approaches provide a shared through/right-turn lane, a through lane, and a channelized right-turn lane. This intersection is under the jurisdiction of MassHighway.

3) Washington Street at the I-95 Northbound Ramps and Tower Park Road: The I-95 northbound ramps and Tower Park Road intersect Washington Street from the west and east, respectively, to form this four-legged, signalized intersection. The I-95 northbound off-ramp approach consists of two travel lanes used as a left-turn lane and a shared left-turn/through movement lane and a channelized right-turn lane that is under YIELD-sign control. The Tower Park Road westbound approach consists of a left-turn lane and a shared through/right-turn lane. The Washington Street northbound approach consists of an exclusive left-turn lane, a through movement lane, and a shared through/right-turn lane. The Washington Street southbound approach consists of a shared left- turn/through movement lane and a through movement lane. Right turns from the Washington Street southbound approach exit the roadway prior to the intersection and are not under traffic signal control.

The traffic signal operates in a three phase, full traffic-actuated mode. Phase one consists of all movements from I-95 and Tower Park Road. Phase two consists of a northbound advance phase, followed by north and southbound movements. Northbound left turns are restricted during the third phase. This intersection is under the jurisdiction of MassHighway.

4) Washington Street at Olympia Avenue: Olympia Avenue intersects Washington Street from the west to form this three-legged, signalized intersection. The Olympia Avenue eastbound approach consists of an exclusive left-turn lane and an exclusive right-turn lane. The Washington Street northbound and southbound approaches each consist of two general-purpose lanes. Directional flow along Washington Street is separated by a double-yellow centerline. Di-

rectional flow along Olympia Avenue is separated by a single-yellow centerline. An 8-footwide crosswalk is present across the Olympia Avenue leg of the intersection, with a 4- to 5-foot wide sidewalk provided along the west side of Washington Street and the south side of Olympia Avenue. NOPARKING ANY TIME signs are posted along both sides of Washington Street. Land use in the vicinity of the intersection consists of residential and office uses. The traffic signal operates in a three-phase, full traffic-actuated mode and is interconnected to the traffic signal at the intersection of Washington Street at the I-95 northbound ramps and Tower Park Road. Phase I consists of all movements from Olympia Avenue. Phase II consists of a northbound advance phase followed by all movements north and southbound.

5) Washington Street at Cedar Street: Cedar Street intersects Washington Street from the east and west to form this four-legged, signalized intersection. The Cedar Street eastbound approach consists of a shared left-turn/through movement lane and a channelized right-turn lane that is not under traffic signal control. The Cedar Street westbound approach consists of a general-purpose lane. The Washington Street northbound approach consists of a shared left-turn/through movement lane and a shared through/right-turn lane. The Washington Street southbound approach consists of an exclusive left-turn lane, a through travel lane, and a channelized right-turn lane that is not under traffic signal control. Directional flow along Cedar Street and the Washington Street north leg are separated by a double-yellow center line. Directional flow along the Washington Street south leg is separated by a single-yellow centerline. A 7.5- to 8-foot wide crosswalk is present across the Cedar Street east leg and through the center of the intersection, extending from the northwest corner to the southeast corner. A 4.5- to 5-foot wide sidewalk is present along the east side of Washington Street, both sides of the Cedar Street east leg, and the north side of the Cedar Street west leg of the intersection. A NO PARKING ANY TIME sign is posted on the south side of the Cedar Street west leg. In addition, a sign restricting trucks between 9:00 PM and 6:00 AM is posted facing Washington Street southbound traffic. Land use in the vicinity of the intersection consists of a parking lot, wooded area, Getty gas station, and Stoves of America retail store. The traffic signal operates in a five-phase, full traffic actuated mode with an exclusive pedestrian phase. Phase I consists of all movements from Cedar Street. This phase is followed by an exclusive pedestrian phase. Phase IV consists of a southbound advance phase, followed by all movements north and southbound.

6) Washington Street at Salem Street: Salem Street intersects Washington Street to form this four-legged, signalized intersection. The Salem Street east and westbound approaches each consist of general-purpose lanes. The Washington Street north and southbound approaches each consist of general-purpose lanes. Directional flow along the Washington Street south leg and the Salem Street west leg are separated by a double-yellow centerline. Directional flow along the Washington Street north leg and the Salem Street east leg are separated by a single-yellow centerline. A 9-foot wide crosswalk is present across the Washington Street north leg and the Salem Street east leg of the intersection, with a 5.5- to 6-foot wide sidewalk provided along the east side of Washington Street and both sides of the Salem Street east leg. A sign restricting trucks between 9:00 PM and 6:00 AM is posted facing Washington Street southbound traffic. Land use in the vicinity of the intersection consists of residential homes and a wooded area. The traffic signal operates in a three-phase, full traffic and pedestrian actuated mode, with an exclusive pedestrian phase provide upon demand.

7) Washington Street at Montvale Avenue: Montvale Avenue intersects Washington Street to form this four-legged, signalized intersection. The Montvale Avenue eastbound and westbound approaches each consist of an exclusive left-turn lane and a shared through/right-turn lane. The Washington Street northbound approach consists of two general-purpose travel lanes. The Washington Street southbound approach consists of an exclusive left-turn lane and a shared through/right-turn lane. Directional flow along the Washington Street north leg is separated by a double-yellow centerline. Directional flow along the Washington Street south leg and Montvale Avenue are separated by a single-yellow centerline. A 6.5- to 8-foot wide crosswalk is present across all legs of the intersection, with a 5- to 8-foot wide sidewalk provided along the north side of the Montvale Avenue west leg, the south side of the Montvale Avenue east leg, the east side of the Washington Street south leg, and the west side of the Washington Street north leg of the intersection. Land use in the vicinity of the intersection consists of Built-In Vacuums, a Citgo gas station, Friendly's restaurant, and a Shell gas station. The traffic signal operates in a three phase, full vehicle- and pedestrian-actuated mode, with an exclusive pedestrian phase provided upon demand.

c. Existing Traffic Volumes: In order to establish base condition traffic volumes within the study area, traffic count data collected as part of traffic studies for recent area developments were examined. These volumes were factored to represent existing year 2001 traffic conditions based on historical growth rates in area traffic. It is based on a review of traffic counts conducted as part of these developments, base year traffic volumes were developed for the weekday morning, weekday evening, and Saturday midday peak hours for the following locations:

- Washington Street at Mishawum Road
- Washington Street at I-95 northbound on-/off.-ramp
- Washington Street at Olympia Avenue
- Washington Street at Cedar Street
- Washington Street at Salem Street
- Washington Street at Montvale Avenue
- Mishawum Road at I-95 southbound on-/off-ramp and Commerce Way

Analyses of the peak-period traffic counts indicate that the weekday morning peak hour generally occurs between 7:45 and 8:45 AM, with the weekday evening peak hour occurring between 5:00 and 6:00 PM. It should be noted, however, that the individual intersection peak hours were examined in this memorandum to facilitate the evaluation of existing traffic conditions.

The 2001 Existing weekday morning, weekday evening, and Saturday midday peak-hour traffic-flow networks are presented on Figures 4.2 through 4.4, respectively.

Daily traffic flow along Washington Street varies between 31,690 vehicles per day (vpd) on a

weekday to 27,450 vpd on a Saturday. Peak-hour traffic volumes range from 2,356 vehicles per hour (vph) during the weekday morning peak hour to 2,607 vph during the weekday evening peak hour. Saturday midday peak-hour volumes are approximately 2,163.

Daily traffic flow along Mishawum Drive ranges from 37,900 vpd on a weekday to 25,000 vpd on a Saturday. Weekday peak-hour traffic flow ranges from 2,451 vph during the weekday morning peak hour to 2,819 vph during the weekday evening peak hour. Saturday midday peak-hour volumes are approximately 1,915 vph.

d. Existing Public Transportation: The study area is served by the Massachusetts Bay Transit Authority (MBTA) Commuter Rail at the Mishawum Station, located approximately one mile from the project site in the City of Woburn. The commuter rail provides service between the Mishawum Station and North Station in downtown Boston. Service is provided along this route between 5:35 AM and 11:54 PM with peak-hour headways of approximately one half hour to one hour. The MBTA also provides two bus routes, Route 136 and Route 137, which provide service to and from the downtown area, east of the project site.

In addition, the MBTA provides additional parking at the Regional Transportation Center located approximately 0.5 mile north of Mishawum Road and Commercial Way. Access to this facility is pro-vided directly from I-93 via the recently completed Commerce Way interchange.

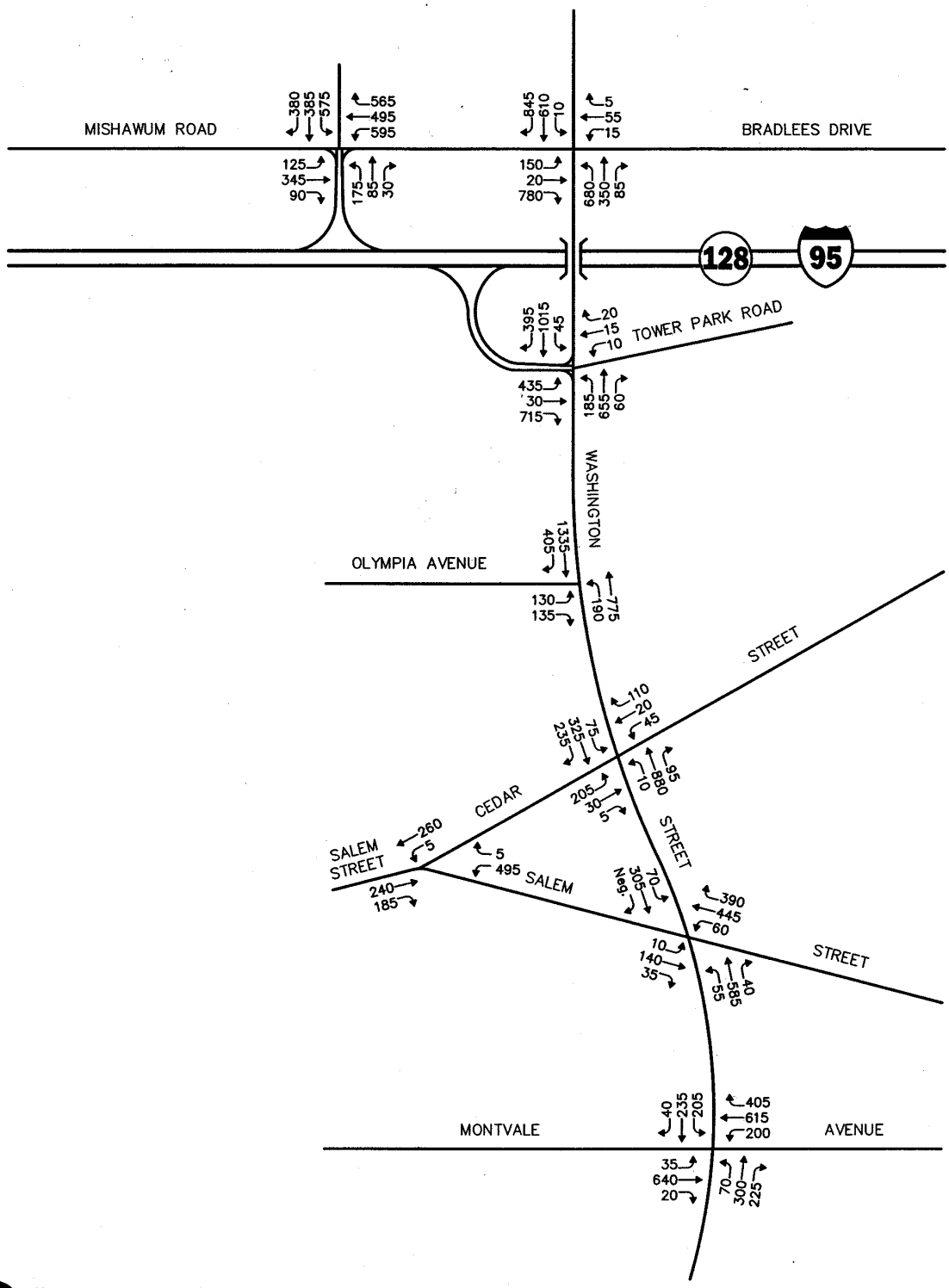
e. Accident Analysis: In order to identify accident trends and/or roadway safety deficiencies in the study area, accident data were obtained from MassHighway for the City of Woburn for the three-year time period between January 1, 1998 to December 31, 2000 (the most recent data currently available). A summary of the accident data for each study area intersection is displayed in Figure 4.5.

Accident crash rates were determined for each study area intersection. These rates quantify the numberof accidents per million entering vehicles. MassHighway was determined the official year 2000 accident rates to be 0.59 for unsignalized intersections and 0.87 for signalized intersections. These rates represent “average" accident experience and serve as a basis for comparing reported accident rates for study area intersections. Based on a review of collected accident data, the following observations were made:

- The greatest number of accidents occurred at the intersection of Washington Street with the I-95 ramps and Tower Park Road. A total of 158 accidents were reported over the three-year period, with a corresponding accident rate of 3.09, more than triple the state average. The majority of accidents at this location were rear-end collisions resulting in property damage only.

- The intersection of Mishawum Road with Commerce Way and the I-95 on-/off-ramp experienced a total of 108 accidents over the three year period, resulting in an accident rate of 2.11 ,more than double the official state average. The majority of accidents at this location were either angle or rear-end collisions, resulting in property damage only.

- A total of 68 accidents were reported at the intersection of Mishawum Road and Washington Street, resulting in an accident rate of 1.29, above the official state average. The



Note: Imbalances exist due to numerous curb cuts and side streets that are not shown.

Not To Scale

Figure 4.2

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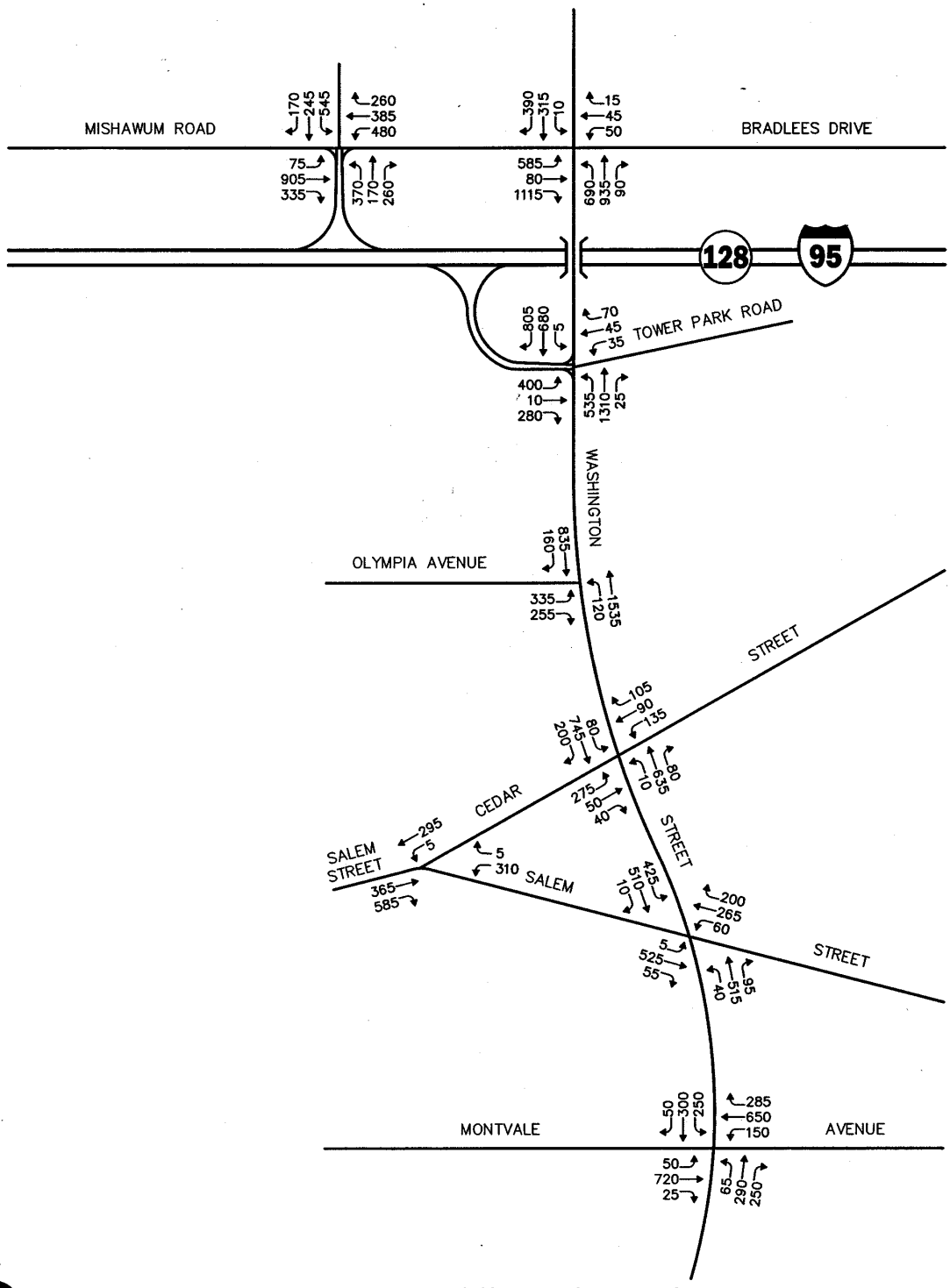
2001 Existing Weekday Morning Peak Hour Traffic Volumes



Note: Imbalances exist due to numerous curb cuts and side streets that are not shown.

Not To Scale

Figure 4.3

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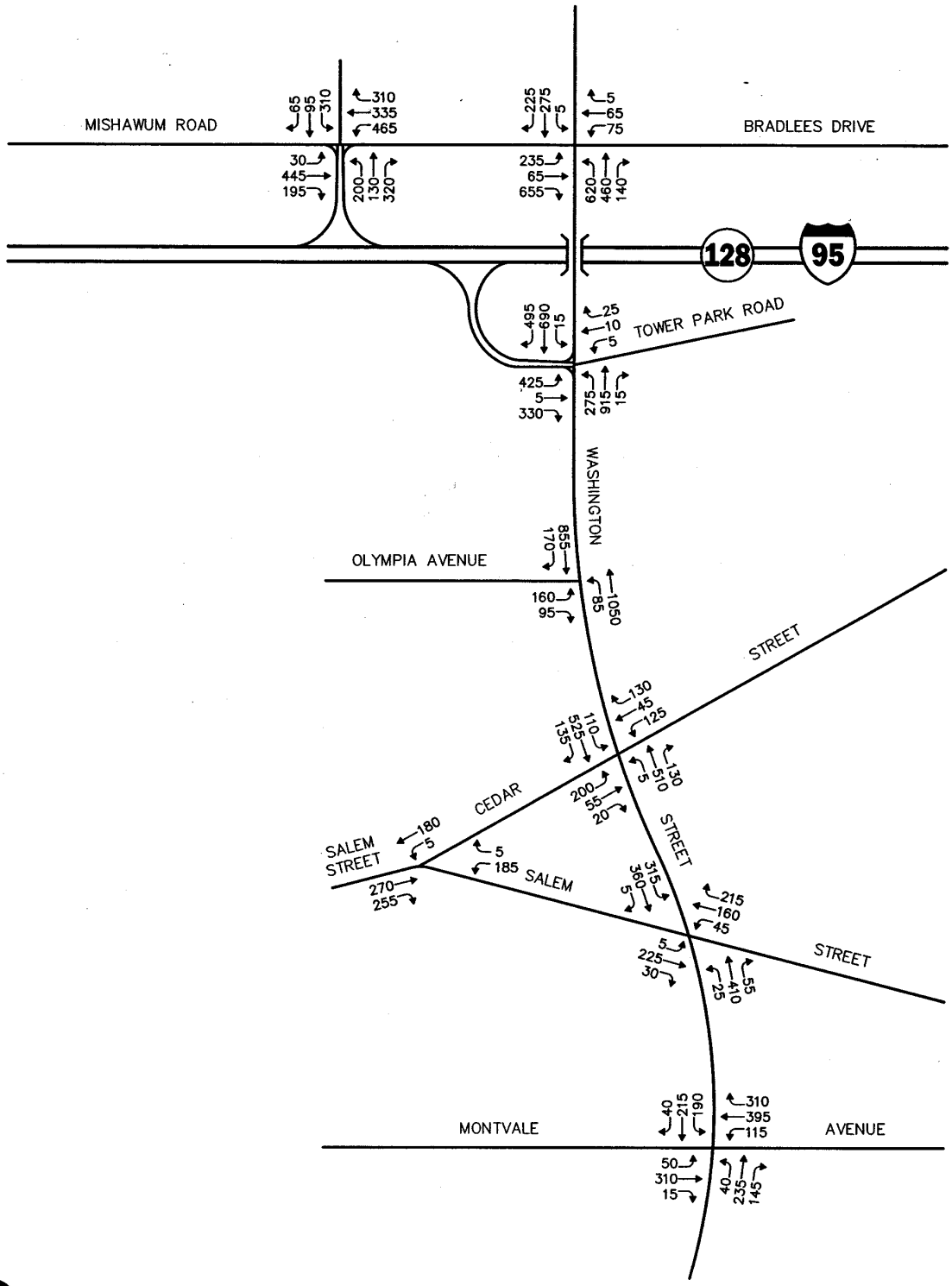
2001 Existing Weekday Evening Peak Hour Traffic Volumes



Note: Imbalances exist due to numerous curb cuts and side streets that are not shown.

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Figure 4.4

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2001 Existing
Saturday Midday
Peak Hour Traffic Volumes

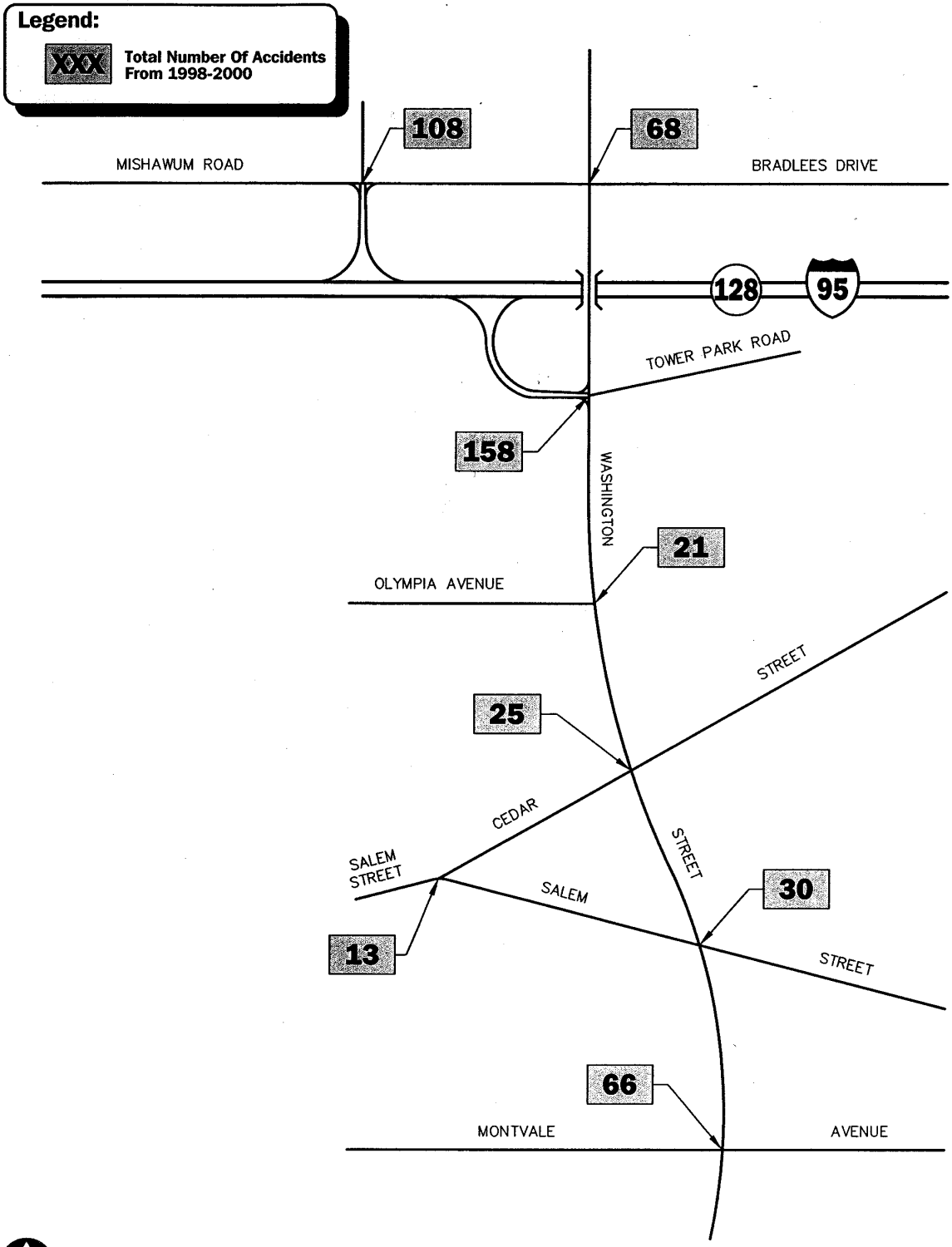

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Figure 4.5

Accident Summary

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majority of accidents at this location were rear-end collisions, resulting in property damage only.

- The intersection of Washington Street and Salem Street experienced a total of 30 accidents over the three-year period, resulting in a crash rate of 0.9l, just over the state average. The majority of accidents were angle- or rear-end collisions, resulting in property damage only.

- The intersection of Washington Street at Montvale Avenue experienced a total of 66 accidents, resulting in an accident rate of 1.76, more than double the state average. The majority of accidents were angle- or rear-end-type resulting in property damage only.

- The remaining study area intersections experienced an average between 5 and 7 accidents per year, the majority of which were angle collisions resulting in property damage only.

f. Existing Traffic Operations: Measuring existing and future traffic volumes quantifies traffic flow within the study area. To assess quality of flow, roadway capacity analyses performed as part of traffic studies for recent area development were reviewed. In summary, a number of study area intersections currently operate at deficient levels of service during one or more peak periods.

g. Methodolgy: This section describes the capacity analysis methodology, and summarizes the capacity analyses for each study area intersection.

1) Levels of Service: A primary result of capacity analyses is the assignment of level of service to traffic facilities under various traffic-flow conditions. The concept of level of service is defined as a qualitative measure describing operational conditions within a traffic stream and their perception by motorists and/or passengers. A level-of-service definition provides an index to quality of traffic flow in terms of such factors as speed, travel time, freedom to maneuver, traffic interruptions, comfort, convenience, and safety.

Six levels of service are defined for each type of facility. They are given letter designations from A to F, with level-of-service (LOS) A representing the best operating conditions and LOS F representing the worst.

Since the level of service of a traffic facility is a function of the traffic flows placed upon it, such a facility may operate at a wide range of levels of service, depending on the time of day, day of week, or period of year.

2) Unsignalized Intersections: The six levels of service for unsignalized intersections may be described as follows:

- LOS A represents a condition with little or no control delay to minor street traffic.

- LOS B represents a condition with short control delays to minor street traffic.

- LOS C represents a condition with average control delays to minor street traffic.
- LOS D represents a condition with long control delays to minor street traffic.
- LOS E represents operating conditions at or near capacity level, with very long control delays to minor street traffic.
- LOS F represents a condition where minor street demand volume exceeds capacity of an approach lane, with extreme control delays resulting.

The levels of service of unsignalized intersections are determined by application of a procedure described in the December, 1977 update to the 1994 *Highway Capacity Manual*. Level of service is measured in terms of average control delay. Mathematically, control delay is a function of the capacity and degree of saturation of the lane group and/or approach under study and is a quantification of motorist delay associated with traffic control devices such as traffic signals and STOP signs. Control delay includes the affects of initial deceleration delay approaching a STOP sign, stopped delay, queue move-uptime, and final acceleration delay from a stopped condition. Definitions for level of service at unsignalized intersections are also given in the December 1997 update to the 1994 *Highway Capacity Manual, Special Report 209*. Table 4.1 summarizes the relationship between level of service and average control delay.

3) Signalized Intersections: The six levels of service for signalized intersections may be described as follows:

- LOS A describes operations with very low control delay. However, most vehicles do not stop at all.
- LOS B describes operations with relatively low control delay. However, more vehicles

Table 4.1
LEVEL-OF-SERVICE CRITERIA FOR UNSIGNALIZED INTERSECTIONS

Level of Service	Average Control Delay (seconds per vehicle)
A	< 10.0
B	0.1 to 15.0
C	15.1 to 25.0
D	25.1 to 35.0
E	35.1 to 50.0
F	>50.0

Source: *Highway Capacity Manual, Special Report 209, Third Edition;* Transportation Research Board; Washington, DC; 1998; page 10-25.

stop than LOS A.

- LOS C describes operations with higher conrol delays. Individual cycle failures may begin to appear. The number of vehicles stopping is significant at this level, although many still pass through the through the intersection, without stopping.

- LOS D describes operations with control delay in the range where the influence of congestion becomes more noticeable. Many vehicles stop and individual cycle failures are noticeable.

- LOS E describes operations with high control delay values. Individual cycle failures are frequent occurrences.

- LOS F describes operations with high control delay values that often occur with oversaturation. Poor progression and long cycle lengths may also be major contributing causes to such delay levels.

Levels of service for signalized intersections are calculated using the operational analysis methodology of the 1997 Update to the 1994 *Highway Capacity Manual*. This method assesses the effects of signal type, timing, phasing, and progression; vehicle mix; and geometrics on delay. Level-of-service designations are based on the criterion of control or signal delay per vehicle. Control or signal delay is a measure of driver discomfort, frustration, and fuel consumption, and includes initial deceleration delay approaching the traffic signal, queue move-up time, stopped delay and final acceleration delay. Table 4.2 summarizes the relationship between level of service and control delay. The tabulated control delay criterion may be applied in assigning level-of-service designations to individual lane groups, to individual intersection approaches, or to entire intersections.

Table 4.2
LEVEL OF-SERVICE CRITERIA FOR SIGNALIZED INTERSECTIONS

Level of Service	Control (Signal) Delay per Vehicle (Seconds)
A	< 10.0
B	10.1 to 20.0
C	20.1 to 35.0
D	35.1 to 55.0
E	55.1 to 80.0
F	>80.0

Source: *Highway Capacity Manual, Special Report 209, Third Edition;* Transportation Research Board; Washington, DC; 1998; page 9-7.

h. Analysis Results: Level-of-service analyses were conducted for 2001 Existing, 2006, No Build, and 2006 Build conditions for the intersections within the study area. The results of the intersection capacity analyses are summarized in Table 4.3. The following is a summary of level-of-service analyses for the intersections within the study area.

As indicated in Table 4.3, under existing conditions, a number of study area intersections currently operate at deficient levels of service during weekday morning and evening commuter peak periods. A summary of key traffic constraints within the study area are presented below:

1) Mishawum Road at Commerce Drive and I-95 Southbound Ramps: During both the weekday morning and weekday evening peak hour, this location operates above capacity due to heavy turning volumes along a number of intersection approaches. Excessive queuing along both the Mishawum Road and Commerce Drive approaches occurs during peak hours.

2) Washington Street at Mishawum Road and Private Drive: During both peak periods, heavy southbound traffic from the downstream intersection of Washington Street with the I-95 northbound ramps periodically queues back to this location, thereby blocking east-bound traffic from turning right onto Washington Street. During the evening peak hour, westbound traffic on Mishawum Road also periodically queues back from the I-95 southbound ramps towards this location.

3) Washington Street at Tower Road/I-95 Northbound Ramps: During the morning peak hour, delays are currently experienced by southbound vehicles traveling along Washington Street. During the weekday evening peak hour, delays are experienced by vehicles traveling northbound and southbound on Washington Street. Queuing from this location often extends to the downstream intersection with Olympia Avenue.

4) Washington Street at Olympia Avenue: Eastbound traffic on Olympia Avenue currently operates at LOS D during the weekday morning peak hour. During the weekday evening peak hour, eastbound traffic currently operates at LOS E, with east-bound left turns operating at LOS F.

5) Washington Street at Cedar Street: During the weekday morning peak hour, eastbound traffic on Cedar Street currently operates at LOS E, due to delay experienced by vehicles turning left onto Washington Street. During the weekday evening peak hour, both eastbound and westbound traffic on Cedar Street currently operate at LOS F due to delay experienced by vehicles turning onto Washington Street.

6) Washington Street at Salem Street: During the weekday morning peak hour, northbound traffic on Washington Street currently operates at LOS E, due to heavy northbound traffic at this location. In addition, westbound traffic operates at LOS F, due to delay experienced by all movements at this approach. During the weekday evening peak hour, this location currently operates at LOS F, due to heavy delays experienced by southbound traffic attempting to turn left from Washington Street onto Salem Street.

7) Washington Street at Montvale Avenue: During both commuter peak periods, this location currently operates at LOS F due to heavy delay experienced by southbound traffic

Table 4.3
2001 EXISTING CONDITIONS
SIGNALIZED INTERSECTION LEVEI.-OF-SERVICE SUMMARY

	2001 Existing		
Location	V/C[1]	Delay[2]	LOS[3]
Mishawum Rd. at Commerce Way/I-95 Ramp:			
Weekday Morning	>1.0	>80	F
Weekday Evening Peak	>1.0	>80	F
Saturday Midday Peak	0.52	18	C
Mishawum Road at Washington Street:			
Weekday Morning Peak	0.75	16	C
Weekday Evening Peak	>1.0	>80	F
Saturday Midday Peak	0.84	15	B
Washington Street at Tower Road/I-95 Ramps:			
Weekday Morning Peak	0.89	>80	F
Weekday Evening Peak	0.96	>80	F
Saturday Midday Peak	0.71	16	C
Washington Street at Olympia Avenue:			
Weekday Morning Peak	0.55	8	A
Weekday Evening Peak	0.54	16	B
Saturday Midday Peak	0.27	11	B
Washington Street at Cedar Street:			
Weekday Morning Peak	0.55	18	C
Weekday Evening Peak	>1.2	>80	F
Saturday Midday Peak	0.81	14	B
Washington Street at Salem Street:			
Weekday Morning Peak	>1.0	>80	F
Weekday Evening Peak	>1.0	>80	F
Saturday Midday Peak	>1.0	>80	F
Washington Street at Montvale Avenue:			
Weekday Morning Peak	>1.0	>80	F
Weekday Evening Peak	>1.0	>80	F
Saturday Midday Peak	>1.	>80	F

Source: *Notice of Project Change;* Proposed Retail Development; Highway and Traffic Signal Design; October 1999, and *Traffic Impact Study;* Jefferson at Washington Crossing; Vanasse & Associates,Inc.; October 1999.

[1]Volume-to-capacity ratio for critical approach movement.

[2]Delay in seconds per vehicle for critical approach movement.

[3]Level of service.

tuurning left from Washington Street onto Montvale Avenue, and westbound traffic turning left from Montvale Avenue onto Washington Street.

i. Conclusion: As summarized in this subsection, under existing conditions, a number of study area locations currently exhibit peak-hour delays and associated queuing due to heavy commuter volumes during the weekday morning and evening peak hours. During the Saturday midday peak hour, traffic volumes along both corridors are lower, allowing most study area locations operate below capacity during Saturday peak-hour conditions.

2. Future No Build Conditions: This subsection documents future year transportation conditions on primary roadways and intersections serving the site, including recently completed and planned roadway improvement projects, and assesses traffic operations with future development projects in place (independent of the W.R. Grace property). The future No-Build transportation conditions are described below.

a. Recently Completed Roadway Improvement Projects: Two significant roadway improvement projects have recently been completed, which directly influence traffic operations in the study area, as described below.

1) Interstate 93 and Commerce Way Interchange: In 2000, the Massachusetts Highway Department (MassHighway) completed construction of the I-93/Commerce Way interchange in Woburn. The interchange, located one mile north of the I-93/I-95 interchange, serves as a full-access interchange between Commerce Way and I-93 to the north and south. In addition, the connector road from the interchange to Commerce Way also provides improved access to the Atlantic Avenue corridor, including the Industri-Plex area businesses and Regional Transportation Center. Analysis of future traffic conditions, as contained in this memorandum, reflect diversion of traffic via this new interchange that has occurred since the completion of this project.

2) Commerce Way Reconstruction/Extension: As part of a Public Works Economic Development (PWED) Grant, the City of Woburn extended Commerce Way between Atlantic Avenue and the exit drive at the Regional Transportation Center to the north. In addition, the Commerce Way corridor was upgraded, including provision of turning lanes at key intersections, signalization at the entrance to the Industri-Plex Parcel A site, and the closure of the median opening to improve traffic flow. This improvement, coupled with the opening of the Commerce Way interchange on I-93, has resulted in less dependence on the I-95 on-/off-ramps as a gateway to Commerce Way and Atlantic Avenue, and the businesses along these corridors.

b. Planned Roadway Improvements: Based on consultation with the City of Woburn, a number of roadway and traffic signal improvements are currently planned or have been recently completed within the study area. These improvements are proposed and sponsored as mitigation for a number of development projects within the study area. The following subsection describes the proposed or completed improvements at each location.

1) Mishawum Road at Commerce Way and I-95 Southbound On-/Off-Ramps: Improvements at the intersection of Mishawum Road with Commerce Way and the I-95 southbound on-/off-ramps, part of the mitigation improvements funded by the Lowes Home Im-

provement Store, included roadway widening and geometric improvements as well as signal timing and phasing modifications. Specifically, these improvements involved the widening of Mishawum Road to provide an additional left-turn lane in the eastbound and westbound directions. The I-95 southbound off-ramp approach was modified to provide an exclusive left-turn lane, a shared left-turn/through lane, and a through lane. Right-turn traffic will continue to process from the off-ramp via the channelized right-turn lane. The southbound Commerce Way approach was widened to extend the length of the southbound right-turn lane. Proposed signal timing modifications at this location calling for a four-phase signal phasing which allows for protected left-turn phases for each intersection approach.

2) Washington Street at Mishawum Road: Improvements at the intersection of Washington Street with Mishawum Road, also part of the Lowe's mitigation, included both geometric and traffic signal enhancements. Geometric improvements include the widening of the eastbound Mishawum Road approach to provide two exclusive left-turn lanes, a through lane, and a channelized right turn lane. In addition, Washington Street, north of Mishawum Road, will be widened to provide two receiving lanes for traffic turning left from Mishawum Road. The northbound Washington Street approach was widened to provide two left-turn lanes, a through lane, and a channelized right-turn lane.

3) Washington Street at the Northbound Ramps and Tower Park Road: Proposed improvements at this location include coordination of the traffic signal at this location with the adjacent intersection of Washington Street with Olympia Avenue, and the upstream intersections of Washington Street with Mishawum Road, and Mishawum Road with Commerce Way and the I-95 southbound on-/off ramps. This location was recently coordinated with the Olympia Avenue intersection by way of radio transmission.

4) Washington Street at Olympia Avenue: Proposed improvements at this location include coordination of the traffic signal at this location with the adjacent intersection of Washington Street, the I-95 northbound ramps and Tower Park Road, with the upstream intersections of Washington Street with Mishawum Road, and Mishawum Road with Commerce Way and the I-95 southbound on-/off-ramps. This location was recently coordinated with the I-95 northbound on-/off-ramp intersection by way of radio transmission.

5) Washington Street at Cedar Street: Future improvements to the intersection of Washington Street at Cedar Street include upgrading the westbound Cedar Street approach to provide a shared left-turn/through lane and a right-turn-only lane. As part of the improvements to this location, existing handicapped access ramps and crosswalks across Cedar Street will be upgraded to meet current Americans with Disabilities Act (ADA) and MassHighway requirements. Traffic signal operations at this location will be coordinated with the adjacent signal at Salem Street. In May 2001, a Functional Design Report (FDR) was filed for improvements at this location. These improvements are sponsored by JPI as mitigation for the Jefferson at Washington Crossing development. These improvements are expected to be complete prior to the design horizon year of 2006.

6) Washington Street at Salem Street: Modifications to the Washington Street at Salem Street approach include restriping the southbound Washington Street approach from a general-purpose lane to an exclusive left-turn lane and shared through/right-turn lane. Existing

handicap ramps across Washington Street and Salem Street would be upgraded to ADA and MassHighway requirements. In addition, the traffic signal controller at this location would be replaced and interconnected with the intersection of Washington Street with Cedar Street via spread-spectrum radio. In May 2001, an FDR was filed for improvements at this location. These improvements are sponsored by JPI as mitigation for the Jefferson at Washington Crossing development. These improvements are expected to be complete prior to the design horizon year of 2006.

7) Washington Street at Montvale Avenue: The City of Woburn plans to upgrade the intersection of Washington Street with Montvale Avenue. Specifically, the northbound Washington Street approach and eastbound Montvale Avenue approach will be redesignated from an exclusive left-turn lane and a through/right-turn lane to two general-purpose lanes. In addition, an exclusive right-turn lane will be added in the westbound direction on Montvale Avenue. Signal timing and phasing will also be implemented at this location.

Proposed roadway and signal improvements expected to be in place under future No-Build conditions are displayed in Figure 4.6.

c. Long-Range Planning Initiatives: The MassHighway has begun preliminary planning for the redesign and reconstruction of the I-93/I-95 interchange. The interchange, which abuts the Wells G & H Superfund site, is the primary gateway to the project area from locations north and south of the study area. Currently, vehicles destined to I-93 northbound or southbound from the Washington Street and Mishawum Road corridors must travel I-95 northbound one exit to access I-93, or utilize Commerce Way to the new I-93 interchange. Preliminary planning efforts have evaluated the possibility of providing direct connections between Washington Street and I-93 via collector distributor roads to a reconstructed and improved I-93 ramp system.

The planning of potential improvements is in the preliminary stages. While MassHighway has estimated that such improvements would likely cost $75 million, no timetable is yet set for when such improvements would be implemented, or when funding would be available. The timetable for implementation of road improvements of this magnitude is likely ten to twenty years, therefore it is unlikely that such improvements would occur within the five-year planning horizon examined in this study. While it is likely that implementation of such improvements would improve regional access between the study area and the regional highway system, this analysis of future conditions assumes only planned and funded roadway improvements that are scheduled to be constructed within a five year horizon, consistent with Executive Office of Environmental Affairs/Executive Office of Transportation and Construction (EOEA/EOTC) guidelines for a traffic impact assessment.

d. Recent and Future Development Projects: In order to establish future year traffic volumes within the study area, future year traffic projections from recent area traffic studies, accounting for approved and/or recently constructed area development projects, were examined. These projected volumes include both general background growth, which consistent with other area studies is estimated at 1.5 percent per year, as well as traffic associated with specific area development projects. Future-year traffic volumes also reflect estimated travel pattern changes associated with the recently completed I-93/Commerce Way activity and Commerce Way re-

construction projects. Future-year traffic conditions were projected to the year 2006 consistent with state guidelines. A summary of specific area developments assumed to be in place under future conditions is described below:

1) Lowes Home Improvement Store: A Lowes Home Improvement Store totaling approximately 130,000 square feet (sf) was completed in the northeast quadrant of the intersection of Commerce Way and Mishawum Road in 2002. Access to and from the proposed development is provided via a signalized site driveway onto Commerce Way, opposite the existing Woburn Mail driveway. Traffic volumes associated with this project were obtained from the Notice of Project Change (NPC) prepared for this development.

2) Jefferson at Washington Crossing: A residential apartment complex was completed in 2003 off Cedar Street, north of Forbes Road. This 204 unit development has primary access provided via a driveway onto Cedar Street. Additional traffic volumes expected to be generated by this development were obtained from the traffic impact study prepared for this project.

3) Industri-Plex Site: As part of the traffic study prepared for the aforementioned Lowes Home Improvement Store, future traffic conditions assumed that continued development of the Industri-Plex Site off Commerce Way would include 200,000 sf of retail space on Parcel A, as well as 570,000 sf of office/research and development (R&D) space and a 220-room hotel on Parcel B. This analysis of future traffic conditions includes background traffic growth associated with these developments, as identified in the Lowes Home Improvement Store NPC.

4) Presidential Park: A 640,000 sf warehouse/office/R&D development has been proposed off Presidential Way. Future traffic volumes associated with this project, as identified in the NPC for the Lowes Home Improvement Store, are included in future year traffic conditions.

e. Future No-Build Traffic Conditions: Future Year 2006 No-Build traffic volumes were determined by adjusting future year Build condition traffic volumes for the Lowes Home Improvement Store and Jefferson at Washington Crossing developments, to account for general background growth over the five-year planning horizon. The 2006 future year 2006 No-Build condition traffic volumes include general background growth as well as traffic associated with specific area developments as identified above. The 2006 Future No-Build weekday morning, weekday evening, and Saturday midday peak-hour traffic-flow networks are presented on Figures 4.7 through 4.9, respectively.

f. Future No-Build Traffic Operations: Measuring existing and future traffic volumes quantifies traffic flow within the study area. To assess quality of flow, intersection capacity analyses were performed for each study area intersection under future No-Build conditions. In summary, under future No-Build conditions, a number of study area intersections are projected to operate at capacity during one or more peak periods. The following section summarizes the capacity analyses for each study area intersection.

g. Analysis Results: Level-of-service analyses were conducted for the 2006 No-Build condition for the weekday morning, weekday evening, and Saturday midday peak peri-

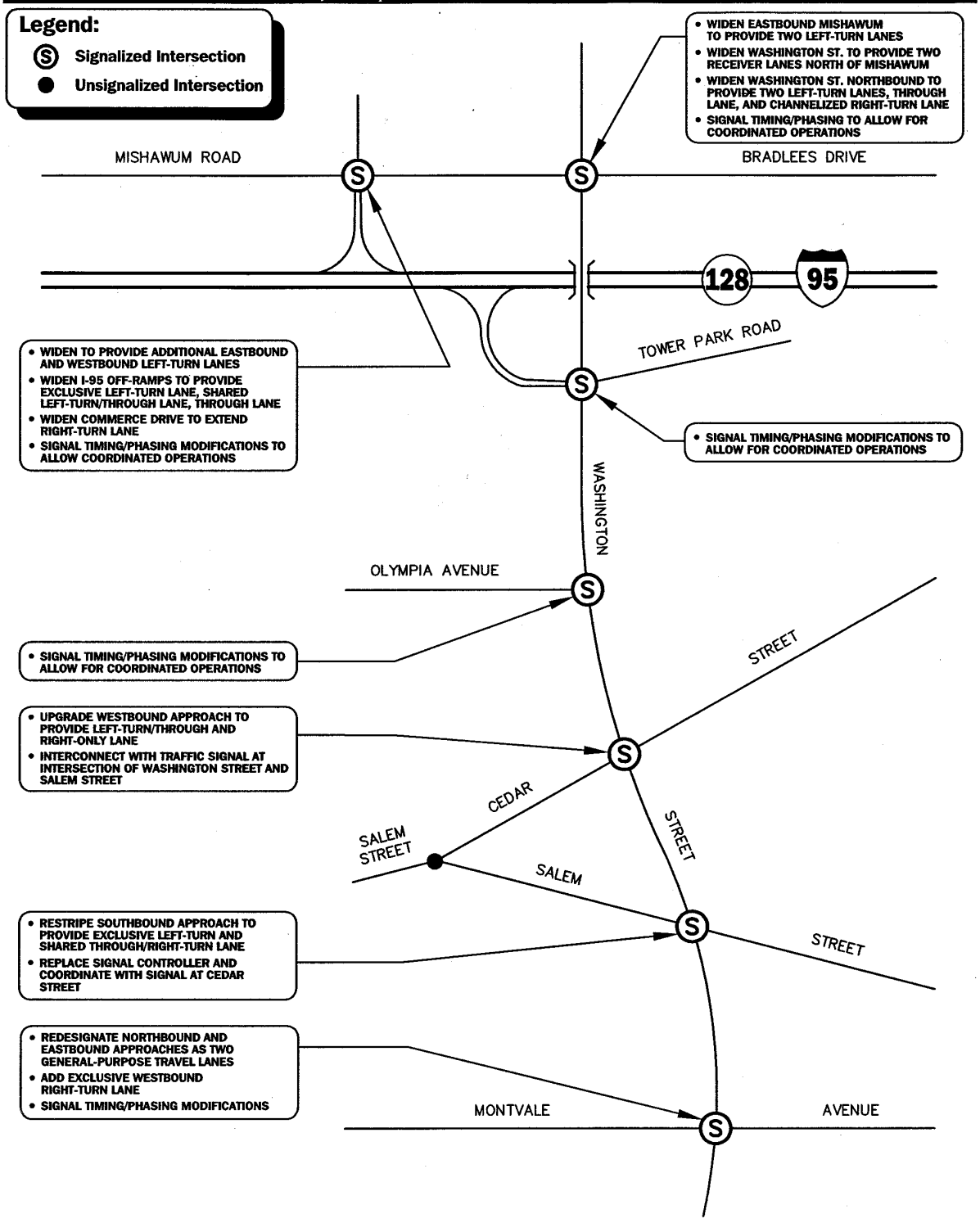

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Figure 4.6

Proposed Area Improvements

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ods. The results of the intersection capacity analyses are summarized in Table 4.4.

As indicated in Table 4.4, under future No-Build conditions, a number of study area intersections are projected to operate above capacity during the weekday morning and evening commuter peak periods. A summary of identified future traffic constraints within the study area are presented below:

1) Mishawum Road at Commerce Drive and I-95 Southbound Ramps: During the weekday morning, weekday evening, and Saturday midday peak hours, this location is projected to operate above capacity due to heavy turning volumes along a number of intersection approaches. Excessive queuing is projected along both the Mishawum Road and Commerce Drive approaches occurs during peak hours.

2) Washington Street at Mishawum Road and Private Drive: During the weekday morning and weekday evening peak hours, heavy southbound right turns from Washington Street are projected to operate at LOS F. Proposed improvements at this location will result in LOS D or better operations for the majority of movements at this location under future conditions. Under future No-Build conditions, this location is projected to operate at LOS B during the weekday morning and Saturday midday peak periods. During the weekday evening peak hour, this location is projected to operate at LOS E due to heavy northbound and eastbound delay.

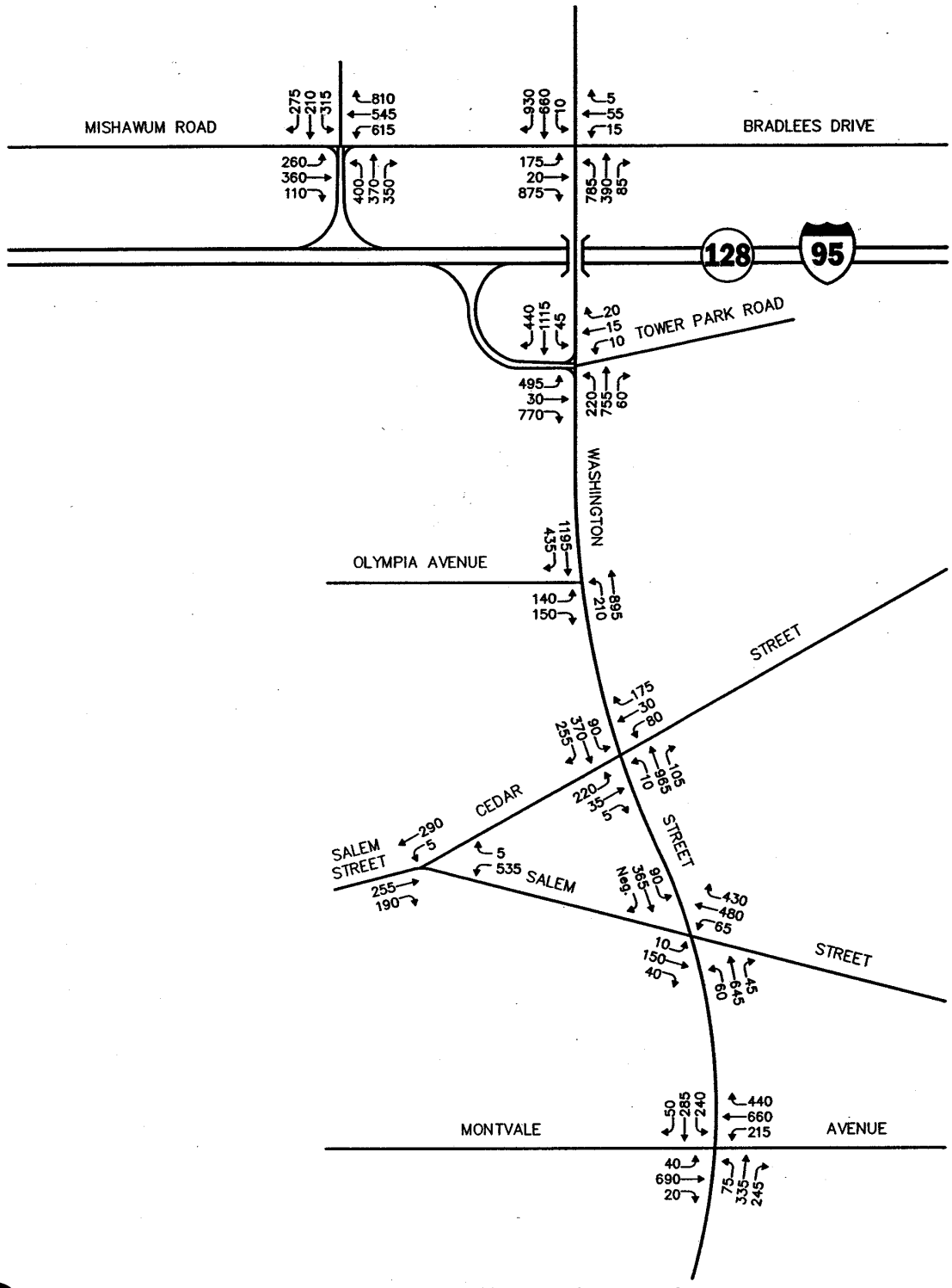
3) Washington Street at Tower Road/I-95 Northbound Ramps: Proposed signal timing improvements at this location are projected to improve traffic operations to an overall LOS C or better during the weekday morning and Saturday midday peak periods. During the weekday evening peak hour, this location is projected to operate at LOS F due to heavy southbound delay.

4) Washington Street at Olympia Avenue: Under future No-Build conditions, this location is projected to operate at LOS B during the weekday morning and Saturday midday peak periods. During the weekday evening peak hour, this location is projected to operate at LOS E due to heavy northbound and eastbound delay.

5) Washington Street at Cedar Street: During the weekday morning and Saturday midday peak hours, this location is projected to operate at LOS C or better, due to part to proposed improvements at this location. During the weekday evening peak hour, this intersection is projected to operate at LOS E due to heavy southbound delay on Washington Street.

6) Washington Street at Salem Street: During all three peak periods, this location is projected to operate at LOS E or F under future No-Build conditions. During both commuter peak periods, heavy westbound delays on Salem Street and mainline delays on Washington Street result in LOS F conditions. During the Saturday midday peak hour, heavy delays experienced by southbound traffic turning left on Washington Street results in LOS E conditions.

7) Washington Street at Montvale Avenue: During the weekday morning and Saturday midday peak periods, this location is projected to operate at LOS D and B, respectively, due to the proposed modifications at this locations. During the weekday evening peak hour, this



Note: Imbalances exist due to numerous curb cuts and side streets that are not shown.

Not To Scale

Figure 4.7

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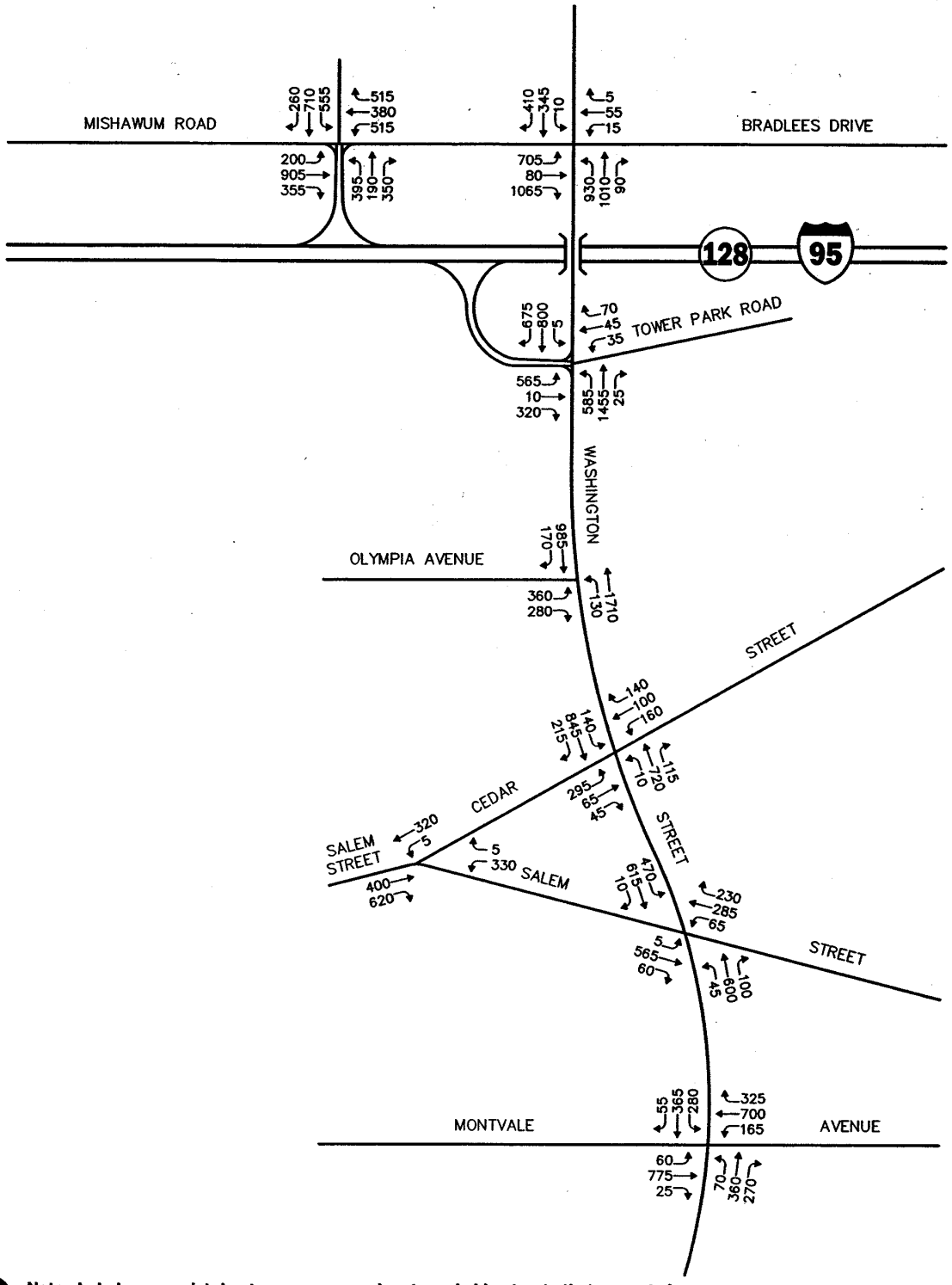
2006 No-Build
Weekday Morning
Peak Hour Traffic Volumes



Note: Imbalances exist due to numerous curb cuts and side streets that are not shown.

Not To Scale

Figure 4.8

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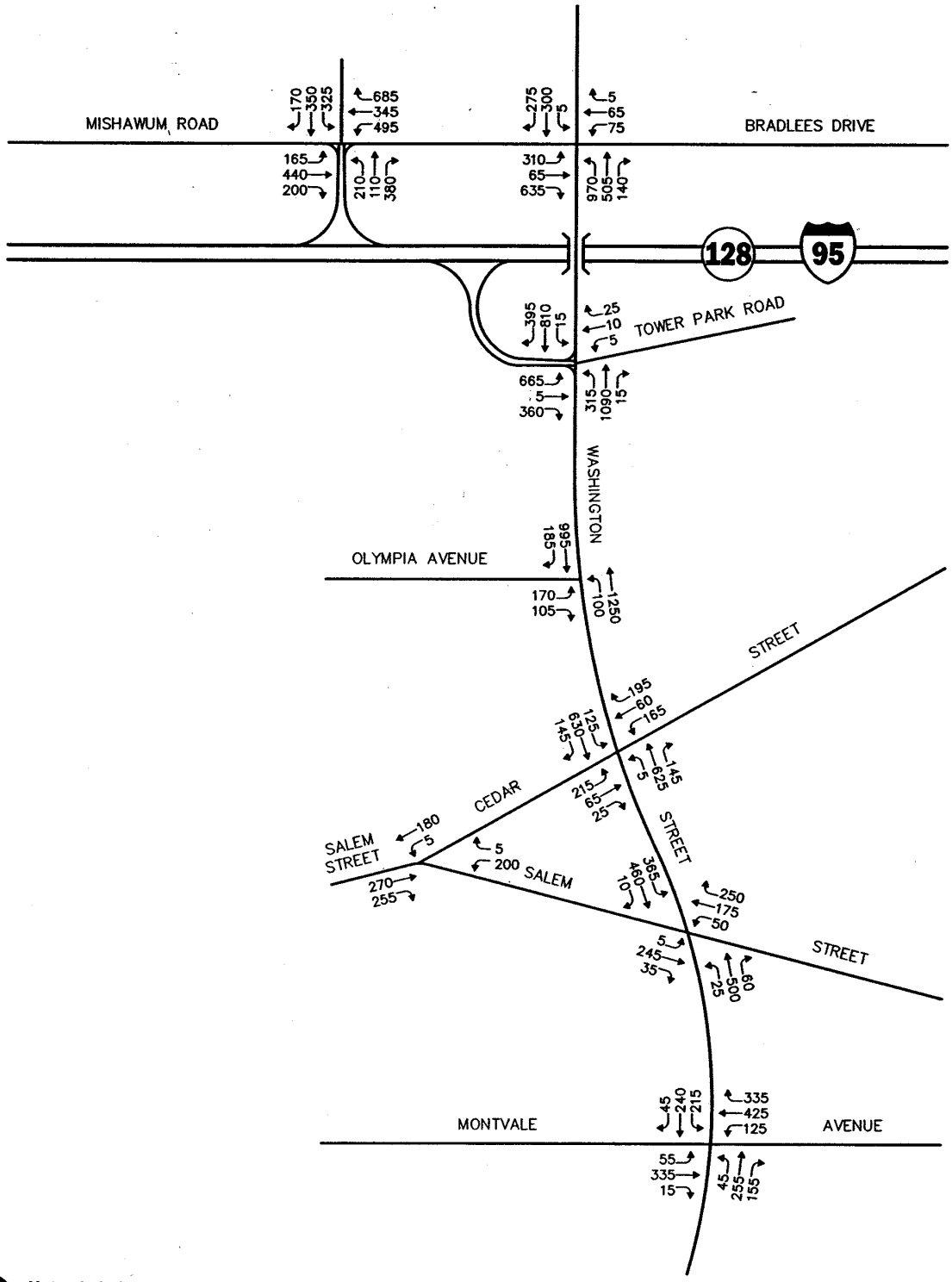
2006 No-Build
Weekday Evening
Peak Hour Traffic Volumes



Note: Imbalances exist due to numerous curb cuts and side streets that are not shown.

Not To Scale

Figure 4.9

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2006 No-Build
Saturday Midday
Peak Hour Traffic Volumes

Table 4.4 2006 FUTURE NO-BUILD CONDITIONS SIGNALIZED INTERSECTION LEVEI.-OF-SERVICE SUMMARY			
	2006 Future		
Location	V/C[1]	Delay[2]	LOS[3]
Mishawum Rd. at Commerce Way/I-95 Ramp:			
Weekday Morning	>1.0	>80	F
Weekday Evening Peak	>1.0	>80	F
Saturday Midday Peak	>1.0	>80	F
Mishawum Road at Washington Street:			
Weekday Morning Peak	>1.0	>80	F
Weekday Evening Peak	>1.0	54	D
Saturday Midday Peak	0.79	22	C
Washington Street at Tower Road/l-95 Ramps:			
Weekday Morning Peak	0.95	33	C
Weekday Evening Peak	>1.0	>80	F
Saturday Midday Peak	0.83	28	C
Washington Street at Olympia Avenue:			
Weekday Morning Peak	0.87	12	B
Weekday Evening Peak	>1.0	75	E
Saturday Midday Peak	0.77	11	B
Washington Street at Cedar Street:			
Weekday Morning Peak	0.67	16	B
Weekday Evening Peak	>1.0	59	E
Saturday Midday Peak	0.88	29	C
Washington Street at Salem Street:			
Weekday Morning Peak	>1.0	>80	F
Weekday Evening Peak	>1.0	>80	F
Saturday Midday Peak	>1.0	71	E
Washington Street at Montvale Avenue:			
Weekday Morning Peak	.88	39	D
Weekday Evening Peak	>1.0	66	E
Saturday Midday Peak	.63	18	B
[1]Volume-to-capacity ratio for critical approach movement.			
[2]Delay in seconds per vehicle for critical approach movement.			
[3]Level of service.			

location is projected to operate at LOS E due to heavy delay experienced on the eastbound Montvale Avenue and northbound Washington Street approaches.

h. Conclusion: As documented in this subsection, a number of proposed area developments are expected to be in place or have recently been completed under future No-Build conditions, resulting in increased traffic volumes along the Washington Street and Mishawum Road corridors. As mitigation for these developments, proposed roadway and traffic signal improvements have been constructed or are proposed at a number of study area intersections. While these improvements are expected to enhance traffic operations and safety within the study area, a number of locations will continue to exhibit deficient traffic operations under future No-Build conditions. This is particularly evident during the weekday evening commuter peak hour, when traffic volumes and resulting conflicts are highest.

3. Build-Out Analysis: This subsection represents the third of four memoranda originally submitted to the Advisory Committee, which specifically identified transportation impacts associated with the redevelopment of the W.R. Grace property in Woburn, Massachusetts. The purpose of this subsection is to evaluate three potential development scenarios for the property on Washington Street. Traffic increases are projected which are associated with each of these land development scenarios, traffic-volume increases are quantifed at each study area intersection based on likely trip-distribution patterns for each scenario, and mitigation strategies are recommended which are aimed at offsetting development-related impacts. The results of this analysis are summarized below.

a. Development Scenarios: Three development alternatives have been evaluated for the redevelopment of the W.R. Grace site in this subsection based on land use analysis provided by Environmental Science Services. Each of these development scenarios is described below. Hotel use is evaluated later, in the final subsection 4.

1) Scenario I - Office Development: The first development scenario for the W.R. Grace property entails construction of an office building with parking for 487 vehicles on-site. The proposed building would be two floors, providing 163,000 square feet (sf) of office space.

2) Scenario II - Retail Development: The second development alternative entails the construction of a multi-story retail facility with parking for 610 vehicles. The proposed building would be three stories tall, providing 163,500 sf of retail space.

3) Scenario III - Industrial/Warehouse Development: The third development alternative involves the construction of a two-story industrial/warehouse facility with parking for 484 vehicles on-site. The proposed building would provide a total of 188,000 sf.

For initial planning purposes, access and egress for the subject site is located on Washington Street, opposite Olympia Avenue. However, in lieu of direct driveway access onto Washington Street, consideration is given to shared access via the adjacent Tower Park Road.

b. Trip Generation: The traffic generated by each of the proposed development scenarios were estimated using trip generation equations published in the Institute of Transportation Engineers (ITE) *Trip Generation* manual. The manual provides trip-generation equa-

tions for a number of Land Use Codes (LUC). Trip-generation calculations were performed for LUC 110 - General Light Industrial, LUC 710 - General Office Building, and LUC 820 - Shopping Center. Table I presents the trip-generation estimates for each development scenario.

As summarized in Table 4.5 below, the office development scenario would result in approximately 1,935 daily trips on a typical weekday. On a Saturday the office development would result in substantially less traffic, approximately 390 trips per day. Weekday peak-hour traffic increases would range from 276 trips (243 entering and 33 exiting) during the weekday morning peak to 263 trips (45 entering and 218 exiting) during the weekday evening peak. Saturday peak-hour trip generation is projected at 67 additional trips (36 entering and 31 exiting).

The retail development scheme is projected to generate approximately 9,350 additional trips during a typical weekday, and 12,454 additional trips during a typical Saturday. Weekday peak-hour trip generation is projected at 168 trips (102 entering and 66 exiting) during the morning peak hour and 869 new trips (417 entering and 452 exiting) during the evening peak hour. Trip generation for the Saturday mid-day peak is estimated at 1,201 trips (625 entering and 576 exit-

Table 4.5
TRIP-GENERATION SUMMARY -
ALTERNATIVE DEVELOPMENT SCENARIOS

	Office[a]	Shopping Center[b]	Warehouse/Light Industrial[c]
Weekday Morning Peak Hour			
Entering	243	102	152
Exiting	33	66	21
Total	276	168	173
Weekday Evening Peak Hour			
Entering	45	417	22
Exiting	281	452	162
Total	263	869	184
Saturday Midday Peak Hour			
Entering	36	417	22
Exiting	31	576	14
Total	67	1,201	26
Weekday Daily	1,936	9,352	1,310
Saturday Daily	388	12,454	248

Source: ITE Trip Generation manual, Sixth Edition, 1997.

[a]ITE LUC 710 trip equation for 163,600 sf office building.

[b]ITE LUC 820 trip equation for 163,500 sf shopping center.

[c]ITE LUC 110 trip equation for 188,000 sf building

ing).

The warehouse/light manufacturing development scenario is projected to generate approximately 1,310 trips on a typical weekday, and 248 trips on a typical Saturday. Peak-hour trip generation is estimated at 173 new trips (152 entering and 21 exiting) during the weekday morning peak hour, 184 new trips (22 entering and 162 exiting) during the weekday evening peak hour, and 26 new trips (12 entering and 14 exiting) during the Saturday midday peak hour. Based on the results of the capacity analysis, the proposed retail development would result in the greatest number of daily trips on both a weekday and Saturday. The retail development would also result in the greatest number of trips during the weekday evening and Saturday midday peak periods. During the weekday morning peak, the proposed office development would generate the greatest number of new trips. The warehouse/light manufacturing development scenario is projected to generate the fewest number of trips on both a daily and peak-hour basis.

c. Trip Distribution: Development of the Build traffic-volume networks requires that site-generated traffic volumes previously described be assigned to area roadways based on projected regional distribution patterns. The trip-distribution patterns for retail facilities is a function of several variables that include population densities within an assumed market area, location of competing retail sites, and characteristics of the local road-way system. The trip-distribution patterns utilized for the shopping center scenario are based on the trip-distribution patterns used for the proposed Lowe's Home Improvement store, which has been approved by the City of Woburn. Trip distribution for the office and warehouse/light industrial development scenarios are based on U.S. Census Journey-to-Work data for employees that work within the City of Woburn, and likely commuter travel routes. The trip-distribution patterns for both scenarios are summarized in Table 4.6, and displayed in Figures 4.10 and 4.11.

d. Build Conditions: Project-related traffic-volume increases were developed by applying the projected trip-distribution patterns to the trip-generation estimates for each development scenario. Future-year 2006 Build condition traffic volumes were derived by adding the project-related traffic increases to the future-year 2006 No-Build traffic volumes. Year 2006 Build condition traffic volumes for each development scenario are displayed in Figures 4.12 through 20.

e. Traffic Volume Increases: Based on the projected increase in traffic volumes for each of the three development scenarios, traffic volume increases were projected for each development scenario, as summarized in Table 4.7.

As indicated in Table 4.7, during the weekday morning peak hour, the office development alternative would result in the greatest traffic increases at study area intersections. Locations most impacted by this development alternative are the intersection of Washington Street at Olympia Avenue, where weekday morning traffic volumes are projected to increase by greater than 9 percent.

The retail development alternative is expected to have the greatest impact during both the weekday evening and Saturday midday peak periods. From a traffic impact standpoint, this development will result in the greatest impact as traffic volumes within the region are highest during the weekday evening peak hour. Intersection traffic-volume increases associated with this de-

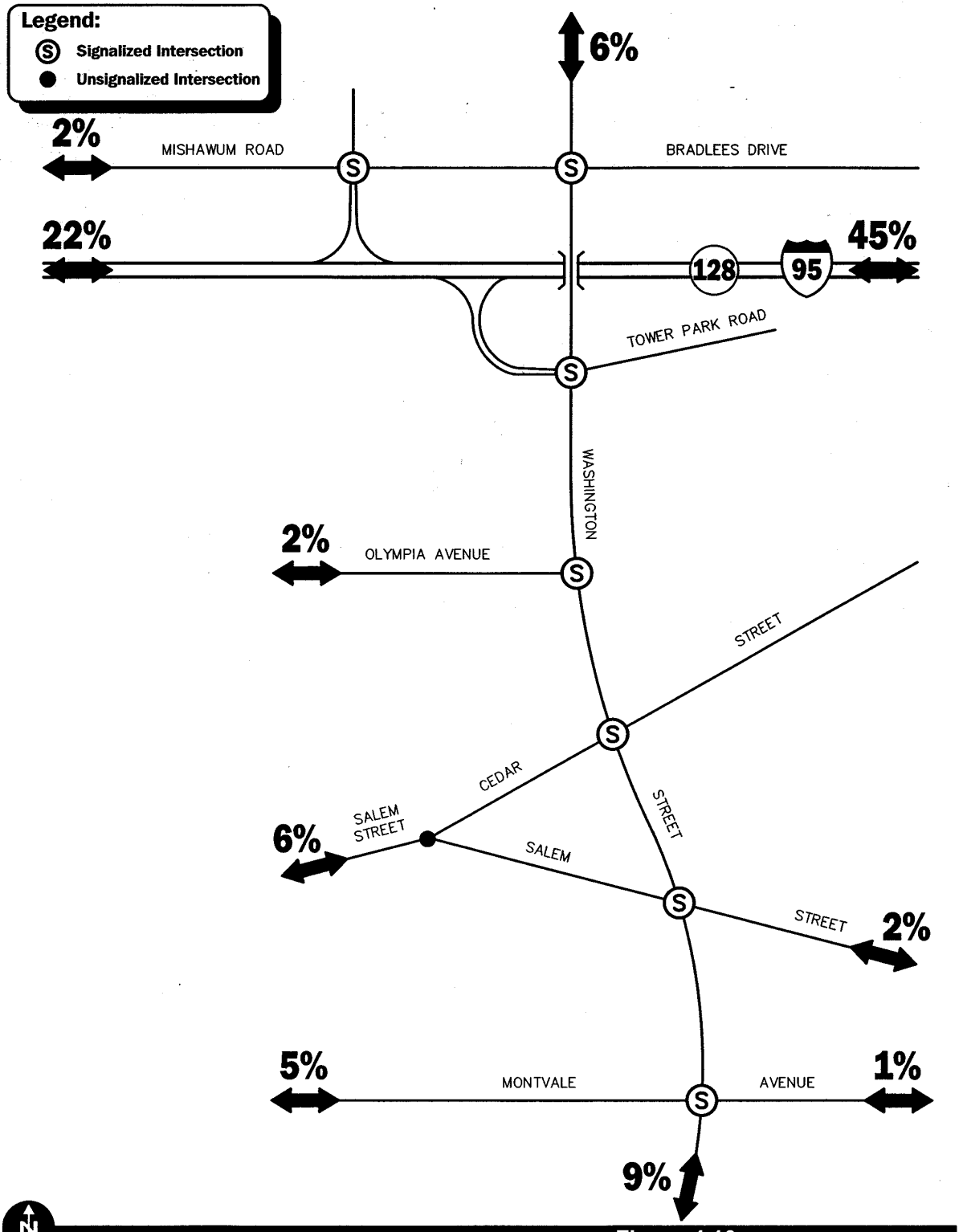

Figure 4.10

Office and Warehouse/ Light Industrial Trip Distribution Patterns

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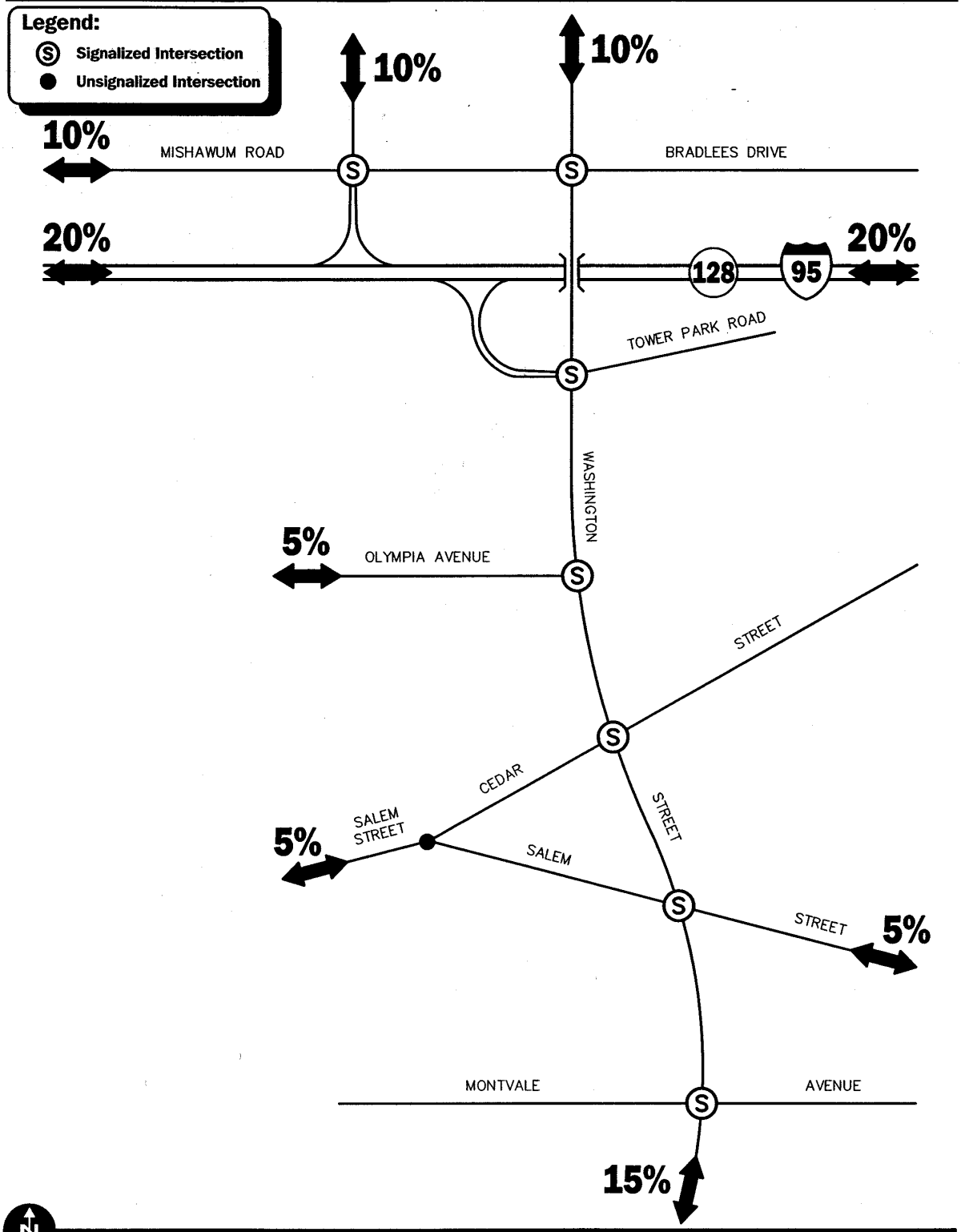

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Figure 4.11

Retail
Trip Distribution Patterns

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Table 4.6 TRIP-DISTRIBUTION SUMMARY		
Route (To/From)	Retail Trip Distribution	Office/Warehouse Light Industrial Trip Distribution
I-95, north of the site	30%	45%
I-95, south of the site	20%	22%
Mishawum Road, east of the site	10%	2%
Washington Street, north of the site	10%	6%
Washington Street, south of the site	15%	15%
Olympia Avenue, west of the site	5%	2%
Salem Street, east of the site	5%	6%
Salem Street, west of the site	5%	2%
TOTAL	100%	100%
Source: Notice of Project Change, Proposed Home Improvement Store; HTSD.		
Source: U.S. Census Journey to Work data for employees within the City of Woburn.		

velopment alternative range as high as 652 new vehicle trips during the weekday evening peak hour and 901 new vehicle trips during the Saturday midday peak hour, resulting in No-Build traffic volumes increasing as high as 32 percent.

The light manufacturing/warehouse development alternative is projected to have the least impact of all three development scenarios. Traffic-volume increases associated with this alternative are expected to result in volume increases of approximately 2 percent or less at all but two locations. During the Saturday midday peak hour, all locations are projected to experience an increase in traffic volume of less than 1 percent.

f. Future Traffic Operations: In order to assess quality of flow, roadway capacity analyses were for study area intersections under future Build conditions. Capacity analyses were performed for each development scenario to provide a comparison of traffic impacts associated with each development alternative. The results of this analysis are summarized below.

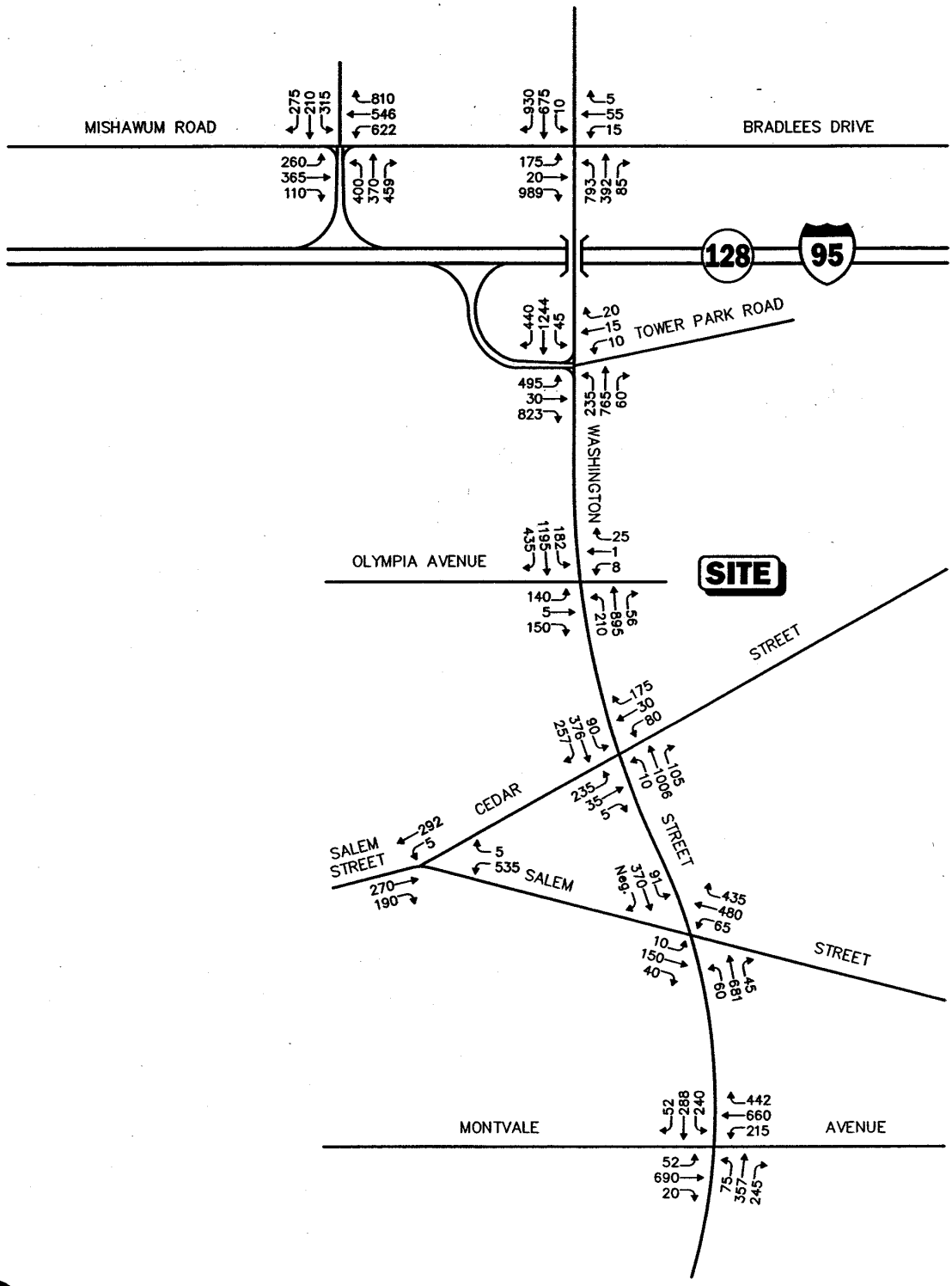
g. Analysis Results: Level-of-service analyses were conducted for the 2006 Build condition for the weekday morning, weekday evening, and Saturday midday peak periods. The results, of the intersection capacity analyses are summarized in Table 4.8.

As documented in the Section 2- Future No-Build Conditions, study area intersections experience constrained operations during weekday commuter hours independent of redeveloping the

Table 4.7
TRAFFIC-VOLUME INCREASE SUMMARY

		Office		Warehouse		Retail	
Location	2006	Project	Percent	Project	Percent	Project	Percent
Mishawum Rd. at Commerce Way/I-95 Ramp:							
Weekday Morning	4,620	122	2.6	76	1.7	46	1.0
Weekday Evening Peak	5,330	73	1.4	49	0.9	227	4.3
Saturday Midday Peak	3,875	24	0.6	9	0.2	318	8.2
Mishawum Road at Washington Street:							
Weekday Morning Peak	4,005	139	3.5	88	2.2	59	1.5
Weekday Evening Peak	4,755	89	1.9	60	1.3	292	6.1
Saturday Midday Peak	3,345	28	0.8	10	0.3	407	12.2
Washington Street at Tower Road/I-95 Ramps:							
Weekday Morning Peak	3,975	207	5.2	130	3.3	89	2.2
Weekday Evening Peak	4,590	198	4.3	138	3.0	455	9.9
Saturday Midday Peak	3,710	50	1.9	20	0.5	630	17.0
Washington Street at Olympia Avenue:							
Weekday Morning Peak	3,025	276	9.1	173	5.7	127	4.2
Weekday Evening Peak	3,635	263	7.2	184	5.1	652	17.9
Saturday Midday Peak	2,805	67	2.4	26	0.9	901	32.1
Washington Street at Cedar Street:							
Weekday Morning Peak	2,340	63	2.7	40	1.7	32	1.4
Weekday Evening Peak	2,850	60	2.1	42	1.5	163	5.7
Saturday Midday Peak	2,400	15	0.6	6	0.2	225	9.4
Washington Street at Salem Street:							
Weekday Morning Peak	2,380	47	2.0	30	1.2	25	1.0
Weekday Evening Peak	3,050	44	1.5	32	1.0	130	4.3
Saturday Midday Peak	2,180	11	0.5	4	0.2	180	8.3
Washington Street at Montvale Avenue:							
Weekday Morning Peak	3,295	41	1.3	26	0.8	19	0.6
Weekday Evening Peak	3,450	39	1.1	27	0.8	98	2.8
Saturday Midday Peak	2,245	10	0.4	4	0.2	135	0.6

*Total entering volume.



Note: Imbalances exist due to numerous curb cuts and side streets that are not shown.

Not To Scale

Figure 4.12

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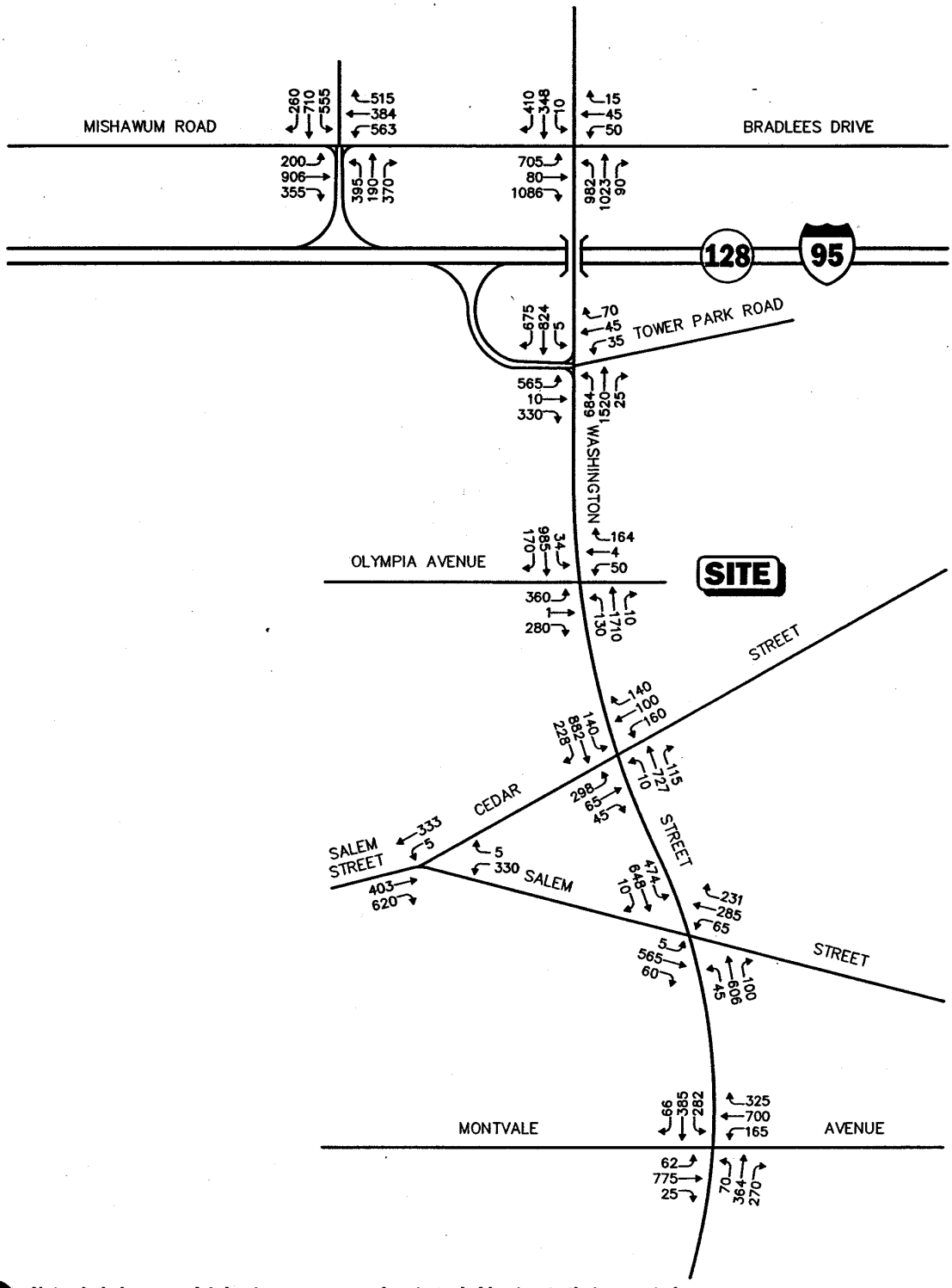
2006 Build-Office
Weekday Morning
Peak Hour Traffic Volumes



Note: Imbalances exist due to numerous curb cuts and side streets that are not shown.

Not To Scale

Figure 4.13

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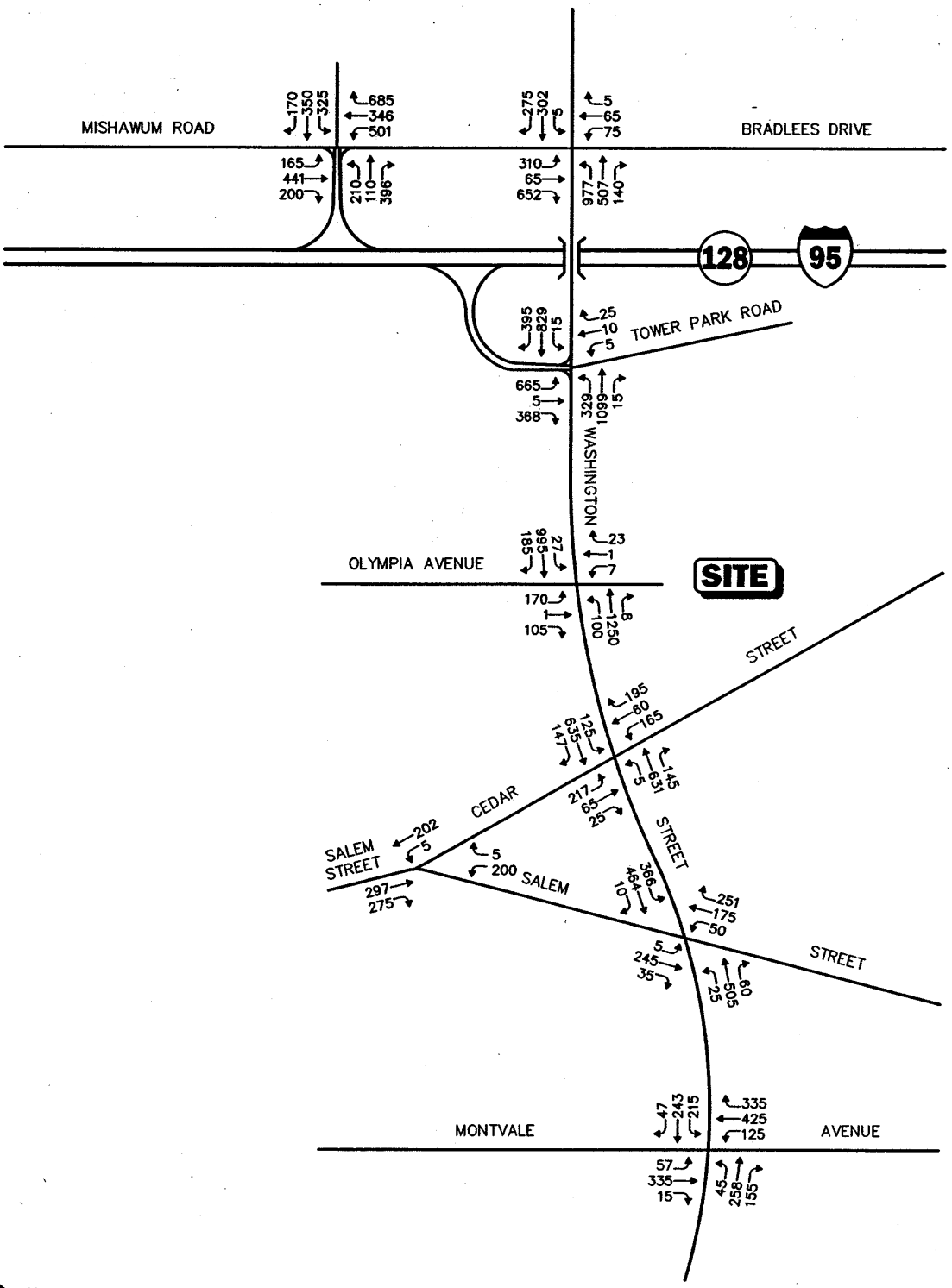
2006 Build-Office Weekday Evening Peak Hour Traffic Volumes



Note: Imbalances exist due to numerous curb cuts and side streets that are not shown.

Not To Scale

Figure 4.14

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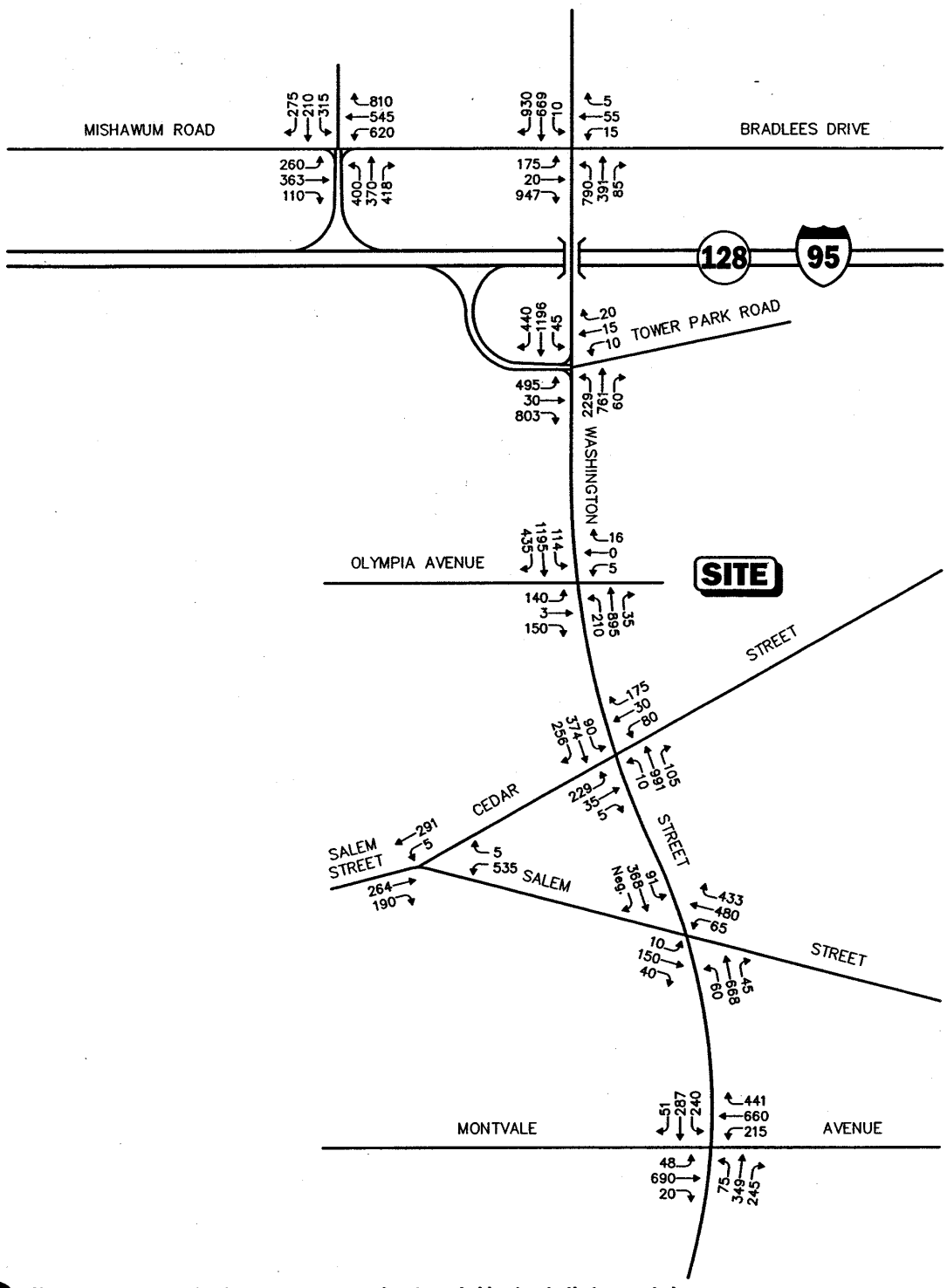
2006 Build-Office
Saturday Midday
Peak Hour Traffic Volumes



Note: Imbalances exist due to numerous curb cuts and side streets that are not shown.

Not To Scale

Figure 4.15

Vanasse & Associates, Inc.
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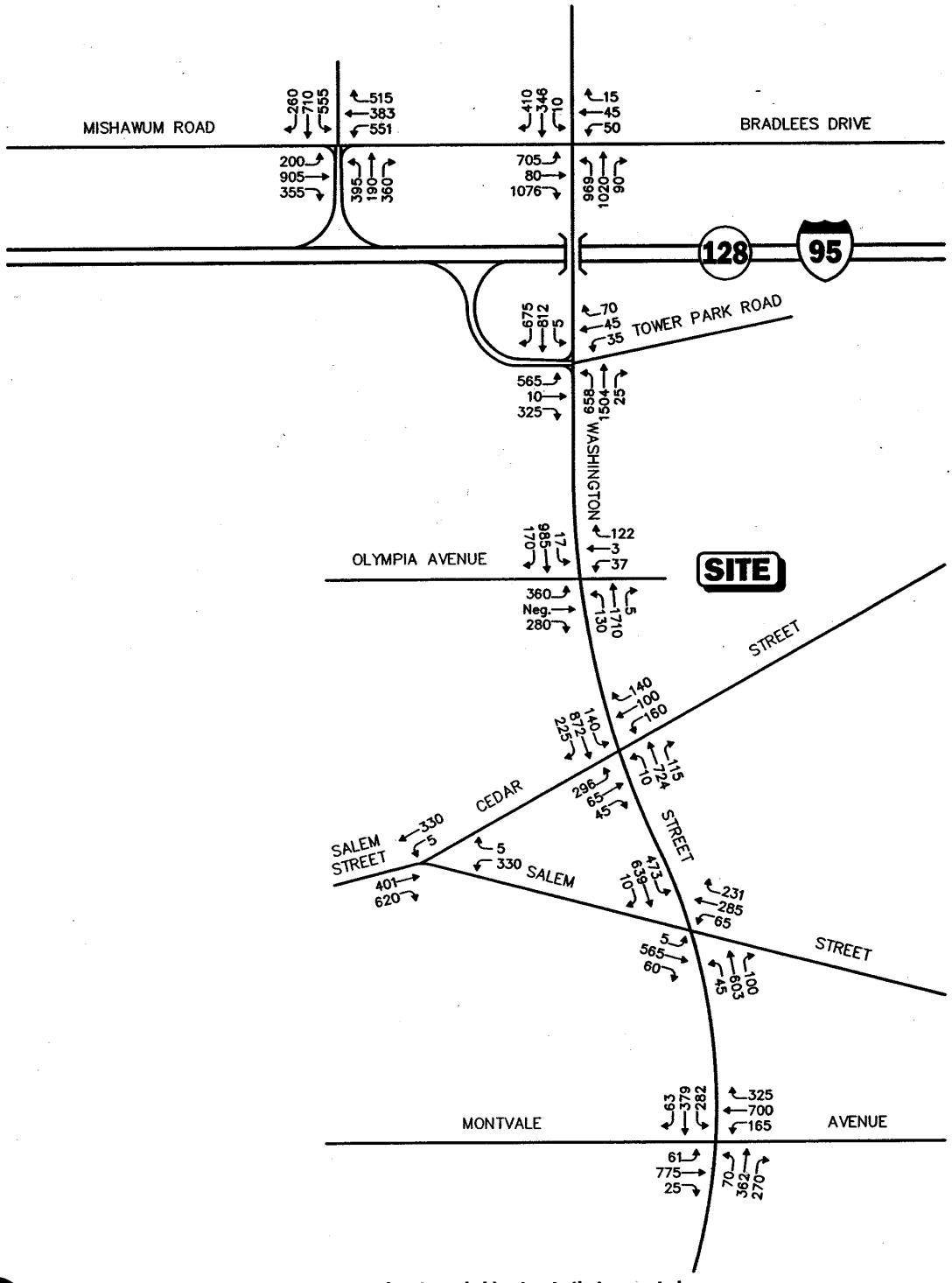
2006 Build-Warehouse/ Light Industrial Weekday Morning Peak Hour Traffic Volumes



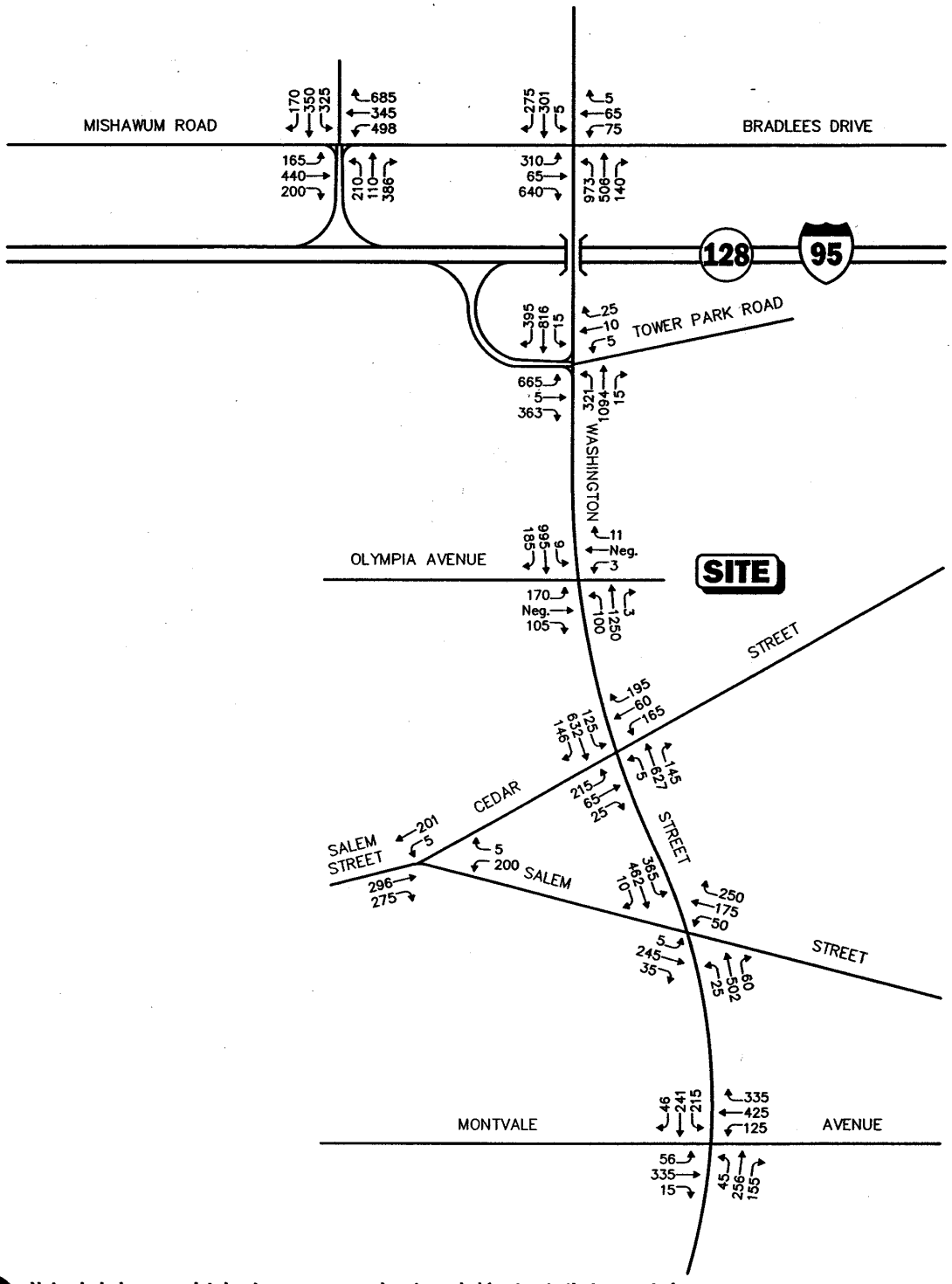
Note: Imbalances exist due to numerous curb cuts and side streets that are not shown.

Not To Scale

Figure 4.16

Vanasse & Associates, Inc.
Transportation Engineers & Planners

2006 Build-Warehouse/ Light Industrial Weekday Evening Peak Hour Traffic Volumes



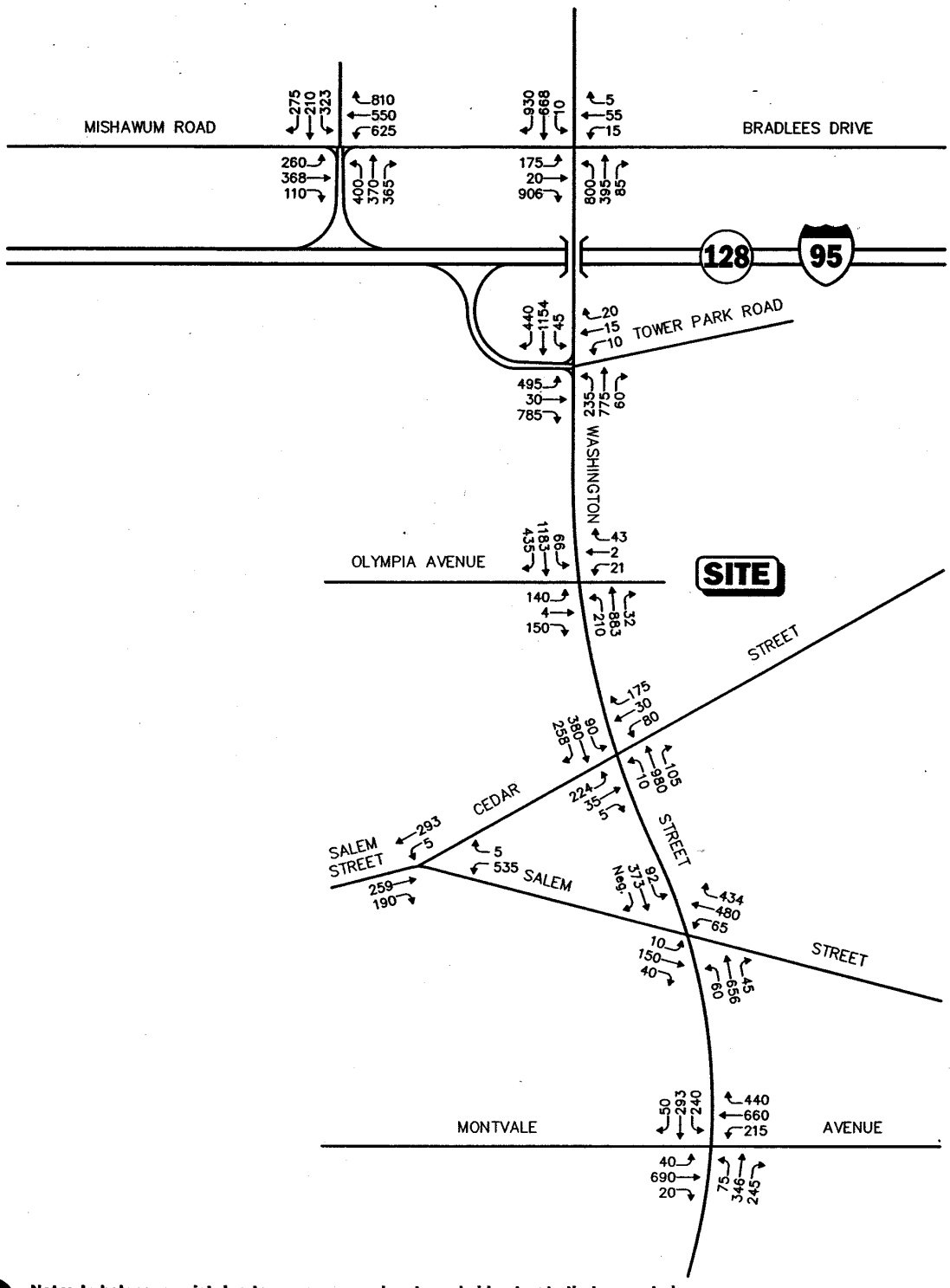
Note: Imbalances exist due to numerous curb cuts and side streets that are not shown.

Not To Scale

Figure 4.17

Vanasse & Associates, Inc.
Transportation Engineers & Planners

2006 Build-Warehouse/ Light Industrial Saturday Midday Peak Hour Traffic Volumes



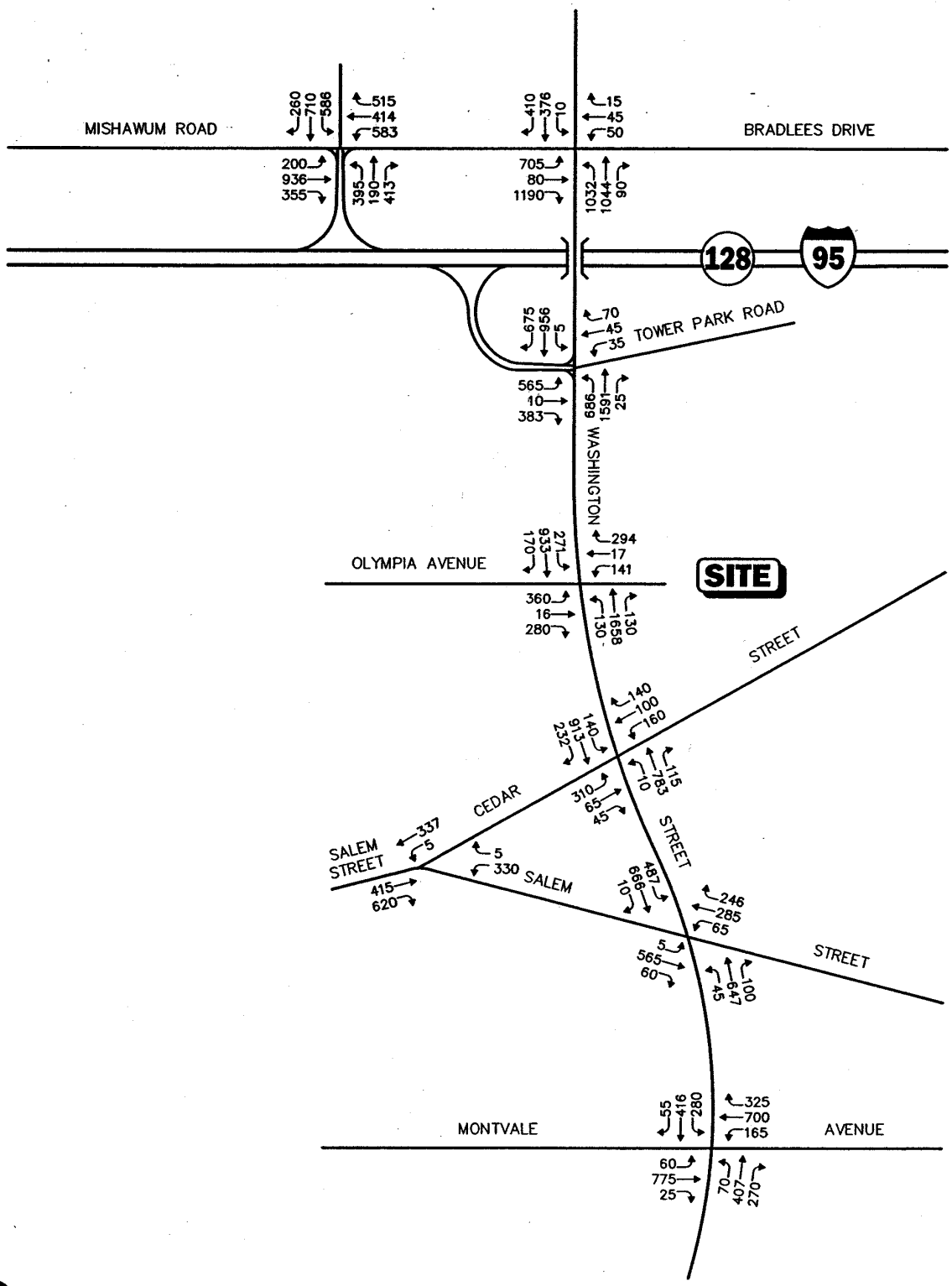
Note: Imbalances exist due to numerous curb cuts and side streets that are not shown.

Not To Scale

Figure 4.18

Vanasse & Associates, Inc.
Transportation Engineers & Planners

2006 Build Retail
Weekday Morning
Peak Hour Traffic Volumes



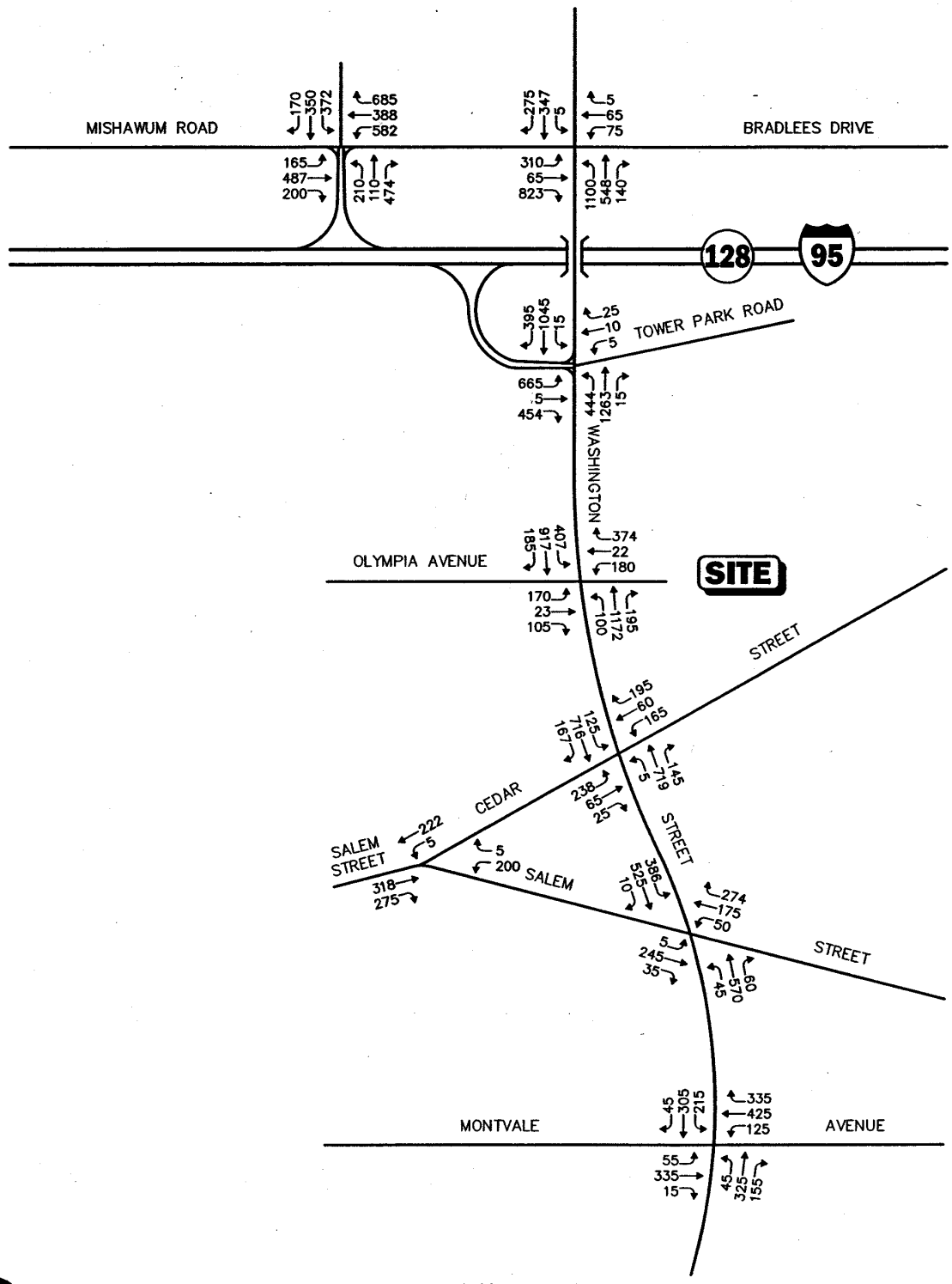
Note: Imbalances exist due to numerous curb cuts and side streets that are not shown.

Not To Scale

Figure 4.19

Vanasse & Associates, Inc.
Transportation Engineers & Planners

2006 Build Retail
Weekday Evening
Peak Hour Traffic Volumes



Note: Imbalances exist due to numerous curb cuts and side streets that are not shown.

Not To Scale

Figure 4.20

Vanasse & Associates, Inc.
Transportation Engineers & Planners

2006 Build Retail
Saturday Midday
Peak Hour Traffic Volumes

W.R. Grace site. In the absence of significant roadway widening and infrastructure improvements, travel along the Washington Street and Mishawum Road corridors will be constrained - particularly during commuter travel periods.

Incremental traffic increases associated with any redevelopment proposed for the W.R. Grace site will notably add to corridor congestion - albeit to varying degrees. As summarized in Table 4.8, many study intersections will continue to operate at or near capacity under the redevelopment scenarios.

The land development scenario that results in the least incremental impact to area roadways in the warehouse/light industrial use, followed by office use and finally retail use. Under any scenario, direct access onto Washington Street (opposite Olympia Avenue) under existing land constraints is undesirable. The close proximity of the Olympic Avenue intersection to the 1-95 ramps will create secondary impacts that would warrant (at a minimum) restricted access to right-in/right-out only. Alternatively, consideration should be given to site access via Tower Park Road, which would likely result in -lesser impacts to the Washington Street corridor.

Use of Tower Park Road as primary access for the sitei s evaluated for planning purposes, with capacity results summarized in Table 4.9. Although weekday evening commuter periods will continue to experience capacity constraints, incremental delays associated with redevelopment of the site will be generally constrained to Tower Park Road. The notable exception is that retail land use on-site will result in constrained operation of Washington Street during both weekday evening and Saturday midday peak hours.

h. Conclusions and Recommendations: Based on the results of the analysis, Vanasse & Associates, Inc. (VAi) offers the following transportation conclusions and recommendations regarding development alternatives for the W.R. Grace site:

- It is recommended that the site access and egress be provided onto Tower Park Road if possible. This would allow for exiting vehicles to travel onto the I-95 northbound on-ramp directly from Tower Park Road, resulting in the least impact to mainline Washington Street flows.

- The results of the analysis indicate that future roadway infrastructure and traffic signal equipment will not support the retail development scenario absent substantial roadway and signal improvements along the Washington Street corridor. During the critical weekday evening peak hour, traffic volume increases associated with this alternative are projected to notably worsen traffic operations at locations that already operate at capacity.

- The proposed office development alternative will result in the greatest impact during the week-day morning peak hour, but can generally be accommodated within future area infrastructure. Traffic impacts associated with office development can also be managed or reduced through Transportation Demand Management (TDM) programs that include flexible work hours, on-site amenities, carpool incentives, car sharing programs, etc.

- The proposed light manufacturing and warehouse development alternative will have the

Table 4.8
2006 FUTURE BUILD CONDITION
SIGNALIZED INTERSECTION LEVEL-OF-SERVICE SUMMARY

	Office Development Scenario			Warehouse/ Light Industrial Development Scenario			Retail Development Scenario		
Location /Peak Hour	V/C[a]	Delay[b]	LOS[c]	V/C	Delay	LOS	V/C	Delay	LOS
Mishawum Rd. at Commerce Way/I-95 Ramp:									
Weekday Morning	>1.2	>80	F	>1.2	>80	F	>1.2	>80	F
Weekday Evening Peak	>1.2	>80	F	>1.2	>80	F	>1.2	>80	F
Saturday Midday Peak	>1.2	>80	F	>1.2	>80	F	>1.2	>80	F
Mishawum Road at Washington Street:									
Weekday Morning Peak	>1.2	>80	F	>1.2	>80	F	>1.2	>80	F
Weekday Evening Peak	1.12	56	E	1.11	55	E	1.19	67	E
Saturday Midday Peak	0.80	23	C	0.79	22	C	0.92	33	C
Washington Street at Tower Road/I-95									
Weekday Morning Peak	1.03	42	D	1.00	37	D	97	34	C
Weekday Evening Peak	>1.2	>80	F	>1.2	0	F	>1.2	>80	F
Saturday Midday Peak	0.85	29	C	0.8	8	C	1.04	37	D
Washington Street at Olympia Avenue:									
Weekday Morning Peak	1.19	>80	F	0.99	28	C	.97	16	B
Weekday Evening Peak	>1.2	>80	F	>1.2	>80	F	>1.2	>80	F
Saturday Midday Peak	0.85	20	B	0.81	28	B	1.04	>80	F
Washington Street at Cedar Street:									
Weekday Morning Peak	0.67	15	B	0.69	17	B	0.68	16	B
Weekday Evening Peak	1.09	67	E	1.08	65	E	1.14	>80	F
Saturday Midday Peak	0.74	15	B	0.81	15	B	0.82	17	B
Washington Street at Salem Street:									
Weekday Morning Peak	>1.2	>80	F	>1.2	>80	F	>1.2	>80	F
Weekday Evening Peak	>1.2	>80	F	>1.2	>80	F	>1.2	>80	F
Saturday Midday Peak	>1.2	72	F	>1.2	71	E	>1.2	>80	F
Washington Street at Montvale Avenue:									
Weekday Morning Peak	0.91	42	D	0.90	41	D	0.88	40	D
Weekday Evening Peak	1.07	68	E	1.07	67	E	1.08	73	E
Saturday Midday Peak	0.64	18	B	0.63	18	B	0.66	19	B

[a]Volume-to-capacity ratio for critical approach movement.
[b]Delay in seconds per vehicle for critical approach movement.
[c]Level of service.

Table 4.9
2006 FUTURE BUILD CONDITION
TOWER PARK ROAD ACCESS

	Office Development Scenario			Warehouse/ Light Industrial Development Scenario			Retail Development Scenario		
Location /Peak Hour	V/C[a]	Delay[b]	LOS[c]	V/C	Delay	LOS	V/C	Delay	LOS
Washington Street at Tower Road/I-95									
Weekday Morning Peak	0.97	35	C	0.95	37	C	0.97	34	C
Weekday Evening Peak	>1.2	>80	F	>1.2	0	F	>1.2	>80	F
Saturday Midday Peak	0.84	29	C	0.84	8	C	>1.2	>80	F
Washington Street at Olympia Avenue:									
Weekday Morning Peak	0.91	14	B	0.89	28	B	0.88	13	B
Weekday Evening Peak	>1.2	81	F	1.2	>80	E	>1.2	80	F
Saturday Midday Peak	0.77	11	B	0.77	28	B	0.87	15	B

[a]Volume-to-capacity ratio for critical approach movement.
[b]Delay in seconds per vehicle for critical approach movement.
[c]Level of service.

least impact during peak hours, and can be accommodated within future area infrastructure with the least incremental impact.

The proposed access directly across from Olympia Avenue is not recommended. During the weekday morning peak hour, southbound left turns into the site driveway at this location would result in a reduction to traffic operations along the Washington Street corridor. In addition, during the weekday evening peak hour, it would be difficult for exiting vehicles to turn right ftom the site driveway and then merge left to turn left onto the 1-95 northbound on-ramp due to queuing along the Washington Street corridor.

4. Hotel Development Scenario: This section was prepared to evaluate transportation impacts associated with the redevelopment of the W.R. Grace property in Woburn, Massachusetts as a business hotel. It is intended to serve as a supplemental analysis to the prior sections, which evaluated the development of this property as office use, retail use, and industrial/ warehouse use. The Wells G&H Advisory Committee requested that use be added to the list of uses under consideration, after completion of the review of land use trends and retail estate market conditions in the superfund area. In addition, potential measures to enhance traffic flow along the Washington Street corridor between Tower Park Drive and Cedar Street are also investigated, including the construction of a frontage road parallel to Washington Street to serve commercial uses located along the east side of the corridor. The results of this analysis are summarized below.

a. Hotel Development Scenario: The final development scenario evaluated for the redevelopment of the W.R. Grace site is a business hotel use. Specifically, the analysis assumes the subject parcel would be redeveloped to accommodate a 150-room business hotel. Prior analyses had evaluated three additional redevelopment alternatives: a 163,600 sf office build-

ing, a 163,500 sf retail building, and a 188,000 sf industrial/warehouse building.

The traffic generated by the proposed hotel development scenario was estimated using trip generation equations published in the Institute of Transportation Engineers (ITE) *Trip Generation* manual. The manual provides trip-generation equations for a number of Land Use Codes (LUC), including LUC 310 – Hotel. Table 4.10 presents the trip-generation estimates for each development scenario.

As summarized in Table 4.10, redevelopment of the W.R. Grace site as a 150-room hotel would result in fewer trips during the weekday morning and evening peak commuter hours than any of the other three redevelopment options. During the weekday morning and weekday evening peak hours, this development alternative is expected to generate 68 trips (41 entering and 27 exiting) and 74 trips (39 entering and 35 exiting), respectively. On a daily basis, the proposed hotel development is expected to generate 974 new trips (487 entering and 487 exiting). On a typical Saturday the hotel development is expected to generate 1,148 new trips (574 entering and 574 exiting).

Based on regional trip distribution patterns described in previous sections, project-related traffic increases were assessed. In general, redevelopment of the W.R. Grace site as a 150-room hotel would result in approximately two or less new vehicle trips per minute at each study area intersection.

b. Frontage Road Analysis: At the request of the Woburn Redevelopment Authority, the potential benefit of providing a frontage road, parallel to the Washington Street corridor was evaluated. This road would be constructed east of the Washington Street corridor, providing a direct connection between Tower Park Drive and Cedar Street, as well as a secondary access route to those properties located on the east side of Washington Street, between Tower Park Drive and Cedar Street. The frontage road would allow vehicles to travel between these commercial properties and Cedar Street, onto the Interstate 95 (I-95) northbound ramp without traveling onto the Washington Street corridor.

Based on observed traffic patterns along Washington Street, between Tower Park Drive and Cedar Street, it is likely that existing curb cuts along the east side of Washington Street may accommodate between 300 and 400 vehicles during peak commuter hours. Additionally between 100 and 150 vehicles travel to Cedar Street eastbound from the north along Washington Street and between 150 and 175 vehicles from Cedar Street in the east to Washington Street northbound during peak commuter hours. Directional flows are primarily inbound (southbound on Washington Street) during the weekday morning peak, and outbound (northbound on Washington Street) during the weekday evening peak. Given that a frontage road system would allow motorists to avoid the intersection of Washington Street and Olympia Avenue, it is reasonable to assume that between 300 and 375 vehicles could be diverted during peak commuter hours. Based on these assumptions, potential impacts due to a connector roadway are as follows:

- During the weekday morning and evening peak hours, approximately 325 to 375 trips would be removed from the Washington Street corridor, bypassing the congested Olym-

TABLE 4.10
TRIP GENERATION SUMMARY
ALTERNATIVE DEVELOPMENT SCENARIOS

	Hotel[a]	Office[b]	Shopping Center[c]	Warehouse/ Light Industrial[d]
Weekday Morning Peak Hour:				
Entering	41	243	102	152
Exiting	27	33	66	21
Total	68	276	168	173
Weekday Evening Peak Hour:				
Entering	39	45	417	22
Exiting	35	281	452	162
Total	74	263	869	184
Saturday Midday Peak Hour:				
Entering	60	36	625	12
Exiting	48	31	576	14
Total	108	67	1,201	16
Weekday Daily	974	1,936	9,352	1,310
Saturday Daily	1,148	388	12,454	248

Source: ITE *Trip Generation* manual
[a]ITE LUC 310 trip equation for 150 room hotel.
[b]ITE LUC 710 trip equation for 163
[c]ITE LUC 820 trip equation for 163
[d]ITE LUC 110 trip equation for 188

pia Avenue intersection. This represents half of the vehicles travelling to sites on the eastern edge of Washington Street and Cedar street to the east of Washington Street

- At the intersection of Washington Street with the I-95 northbound ramp and Tower Park Drive, as many as 175 to 200 vehicles per hour could be diverted from the over-capacity northbound left-turn movement to the westbound through movement from Tower Park Drive.

- Peak hour delays for the northbound left-turn movement from Washington Street to the I-95 northbound ramp is projected to drop by as much as 13 seconds per vehicle during the weekday evening peak commuter hour. Average queuing is expected to drop by 70 feet per vehicle during the weekday evening peak, as well.

c. Access Management Options: In an effort to enhance traffic operations along the Washington Street corridor the City of Woburn may evaluate a number of alternatives to reduce both traffic volume along the corridor, and existing conflicts created by the high number

of curb cuts along this roadway. Potential access management options that could be considered are:

- ***Frontage Road Connector–*** Construction of the aforementioned frontage road to serve the existing commercial uses on the east side of Washington Street and north side of Cedar Street would alleviate congestion along the Washington Street corridor. This frontage road would reduce existing conflicts between mainline Washington Street flow and vehicles turning to and from the commercial properties located along Washington Street.

- ***Driveway Modifications–*** In an effort to minimize conflict between Washington Street traffic and the number of curb cuts along the corridor, existing curb-cuts could be modified to prohibit certain movements. Specifically, signage could be posted at existing driveways prohibiting left-turns onto Washington Street at select locations. Another potential measure is to reconstruct existing driveways to operate as right-in/right-out only driveways.

- ***Curb-cut Closure–*** The final measure that could be examined to reduce congestion along Washington Street is the closure and consolidation of existing curb-cuts to reduce the number of conflict points along the corridor. This measure could be implemented in conjunction with the Frontage Road connector to provide a more efficient route to the I-95 ramps, thereby avoiding the Washington Street corridor altogether.

d. Conclusions and Recommendations: Based on the results of the analysis, Vanasse & Associates, Inc. (VAI) offers the following transportation conclusions and recommendations regarding development alternatives for the W.R. Grace site:

- On a peak hour basis, the proposed 150-room hotel would generate substantially less traffic than the previously evaluated alternatives, including an office, retail, and industrial/warehouse development.

- Construction of a frontage road between Cedar Street and the Tower Park Drive has the potential to divert as many as 375 trips from the Washington Street corridor (south of Tower Park Drive) during peak commuter hours.

- Traffic operations at the intersection of Washington Street with the I-95 northbound ramps and Tower Park Drive are critical to the operation of the Washington Street corridor. Diversion of traffic volumes from Washington Street to Tower Park Road relieves the Washington Street corridor, however, impacts the Tower Park Road and I-95 northbound ramps. A diversion in excess of 375 vehicles during peak commuter hours could adversely affect queuing along the I-95 northbound ramps at Washington Street outside of additional geometric improvements.