Precursor Systems Analyses of Automated Highway Systems

RESOURCE MATERIALS

Roadway Deployment Analysis and Impact of AHS

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FOREWORD

This report was a product of the Federal Highway Administration's Automated Highway System (AHS) Precursor Systems Analyses (PSA) studies. The AHS Program is part of the larger Department of Transportation (DOT) Intelligent Transportation Systems (ITS) Program and is a multi-year, multi-phase effort to develop the next major upgrade of our nation's vehicle-highway system.

The PSA studies were part of an initial Analysis Phase of the AHS Program and were initiated to identify the high level issues and risks associated with automated highway systems. Fifteen interdisciplinary contractor teams were selected to conduct these studies. The studies were structured around the following 16 activity areas:

> (A) Urban and Rural AHS Comparison, (B) Automated Check-In, (C) Automated Check-Out, (D) Lateral and Longitudinal Control Analysis, (E) Malfunction Management and Analysis, (F) Commercial and Transit AHS Analysis, (G) Comparable Systems Analysis, (H) AHS Roadway Deployment Analysis, (I) Impact of AHS on Surrounding Non-AHS Roadways, (J) AHS Entry/Exit Implementation, (K) AHS Roadway Operational Analysis, (L) Vehicle Operational Analysis, (M) Alternative Propulsion Systems Impact, (N) AHS Safety Issues, (O) Institutional and Societal Aspects, and (P) Preliminary Cost/Benefit Factors Analysis.

To provide diverse perspectives, each of these 16 activity areas was studied by at least three of the contractor teams. Also, two of the contractor teams studied all 16 activity areas to provide a synergistic approach to their analyses. The combination of the individual activity studies and additional study topics resulted in a total of 69 studies. Individual reports, such as this one, have been prepared for each of these studies. In addition, each of the eight contractor teams that studied more than one activity area produced a report that summarized all their findings.

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NOTICE

VOLUME III — AHS ROADWAY ANALYSIS

CHAPTER 2: ROADWAY DEPLOYMENT ANALYSIS AND IMPACT OF AHS ON SURROUNDING ROADS (TASKS H & I)

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VOLUME III — AHS ROADWAY ANALYSIS

Chapter 2 ROADWAY DEPLOYMENT ANALYSIS AND IMPACT OF AHS ON SURROUNDING ROADS (TASKS H & I)

1.0 EXECUTIVE SUMMARY

Tasks H and I are reported in a single report chapter because of the high level of coupling between them.

1.1 OBJECTIVE

The objectives of these tasks are the following:

- Identify the types of infrastructure configurations which should be deployed. Representative System Configuration (RSC) definitions are discussed in Volume I. Since RSC I1 requires no change to the infrastructure, the studies included RSCs I2 and I3. RSC definitions are provided in Section 1.3.1.
- Identify examples of Automated Highway System (AHS) deployment in the context of real case studies and quantify the benefits of these deployment scenarios using measures of effectiveness such as speed, delay, and throughput.
- Assess the effect of AHS market penetration (MP) on traffic patterns for RSCs I2 and I3 based AHS deployments.
- Assess the effect of traffic pattern changes on non-AHS roadways resulting from AHS deployment.

1.2 SUMMARY OF TECHNICAL APPROACH

1.2.1 Approach

The objectives described above were accomplished as follows:

- AHS roadway design concepts for RSCs I2 and I3 were developed (Section 3.1). A physical layout of an AHS system employing these concepts was developed for the Long Island Expressway (LIE) (Section 3.5).
- Four case studies were developed to assess the performance and potential benefits of AHS installation. These included one urban, two suburban, and one rural freeway (Section 3.2). Traffic loading and AHS and general lane configurations were developed for each case study. The INTEGRATION traffic model was adapted for evaluation purposes, and the performance of each AHS design was evaluated relative to a baseline or no build case. The effects on nearby surface street intersections were evaluated in some cases (Section 3.2).

- An existing TRANPLAN traffic model of Long Island was modified to determine the effect of AHS deployment on areawide traffic. AHS MP was used as a variable parameter for this study (Section 3.3).
- The generalized traffic pattern changes on surface streets caused by the introduction of the AHS were identified. Conceptual changes in traffic assignment models resulting from the introduction of AHS use costs to the motorists were identified (Section 3.4).
- Certain AHS control strategies require tight control of vehicles desiring to enter the AHS. One approach to achieving this merge is to release vehicles desiring AHS access from an entry queue at the appropriate instant and under automated control. A study was performed to determine the queue delays experienced by the motorist and the queue storage requirements.

1.2.2 Key Assumptions

Analyses were conducted by making certain assumptions about the AHS. These assumptions were used as constraints for the evaluation of a variety of AHS designs.

- The capacity of the AHS lane was assumed to be 5000 vehicles per hour (vehicles/hr) with a usable capacity of 4500 vehicles/hr.
- All AHS access and egress ramps were assumed to have a capacity of at least 1400 vehicles per hour (vehicles/hr).
- The AHS access transition lane requires approximately 2500 feet.
- The AHS egress transition lane requires approximately 1600 feet.
- For the RSC I3, all AHS ramps enter and exit from and to a service road and/or a general use lane and/or a separate ramp. This eliminates the weaving movements of AHS equipped vehicles that utilize the AHS lane. Therefore, the AHS ramps can be placed closer to the traditional on and off-ramps.
- For the RSC I2, the access points to the AHS lane were placed at least 2000-3000 feet from the preceding on-ramp. Also, the egress points from the AHS lane were placed at least 2000-3000 feet from the next off-ramp. These distances were assumed to adequately facilitate weaving movements required by AHS equipped vehicles that utilize the AHS lane.

1.3 CONCLUSIONS/KEY FINDINGS

1.3.1 Infrastructure Design

This study concentrated on AHS infrastructure designs which provide separate lanes for AHS and non-AHS vehicles. The separate facility provides an environment which maximizes the constant speed and headway keeping capabilities of AHS vehicles. To create separate facilities, RSCs, with respect to the infrastructure, were developed. The RSCs developed were termed I2 and I3. RSC I2 provides for entry and exit to and from the AHS facility directly from the general use lanes of an expressway mainline. With the I2 design, the AHS lane can be physically separated by a barrier, a striped separation a few feet wide, or by a continuous transition lane for the length of the AHS lane. The barrier design is preferable for safety reasons. The continuous transition lane option for the RSC I2 design would require increased right-of-way as compared with the barrier option. Ingress/egress for the AHS lane would be allowed at any point. Finally, for RSC I2, both the transition lane option and the striped separation option require an impracticable level of enforcement to ensure exclusion of non-AHS vehicles. RSC I3 is achieved by providing separate ingress and egress for the AHS facility. The RSC I3 design was developed by separating the general use lanes from the AHS lane using physical barriers and providing AHS access/egress ramps that link directly to service roads or ramps.

1.3.2 AHS Performance Evaluation

Evaluation of the implementation of an AHS facility in urban, suburban, and rural environments provided the following results:

- AHS deployments using RSCs I2 and I3 on congested urban and suburban freeways can significantly improve speed and travel time on these facilities. Travel time improvements of up to 38 percent were obtained for the cases studied. This is illustrated in Table 2-1.
- Significant travel time improvements on the rural facility were only obtained when the AHS cruise speed was increased to 80 mph from the 62 mph speed used for the other cases.
- The selection of I2 or I3 AHS lane access techniques is best determined by the AHS access and egress volume requirements, by the general lane traffic of these locations, and by the level of service (LOS) on the general lanes.
- AHS deployments using RSCs I2 and I3 on congested urban and suburban freeways may significantly increase facility capacity to respond to future year demand (Table 2-1). Depending on the origin-destination (OD) requirements, the capacity of the remaining general lanes rather than the AHS lanes may limit capacity.

- In areas which experience traffic congestion, such as Long Island, high levels of AHS utilization are obtained based on RSCs I2 and I3 type facilities at relatively low levels of AHS MP (15-25 percent).
- In congestion prone areas, the AHS may generate significant changes in the utilization of parallel facilities located several miles away from the AHS. However, as MP increases, as was evident on Long Island, the attraction of the AHS facility to distant parallel roadways decreases, and total vehicle-miles traveled (VMT) in the study area decreases.
- The need to access the AHS will, in many cases, cause saturation of surface street intersections. Geometric improvements and signal timing changes will be commonly required.
- Certain AHS control strategies call for queuing vehicles at AHS entry points (auxiliary lanes in the I2 configuration and ramps in the I3 configuration). Properly managed AHS traffic maintains queue delays and queue lengths at acceptable values.
- The attraction of the AHS facility in congestion prone areas results not only from increased capacity, but also, because of the facility's ability to sustain a constant comfortably high speed of 60 mph at increased volume.
- An AHS facility on a congested urban or suburban freeway might tend to reduce the total travel time vehicle-hours in comparison to comparable non-AHS facilities, while satisfying the trip demand. This finding, however, must be tested further using a more precise modeling technique.

Table 2-1. Case Study Performance Summary

Characteristic / Case Study	Peak Hour Facility Mainline Speed MPH: No Build	Peak Hour Facility Mainline Speed MPH: With AHS		AHS Improvement in Peak Hour VMT Percent		AHS Reduction in Peak Hour Vehicle Hours Traveled Percent		Maximum Potential Increase in Facility Peak Hour Vehicle Miles Over Baseline (Percent)	
1. Boston area I-93 (Urban) Baseline is current highway configuration and volumes	45	59		7.4		19.4		30.4	
2. Long Island Expressway I-495 (Suburban) Baseline is four lane LIE and 2015 I2 volumes	32.3	35.4[1]	44.7[2]	-10.5[1]	7.9[2]	18.7[1]	23.8[2]		
3. Maryland I-495 (Suburban) Baseline is current highway configuration and volumes	39.9	59.5		9.7		38.6		18.7	
4. New York State Thruway Baseline is current highway configuration and volumes.	55.9	60.9[3]	71.4[4]	2.4[3]	7.7[4]	5.7[3]	16.4[4]	4.5[3]	10.2[4]

Notes:

1. I2 with 2 general lanes
2. I2 with 3 general lanes
3. AHS lane operates at a speed of 62mi/hr.
4. AHS lane operates at a speed of 80mi/hr.

1.4 RECOMMENDATIONS FOR FUTURE RESEARCH

1.4.1 Roadway Configuration

A number of different design alternatives are possible for RSC I2. These include:

- Continuous transition lane and continuous entry/exit versus entry/exit at discrete locations.
- Provision and configuration of an AHS breakdown lane or shoulder.
- Physical barriers versus striping.

These alternatives have an important influence on the AHS physical design and right-of-way requirements. The selection of the alternatives is, however, largely dependent on safety issues, longitudinal control issues, and entry/exit issues. Although these issues are discussed under the separate tasks, their resolution is key to roadway design.

1.4.2 Modeling and Simulation

Existing models enable studies to be carried out at the following levels:

- Area Wide Level
- AHS Network Design Level
- Microscopic Level

This task utilized models at the first two levels. Sections 1.4.2.1 and 1.4.2.2 describe ways in which models at these levels should be used to improve AHS deployment studies.

1.4.2.1 Area Wide Level

This level is useful for establishing the "catchment area" for AHS and the effect on non-AHS roadways. The TRANPLAN model was used for this purpose in the study. These models are generally based on the use of trip generation and trip assignment on a daily average (or other average) basis. The model is generally developed on an area wide basis. The model does not provide for discrete placement of traffic controls; thus, it is most useful to establish general trip patterns, not to study detailed implementations. Limitations which were encountered included the following:

- It is not feasible to convert the daily model to a peak hour model. This strongly limits the ability of the model to generate trip demand and trip tables for the AHS Network Design (Section 1.4.2.2) which can be used during peak periods and various other periods.
- TRANPLAN has no current capability to model different AHS MP at different locations or at different distances from the AHS. The modeling effort for this study assumed a constant level of MP for the entire area.

- TRANPLAN has no capability to model trip based AHS user costs (tolls).

It is recommended that the investigation of a model which corrects these deficiencies be considered.

1.4.2.2 AHS Network Design Level

While the area wide modeling level described in Section 1.4.2.1 is useful to identify large scale impacts, a more detailed level is required for the following purposes:

- AHS network design
- Assessment of traffic flows on the AHS and on nearby non AHS roadways
- Assessment of traffic impacts as a function of time of day

Case studies were conducted at this level by using the INTEGRATION model. This level is intended to model the AHS network (AHS roadways and non-AHS roadways which are significantly affected by AHS traffic). The intent is not to model on a microscopic basis but rather to establish the network traffic flows, identify flow problems, and obtain the performance characteristics for different design alternatives. INTEGRATION was designed for modeling highways. AHS lanes, ramps, and traffic flows were modeled by adapting the freeway and ramp flow characteristics to the approximate characteristics of the AHS, but this could only be accomplished imperfectly. AHS flow characteristics which could be adapted to the specific design would have been preferred.

1.4.3 Development of a Methodology to Determine AHS Entry and Exit Locations

The development of entry and exit locations for the three urban scenarios was performed by considering entry and exit volumes together with OD characteristics. With the possibility of using either RSC I2 or I3 access configurations, a large number of designs are possible. Several design combinations were heuristically developed for each case study, and the preferred approach was selected.

It is recommended that research be considered to develop a more structured methodology. Such a methodology might use a combination of data based and rule based techniques.

2.0 INTRODUCTION

2.1 FUNCTION OF ACTIVITY AREA AND PURPOSE OF EFFORT

The objectives of these tasks are the following:

- Identify the types of RSCs I2 and I3 AHS deployments which might be used. RSC definitions are discussed in Volume I.
- Identify examples of these AHS deployments in the context of real case studies and quantify the benefits of these deployments using measures of effectiveness such as speed, delay, and throughput.
- Assess the effect of AHS market penetration (MP) on traffic patterns for RSCs I2 and I3 based AHS deployments.
- Assess the effect of traffic pattern changes on non-AHS roadways resulting from AHS deployment.

2.2 ISSUES ADDRESSED AND TECHNICAL APPROACH

The objectives described in Section 2.1 were accomplished as follows:

- AHS roadway design concepts for RSCs I2 and I3 were developed (Section 3.1). A physical layout of an AHS along with the freeway general lanes and ramp connections was developed for the LIE (Section 3.5).
- Four case studies were performed which represent a spectrum of urban, suburban and rural AHS deployments. Traffic loading and AHS deployment scenarios were developed for each case. The INTEGRATION traffic model was adapted for evaluation purposes and the performance of each scenario was evaluated relative to a baseline or no build case. The effect on nearby surface street intersections was evaluated in some cases (Section 3.2).
- The effect of AHS deployment on areawide traffic was studied using the TRANPLAN model. AHS MP was used as a variable parameter for this study (Section 3.3).
- The generalized traffic pattern changes on surface streets caused by the introduction of the AHS were identified. Conceptual changes in traffic assignment models resulting from the introduction of AHS use costs to the motorist were identified (Section 3.4).
- Certain AHS control strategies require tight control of vehicles desiring to enter the AHS. One approach to achieving this merge is to release vehicles desiring AHS access from an entry queue at the appropriate instant, and under automated control. A study was performed to determine the queue delays experienced by the motorist and the queue storage requirements.

2.3 GUIDING ASSUMPTIONS

The assumptions and study limitations are discussed under each of the technical topic areas. The assumptions for the scenarios for each of the case studies (Section 3.2) are described in detail for each case study. In general they include:

- Base year highway configuration.
- Base year traffic demand volume set.
- Number of AHS lanes to be studied.

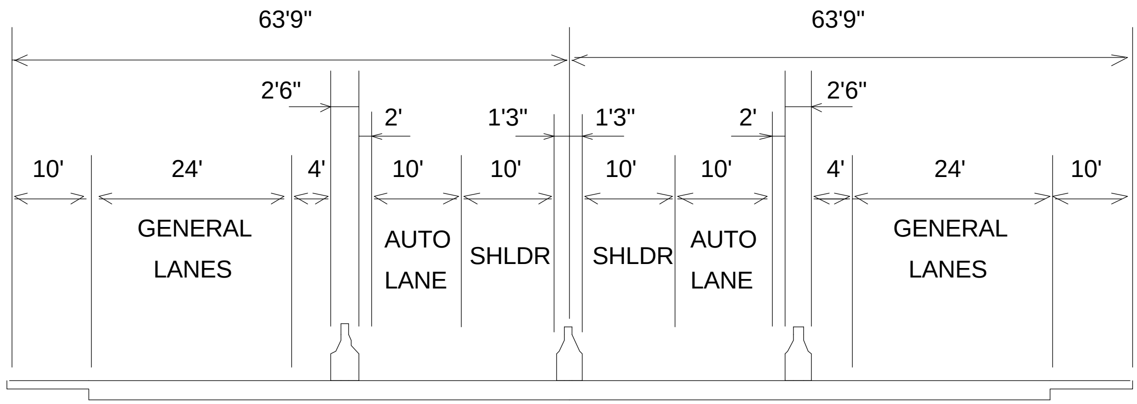
- Number of general use freeway lanes to be retained in the overall AHS highway configuration.
- Location of AHS access and egress points.
- AHS access and egress configuration (RSC I2 or I3) for each location.
- Assumptions in the adaptation of the INTEGRATION model for AHS modeling purposes.
- AHS capacity and mainline speed.
- General freeway lane traffic flow characteristics.

3.1 FUNCTIONAL REQUIREMENTS FOR RSC I2 AND I3 ROADWAY CONFIGURATION USED IN SCENARIO EVALUATIONS

3.1.1 AHS Roadway Cross Section Analysis

The roadway cross-sections developed for the AHS scenarios were evaluated considering safety and compatibility to AHS operations. The cross-sections deemed to be the most appropriate are illustrated in Figures 2-1 and 2-2. Therefore, RSCs I2 and I3 were designed to reflect these design options. Both options require the physical separation of the AHS lane from the general use lanes to reduce potential conflict between AHS and non-AHS vehicles. The Figure 2-2 option could be used for short sections where right-of-way is exceptionally difficult to obtain. The Figure 2-3 option also provides for the physical separation of AHS and non-AHS vehicles. The shared shoulder allows for the storage and retrieval of disabled vehicles in both directions. A sophisticated level of AHS control is required to avoid serious conflicts resulting from the bi-directional use of the shoulder. Also, consideration of an alternating shoulder is another viable option as illustrated in Figure 2-4. However, the alternating shoulder option was not considered further at this time.

The continuous transition lane option (Figures 2-5 to 2-7) was not selected for the RSC I2 because of the safety implications of violation by non-AHS vehicles and the additional right-of-way requirements. Also, controlling access to and egress from the AHS lane would be difficult if these operations are allowed at any



This typical section shows R.O.W requirements of a freeway with one automated lane. A barrier is utilized to separate the automated lane from the general use lanes. A 10'-0" shoulder is located next to the automated lane. This illustrates RSC I3 or I2 with barrier option.

ADVANTAGES

1) Barrier could provide additional focal point for machine vision or magnetic sensors.
2) Barrier provides physical separation of the automated lane from the general use lanes. This reduces the possibility of adverse traffic operations on the general use lanes impacting on the automated lane.
3) Barrier, also, contributes to the percieved safety of the automated lane.
4) Requires approximately 7' less R.O.W. than the comparable transition lane option with 10'-0" shoulder.

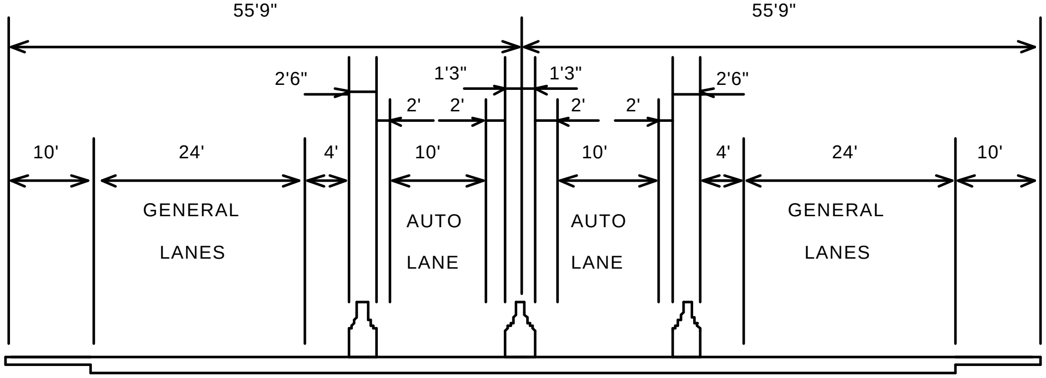
ADVANTAGES (continued)

5) Provides a means of coordinating access/egress to and from the automated lane. This limits automated lane interruptions to specific points.

DISADVANTAGES

1) Would require additional R.O.W. at the access/egress points.

Figure 2-1. Typical Section RSC I3 or I2 with Barrier and Shoulder Options



This typical section shows
requirements of a freeway
one automated lane. A

automated lane from the

next to the automated lane.
illustrates RSC I3 or I2
barrier option.

ADVANTAGE

1) Barrier could provide additional focal point for
vision or magnetic
2) Barrier provides physical separation of the
lane from the general use lanes. This reduces
possibility of adverse traffic operations on the

the automated

4) Requires approximately 7' less R.O.W. than the
transition lane option with no

ADVANTAGES

5) Provides a means of coordinating access/egress to

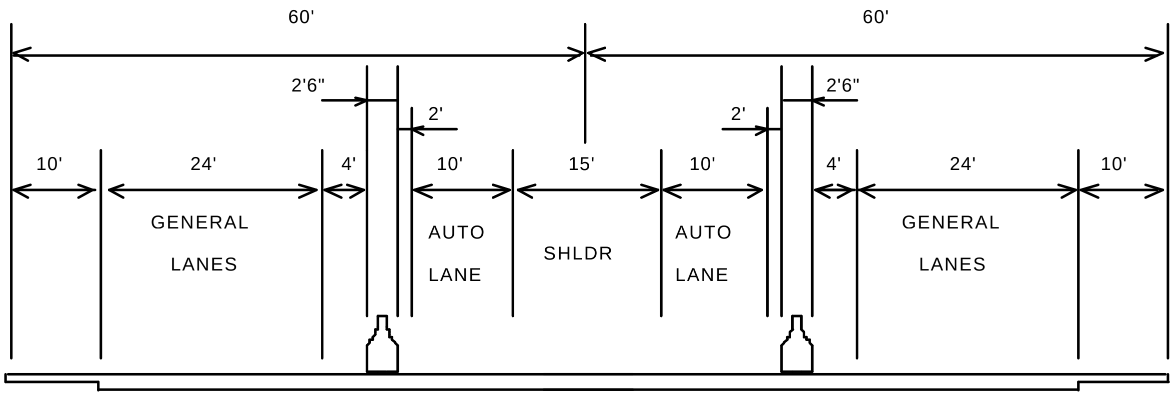
may be utilized under an existing overpass to avoid
costly reconstruction of the

DISADVANTAGE

1) Would require additional R.O.W. at the
points.

2) Vehicle breakdown on the automated lane would
lane

Figure 2-2. Typical Section RSC I3 or I2 with Barrier



requirements of a freeway

one automated lane. A

automated lane from the

located next to the

lane. The shoulder is

by both lanes. This

RSC I3 or I2 with barrier

ADVANTAGE

1) Barrier could provide additional focal point for

vision or magnetic

lane from the general use lanes. This reduces

possibility of adverse traffic operations on the

the automated

4) Requires approximately 7'-6" less R.O.W. than the

comparable transition lane option with 10'-0"

ADVANTAGES

from the automated lane. This limits automated

interruptions to specific

DISADVANTAGE

1) Would require additional R.O.W. at the

points.

2) Breakdown vehicles on the automated lane would

to determine the shoulder is free before

3) Breakdown vehicles being confined between two

opposing traffic could be

4) An errand vehicle from the automated lane could

the shoulder and cause a head on collision without

presence of a

Figure 2-3. Typical Section RSC I3 or I2 with Barrier and Shared Shoulder

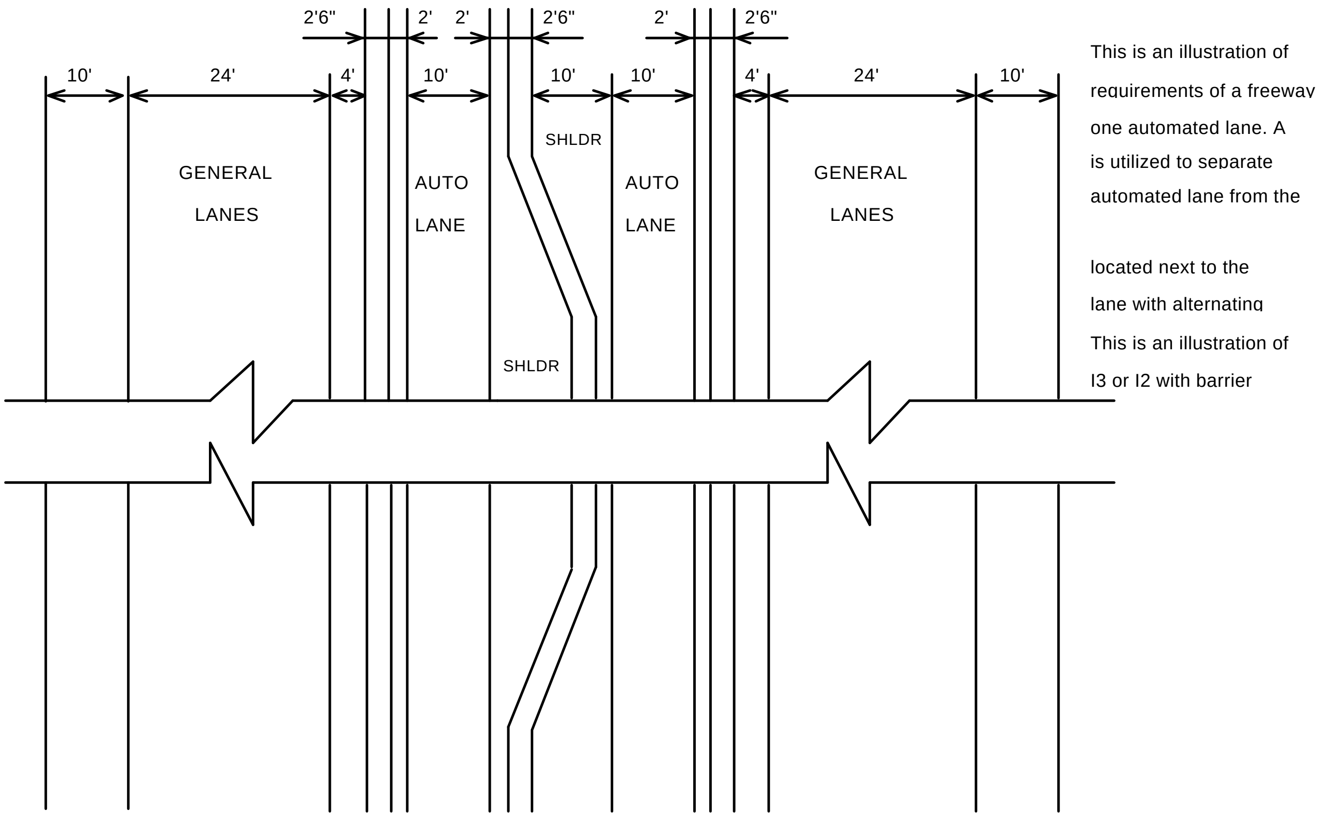
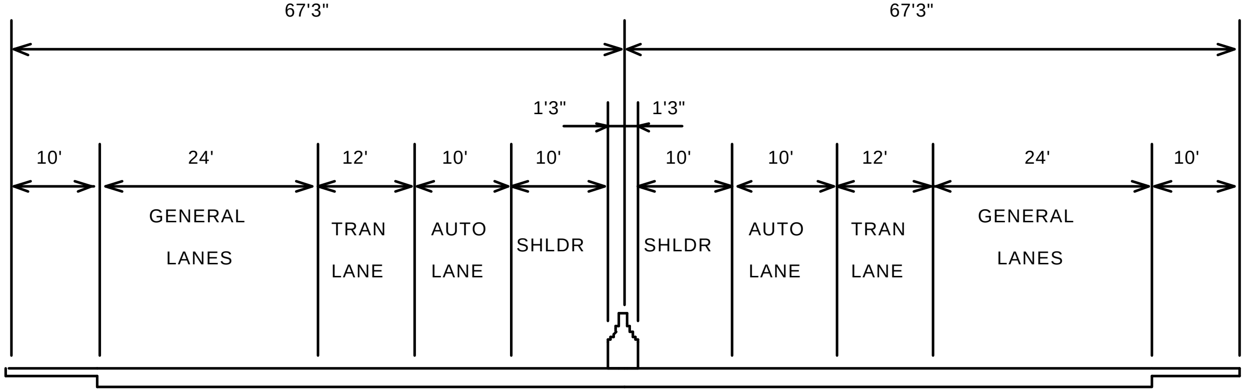


Figure 2-4. Illustration of RSC I3 or I2 with Barrier and Alternating Shoulder



This typical section shows requirements of a freeway

lane is utilized for the of the automated lane. A 10'- shoulder is located next to automated lane. This

ADVANTAGE

1) Access to and egress from the automated lane does require additional R.O.W. since these operations from the transitional

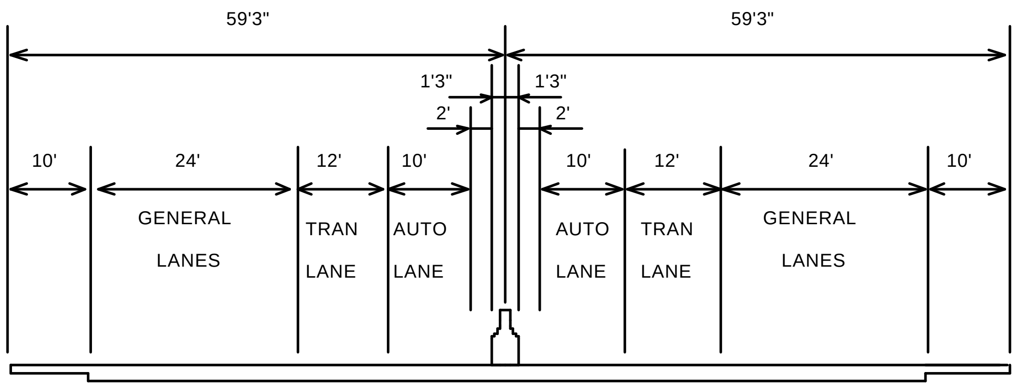
DISADVANTAGE

1) The lack of physical separation of the automated from the general use lanes could result in

general use lane utilizing the transition lane as overtaking

2) The transition lane is essentially a zero capacity

Figure 2-5. Typical Section RSC I2 with Transition Lane and Shoulder



requirements of a freeway
one automated lane. A
lane is utilized for the
of the automated lane. There
no shoulder next to the
lane. This illustrates an RSC
option.

ADVANTAGE

1) Access to and egress from the automated lane does
require additional R.O.W. since these operations
from the transitional
2) Less R.O.W. required than shoulder option. This
may be utilized under an existing overpass to avoid

DISADVANTAGE

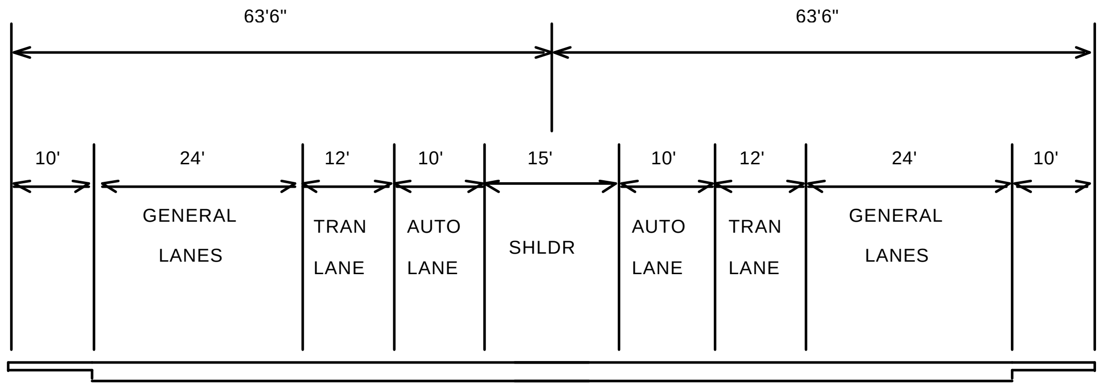
1) The lack of physical separation of the automated
from the general use lanes could result in

use of the automated lane. This could result in

overtaking
2) The transition lane is essentially a zero capacity

3) Vehicle breakdown on the automated lane would
lane closure or a difficult maneuver around the

Figure 2-6. Typical Section RSC I2 with Transition Lane and no Shoulder



This typical section shows

requirements of a freeway

lane is utilized for the

shoulder is located next to

automated lane. The shoulder

utilized by both lanes.

is an illustration of an RSC

option.

ADVANTAGE

1) Access to and egress from the automated lane does

require additional R.O.W. since these operations

from the transitional

DISADVANTAGE

1) An errand vehicle from the automated lane could

the shoulder and cause a head on collision without

presence of a

2) The lack of physical separation of the automated

DISADVANTAGES

use of the automated lane. This could result in

overtaking

3) The transition lane is essentially a zero capacity

determine the shoulder is free before

opposing traffic could be

Figure 2-7. Typical Section RSC I2 with Transition Lane and Shared Shoulder point. Therefore, although this may be a viable option, efforts to analyze the safety, right-of-way, and access/egress methods were deemed beyond the scope of this effort.

A striped separation for the RSC I2 as illustrated in Figure 2-8 is currently utilized by the High Occupancy Vehicle (HOV) facility on a segment of the LIE. However, in ride-through observations of this HOV facility during off-peak hours, numerous violations of the striped buffer separations were observed. Therefore, in considering the impact on safety of violations of this type on an AHS facility, it was concluded that this option may require an impractical level of enforcement to deter violators.

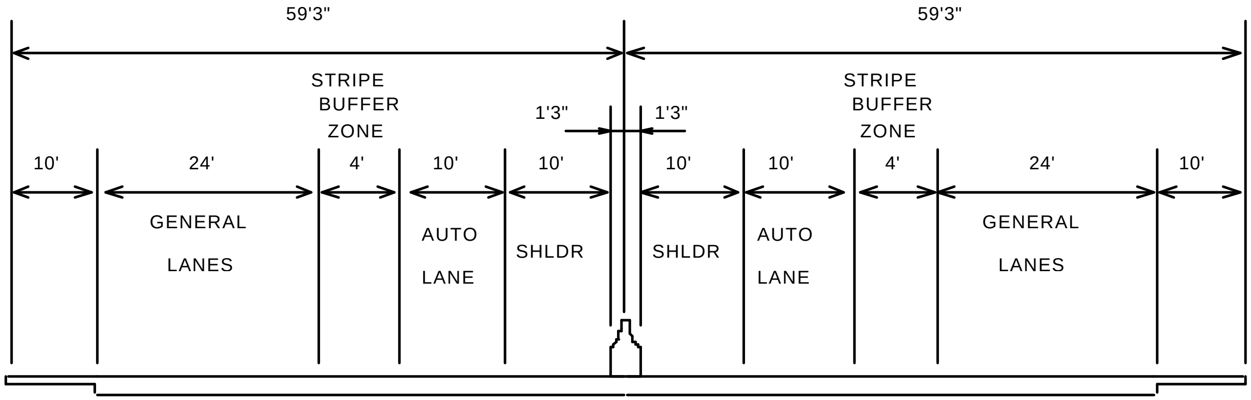
3.1.2 AHS Roadway Layout Analysis

RSCs I2 and I3 refer to the infrastructure requirements incorporated in a given AHS system. The level of infrastructure complexity increases from I2 to I3.
RSC I2 refers to access and egress to and from the AHS lane directly from the general use lanes. As illustrated in Figure 2-9, the I2 scenario can possess barriers. The I3 scenario refers to an AHS infrastructure that is totally separate from the traditional roadway system. The I3 infrastructure is achieved by providing separate access and egress to and from the AHS facility which is kept separate from the traditional roadway. This could be achieved by utilizing barriers to separate AHS lanes from the general lanes and providing ramps to connect directly to service roads or ramps.

Check-in and check-out procedures will be required under both RSCs I2 and I3. The check-in procedure will assure that all the required equipment for operating on the exclusive AHS lane is functional and that the driver is capable of operating in the AHS environment. The check-out procedure will be used to verify that the driver is capable of assuming manual control of the vehicle prior to exit from the AHS environment.

An area of each AHS entry ramp, estimated to be 200-300 feet in length, whether for the I2 or I3 RSC, will be dedicated for vehicle check-in. Vehicle check-in is expected to be accomplished while vehicles are in motion. Vehicles that do not meet the check-in requirements will not be permitted onto the AHS facility and will be directed back onto the general use lanes in the I2 scenario (Figure 2-10) or the local roadway the vehicle entered the ramp from.

The AHS check-out procedure will occur upstream of the AHS exit point. If the vehicles fail the check-out procedure, (i.e. the driver is unable to resume manual control) the vehicle must exit the AHS lane and be brought to a safe stop at a designated storage location. With the I2 configuration, the storage area may be a shoulder. With the I3 configuration, the storage area is more likely to be a separate parking area.



This typical section shows requirements of a freeway one automated lane. A buffer zone is utilized separate the automated lane the general use lanes. A 10'- shoulder is located next the automated lane. illustrates an RSC I2

ADVANTAGE

1) Requires 16' less R.O.W. than the comparable

than the comparable barrier separation option with shoulder.

2) Provides a means of coordinating access/egress to from the automated lane. This limits automated interruptions to specific

DISADVANTAGE

1) Would require additional R.O.W. at the points unless shoulder width is utilized access/egress

2) Provides minimal separation between the lane and the general use lanes. This could in drivers from the general use lane utilizing automated lane as an overtaking lane. These non- vehicles would be sensed in the AHS environment could result in catastrophic evasive the AHS

Figure 2-8. Typical Section RSC I2 with Buffer Zone and Shoulder

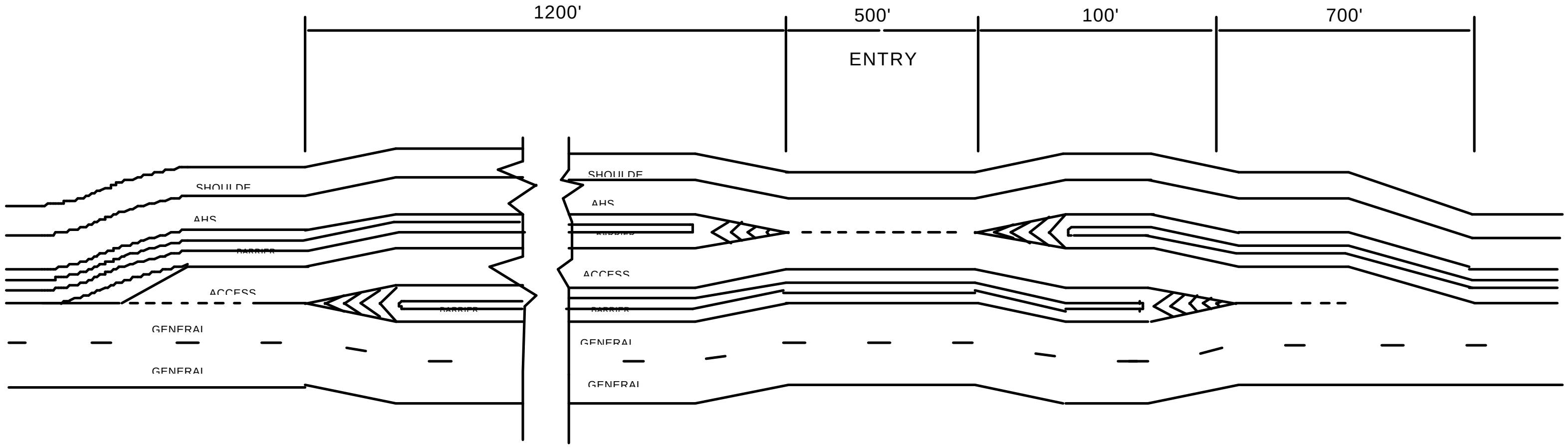


Figure 2-9. Illustration of RSC I2 Typical Entry Barrier

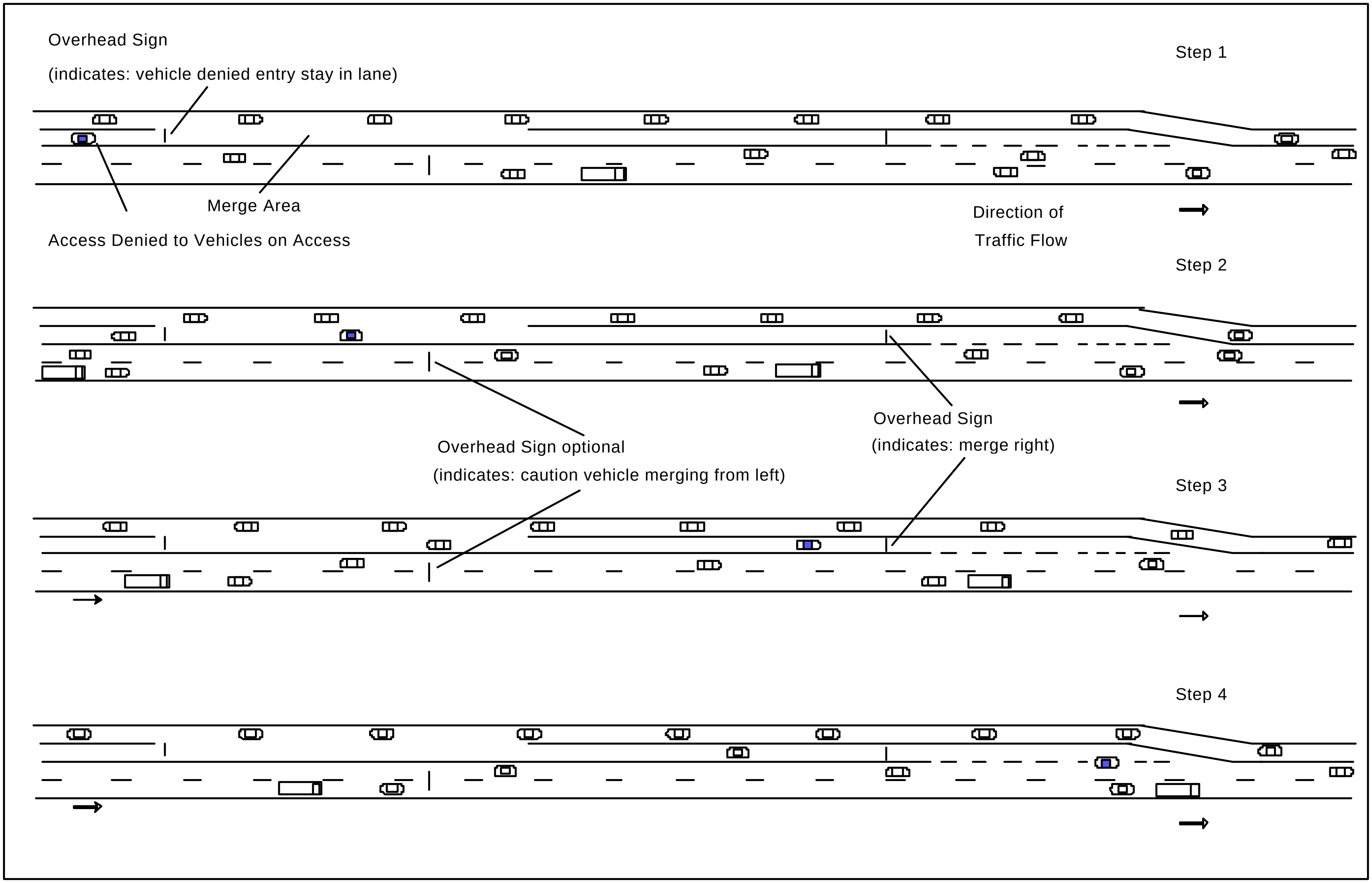


Figure 2-10. Illustration of Access Denied

3.1.3 Assumptions

Analyses were conducted by making certain assumptions about an AHS. These assumptions were used as constraints for the layout and capacity of the AHS.

3.1.3.1 Assumptions for RSC I2 with the Barrier Option

- The access points to the AHS lane were placed at least 2000-3000 feet from the preceding on-ramp. This distance was assumed to adequately facilitate weaving movements required by AHS equipped vehicles from the on-ramp to the AHS lane access point.
- The egress point from the AHS lane were placed at least 2000-3000 feet from the next off-ramp. This distance was assumed to adequately facilitate weaving movements required by vehicles from the AHS lane to the off-ramp.
- The length of the access ramps were assumed to be approximately 2500 feet.
- The capacity of the AHS lane was assumed to be 5000 vehicles per hour (vehicles/hr) with a usable capacity of 4500 vehicles/hr.
- All AHS access and egress ramps were assumed to have a capacity of at least 1400 vehicles per hour (vehicles/hr).
- The AHS egress transition lane would be approximately 1600 feet long.

3.1.3.2 Scenario Assumptions for I3 RSC

- The length of the access ramps were assumed to be approximately 2500 feet.
- The capacity of the AHS lane was assumed to be 5000 vehicles per hour (vehicles/hr) with a usable capacity of 4500 vehicles/hr.
- All AHS access and egress ramps were assumed to have a capacity of at least 1400 vehicles per hour (vehicles/hr).
- All AHS ramps enter and exit from and to a service road and/or a general use lane and/or a separate ramp.
- The AHS ramps which enter and exit the general use lanes utilize the right side of the roadway, eliminating weaving across the general use lanes to and from the traditional on and off-ramps. Therefore, the AHS ramps could be placed closer to the traditional on and off-ramps.

3.2 CASE STUDIES PERFORMANCE EVALUATION

The objective of this activity is to develop a comparison of the performance capability of AHS facilities with conventional freeways in a real world setting. To this end, four cases were studied, one urban, two suburban, and one rural. They are as follows:

- Long Island Area - I-495 EB from Cross Island Parkway to NY 135 (Seaford Oyster Bay Expressway). This is a suburban case study.
- Boston Area - I-93 NB from Rt. 128/Rt. 3 to Exit 18 (Southampton St.). This is primarily an urban case study.
- Suburban Washington, D.C. - Capital Beltway I-495 WB from I-95 to I-270. This is a suburban case study.
- New York State Thruway - NB section from Harriman (Exit 16) to New Paltz (Exit 18). This is a rural case study.

The general approach was to define a no build or baseline condition and one or more AHS designs typified by RSCs I2 and I3 roadway configurations. AHS entry and exit locations were selected heuristically based on origin-destination (OD) trip table demands. The selection of the AHS access technique (RSC I2 or I3) depended primarily on the ramp volumes involved, with I2 configurations being used at low volume locations and I3 configurations at high volume locations.

The INTEGRATION model was adapted to model the AHS, conventional freeway lanes, and ramps. A peak hour volume profile was generated and was varied in a downward direction to assess the AHS performance capability in off peak traffic situations. It was also varied in an upward direction to assess the effects of future year demands, and to try to determine the limits of AHS lane performance.

In the case of the three urban/suburban scenarios, the baseline highway configuration was adapted for AHS by keeping the total number of functional lanes (AHS and general freeway lanes) approximately constant. The AHS construction, in general requires additional pavement width for auxiliary lanes, barriers, and AHS shoulders.

In the case of the rural scenario, an AHS lane was added to the current two lane northbound highway section.

Table 2-1 Section 1.3.2 summarizes the results of the evaluation studies. The urban and suburban cases show that the AHS lane provides considerable improvement in speed and travel time. It also enables the highway to provide additional capacity in terms of vehicle-miles traveled (VMT) during the peak hour. In some cases it provides considerable potential to handle increased traffic demand.

Because the current speeds in the rural sections are high and capacity is generally sufficient, no significant performance gains with AHS are achievable unless the AHS mainline speed is raised significantly.

The following subsections describe the individual case studies.

3.2.1 Long Island Expressway Case Study

3.2.1.1 Scenario Description and Study Methodology

The purpose of this study was to determine the impact of implementing an AHS on Long Island. The study area extended along the LIE from Cross Island parkway in the west to Seaford Oyster Bay in the east. This area is illustrated in Figure 2-11, and only traffic flow in the eastbound direction was investigated.

The traffic volume data was developed from the LIE TRANPLAN and Market Penetration Study (Section 3.3). That study provided daily traffic volumes for the year 2015 on the LIE. These volumes were reduced to peak hour volume by factoring the daily traffic volumes in the study area. The conversion factor was developed from New York State Department of Transportation ground counts which provide the peak hour to daily volume relationship for the study area.

Additional assumptions for the study are as follows:

- Baseline
  - Future LIE with four general lanes. Note that the current Expressway is comprised of three general lanes in each direction.
- AHS implementation
  - Two AHS implementations were studied for the I2 scenario. One consists of one AHS lane and two general lanes while the other is comprised of one AHS lane and three general lanes.
- AHS Market Penetration - 100 percent.
- AHS ramp configurations shown in Figures 2-12 and 2-13.
- Entry characteristics
  - I2 scenario - consists of one I3 AHS ramp and I2 configurations for the remaining ramps (Figure 2-12).
  - I3 scenario - Combination of I2 and I3 AHS ramps (Figure 2-13).

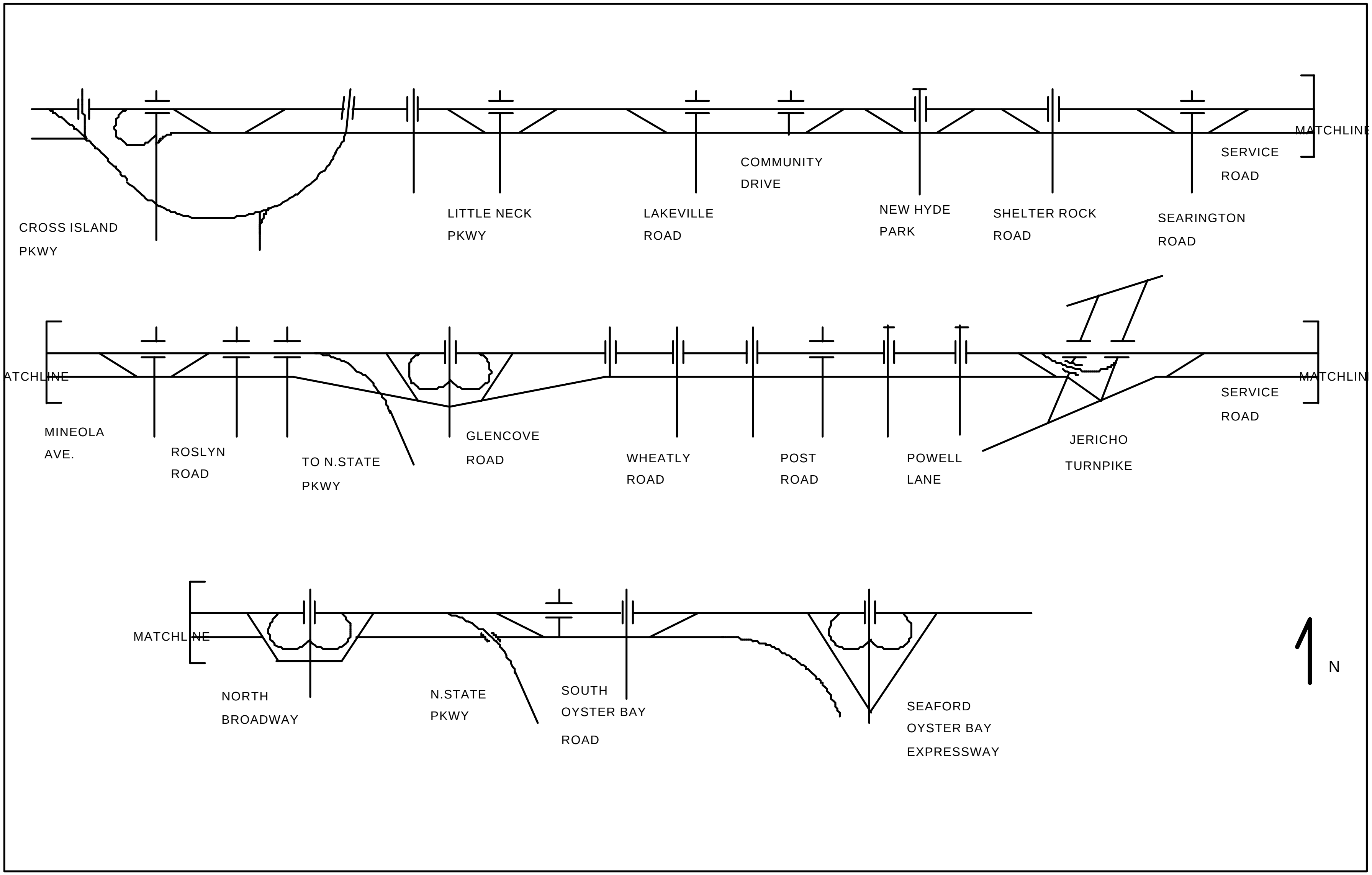


Figure 2-11. LIE Four Lane Baseline

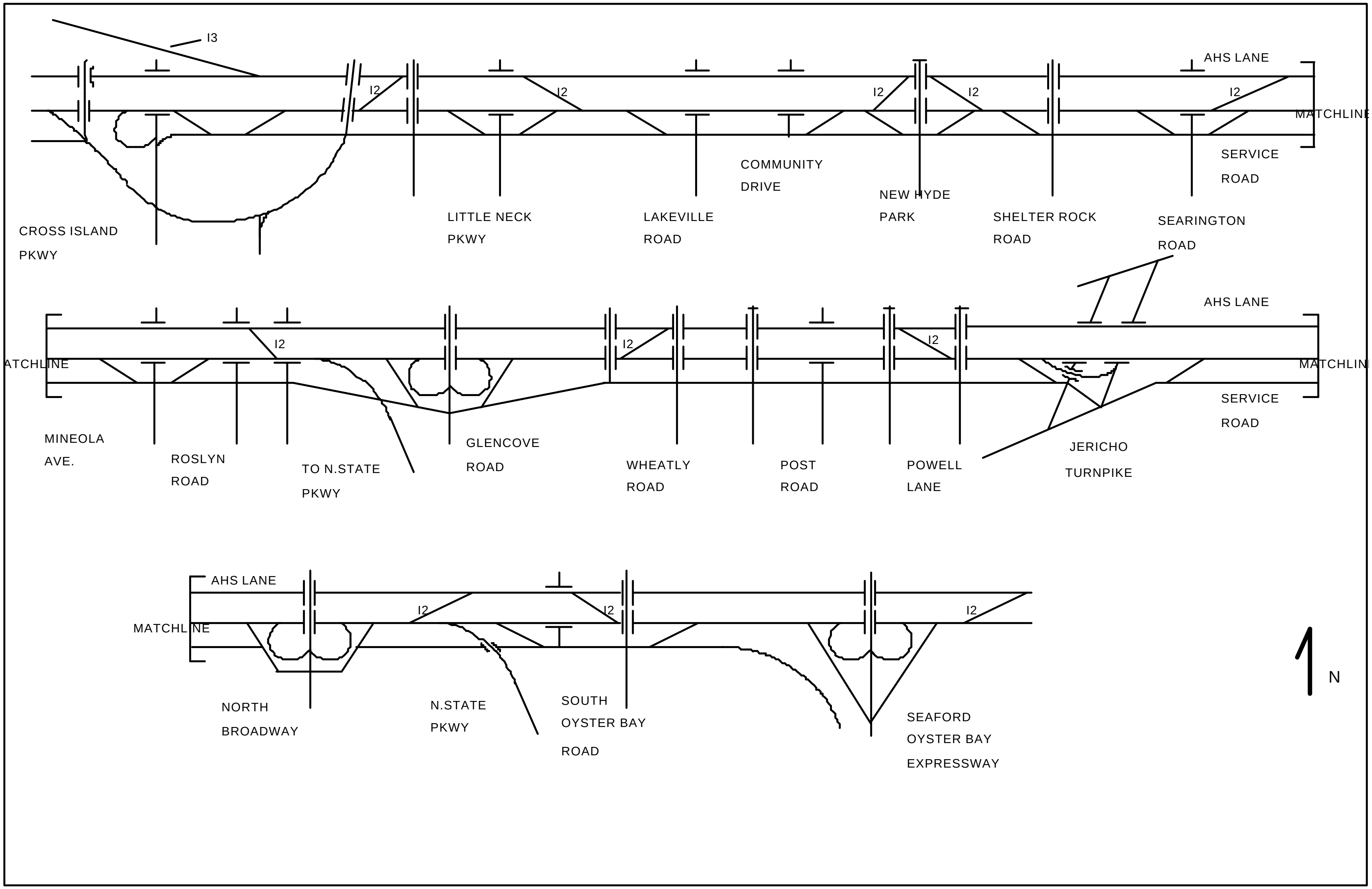


Figure 2-12. LIE (I-495) RSC I2

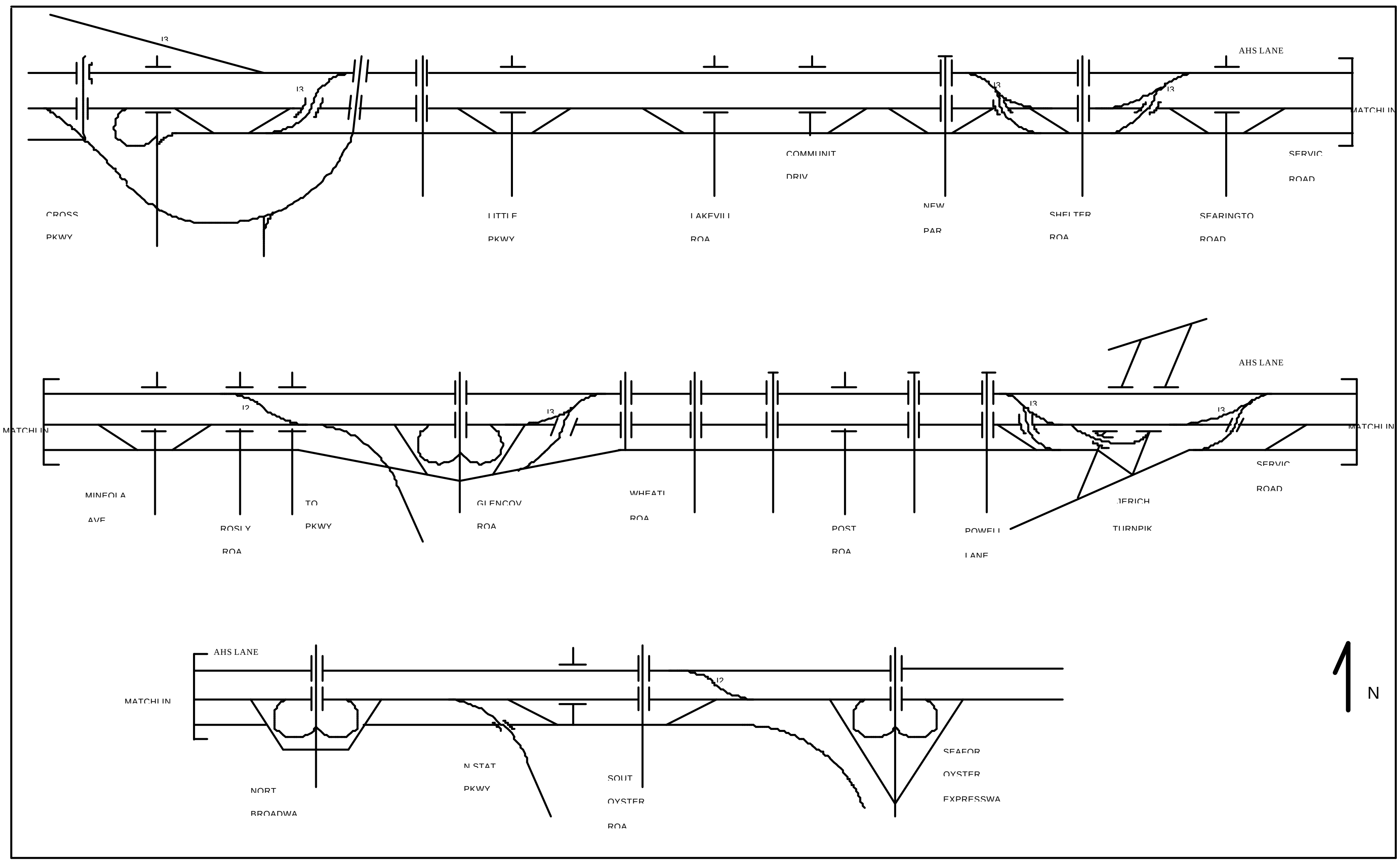


Figure 2-13. Configuration of LIE I-495 AHS (Combination of I2 and I3)

The general characteristics of the scenario are described in Table 2-2. The volumes generated from the LIE TRANPLAN Study were factored as described. OD trip tables required by the INTEGRATION model were generated by the QUEENSOD model (Appendix E). The link characteristics and the results of the through link operations are tabulated in Appendix A.

AHS lane assignments were made by assuming that AHS equipped vehicles would utilize the AHS lane at the earliest opportunity if individual trip origins and destinations were compatible with the design configuration utilized.

3.2.1.2 Results

The throughput graphs (Figure 2-14) were obtained by running INTEGRATION with 60, 70, 80, 90 and 100 percent of the year 2015 peak hour volumes. The model was run for the four lane baseline and the I2 configurations using both two general lanes and three general lanes with one AHS lane. Table 2-3 is a tabulation of the results.

The results show that the configuration using only two general lanes under-performed the baseline because of insufficient capacity on the general lanes. When this deficiency is corrected by the addition of a general lane, the performance of the AHS based system exceeds the baseline configuration.

3.2.2 Boston I-93 Case Study

3.2.2.1 Description of Location

The site for this scenario is a northbound section of I-93 south of the Boston Central Business District (CBD) (Figure 2-15). The existing Boston I-93 (Southeast Expressway) is an urban expressway with four lanes in each direction with a 55 mph speed limit. Most of the traffic on I-93 is bound for the Boston CBD or Outer Business District (OBD). It mainly serves commuters. During morning peak hours and afternoon peak hours, certain sections of I-93 are highly congested, with volumes close to 8600 vehicles/hr.

The scenario site begins at the merge of Rt. 128 and Rt. 3 and continues to Exit 16, a distance of approximate 8.1 miles. There are total of 12 northbound ramps in the study section, of which five are on-ramps and seven are off-ramps (Figure 2-16). Along this section of expressway, there are approximately twenty surface street intersections which are directly or indirectly impacted by ramp volumes. Figure 2-17 shows the current traffic flows.

Table 2-2. General Characteristics of LIE Scenario

1. Location & length	Long Island Expressway from Cross Island Expressway to Seaford Oyster Bay; EB; PM peak hour; approximately 16.1 mi.
2. Type of highway	Suburban highway, high volumes, existing congestion, most traffic bound for CBD or OBD.
3. Condition without AHS implementation	4 Eastbound lanes, ramp locations shown in Figure 2-11.
4. AHS ramp configuration	Predominantly I2 for I2 scenario, and I3 and I2 mix for I3 scenario illustrated in Figures 2-12 and 2-13.
5. Condition after AHS implementation	One AHS lane, two general use lanes for one implementing and three general use lanes for a second implementation. Ramp locations; lane configurations shown on Figures 2-12 and 2-13 for the two general lane implementation.
6. AHS capacity and speed	62.1 mph constant speed up to capacity. Capacity defined as 5000 vph (vehicle spacing criteria) with useable capacity up to 4500 vph.
7. Percent of AHS equipped vehicles on facility	100%
8. Assumptions for traffic assignment to AHS lanes.	All AHS equipped vehicles (100%) are assigned to AHS up to useable capacity if their destination includes at least one AHS exit ramp from the AHS entry point.
9. Source of trip tables	The QUEENSOD model was used to convert ramp volumes to trip tables.

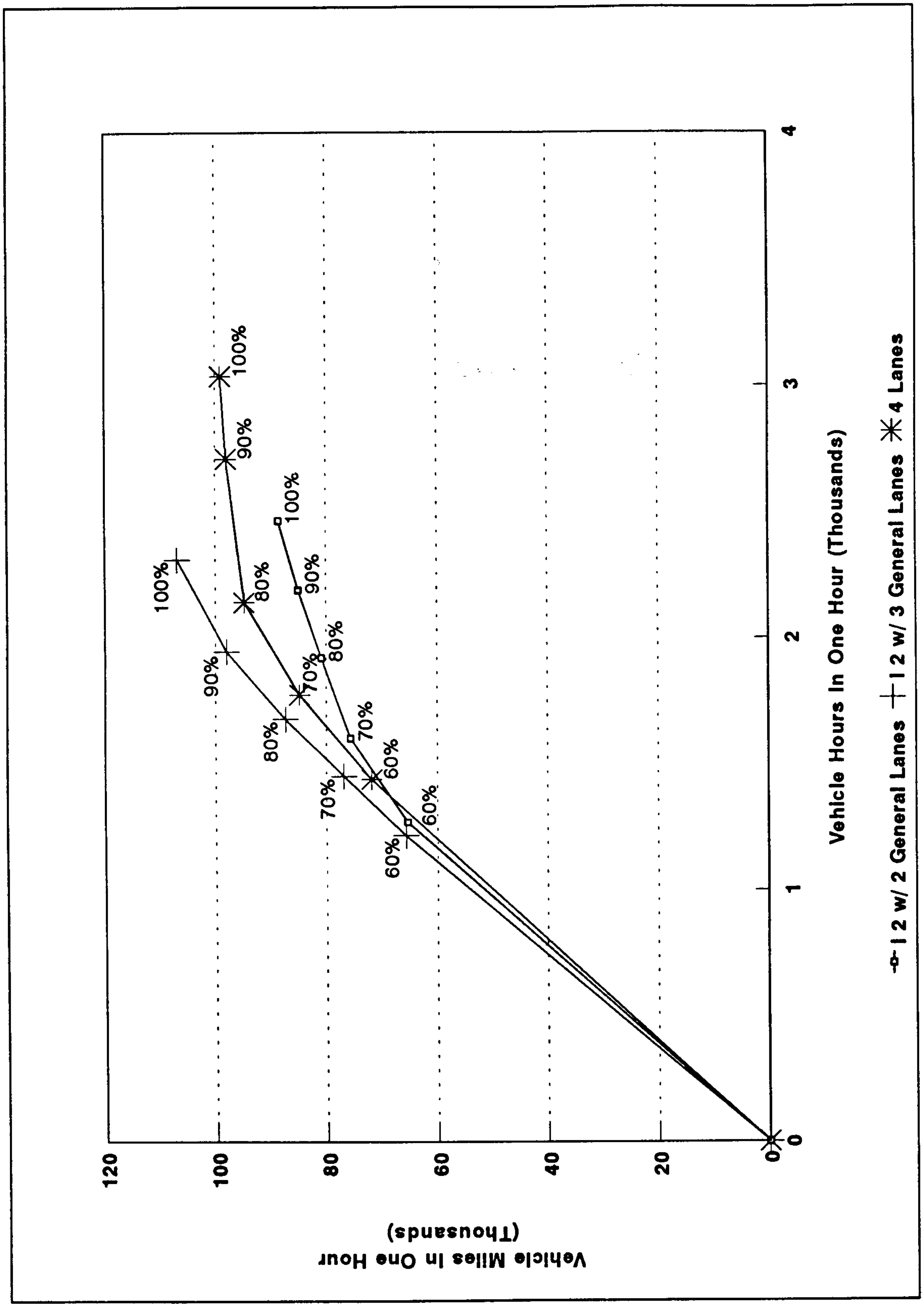


Figure 2-14. Comparison of Throughput for Long Island Expressway AHS Against Four Lane LIE

Table 2-3.
Long Island Expressway Four Lane and AHS Facilities Performance Comparison
For Different Traffic Volumes

MOE	Facility	Percentage of 2015 AHS Volumes 60%	70%	80%	90%	100%
Speed (Mile/Hr)	Four Lane	49	47.2	43.5	36	32.3
	AHS(RSC I2)*	50.3	46.6	41.6	37.9	35.4
	AHS(RSC I2)**	52.8	51.6	50.3	49.1	44.7
Vehicle Miles Traveled (Veh-Mi)	Four Lane	71850	84889	94803	98028	99066
	AHS(RSC I2)*	65396	75698	80914	85090	88636
	AHS(RSC I2)**	65707	76924	87408	98001	106921
Vehicle Hours (Veh-Hr)	Four Lane	1440	1778	2144	2713	3037
	AHS(RSC I2)*	1271	1604	1922	2192	2469
	AHS(RSC I2)**	1217	1453	1681	1948	2315

NOTE:

Speed is the average speed of the network.
Veh-Mi is calculated based on through volume.
Veh-Hr is calculated based on through volume.
* One AHS lane two general use lanes
** One AHS lane and three general use lanes

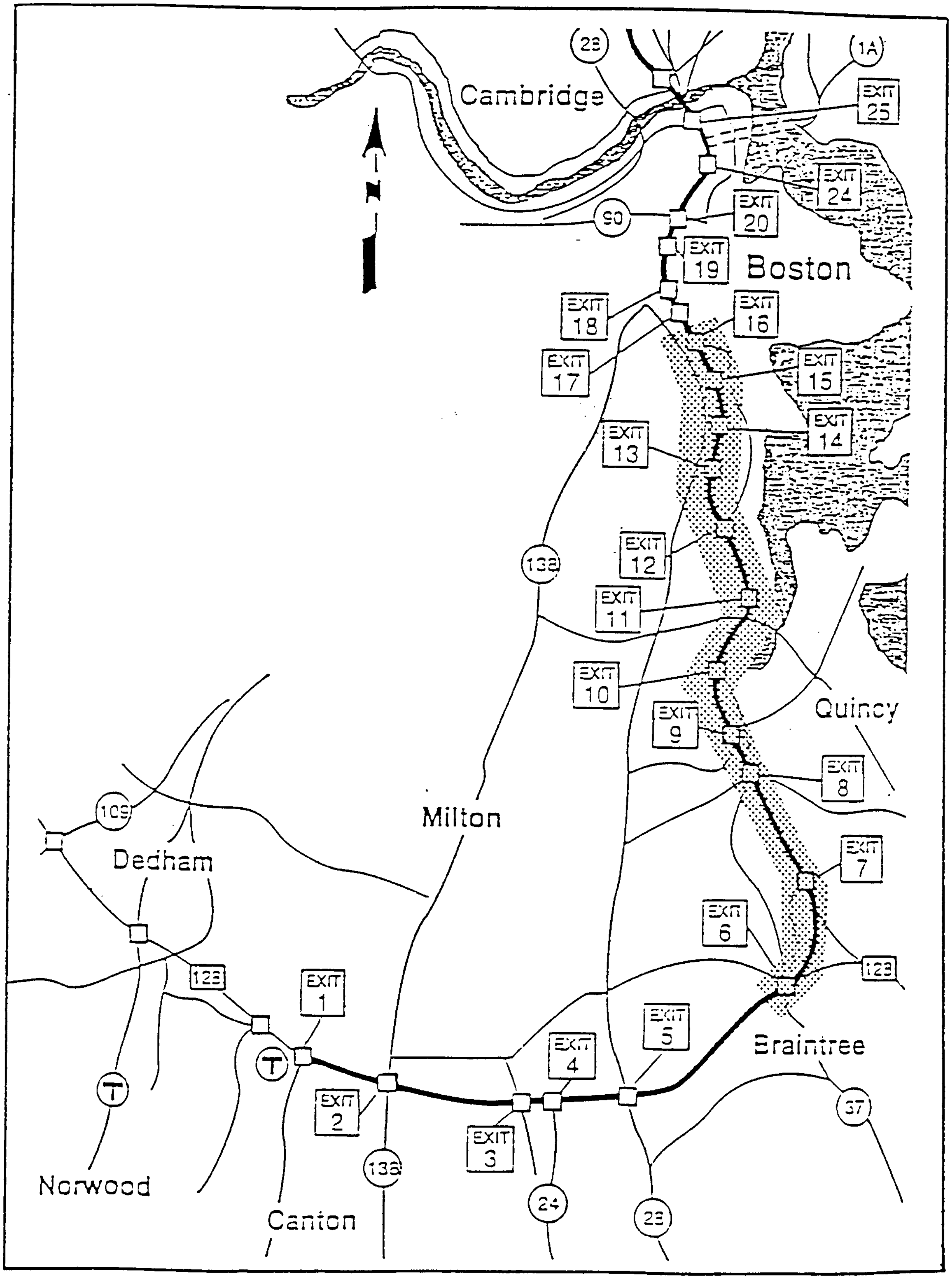


Figure 2-15 Boston I-93 Southeast Expressway Case Study Location

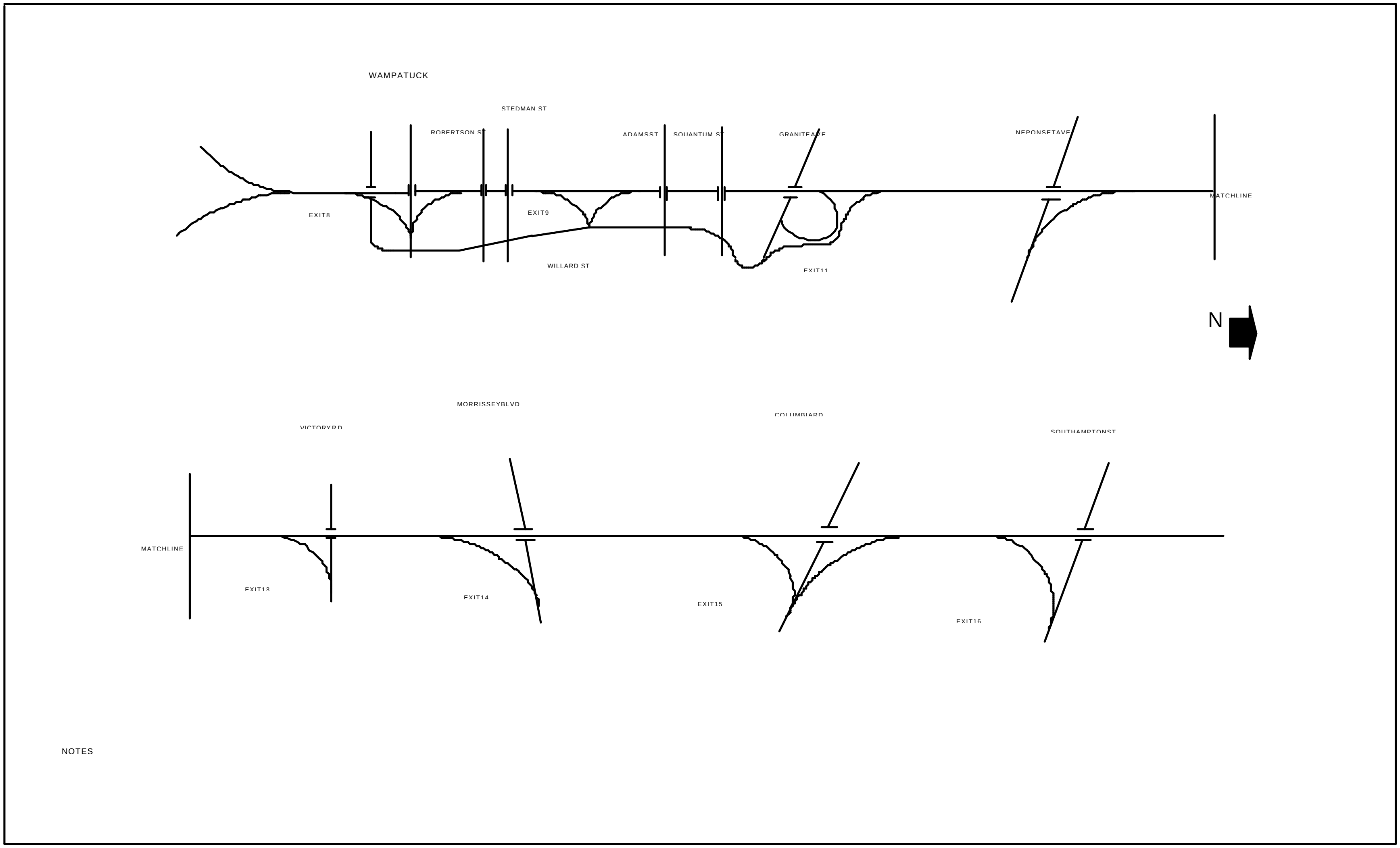


Figure 2-16. Boston I-93 Southeast Expressway Existing Configuration (NB)

3.2.2.2 *Scenario Discussion*

The AHS facility designed for I-93 consists of two AHS lanes and two general use lanes along with six AHS ramps. The existing available space as well as traffic volumes played a significant role in determining the AHS lane
configuration and ramp locations. Table 2-4 summarizes the general scenario characteristics.

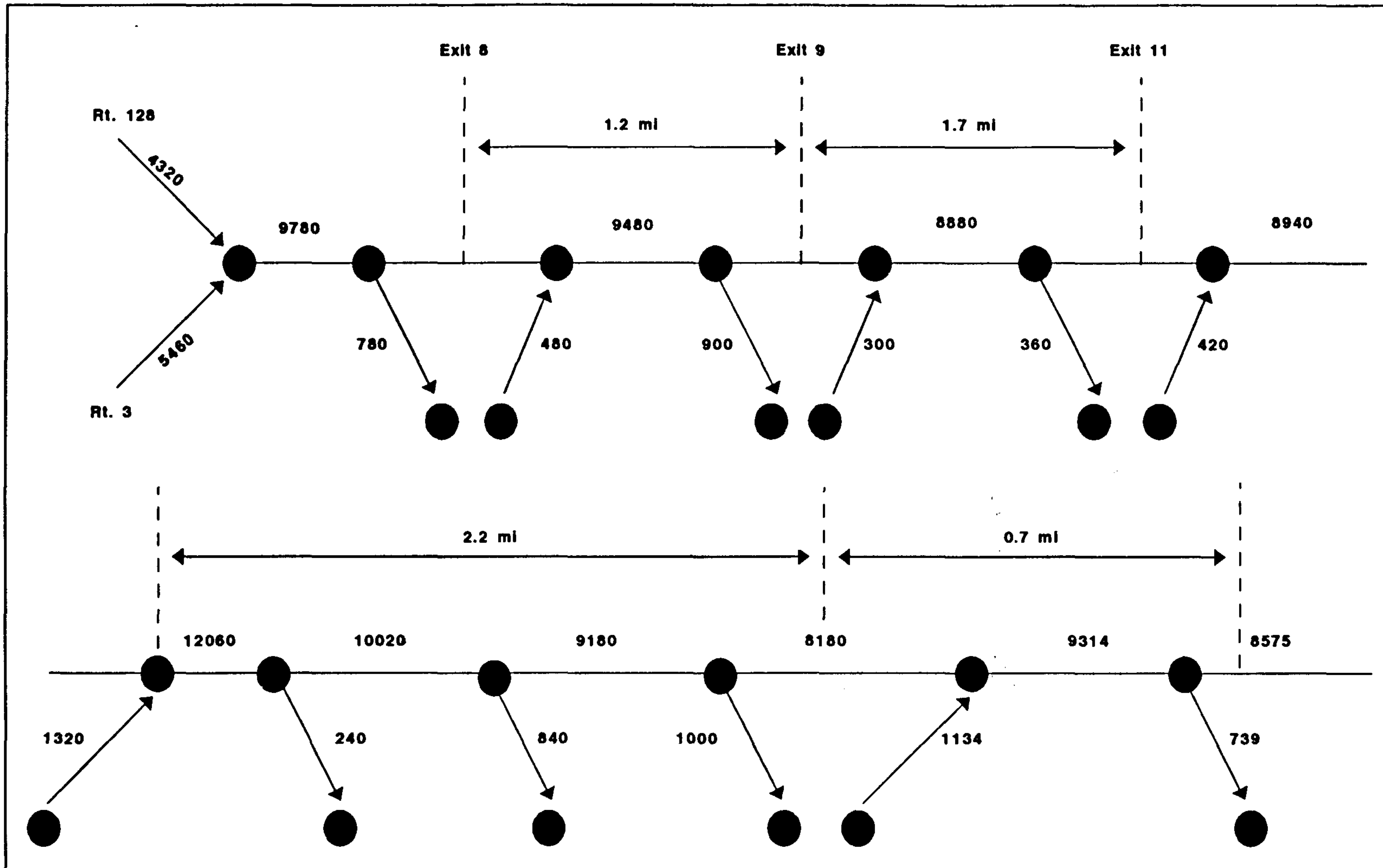
Determination of whether RSC I2 or I3 ramp configurations were to be used was based on both the volume anticipated to utilize the AHS ramp and the through volume on general use lanes. For example, at Neponset Avenue the AHS ramp volume was anticipated to be 1090 vehicles/hr. while the general use lane through volume was 1340 vehicles/hr. Thus, use of an I3 ramp avoids a great deal of vehicle weaving. At Exit 9 the demand consists of only 400 through vehicles and 180 ramp vehicles, thus, an I2 entry ramp was applied. Figure 2-18 shows the AHS interchange configurations deployed.

The AHS traffic assignment was based on two assumptions:

- Vehicles whose destinations were beyond Exit 16 will use AHS lanes.
- Vehicles destined to travel a distance of at least two AHS exit ramps from the AHS entry point will use the AHS lanes.

These two assumptions eliminated short trips on AHS lanes, while still assigning most of the traffic to AHS lanes and thereby preserving a high speed general use lane. Figure 2-19 shows the network loading resulting from these assumptions. The volume on the AHS lanes after Neponset Ave. is 8920 vehicles/hr. which is close to capacity. However, general through lane volume is only 1340 vehicles/hr. at this point.

Evaluation of this scenario was done by running the INTEGRATION Model (Appendix E). The smooth merge was simulated with the INTEGRATION Model by setting the capacity at the merge point to be larger than the volume of the two AHS lanes. Since INTEGRATION uses conventional traffic flow models, these steps must be taken to provide for a smooth flowing AHS lane.



NOTES:
Distances are approximate, Volumes are rounded 20% increase of existing peak hour volumes, Four lane urban expressway.

Figure 2-17.
Simplified Representation - Boston I-93
Approximate Major Traffic Flow (NB)

Table 2-4. Summary of Boston I-93 Scenario Characteristics

1. Location & Length	Boston I-93 from Rt. 128/Rt. 3 to Exit 16 (Southampton St.); NB; AM peak hr.; approximately 8.1 mi
2. Type of Highway	Urban highway, high volumes, existing congestion, most traffic bound for CBD or OBD.
3. Condition before AHS implementation	4 northbound lanes, ramp locations show in Figure 2-16.
4. AHS ramp configuration	I2 and I3 entry as shown in Figure 2-18.
5. Condition after AHS implementation	Two AHS lanes, 2 general lanes.
6. AHS entry and exit spacings	Average 2.0 mi. spacing between entry ramps and 2.0 mi. spacing between exit ramps.
7. AHS capacity and speed	62.1 mph constant speed up to capacity. Capacity defined as 5000 vph (vehicle spacing criteria) with useable capacity up to 4500 vph.
8. Percent of AHS equipped vehicles on facility (manual & automated lanes)	100%
9. Assumptions for traffic assignment to AHS lanes	All AHS equipped vehicles (100%) are assigned to AHS up to useable capacity if their destination includes at least two AHS exit ramps from the AHS entry point.
10. Source of trip tables	The QUEENSOD model was used to convert ramp volumes to trip tables.

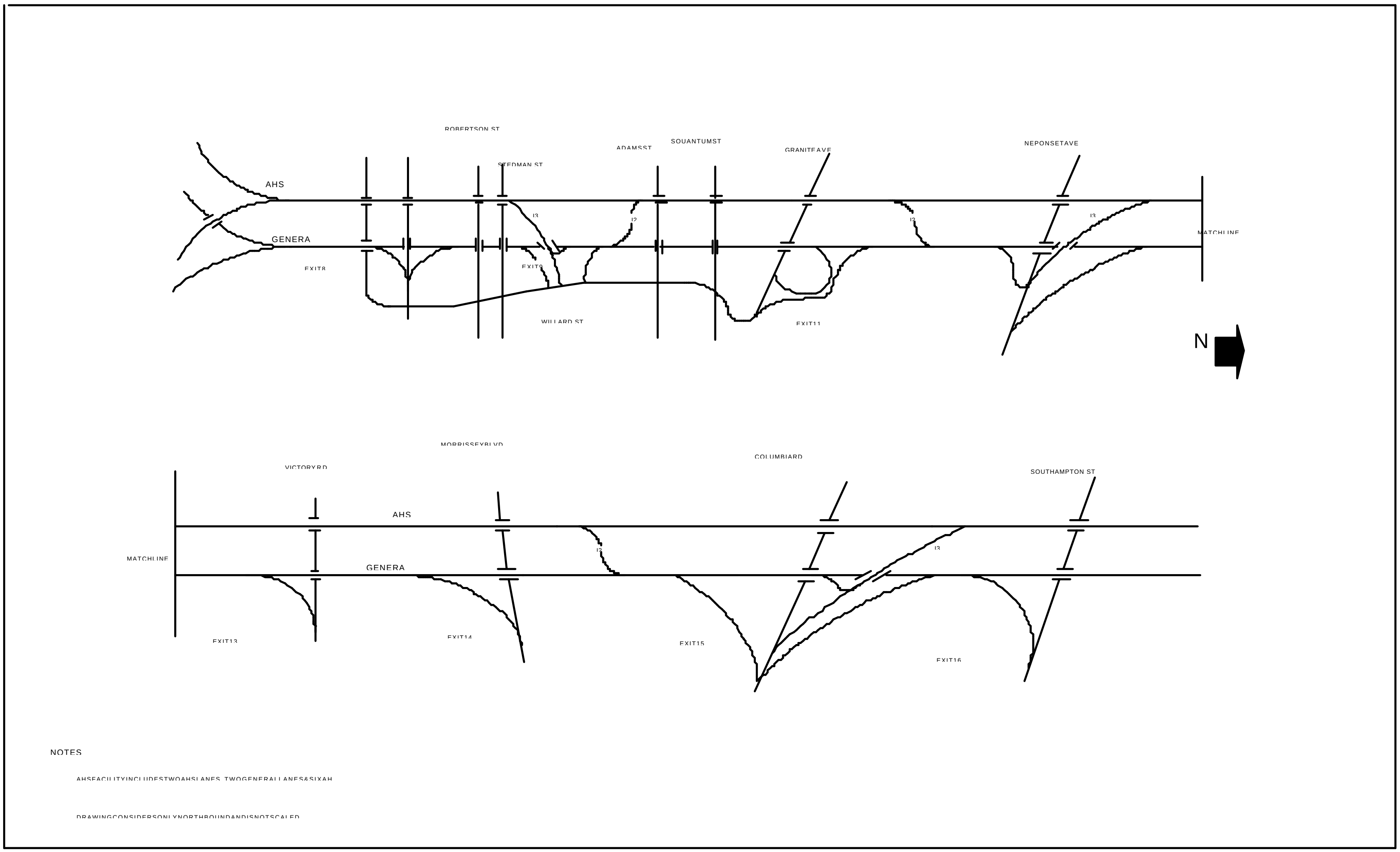
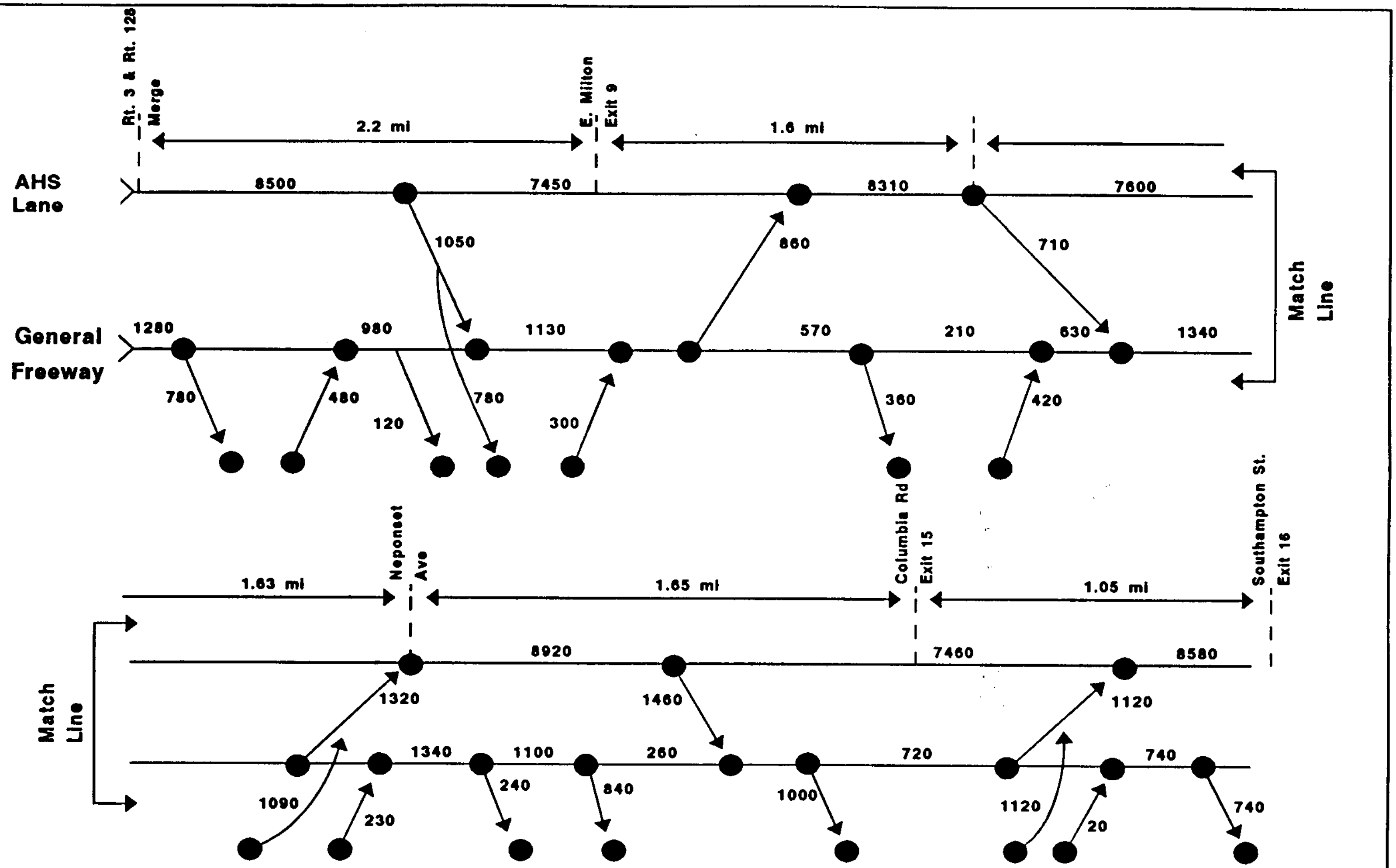


Figure 2-18. Boston I-93 Southeast Expressway AHS Configuration (NB)



NOTES:

Distances are approximate, Volumes are rounded

Volumes are based on 120% of Existing Volumes. Total distance approximate 8.14 mi (13.1 km)

Two AHS lanes, Two general lanes

Figure 2-19.
Simplified Representation - Boston I-93 Access From Separate Ramps Approximate Major Traffic Flows

3.2.2.3 Results

The throughput graph (Figure 2-20) was obtained by running INTEGRATION with 40, 60, 80, 85, 90, 95, 100, 110, 115, and 120 percent of the existing peak hour volume for both existing and AHS facilities. While the traffic volume was below 80 percent of existing volume, average speed on the combined AHS lane and general use lane facility in terms of (veh-mi/hr)/(veh-hrs/hr), was the same as the baseline (no build) case. Delay on the existing I-93 network started at 90 percent of existing peak hour volume. Between 95 percent to 120 percent of existing peak hour volume, the existing network had no increase in veh-mi/hr traveled, but veh-hrs/hr increased by almost 600 due to saturated conditions. The combined AHS and general use lane facility throughput line preserved a constant slope from 0 to 120 percent of present volume. This illustrates the ability of the combined AHS and general use lane facility to serve up to 120 percent of existing peak hour volume, with no delay to through traffic on either the AHS or general use lanes. From the performance comparison chart (Table 2-5), the average speed on the existing network decreased from free flow speed to 30 mi/hr when 120 percent of existing volume attempts to utilize the facility. In contrast, the AHS network experiences almost no speed reduction.

In addition to the AHS network discussed, an AHS network with all six ramps configured as I3 entry/exit points was also simulated. The results indicated that using all I3 configurations increased the network average speed by approximately 0.5 mi/hr due to the improvement of the merges and diverges from the general lanes. Since the deployment in Figure 2-18 has already implemented I3 ramps in the most useful locations, implementing the remaining ramps as I3 is only of marginal value.

Selected surface street intersections were analyzed by Highway Capacity manual techniques using a computer program (HCSII) based on turning movement count observations made during the study. The results indicated that many of the intersections were not operating at good levels of service (LOSs) with existing turning movement volumes. Each intersection had at least one approach at a LOS below C. When 120 percent of current volume was modeled for the AHS scenario, the additional surface street traffic resulting from increased AHS capacity resulted in LOS of F at certain intersections. The signalized intersection at the off-ramp at Exit 9 dropped from existing LOS D to F (Figure 2-21). Both geometric improvement and signal retiming would be necessary to accommodate the increased volumes for this intersection. Figure 2-22 shows additional examples of performance degradation resulting from AHS volumes.

Appendix B contains additional details of the scenario and results.

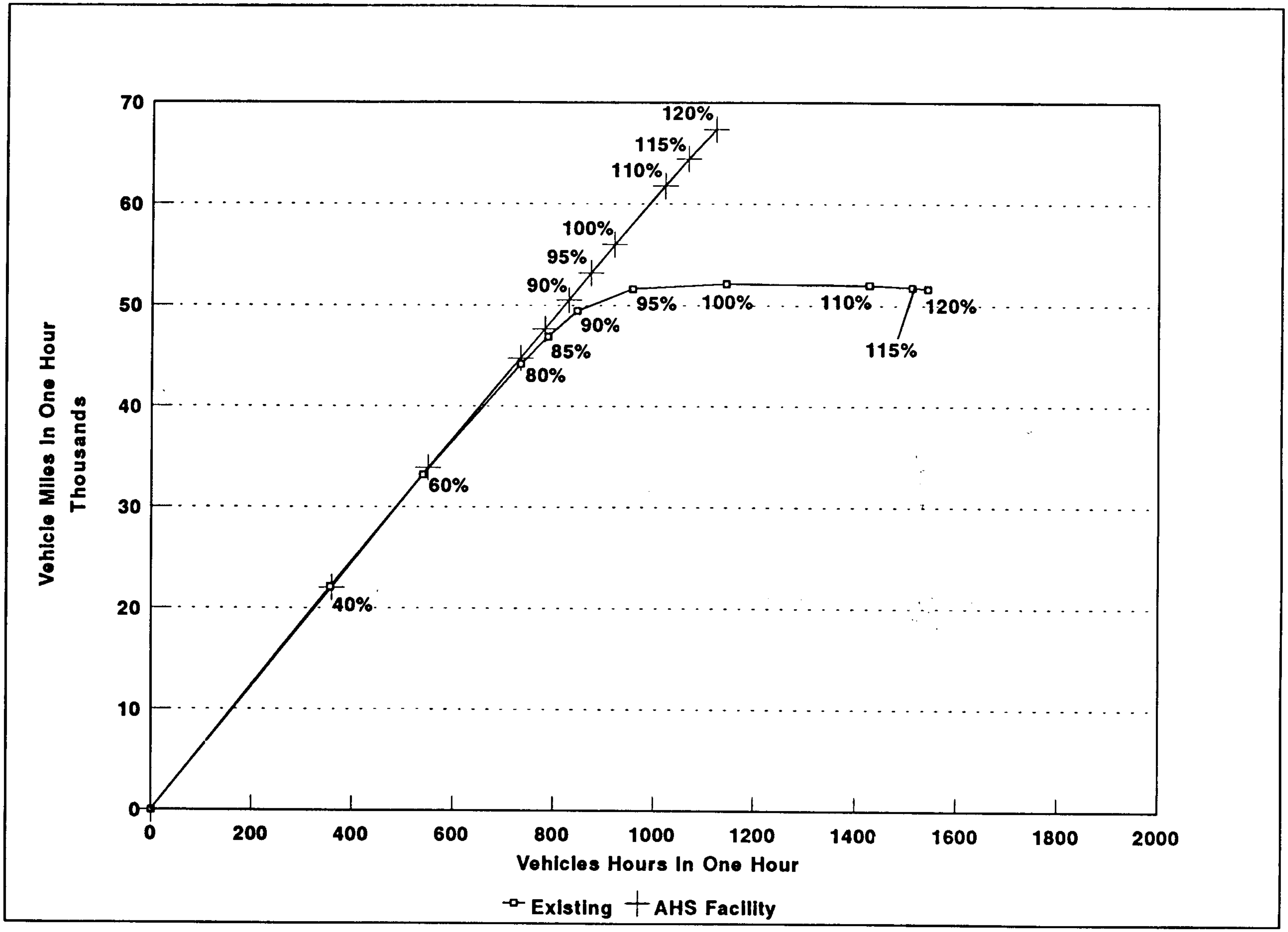


Figure 2-20. Throughput For Boston I-93
(Southeast Expressway NB)

Table 2-5.
Existing and AHS Facilities Performance Comparison
For Different Traffic Volumes

MOE	Facility	Percentage Of Existing Volume									
		40%	*60%*	*80%*	*85%*	*90%*	*95%*	*100%*	*110%*	*115%*	*120%*
Speed (Miles/Hr)	**Existing**	62	61	60	59	58	53	45	36	34	33.5
	AHS	60	60	59	59	59	59	59	58	58	58
VMT (Veh-Miles)	**Existing**	22106	33199	44208	46901	49442	51623	52126	52011	51770	51642
	AHS	22029	33890	44778	47667	50504	53199	55988	61780	64445	67343
Veh Time Travel (Veh-Hr)	**Existing**	357	540.4	734.3	788.1	846	957.4	1143.4	1426.3	1511	1542
	AHS	360.3	550.4	734	782	829.2	874	921.2	1022	1068.4	1123.5

NOTE:

Speed is the average speed of the network.
VMT is calculated base on the through volume.
Vehicle time travel is calculated base on the through volume.

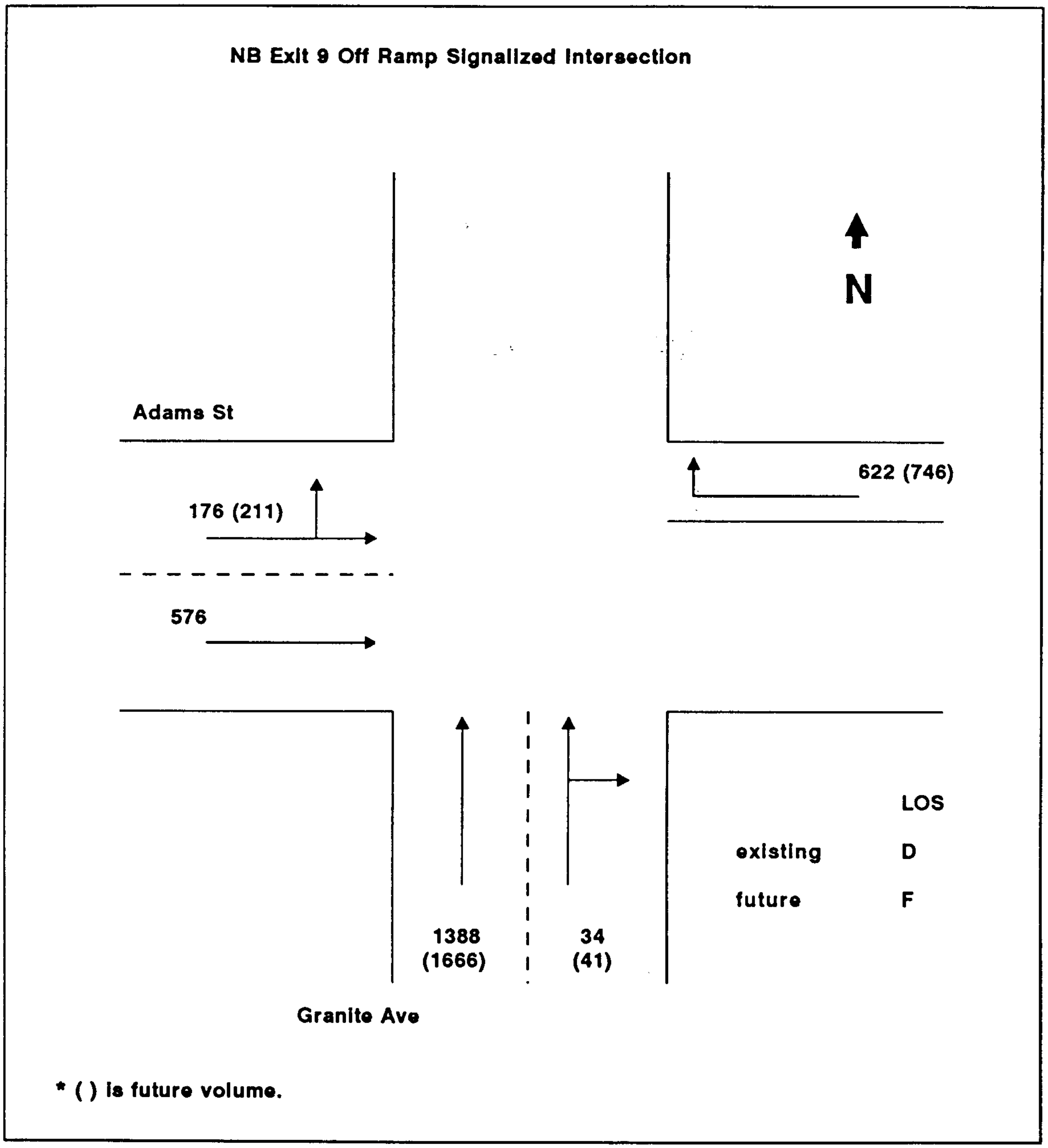


Figure 2-21.
Surface Intersection LOS With Simplified Diagram
NB Exit 9

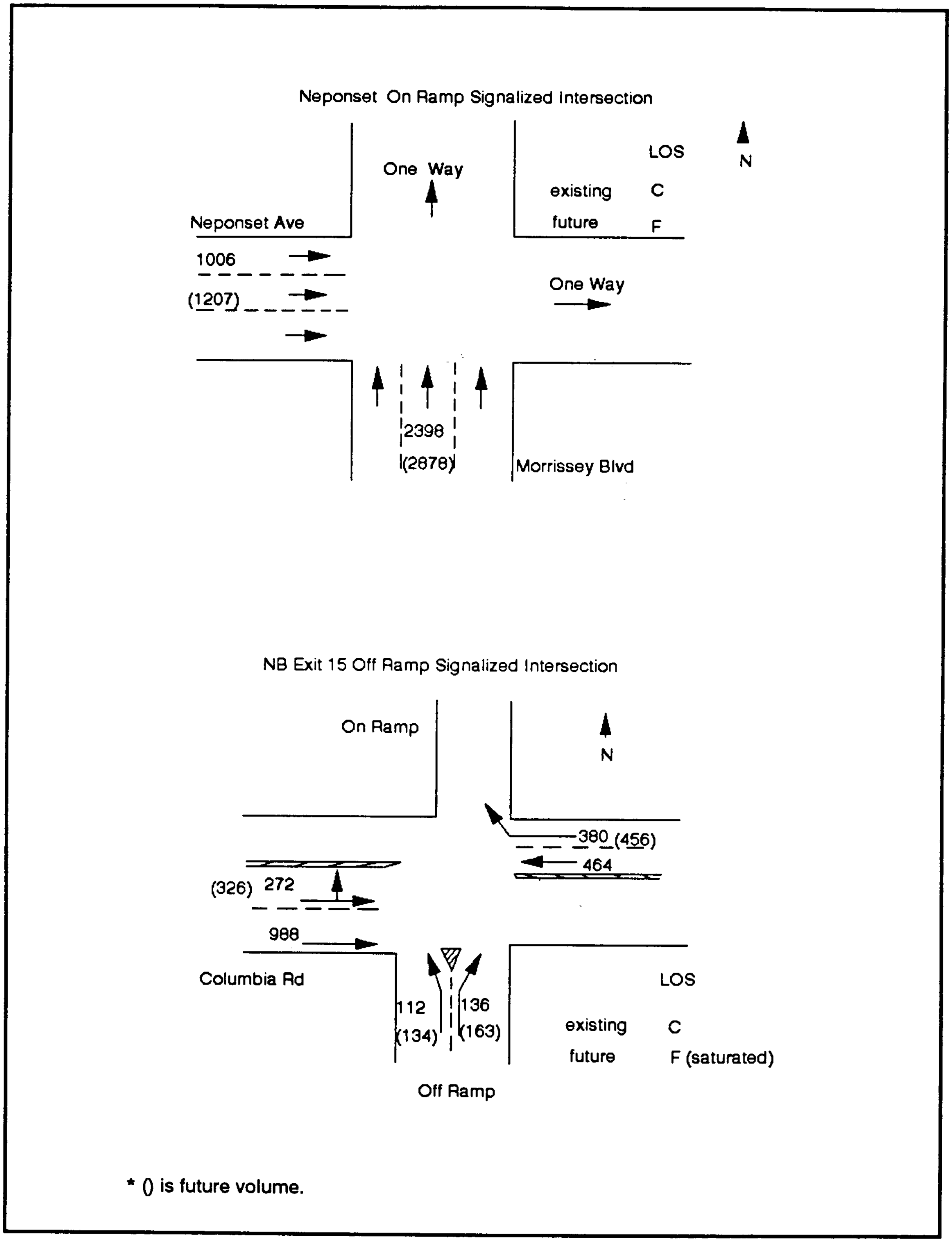


Figure 2-22. Surface Intersection LOS With Simplified Diagram

3.2.3 Capital Beltway I-495 Case Study

3.2.3.1 Scenario Description and Study Methodology

The purpose of this study was to determine the impact of implementing an AHS on the Capital Beltway (I-495). The study area extended along the Capital Beltway from I-95 in the east to I-270 in the west. This area is illustrated in Figures 2-23 and 2-24.

The traffic volume data was developed from Maryland State Highway Administration traffic counts. Traffic counts were provided for the Capital Beltway ramps in the study for the period May to June 1992. A mainline traffic count 0.7 miles west of New Hampshire Ave. was also provided. Continuous mainline traffic flow volumes were calculated using the single mainline count and adding on-ramp volumes and subtracting off-ramp volumes at appropriate points along the study area. Roadway characteristics were obtained by on-site visits and video tape analysis of the study area.

The general characteristics of the scenario are described in Table 2-6. Current peak hour volume characteristics are shown in Figure 2-25. The volumes for the general use lanes and the AHS lane after AHS implementation are shown in Figure 2-26.

AHS lane assignments were made by assuming that AHS equipped vehicles (50 percent of the entering vehicles in this case) would utilize the AHS lane at the earliest opportunity if individual trip origins and destinations were compatible with the design configuration utilized.

Appendix C provides detailed characteristics of the scenario.

3.2.3.2 Results

Figure 2-27 presents a graphical comparison of throughput performance on the Capital Beltway with an AHS lane and one less general use lane versus the existing conditions. The comparison is performed over a range of traffic volumes from 5 percent of current peak hour traffic to 110 percent. Table 2-7 presents the same information in tabular form. Table 2-8 compares the volume of traffic that can utilize the facility if the trip demand is 110 percent of the existing demand. A comparison of the total through volume on the AHS facility and the through volume on the existing facility indicates that the existing facility does not satisfy the demand for this condition, but that the AHS facility (AHS lanes and general lanes) can satisfy this demand.

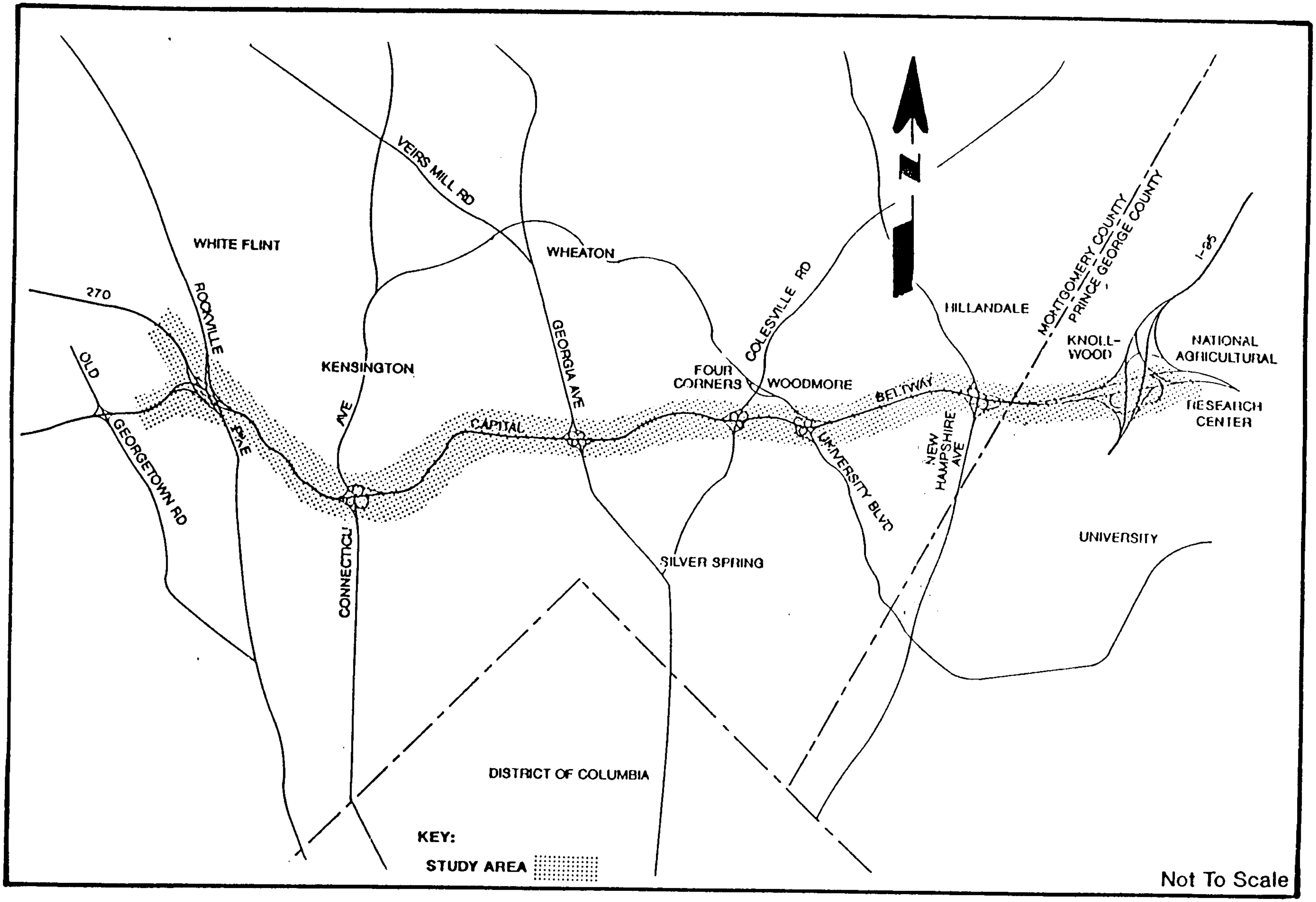


Figure 2-23 Capital Beltway Corridor Case Study Location

2-45

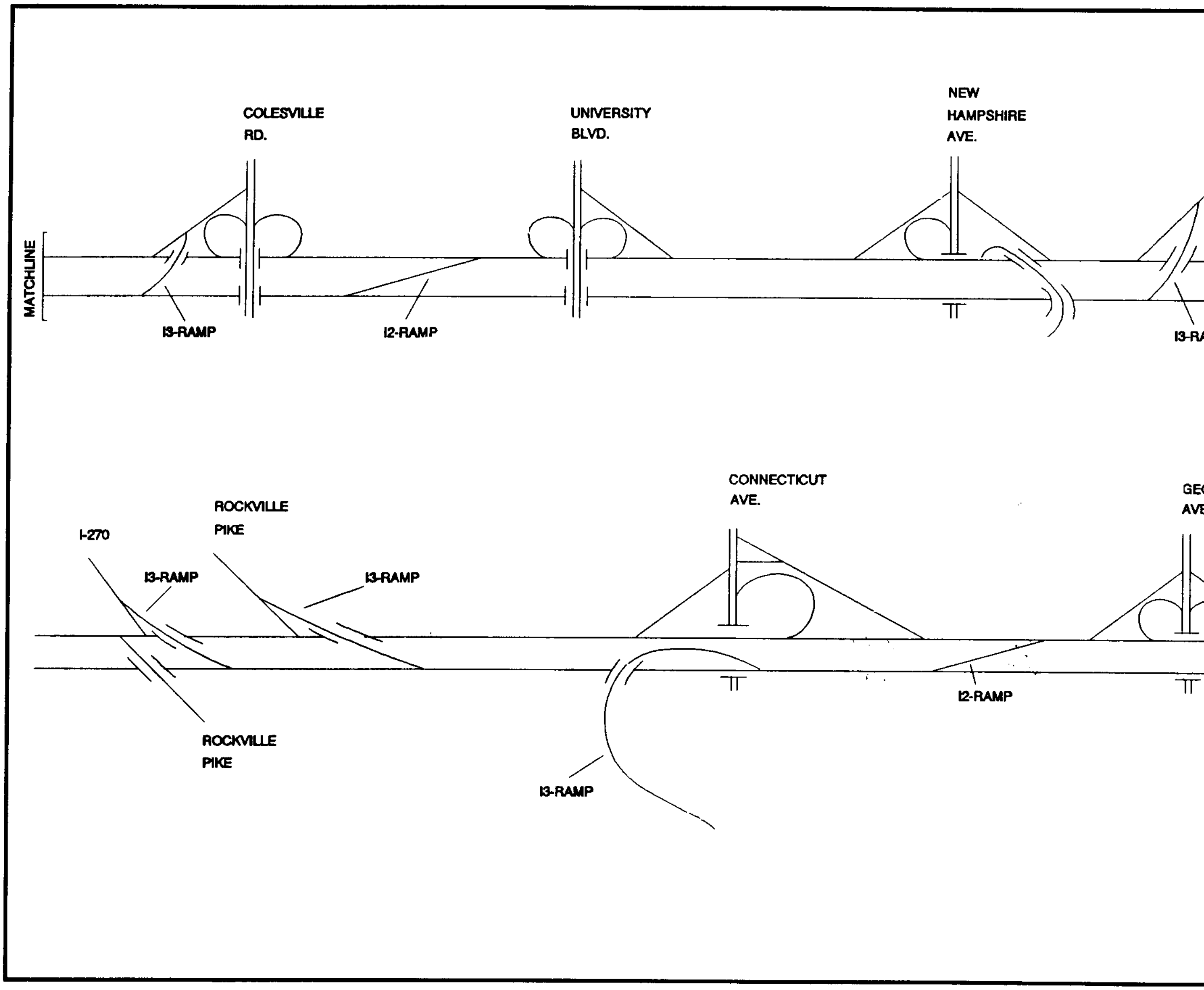


Figure 2-24. Capital Beltway (I-495) Westbound With AHS Lane

Table 2-6. **General Characteristics of Capital Beltway I-495 Scenario**

1. Location & length	Maryland I-495 (Washington DC Beltway) from I-95 to I-270; WB; A.M. peak hour; approximately 9.3 mi.
2. Type of highway	Suburban highway, high volumes, existing congestion, most traffic not bound for CBD or OBD.
3. Condition before AHS implementation	Ramp locations; current volumes; lane configurations shown on Figure 2-23 and 2-25.
4. AHS ramp configuration	Predominantly I3, some I2 as shown on Figure 2-24.
5. Condition after AHS implementation	One AHS lane, one less general use lane than current configuration. Scenario configuration shown in Figure 2-24.
6. AHS entry and exit spacings	Average 2.3mi. spacing between entry ramps and 3. mi. spacing between exit ramps.
7. AHS capacity and speed	62.1 mph constant speed up to capacity. Capacity defined as 5000 vph (vehicle spacing criteria) with useable capacity up to 4500 vph.
8. Percent of AHS equipped vehicles on facility	50 percent
9. Assumptions for traffic assignment to AHS lanes.	All AHS equipped vehicles (50 percent) are assigned to AHS up to useable capacity if their destination includes at least one AHS exit ramp from the AHS entry point.
10. Source of trip tables	The QUEENSOD model was used to convert ramp volumes to trip tables.

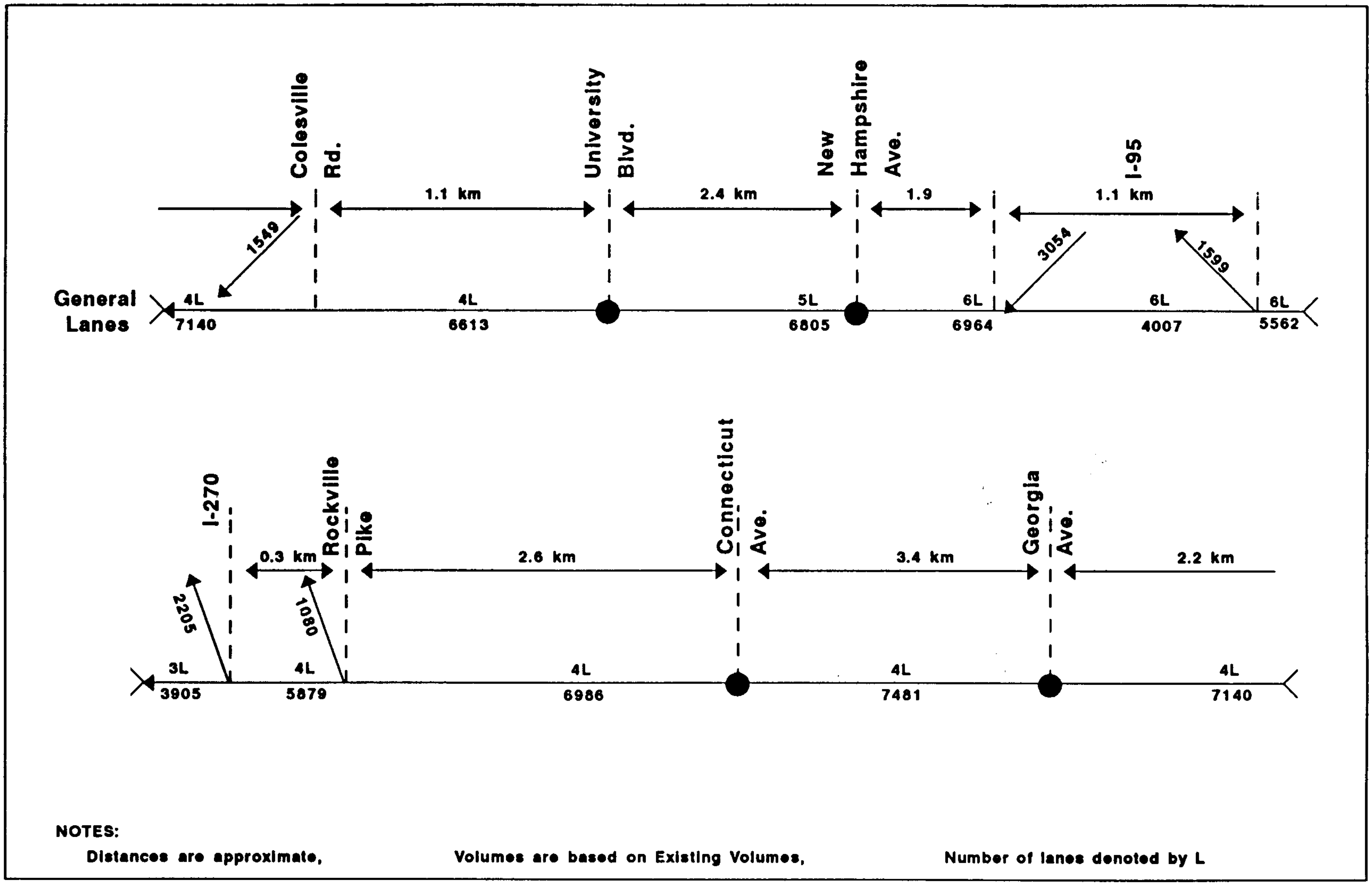


Figure 2-25.
Capital Beltway (I-495) Case Study Traffic Volume

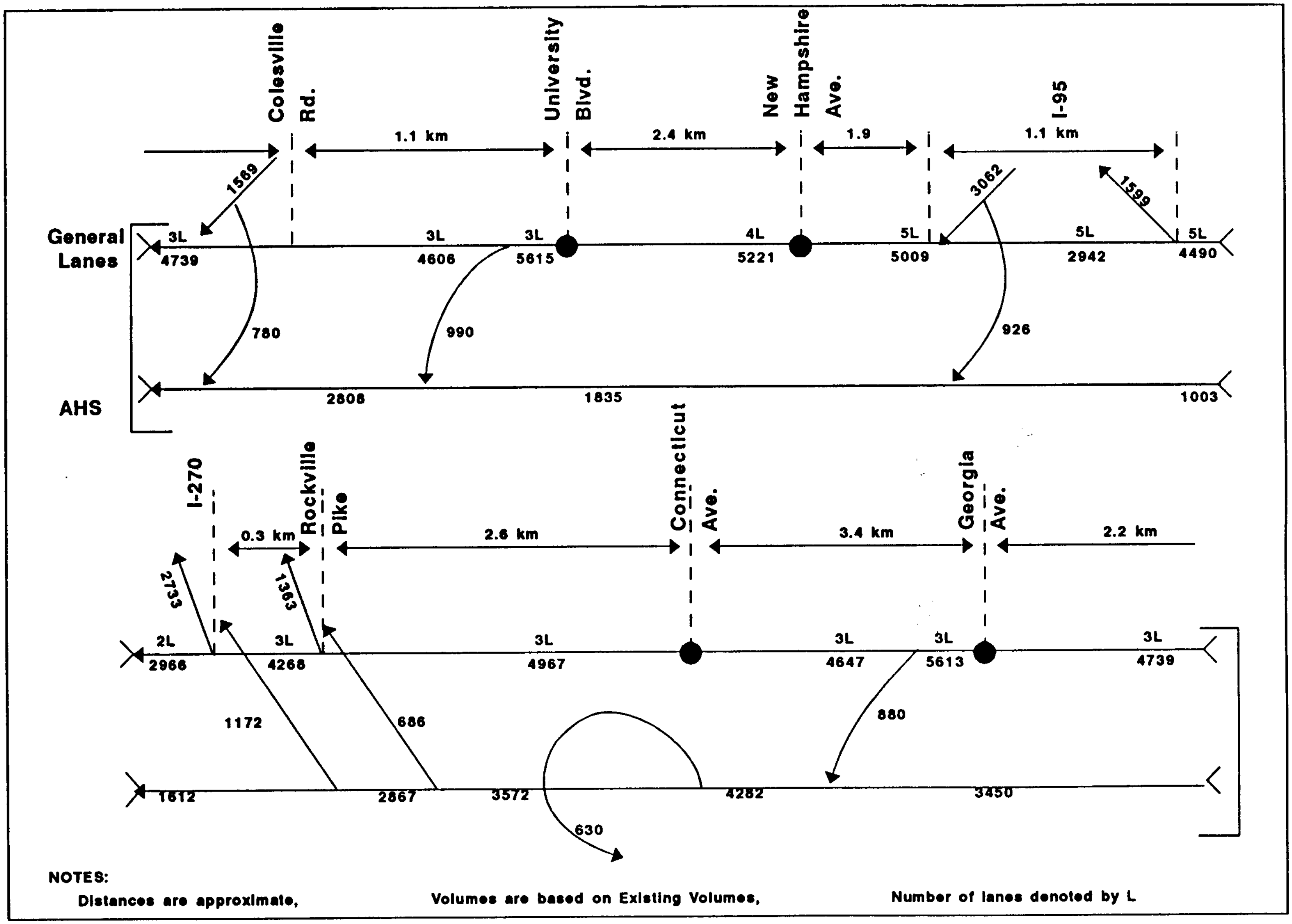


Figure 2-26.
Capital Beltway AHS (I-495) Case Study Traffic Volume

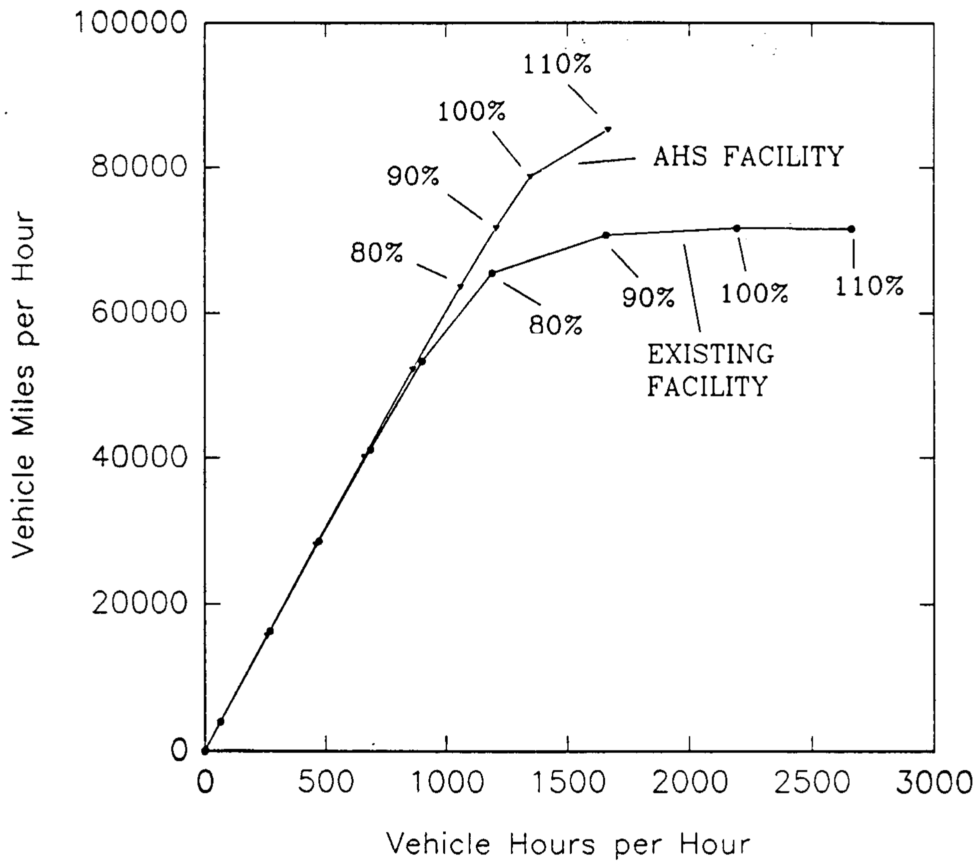


Figure 2-27. Comparison of Throughput for Capital Beltway with AHS Against Existing Conditions

Table 2-7.
Existing and AHS Facility Performance Comparison at Different Percentage Traffic Volumes

MOE	FACILITY	LANE TYPE	PERCENTAGE OF 1992 TRAFFIC VOLUME								
			5%	20%	35%	50%	65%	80%	90%	100%	110%
SPEED (MI/HR)	EXISTING	GENERAL LANES	61.8	61.4	61.0	60.4	59.5	56.2	48.3	39.9	34.2
	AHS	GENERAL LANES	61.8	61.5	61.1	60.7	60.1	59.3	58.4	57.2	51.2
		AHS LANE	62.1	62.0	62.0	62.0	61.9	61.9	61.8	61.8	61.7
		ALL THRU LANES	61.9	61.8	61.6	61.3	61.0	60.6	60.1	59.5	56.4
VEHICLE MILES TRAVEL (VMT)	EXISTING	GENERAL LANES	4046.8	16498.0	28787.9	41406.6	53510.7	65644.2	70841.3	71776.1	71745.9
	AHS	GENERAL LANES	2596.9	10247.2	18305.3	26398.2	34407.4	41725.7	47063.8	51652.4	55677.9
		AHS LANE	1227.0	5444.0	9812.3	13834.6	17900.4	21980.0	24662.2	27124.6	29484.0
		ALL THRU LANES	3823.9	15691.2	28117.7	40232.8	52307.8	63705.7	71726.0	78777.0	85161.9
VEHICLE HOURS (VEH-HR)	EXISTING	GENERAL LANES	65.5	268.5	472.1	686.4	902.7	1192.3	1658.2	2193.5	2665.6
	AHS	GENERAL LANES	42.1	166.7	299.4	435.2	573.3	705.1	807.8	907.1	1187.4
		AHS LANE	19.8	87.8	158.3	223.4	289.3	355.5	399.4	439.6	478.5
		ALL THRU LANES	61.8	254.4	457.8	658.6	862.6	1060.7	1207.1	1346.8	1665.9

NOTE:

Speed refers to the average mainline speed
VMT is based on mainline travel only
VEH-HR is based on mainline travel only

Table 2-8.
AHS and Existing Facility Volume Distribution Assuming 50% AHS MP

	EXISTING FACILITY			AHS FACILITY						
LOCATION	RAMP VO	LANES	THRU VOL	GENERAL RAMP VO	GENERA LANES	GENERAL THRU VOL	AHS RAMP	AHS RAMP VO	AHS THRU VOL	TOTAL THRU VOL
			6099			5003			1105	6108
I-95	-1750	4	4326	-1749	3	3236			1105	4341
PARK & RIDE	90	5	4378	95	4	3308			1105	4413
I-95	3330	6	6858	2314	5	5533	ON RAMP 1 (I3)	1048	2038	7571
NEW HAMPSHIRE AV	-366	5	6296	-417	4	5096			2038	7134
	627	6	6796	618	5	5703			2038	7741
	-441	5	6249	-498	4	5195			2038	7233
	626	4	6471	616	3	5696			2038	7734
UNIVERSITY BLVD.	-195	4	5815	-250	3	5236			2038	7274
	992	5	6711	999	4	6169			2038	8207
	-71	4	6391	-96	3	6008	ON RAMP 2 (I2)	1047	3064	9072
COLEVILLE RD.	273	5	6551	277	4	5201			3064	8265
	-595	4	5879	-787	3	4408			3064	7472
	1529	4	6967	786	3	5029	ON RAMP 3 (I3)	784	3713	8742
GEORGIA AVE.	-163	4	6755	-210	3	4784			3713	8497
	921	5	7594	934	4	5661			3713	9374
	-284	4	7267	-380	3	5256			3713	8969
	843	4	7423	863	3	5954	ON RAMP 4 (I2)	979	4630	10584
CONNECTICUT AVE.	-1307	4	5985	-1084	3	3776	OFF RAMP 1 (I3)	-680	3849	7625
	630	4	6509	632	3	4389			3849	8238
	1088	4	7185	1092	3	5325			3849	9174
ROCKVILLE PIKE	-1015	4	6143	-689	3	4620	OFF RAMP 2 (I3)	-725	3107	7727
I270	-2289	3	3848	-1679	2	2939	OFF RAMP 3 (I3)	-1268	1741	4680
ROCKVILLE PIKE	390	3	4119	391	2	3238			1741	4979

NOTE:

Negative traffic volume denotes off-ramp volume
Traffic volume used is 110% of existing volume year 1992 as modelled by INTEGRATION
Traffic volume may not balance between adjacent segments due to congestion and enroute traffic

The existing facility operates at a lower speed than the AHS facility from 70 percent of existing volume to 110 percent of existing volume. The total VMT by the AHS facility increases linearly while maintaining an optimal average speed. However, on the existing facility, demand in excess of 80 percent of the existing demand causes the average speed to decrease if additional OD demands are made on the facility.

Because the throughput for the combined AHS/freeway facility is higher than for the baseline freeway facility for demands greater than 80 percent of current peak period volumes, the off-ramp volumes for the AHS facility will be greater for these conditions. Except for the Rockville Pike off-ramp, the average
speeds observed on the off-ramps were the same for both the existing and the AHS facility.

The AHS egress ramp at Connecticut Ave. flows southbound. This ramp removes some traffic which currently turns left at the Connecticut Ave. traffic signal and travels southbound. Removal of this traffic results in faster average speeds on the roadways near the traffic signal.

The AHS design concept utilized for the Capital Beltway scenario will provide additional capacity for the through traffic. The trip patterns are sufficiently long to enable this additional capacity to be utilized by this particular AHS scenario. The reduction in volume to capacity ratios on the general lanes when an AHS lane is present further assists in easing the traffic flow on most on-ramps. The average speeds on the off-ramps for both the existing and the AHS facility remained the same because most off-ramp volumes are significantly below capacity.

3.2.4 New York State Thruway Case Study

3.2.4.1 Description of Location

Stretching from New York city to Buffalo, the New York State Thruway provides the fundamental transportation link for commerce, trade, and tourism through the state. In most locations, it is a two lane uncongested toll freeway. The section selected for the case study lies between Exit 16 and Exit 18 in the northbound direction, and is approximately 31 miles in length. It is a rural roadway. Six ramps are included in this section, of which three are on-ramps and three are off-ramps. The average distance between these interchanges is approximately 15.5 miles. Figure 2-28 is a general map of the scenario area.

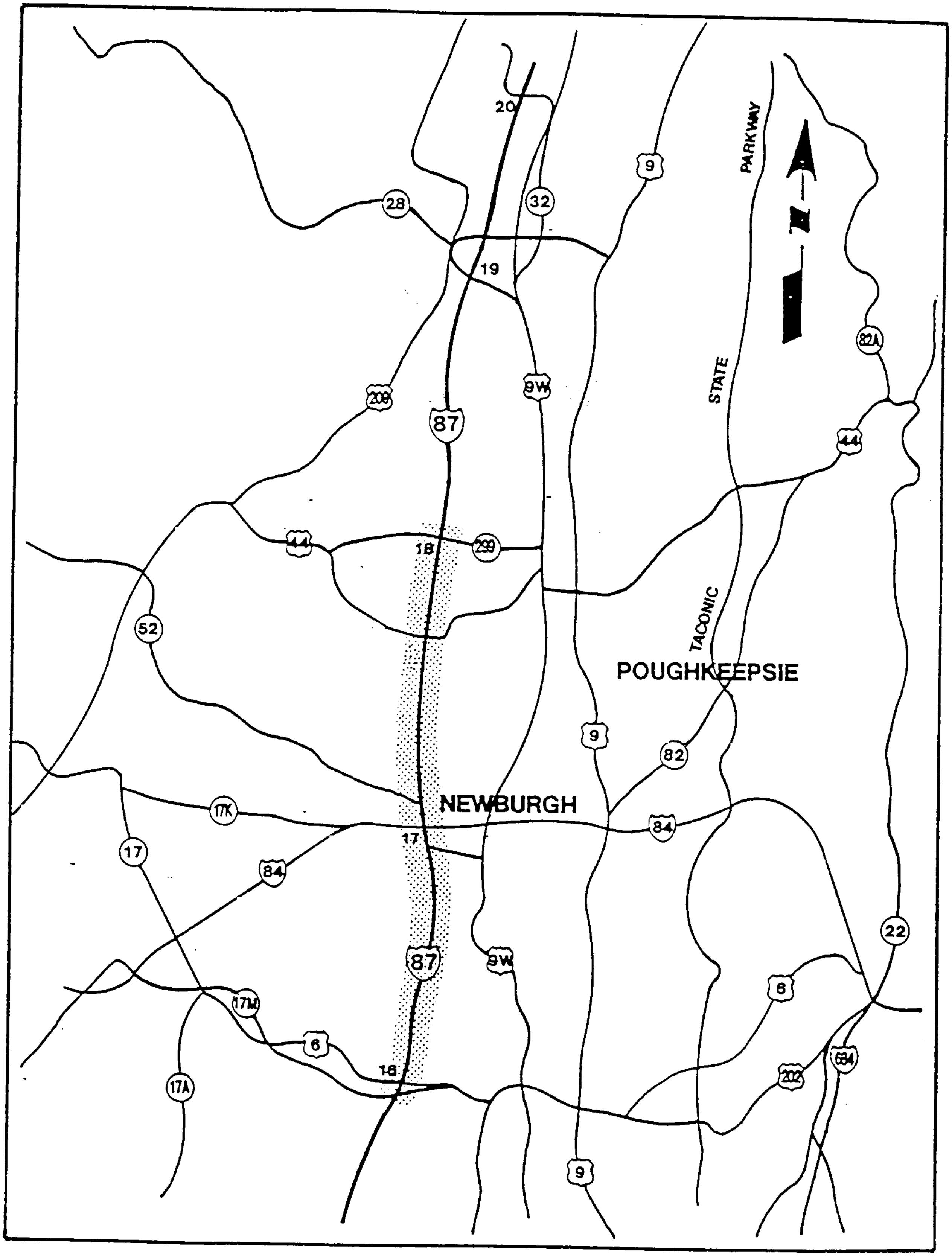


Figure 2-28 New York State Thruway Case Study Location

3.2.4.2 Scenario Discussion

The general characteristics of the scenario are provided in Table 2-9. Figure 2-29 shows the current configuration and Figure 2-30 is a model of the current volumes.

The AHS design configuration includes one AHS lane and two general lanes, with six AHS ramps, three on-ramps and three off-ramps (Figure 2-31). Since no section volume exceeds 2000 vehicles/hr, an I2 ramp configuration was used for all six AHS ramps. The AHS traffic assignment was based on a 70 percent MP, i.e. 70 percent of vehicles were assigned to AHS lane, while 30 percent of vehicles were assigned to the two general lanes. The flow model is shown in Figure 2-32.

The INTEGRATION Model was applied to evaluate both the existing and the AHS networks. The AHS network was evaluated for two cases, AHS lane speeds of 62 mi/hr and 80 mi/hr. The use of the INTEGRATION Model is described in Appendix E. The throughputs were generated by running the INTEGRATION Model with 60, 80, 90, 100, 110, 115, 120, 125, and 130 percent of the existing peak hour volume for both the existing and AHS facilities. Figure 2-33 and Table 2-10 show the throughput performance evaluation results.

The increased throughput of the AHS network is largely accounted for by the increased AHS speed over the speed in the general lanes. Since this section of the New York State Thruway experiences little congestion, an AHS system operating at speeds of approximately 60 mph shows little travel time benefit. Appendix D presents additional scenario and simulation data.

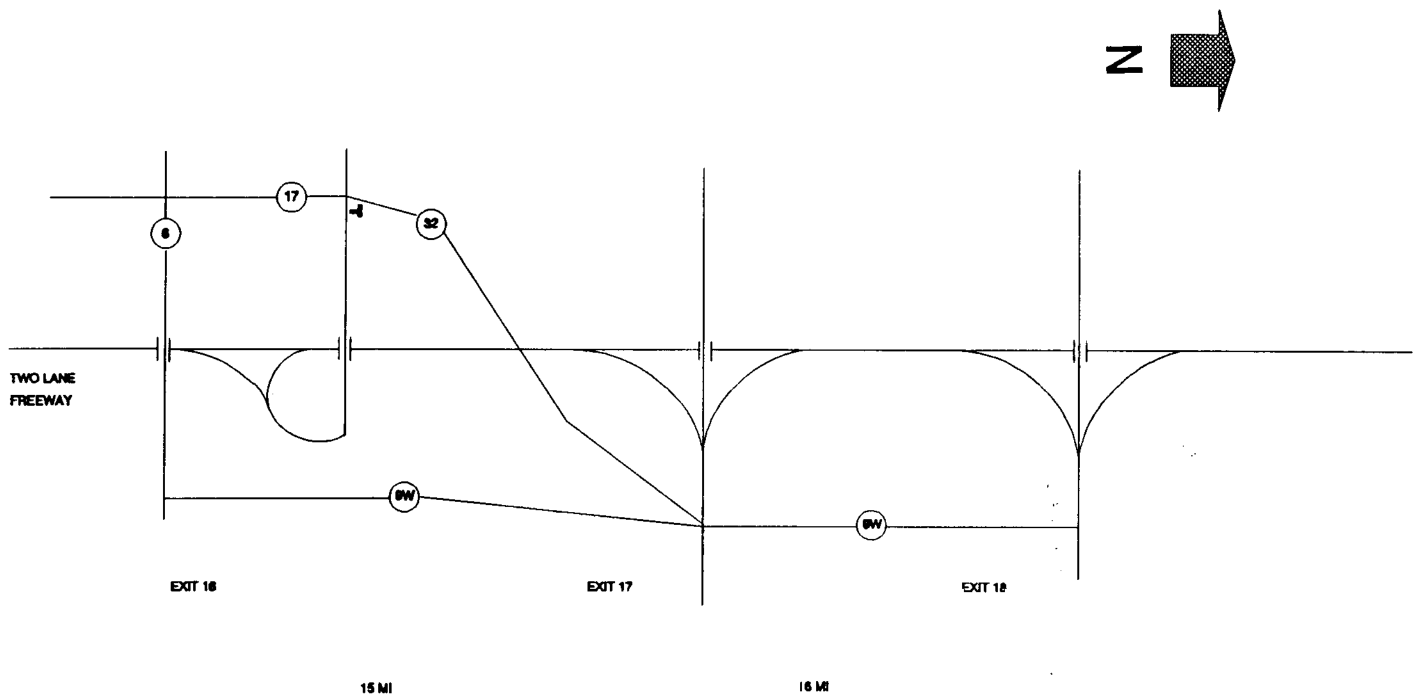
3.3 LONG ISLAND EXPRESSWAY TRANPLAN AND MARKET PENETRATION STUDY

The objective of this study is to assess the effect of AHS MP on the utilization of the AHS lane. The implementation of an AHS facility in an existing highway network will alter travel patterns in the network in a dynamic manner. Factors that will affect route selection by the motorist are:

1. Travel time between origin and destination.
2. Distance of route between origin and destination.
3. MP of AHS equipment in vehicles (i.e. What percentage of vehicles are AHS capable).
4. Safety and Comfort on trip.
5. Cost of AHS usage (i.e. Is there a toll or charge for AHS use).

Table 2-9. Summary NY State Thruway Scenario Characteristics

1. Location & length	New York State Thruway (I-87) from Exit 16 (Harriman) to Exit 18 (New Paltz); NB, AM peak hr; Approx. 31 mi.
2. Type of highway	Rural highway, relatively low volumes, little congestion, most traffic not local.
3. Condition before AHS implementation	2 northbound lanes, ramp locations & current volumes shown on Figures 2-29 and 2-30.
4. AHS ramp configuration	I2 as illustrated in Figure 2-31.
5. Condition after AHS implementation	One AHS lanes, 2 general lanes, scenario uses current volumes. Variations up to 130% of current volumes.
6. AHS entry and exit spacings	Average 15.5 mi spacing between entry ramps and 15.5 mi spacing between exit ramps.
7. AHS capacity and speed	a. 62.1 MPH constant speed up to capacity (5000 VPH with 4500 VPH useable capacity). b. 80 MPH constant speed up to capacity (3000 VPH with 2700 VPH useable capacity).
8. Percent of AHS equipped vehicles on facility	70%
9. Assumptions for traffic assignment to AHS lanes.	All AHS equipped vehicles (70%) are assigned to AHS up to useable capacity.
10. Source of trip tables	NYS Thruway data.



NOTES:

EXISTING FACILITY IS A TWO LANE FREEWAY.

EXIT 16 SERVES AS TWO LANE RAMP DUE TO THE EXISTING HIGH EXIT VOLUME.

TOTAL LENGTH FROM EXIT 16 TO EXIT 18 IS APPROXIMATE 31 MI (50 KM).

DRAWING IS NOT TO SCALE. ONLY NORTH BOUND IS CONSIDERED.

Figure 2-29. N.Y.S. Thruway Existing Configuration (NB)

2-57

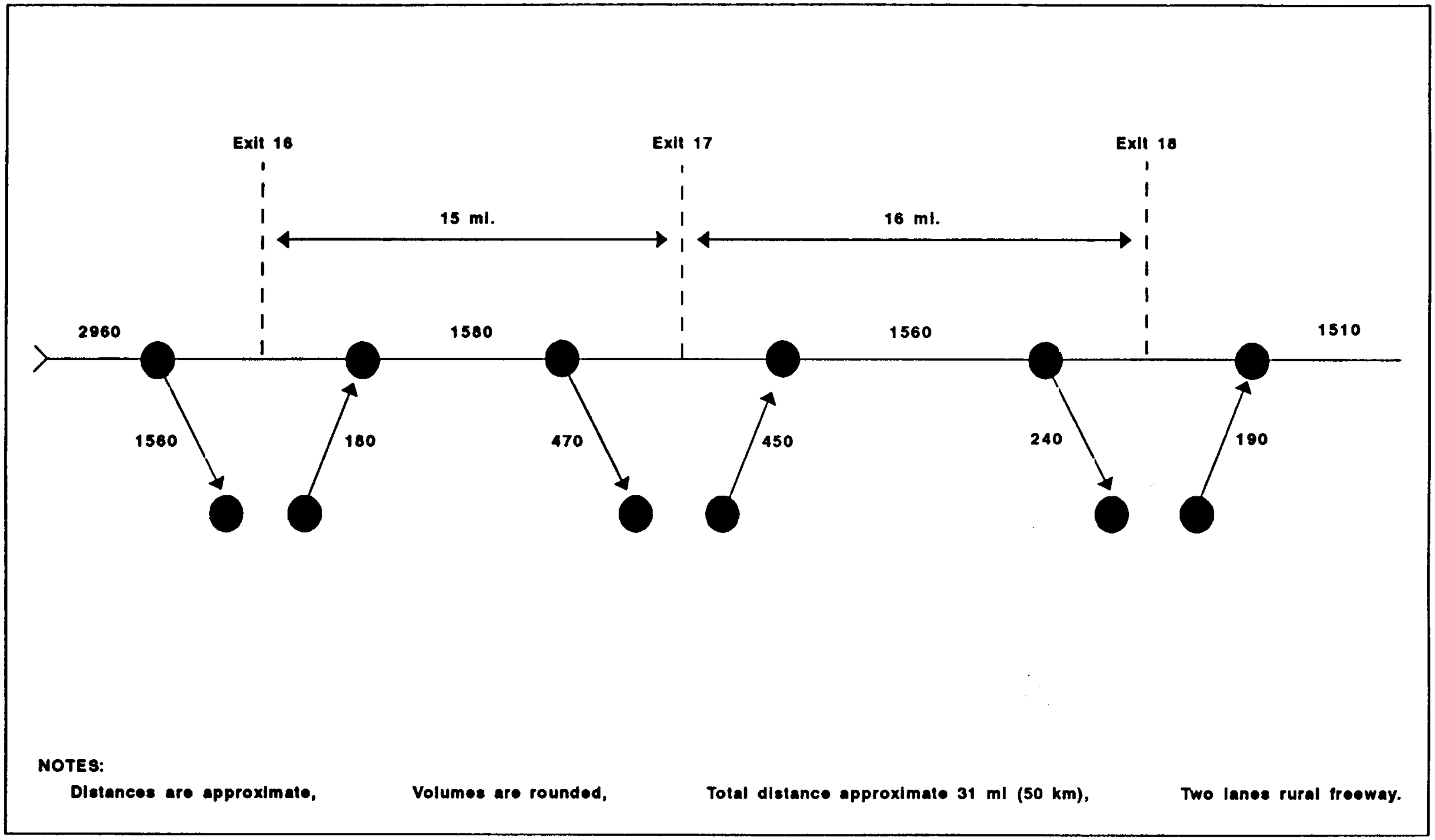


Figure 2-30.
Simplified Representation - N.Y.S. Thruway
Approximate Major Existing Traffic Flow (NB)

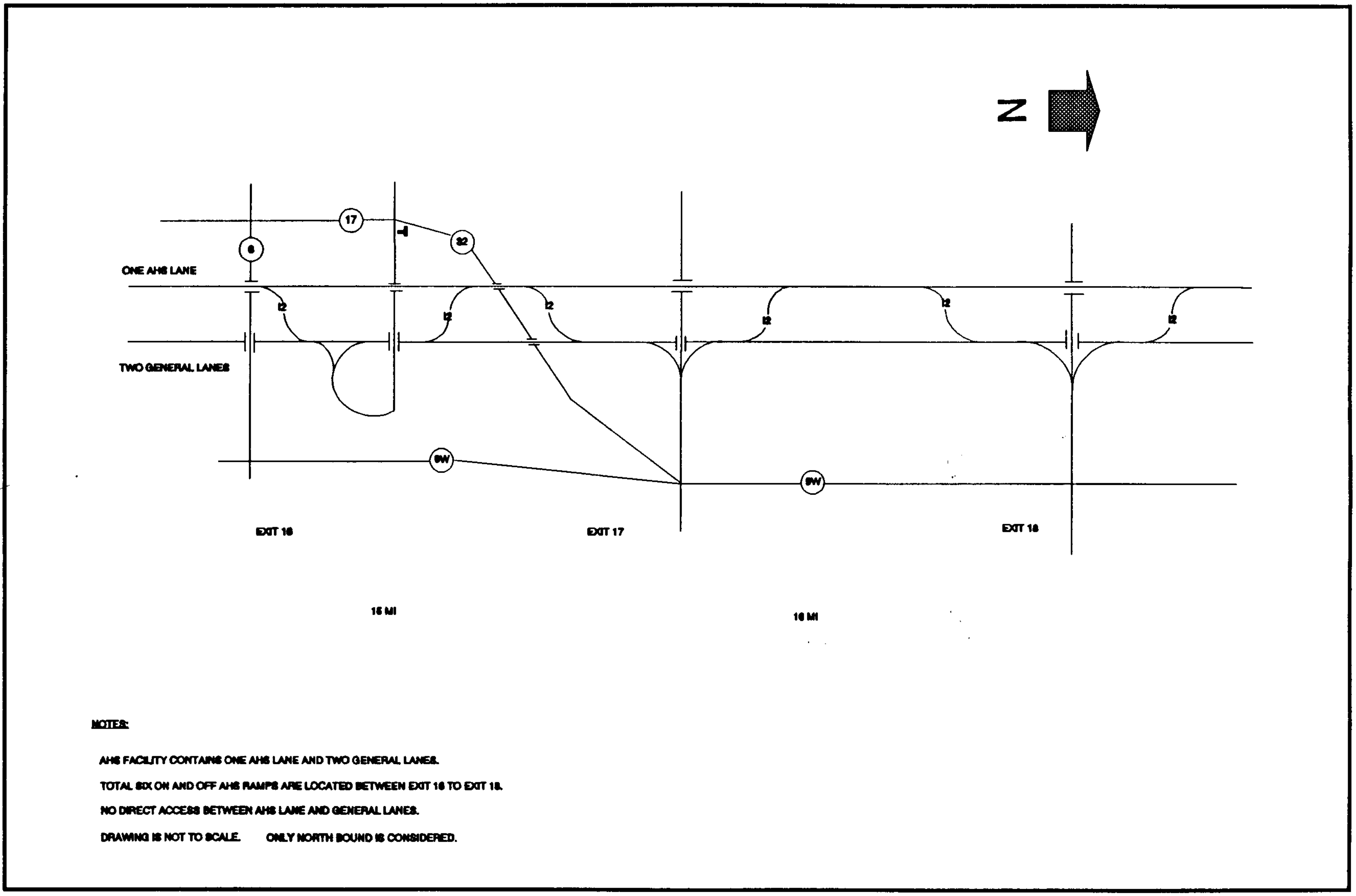
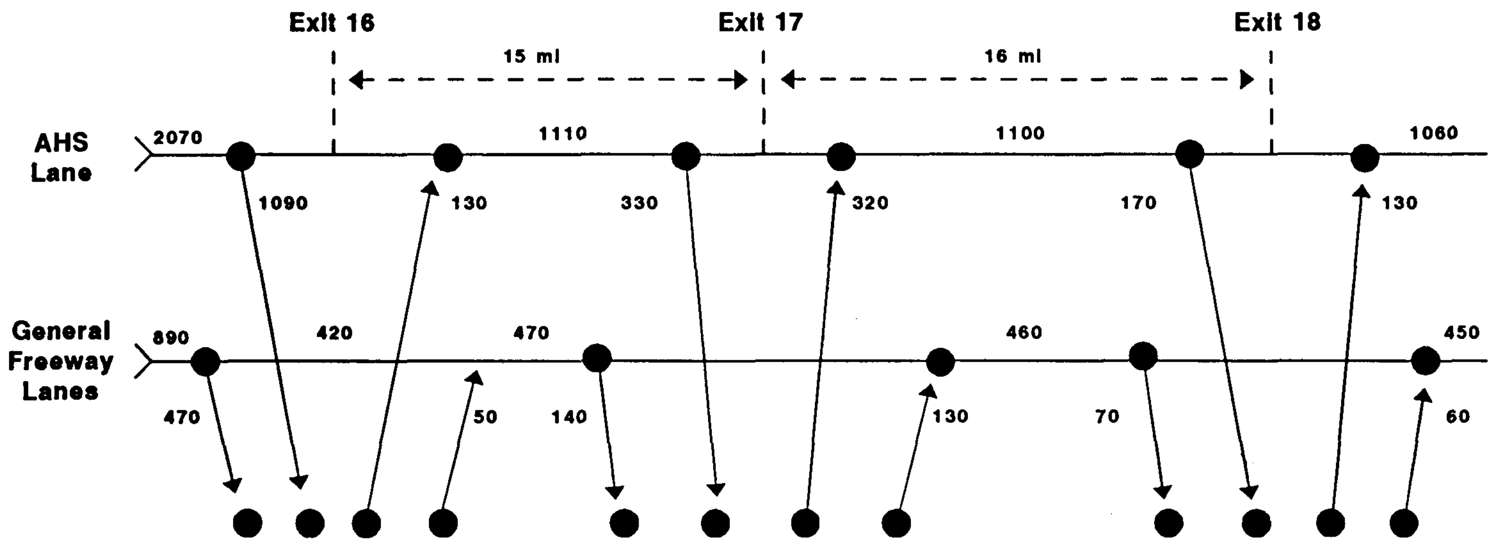


Figure 2-31. N.Y.S. Thruway AHS Configuration (NB)



Notes:

Distances are approximate

Volumes are rounded Existing peak hour volumes

Total distance approximate 31 mi (50 km)

One AHS lane, two general lanes

Assume 70% of vehicles on one AHS lane, 30% of vehicles on two general lanes

Figure 2-32.
Simplified Representation - N.Y.S. Thruway AHS Access From Separate Ramps Approximate Major Traffic Flows

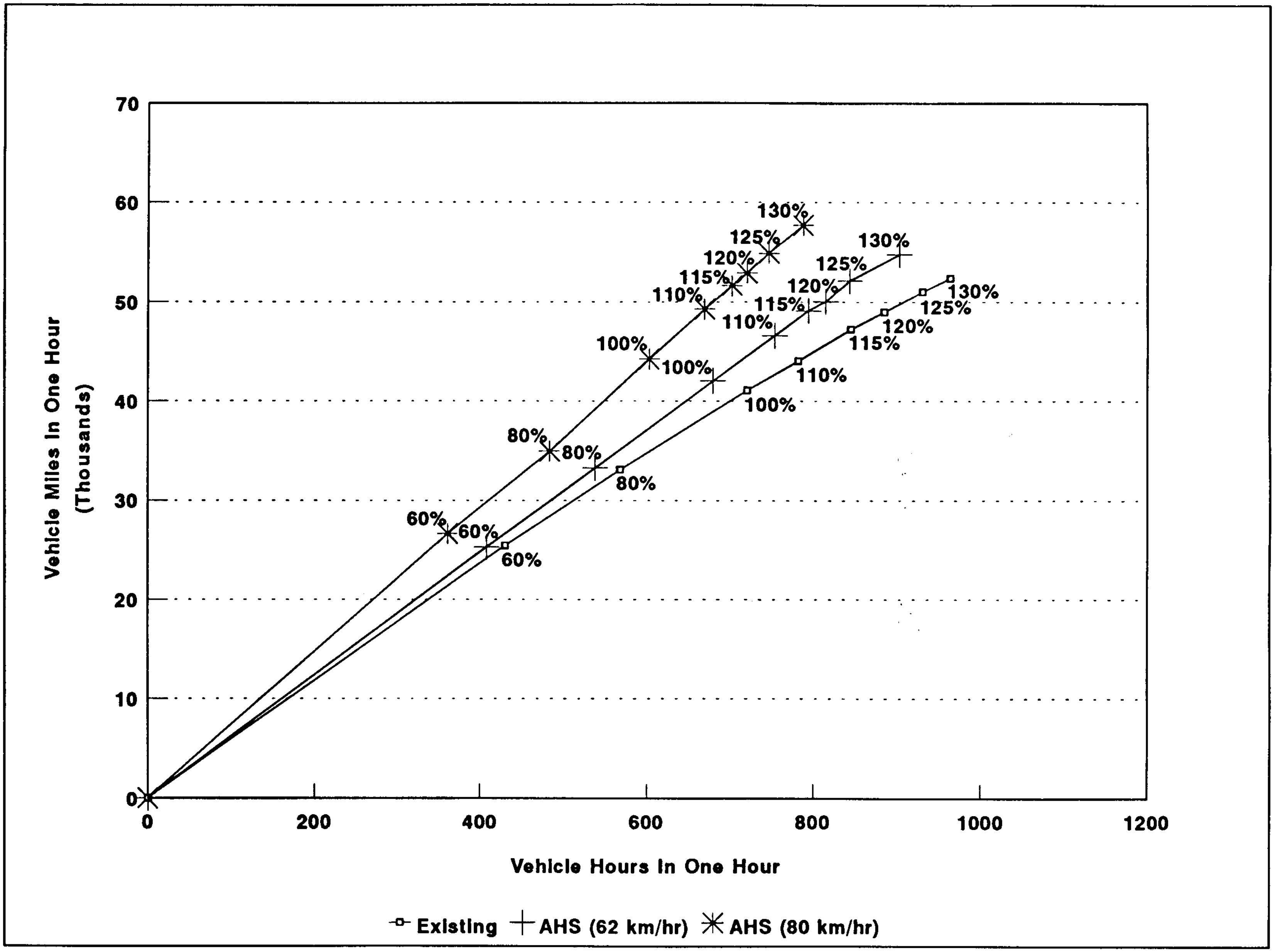


Figure 2-33. Throughput For NYS Thruway Case Study

Table 2-10.

N.Y.S. Thruway Existing and AHS Facilities Performance Comparison

For Different Traffic Volumes

MOE	Facility	Percentage of Existing Volume							
		60%	80%	100%	110%	115%	120%	125%	130%
Speed (Mile/Hr)	Existing	58.4	57.1	55.9	55.3	55.3	54.7	54	53.4
	AHS(62mi/hr)*	60.9	60.9	60.9	60.2	60.2	60.2	60.2	59.6
	AHS(80mi/hr)**	72	71.4	71.4	71.4	70.8	70.8	70.2	69.6
VMT (Veh-Mile)	Existing	25458	33107	41085	44053	47246	48986	51016	52389
	AHS(62mi/hr)*	25292	33276	42064	46599	49112	50060	52127	54765
	AHS(80mi/hr)**	26646	34952	44251	49279	51648	52917	54901	57713
Veh Time Travel (Veh-Hr)	Existing	430	568	721	782	845	885	931	964
	AHS(62mi/hr)*	408	538	680	754	795	815	844	903
	AHS(80mi/hr)**	361	483	603	670	703	721	747	788

NOTE:

Speed is the average speed of the network.
VMT is calculated base on the through volume.
Vehicle time travel is calculated base on the through volume.

3.3.1 TRANPLAN Model

Factors that affect route selection may vary, and as they do the attractiveness of route paths will change. This alters certain of the other factors, and results in additional changes to traffic patterns. Given the modeling techniques available, it is not currently possible to dynamically model all of the above noted factors. There are several models available which allow simulation of the most significant factors and can provide significant insights into the alteration of travel patterns resulting from AHS deployment. The TRANPLAN model was selected from the various available planning models.

The TRANPLAN software provides a dynamic planning tool to effectively analyze transportation systems. The set of functions provided by TRANPLAN enables planners to describe roadway networks, develop trip generation tables,
distribute vehicle trips, and assign trips to an extensive network. It also provides accurate reports and plots the results of the analysis. Additionally, an interactive Network Information System software (NIS) acts as a graphical interface allowing a user to develop, display, and update TRANPLAN networks. The combination of this software provides the transportation planning engineer with a “user friendly” developmental product to update, analyze, and predict changes. In order to provide accurate results, the TRANPLAN Program like others of its type requires extensive data. The New York State Department of Transportation (NYSDOT) utilized the TRANPLAN software for the LIE Capacity Study and collected the required data in order to calibrate the model. This study focused on the LIE from its interchange with Clearview Expressway in New York City to its interchange with William Floyd Parkway (C.R. 46) in Suffolk County.

The TRANPLAN model of Long Island was developed to analyze the effects of alternate improvements to the LIE. This model encompassed a large portion of Long Island with a particular focus on the LIE. Vehicle Trip Ends (VTEs) at input points or zones for the origin or destination of the vehicle trips were provided on the LIE network model in a grid. This grid or matrix of zones was structured to correspond to the New York Metropolitan Transportation Council (NYMTC) database of estimated VTE for Long Island. Zone or centroid connectors connected the zones to the roadway network allowing the vehicle trip to enter or exit the network at a predetermined point. VTE is an estimate of vehicle trips originating or ending from a bounded area based on the available socio-economic data. These estimates account for vehicle trips to or from residences, offices, retail centers, etc. The estimated existing and future VTEs for the New York Metropolitan area were determined from the NYMTC database. Each zone’s VTE represented the predicted trips associated by the socio-economics of the local area.

The roads represented by links are assigned characteristics to identify the quality and type of facility. The number of lanes, speed, length, running speed, capacity, and roadway type are encoded into each link. The software compares the characteristics of the different links to assess its ability to carry traffic. System wide this assessment distinguishes the different roads by classifying them as limited access highways, major arterial, minor collector streets, etc.

The roadway characteristics utilized in the LIE study are listed in Table 2-11 and Table 2-12. Table 2-11 lists the network characteristics utilized in the TRANPLAN Model based on the roadway type. Table 2-12 summarizes the ratios of free flow travel time to actual travel time based on the volume to capacity ratio and the assignment group code. The model utilizes these characteristics for assigning traffic to the network and to distinguish the different road types.

3.3.2 Market Penetration Studies

The TRANPLAN analysis used in the Precursor Systems Analysis (PSA) study investigates the implementation of AHS scenarios on the LIE. This macroscopic analysis identifies the impact on Long Island traffic of replacing one general lane in each direction on the current LIE with one AHS lane in each direction. The configuration consisted of one AHS lane and two general lanes. This study area extends from the LIE interchange with Clearview Expressway to its interchange with William Floyd Parkway, as illustrated in Figure 2-34.

Databases of traffic volumes were created for the Long Island network by running a series of AHS scenarios on the LIE with traffic volumes representing the year 2015. The MP of AHS equipped vehicles was increased from 5 percent to 100 percent in increments of 5 percent. The MP refers to the percentage of vehicles that are assumed to have the capability to use the AHS facility. MP is assumed to be evenly distributed across the entire Long Island population.

Table 2-13 lists the average daily roadway volumes along the major east-west roadways as a function of MP. Figures 2-35 and 2-36 illustrate the influence of MP on the AHS lane volumes in the eastbound and westbound directions respectively. The AHS lane volume rises sharply up to approximately 40 percent MP and levels off beyond this point. Thus the capacity of the AHS lane is attained at approximately 40 percent MP in this corridor.

Figures 2-37 and 2-38 illustrate the influence of MP on the LIE general lanes daily volumes for eastbound and westbound flows respectively. The average daily traffic volume for the general lanes decreases for up to 50 percent MP at which point the volume levels off. Thus traffic volume is continually drawn from the general use lanes as MP increases up to the point of AHS lane saturation.

TABLE 2-11

TRANPLAN Roadway Characteristics

ROADWAY DESCRIPTION			CAPACITY vplpd	SPEED (M.P.H.)	ASSIGNMENT GROUP
Long Island Expressway			21,000	65	1
Parkways (4 lanes)			18,000	60	1
Parkways (6 lanes)			18,800	65	1
Centroid Connectors			15,000	30	9
Arterial Multilane Highways Type	Multilane Signals	Lateral Clearance			
1. Divided	Yes	Unrestricted	7,800	30-50	5-8
2. Divided	Yes	Restricted	6,900	30-50	5-8
3. Divided	No	Unrestricted	16,900	35-55	5-8
4. Divided	No	Restricted	14,600	35-55	5-8
5. Undivided	Yes	Unrestricted	7,500	30-45	5-8
6. Undivided	Yes	Restricted	6,600	30-45	5-8
7. Undivided	No	Unrestricted	15,900	35-55	5-8
8. Undivided	No	Restricted	14,000	35-55	5-8

Notes: vplpd vehicle per lane per day
Divided a. Raised Median
b. Flush Median greater than 9 feet and 4 feet for all other highways
Unrestricted shoulder 6 feet or more in width
Assignment Group designates the relationship between speed and volume for a particular road within the TRANPLAN Model

Source: NYS Route 347 Corridor Study

Table 2-12.

Relationship Between V/C Ratio and Free Flow Link Travel Time/Link Travel Time For TRANPLAN Network

LINK TYPE	EXPRESSWAY & PARKWAYS	SIGNALIZED INTERSECTION				UNSIGNALIZED SERVICE ROAD	RAMPS & CENTROIDS
AVERAGE SIGNAL SPACING (MI)	NA	0-0.2	0.2-0.4	0.4-0.8	OVER 0.8	NA	NA
ASSIGNMENT GROUP CODE	1	5	6	7	8	2	9
V/C	To/T	To/T	To/T	To/T	To/T	To/T	To/T
0.0	1.000	0.707	0.828	0.906	0.923	0.960	1.000
0.1	0.982	0.697	0.821	902.000	0.920	0.940	1.000
0.3	0.964	0.686	0.813	0.897	0.916	0.900	1.000
0.3	0.945	0.673	0.805	0.892	0.912	0.880	0.999
0.4	0.927	0.659	0.795	0.886	0.906	0.840	0.995
0.5	0.909	0.643	0.783	0.878	0.900	0.800	0.980
0.6	0.873	0.622	0.767	0.868	0.892	0.760	0.944
0.7	0.836	0.596	0.747	0.855	0.881	0.740	0.870
0.8	0.800	0.557	0.716	0.834	0.863	0.680	0.749
0.9	0.709	0.490	0.657	0.793	0.828	0.600	0.596
1.0	0.545	0.358	0.527	0.690	0.736	0.560	0.440
1.1	0.248	0.078	0.145	0.253	0.298	0.113	0.307
1.2	0.160	0.044	0.084	0.155	0.187	0.063	0.208
1.3	0.119	0.030	0.059	0.112	0.136	0.044	0.140
1.4	0.094	0.023	0.046	0.087	0.107	0.033	0.094
1.5	0.078	0.019	0.037	0.072	0.088	0.027	0.064
1.6	0.067	0.016	0.031	0.061	0.075	0.023	0.045
1.7	0.058	0.014	0.027	0.053	0.065	0.020	0.031
1.8	0.051	0.012	0.024	0.047	0.058	0.017	0.023
1.9	0.046	0.011	0.021	0.042	0.052	0.015	0.016
2.0	0.042	0.010	0.019	0.038	0.047	0.014	0.012
2.5	0.029	0.007	0.013	0.026	0.032	0.009	0.003
3.0	0.022	0.005	0.010	0.019	0.024	0.007	0.001
4.0	0.015	0.003	0.007	0.013	0.016	0.005	0.000

NOTES:

V/C refers to Volume/Capacity Ratio
To refers to Free Flow Link Travel Time
T refers to Link Travel Time

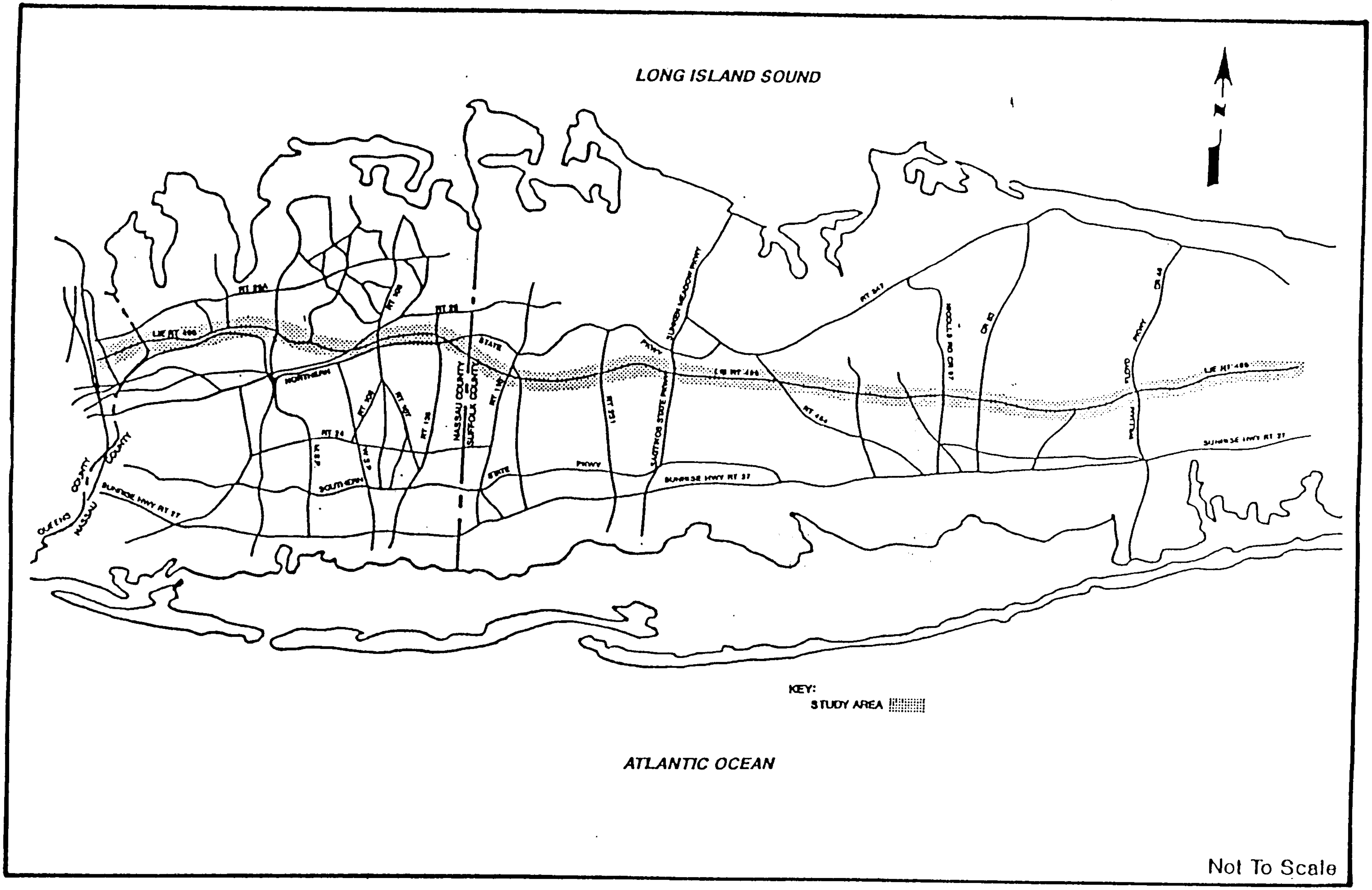


Figure 2-34 Area Included In Penetration Study

Table 2-13.
Average Daily Traffic Volumes on Major East West Roadways on Long Island

Market Penetration (%)	AVERAGE DAILY TRAFFIC VOLUME ON ROADWAY									
	AHS Lane East	AHS Lane West	Freeway General Lanes East	Freeway General Lanes West	Northern State Pkwy East	Northern State Pkwy West	Southern Parkway East	Southern Parkway West	Sunrise Highway East	Sunrise Highway West
5	11080	10713	65196	66142	65293	65799	65439	63186	51437	54837
10	22085	21099	62719	65225	63622	63944	64978	63688	50202	52688
15	32739	31021	58733	63388	62979	64261	62235	63125	53180	52960
20	42863	40887	57968	61614	60159	61105	61540	60800	50651	52412
25	46452	47172	57100	59952	61359	62373	61285	60764	48758	50245
30	51083	51744	55415	58680	61717	62159	61493	60530	48390	48198
35	50768	55023	56723	57621	60294	60879	62224	61002	47865	47949
40	51986	55819	55702	56839	61010	61177	61722	61024	46936	47907
45	53115	56460	55904	55641	60163	61288	61859	62182	46912	47271
50	55180	58377	54822	55465	60915	60921	62262	60671	46619	48813
55	55352	60439	53979	54624	60263	61776	62399	60537	46455	48213
60	55298	61106	54527	53669	59259	61868	62291	59431	47046	49083
65	55015	60824	53718	53735	61754	62509	61733	60606	48061	47547
70	54330	60699	55148	53893	61938	61610	64590	62238	46171	47885
75	54762	60967	52880	53876	62542	61721	64767	61961	45810	47289
80	55486	61033	54474	53670	63955	61596	63213	62592	46363	46155
85	55798	63285	53265	50839	62322	61360	65616	61233	45838	45830
90	57142	60363	51132	54689	62581	61789	66448	62048	47199	46930
95	57913	63644	53305	50679	61267	61335	61992	59996	47126	47649
100	56714	61237	54202	53499	60584	60711	62671	60726	47118	47360

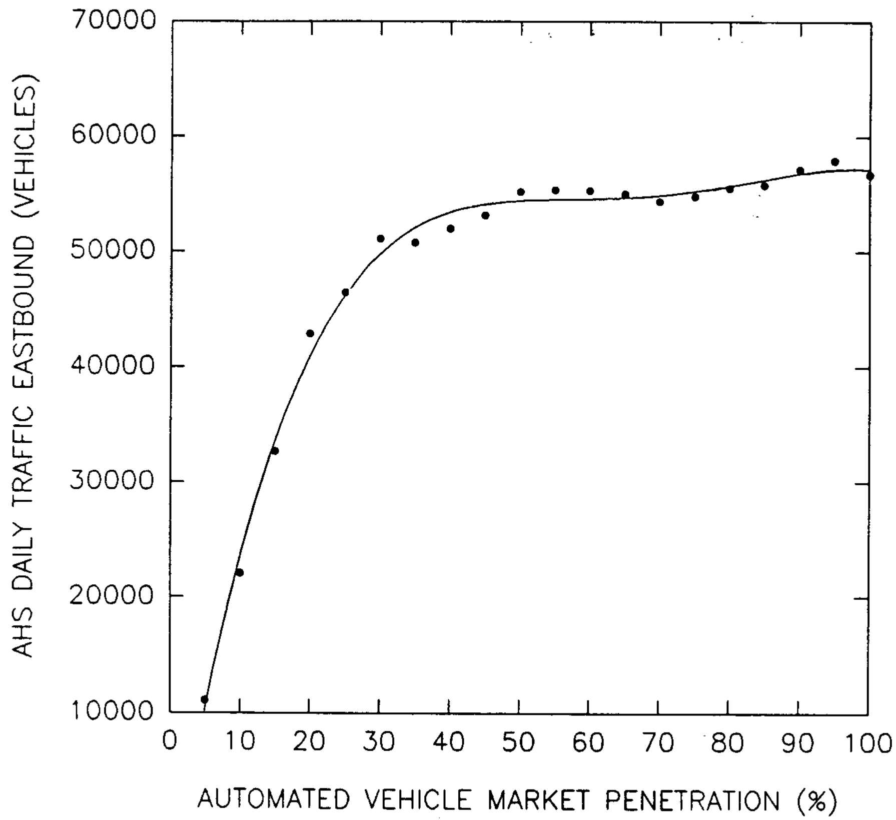


Figure 2–35. Market Penetration Influence on LIE AHS EB

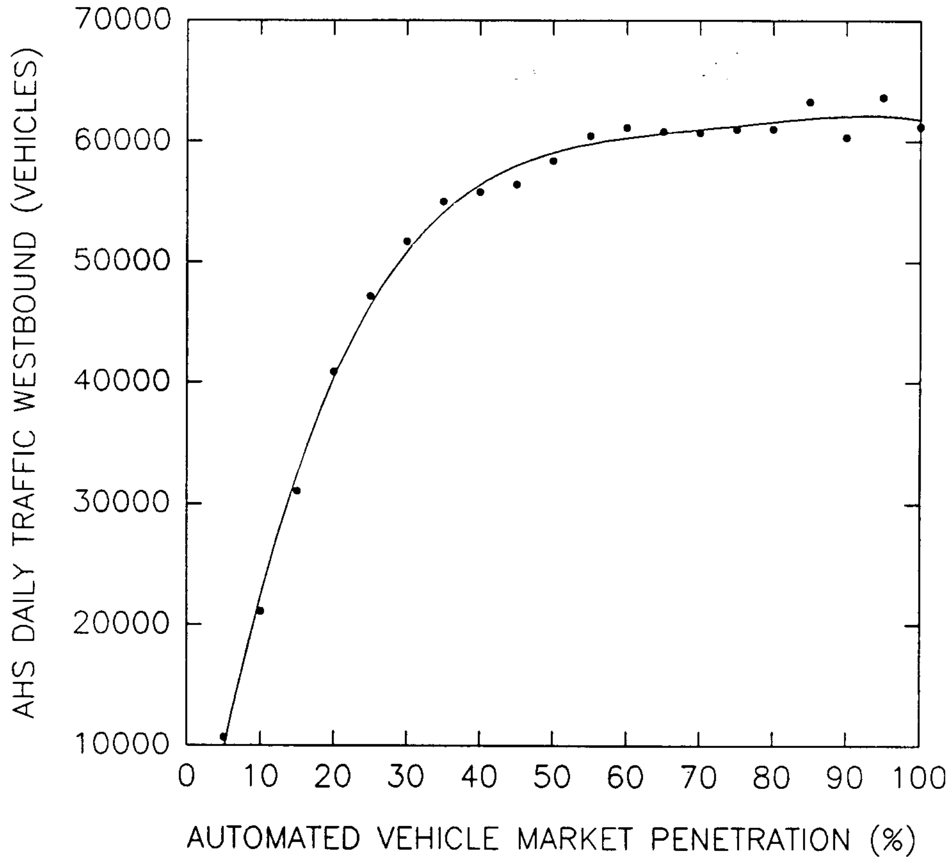


Figure 2–36. Market Penetration Influence on LIE AHS WB

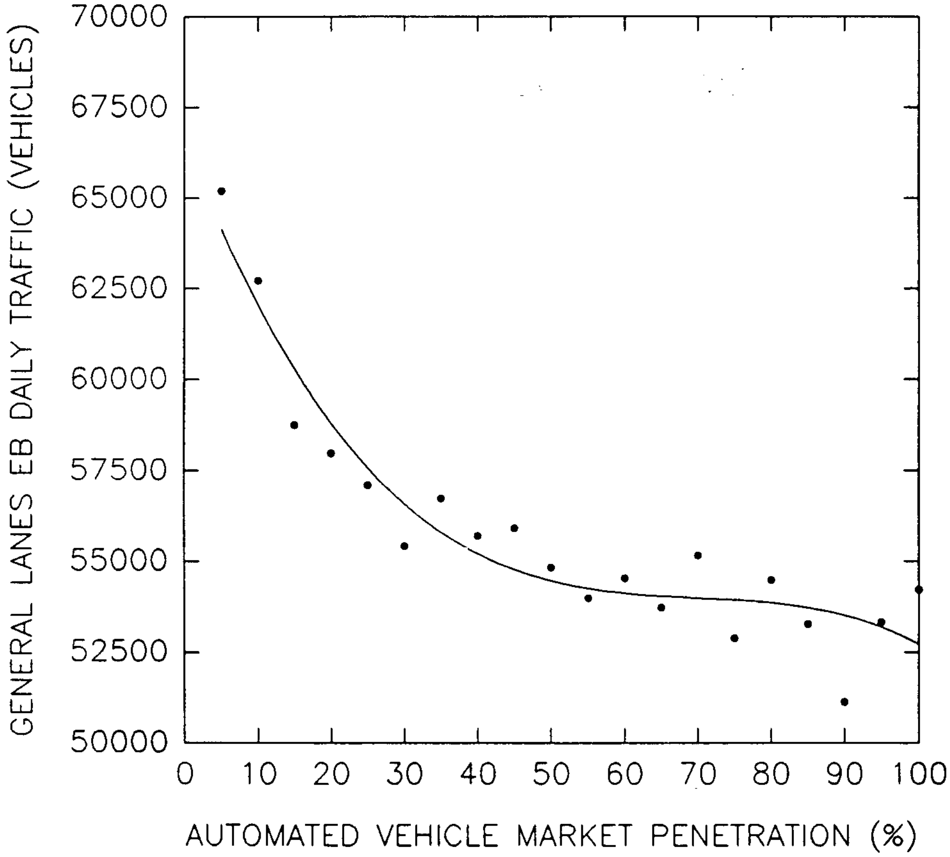


Figure 2-37. Market Penetration Influence on LIE General Lanes EB

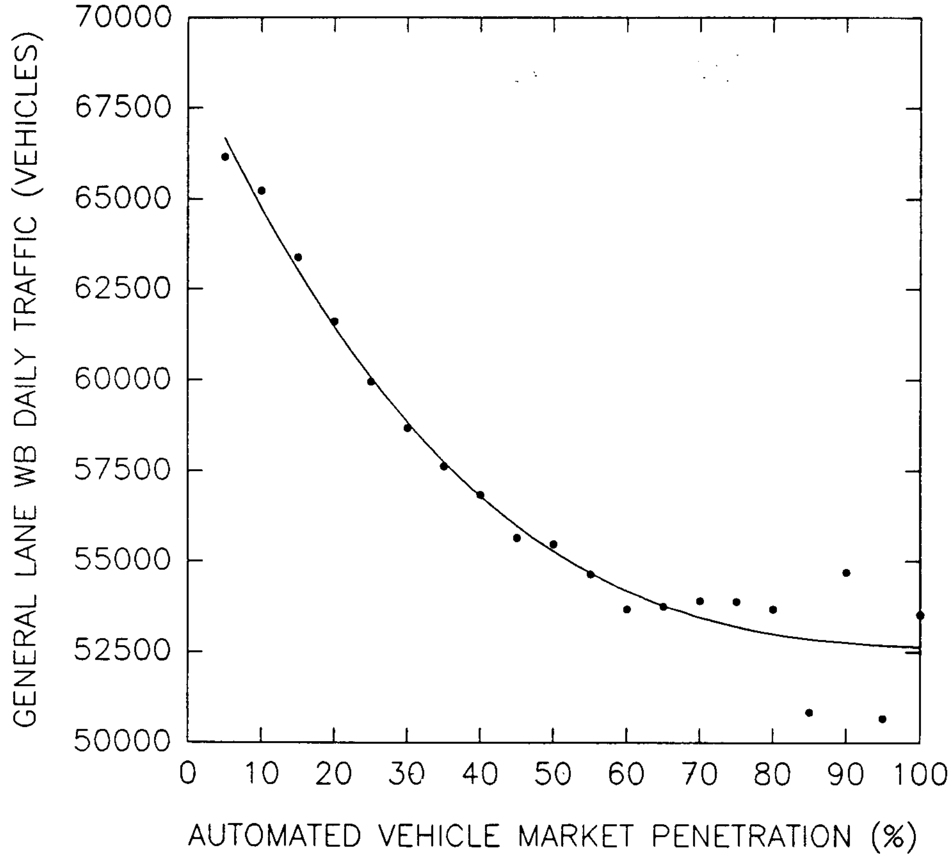


Figure 2-38. Market Penetration Influence on LIE General Lanes WB

Figures 2-39 and 2-40 illustrate the influence of MP on average daily traffic volumes on Northern State Parkway for the eastbound and westbound flow respectively. The average daily volume on the eastbound Northern State Parkway decreases for up to 25 percent MP and levels off then rises at approximately 65 percent MP. The average daily volume on the westbound Northern State Parkway decreases up to 35 percent then it rises slightly beyond 50 percent MP. At the lower MPs the increase in capacity resulting from the AHS lane draws AHS equipped vehicles that would have used Northern State Parkway up to the point where the increased MP results in additional utilization of the LIE AHS lane. It may also mean that trips formerly made on the Northern State Parkway may have relocated to the LIE general use lanes because of available capacity and faster travel times.

Figures 2-41 and 2-42 illustrate the influence of MP on average daily traffic volumes on Southern State Parkway for both eastbound and westbound respectively. The average daily volume on the Southern State Parkway decreases for up to 25 percent MP, then levels off, and rises at approximately 65 percent MP. The added capacity provided in the vicinity of the LIE attracts some of the Southern State Parkway trips until the LIE AHS lane becomes saturated.

Figures 2-43 and 2-44 illustrate the influence of MP on average daily traffic volume on Sunrise Highway for both eastbound and westbound respectively. The average daily volumes on Sunrise Highway decrease until approximately 40 to 50 percent of MP is reached. The added capacity created in the north Long Island region by the AHS lane on the LIE influences route choice so that Sunrise Highway trips in the south Long Island region are probably directed to parallel roadways closer to the LIE.

In reviewing the results of the MP study with respect to parallel facilities (Northern State parkway, Southern State Parkway, and Sunrise Highway) at varying distances away from the LIE the following general observations can be made:

- At low MP (less than 40 percent) there is a significant shift from parallel facilities. A 7.5 percent decrease occurs on the Northern State Parkway, a 5.0 percent decrease on the Southern State Parkway and a 10 percent decrease on Sunrise Highway.
- After a MP of 40 to 50 percent is reached, the draw from the parallel facilities decreases. This decrease results from the increased saturation of the AHS and general use freeway lanes, and in travel time increases on the north-south roadways which access these facilities.
- At lower MP there is a considerable amount of shifting as AHS equipped vehicles that currently use the Northern State Parkway or other parallel facilities are attracted to the LIE AHS facility. Non-AHS equipped vehicles find the two remaining general use lanes of the LIE congested because of the decrease in capacity, since one general use lane has been replaced by an AHS lane. Non-AHS equipped vehicles shift from the LIE to the Northern State Parkway and other parallel facilities to utilize the capacity made available by the diversion of the AHS equipped vehicles to the LIE AHS.

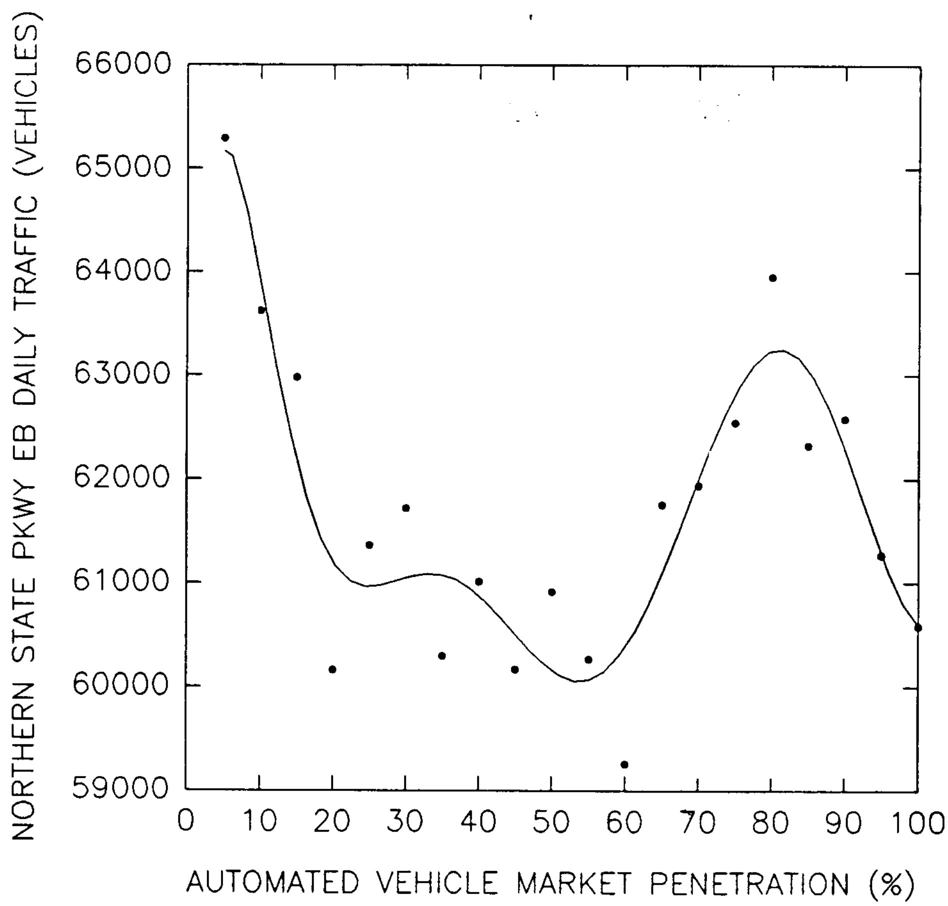


Figure 2-39. Market Penetration Influence on Northern State Parkway EB

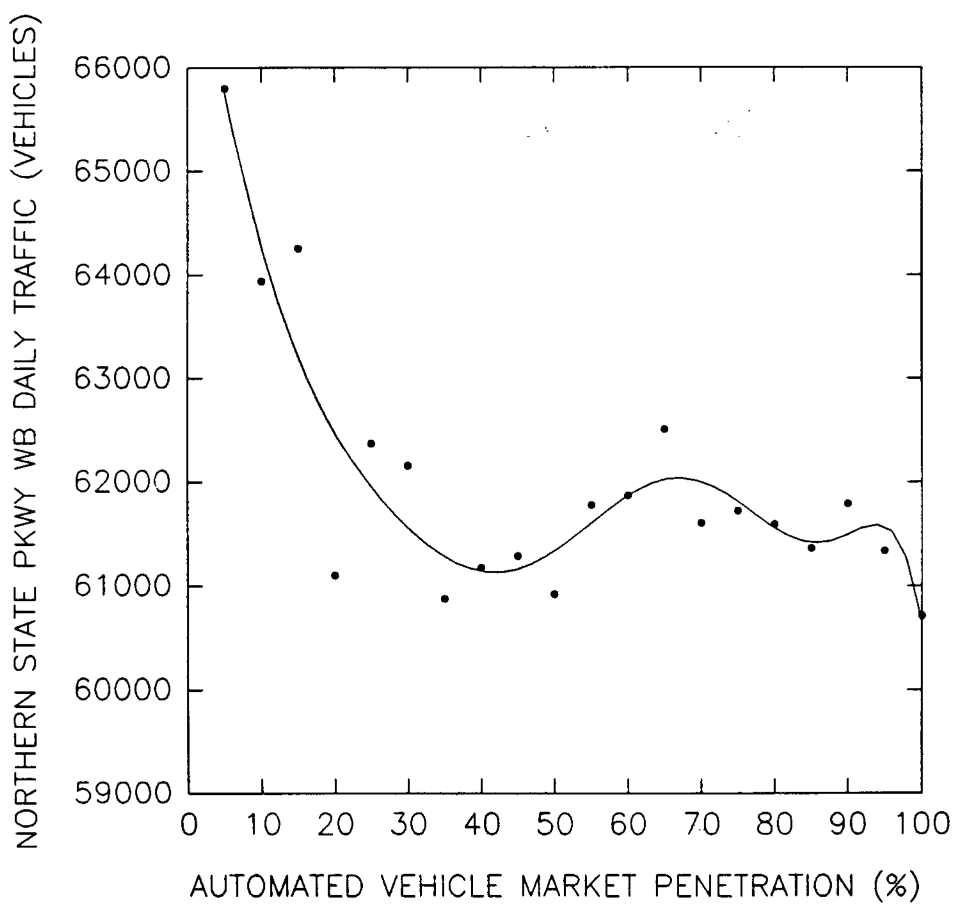


Figure 2–40. Market Penetration Influence on Northern State Parkway WB

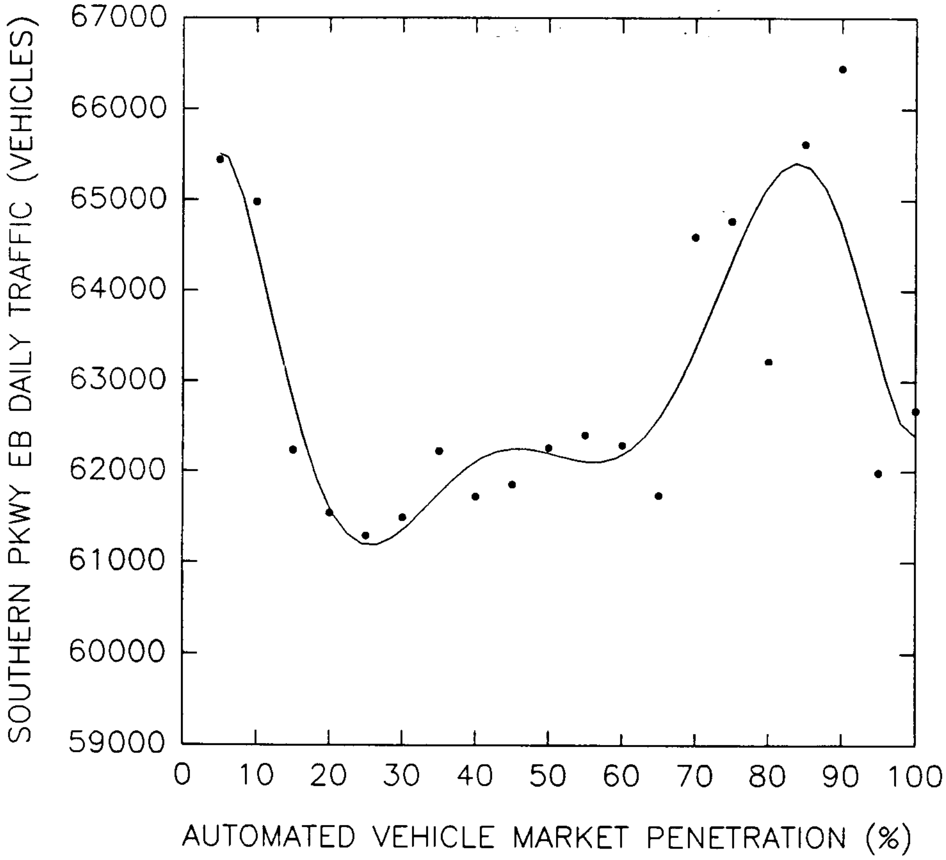


Figure 2-41. Market Penetration Influence on Southern Parkway EB

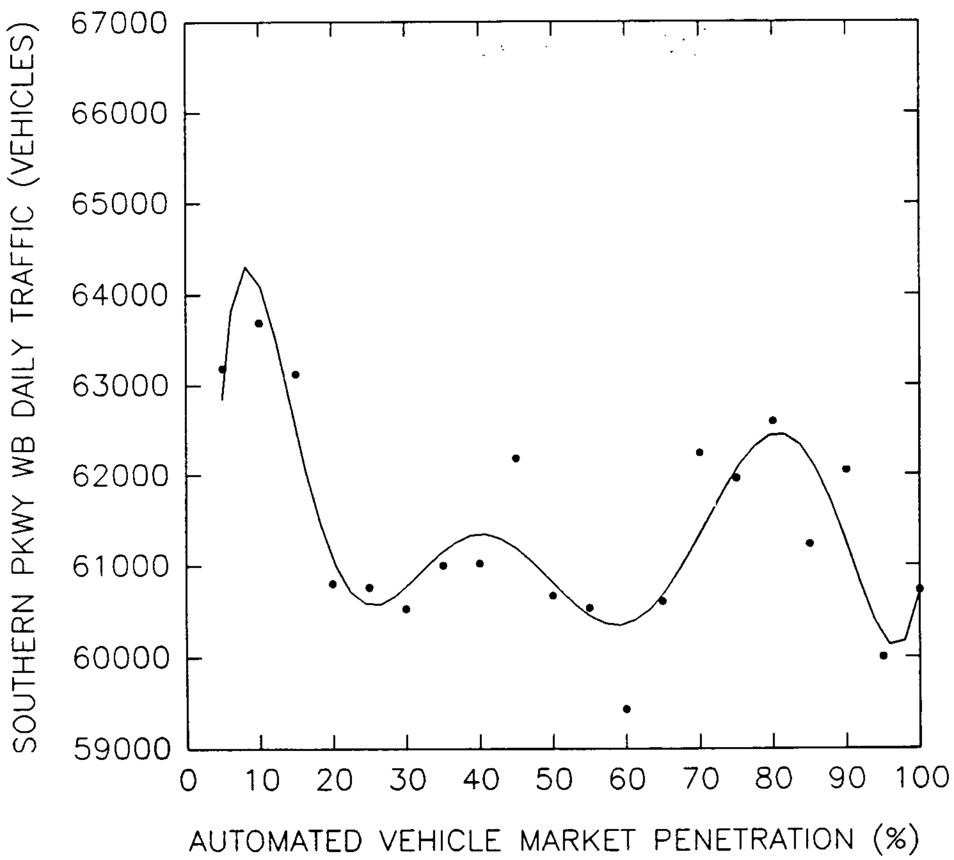


Figure 2-42. Market Penetration Influence on Southern Parkway WB

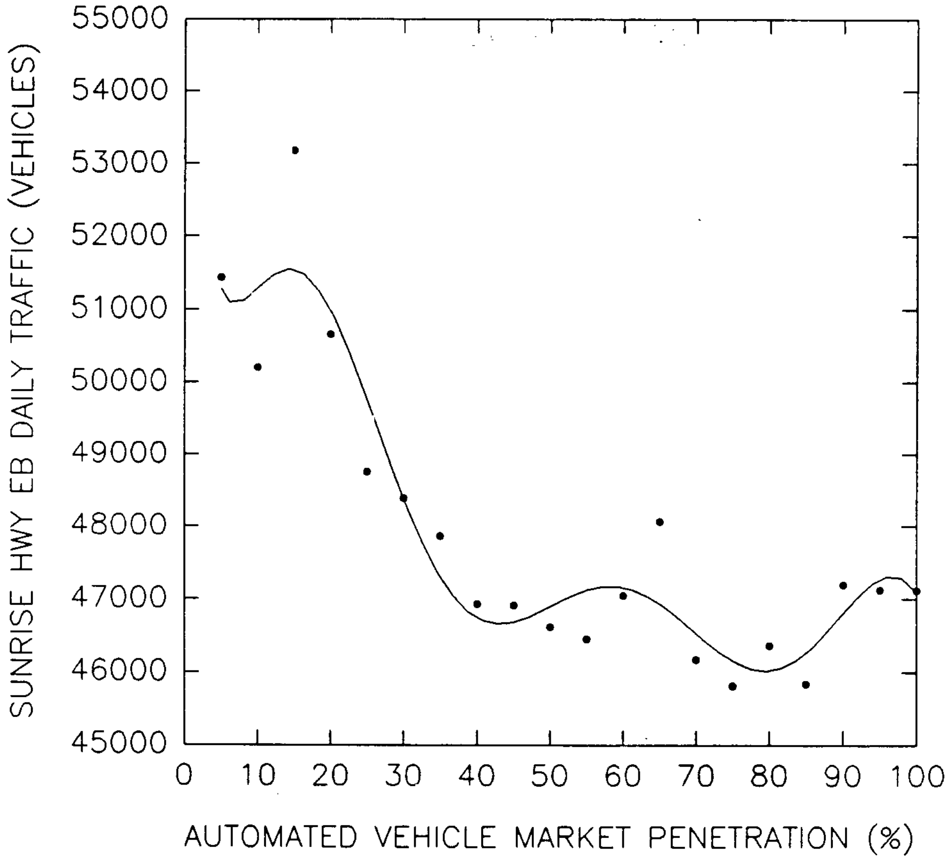


Figure 2–43. Market Penetration Influence on Sunrise Highway EB

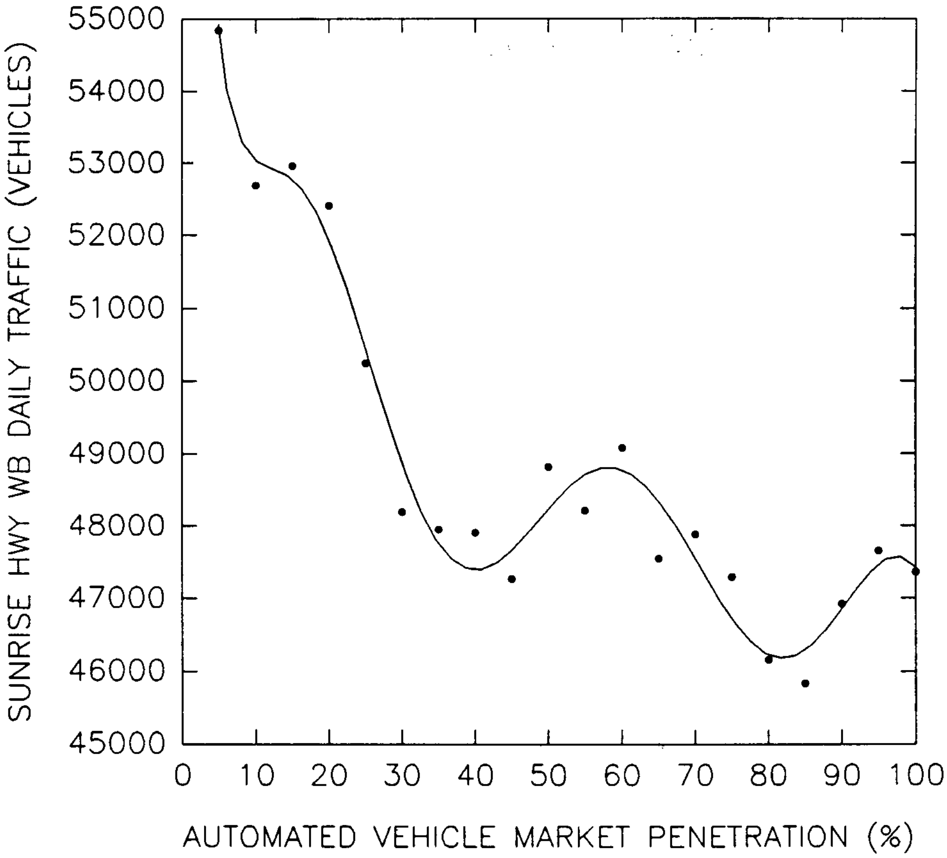


Figure 2-44. Market Penetration Influence on Sunrise Highway WB

3.3.3 Effect of AHS on Vehicle Miles Traveled

Analyses of the vehicle-miles traveled (VMT) were conducted for the Long Island study area. The general lanes VMT versus MP and the AHS lane VMT versus MP are illustrated on Figure 2-45. It is observed that as the MP increases the VMT for the AHS lane increase and level off at approximately 50 percent MP, and the VMT on the general lanes decrease continually, leveling off at over 80 percent MP. This result indicates that although the AHS lane attains saturation at approximately 50 percent MP, it continues to draw traffic from the general use lane and less traffic from the more distant roadways as MP increases. This is because as MP increases there is less diversion between roadways. The results relating VMT on the LIE and the entire Long Island corridor is illustrated in Table 2-14 and Figure 2-46.

3.3.4 Effect of Variations in Highway Configuration on Vehicle Miles Traveled

The TRANPLAN model was employed to assess the effects of LIE configurations, including various AHS configurations on the VMT in the area. Table 2-15 presents the results using baseline year 2015 volumes. The LIE Four Lane case was compared with the existing (three lane) Expressway. It was also compared with a predominantly I2 AHS (termed I2 in the table) and an AHS using a combination of I2 and I3 entry/exit (termed I3 in the table). The AHS capacity of the I3 configuration was also varied. The results show that:

- As the type of facility improves, modest decreases in VMT are obtained.
- VMT improvements are made for AHS capacity increases up to 7000 vehicles/hr but no VMT improvements are made past this point.

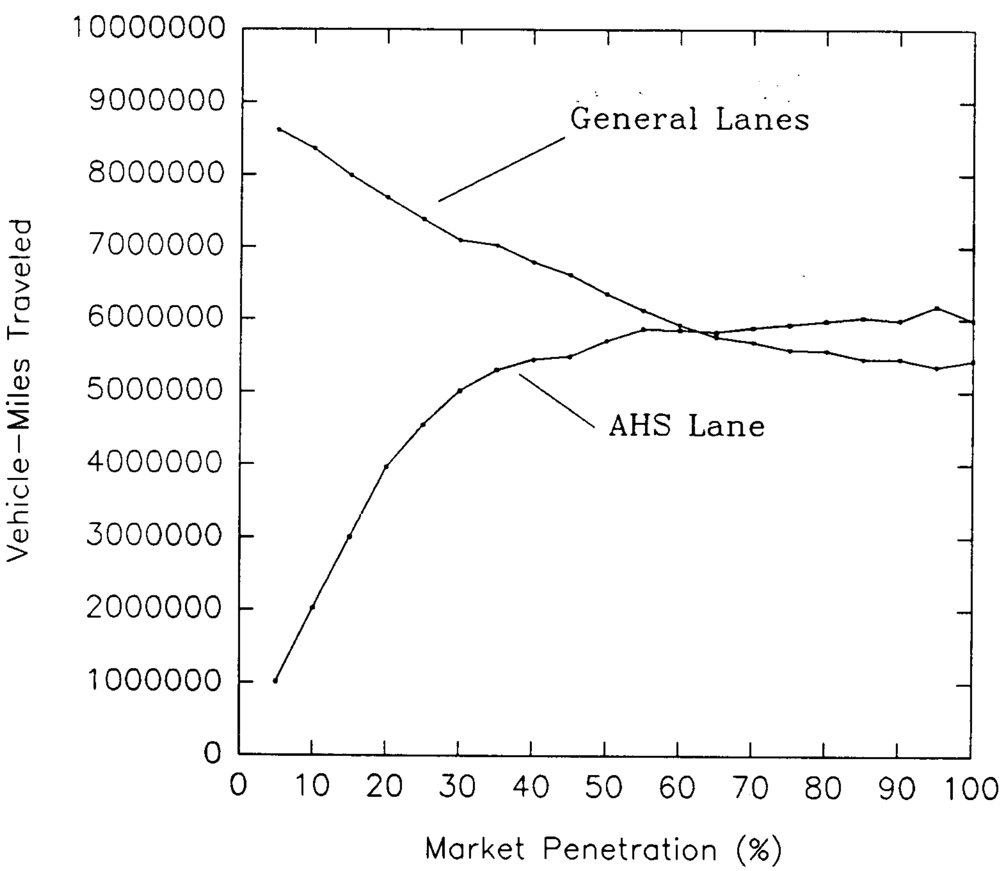


Figure 2-45. Total Vehicle-Miles Traveled on the LIE at Different Market Penetrations

Table 2-14.
RSC I3 AHS Facility Operation Comparison at Different Percentage Market Penetrations

MOE	FACILITY	LANE TYPE	MARKET PENETRATION									
			5%	10%	15%	20%	25%	30%	35%	40%	45%	50%
VEHICLE MILES TRAVELED (VMT)	LONG ISLAND EXPRESSWAY	GENERAL LANES	8614757.0	8354251.0	7987117.0	7681580.0	7382611.0	7090705.0	7021284.0	6785054.0	6614695.0	6348017.0
		AHS LANE	1014248.0	2024819.0	3000601.0	3960994.0	4544913.0	5017342.0	5303653.0	5445408.0	5488901.0	5700712.0
		ALL THRU LANES	9629005.0	10379070.0	10987720.0	11642570.0	11927520.0	12108050.0	12324940.0	12230460.0	12103600.0	12048730.0
	TRANPLAN NETWORK	ALL ROADWAYS ON NETWORK	73762710.0	73474160.0	73272680.0	72992660.0	72706990.0	72390210.0	72053500.0	71896340.0	71571180.0	71506100.0

MOE	FACILITY	LANE TYPE	MARKET PENETRATION									
			55%	60%	65%	70%	75%	80%	85%	90%	95%	100%
VEHICLE MILES TRAVELED (VMT)	LONG ISLAND EXPRESSWAY	GENERAL LANES	6123382.0	5921039.0	5757879.0	5683839.0	5576950.0	5566421.0	5453169.0	5456013.0	5350178.0	5442828.0
		AHS LANE	5860725.0	5846001.0	5821514.0	5883530.0	5926413.0	5975107.0	6021939.0	5986562.0	6179107.0	5990557.0
		ALL THRU LANES	11984110.0	11767040.0	11579390.0	11567370.0	11503360.0	11541530.0	11475110.0	11442570.0	11529280.0	11433380.0
	TRANPLAN NETWORK	ALL ROADWAYS ON NETWORK	71255220.0	71136180.0	71001780.0	70852450.0	70810230.0	70728040.0	70714250.0	70635800.0	70646500.0	70854940.0

NOTE:

VMT is based on the TRANPLAN model of the LIE from Clearview Expressway to William Floyd Parkway and its environs

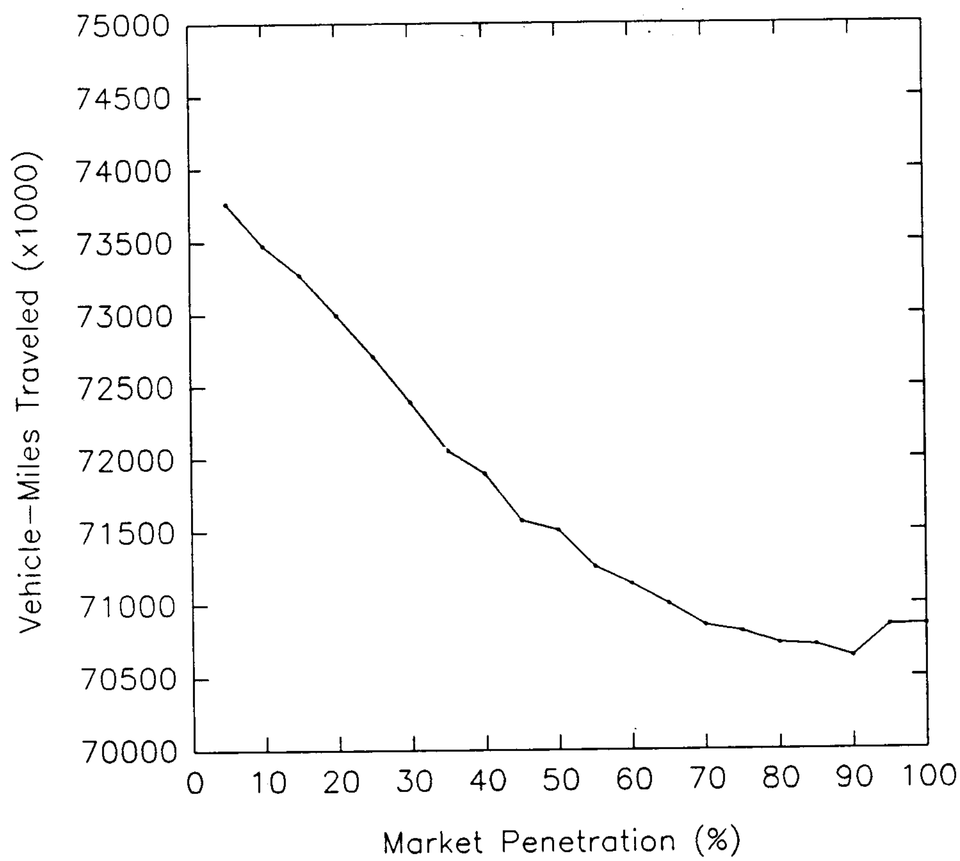


Figure 2–46. Total Vehicle–Miles Traveled on Network

Table 2-15.
LIE Facilities Performance Comparison

MOE	FACILITY	LANE TYPE	SCENARIO						
			LIE THREE LANES	LIE FOUR LANES	I2 AHS CAPACITY 4500	I3 AHS CAPACITY 4500	I3 AHS CAPACITY 7000	I3 AHS CAPACITY 10000	I3 AHS CAPACITY 12000
VEHICLE MILES TRAVELED (VMT)	LONG ISLAND EXPRESSWAY	GENERAL LANES	11162750.0	12874040.0	5366991.0	5442828.0	4195436.0	3705856.0	3699800.0
		AHS LANE	0.0	0.0	6029854.0	5990557.0	8409843.0	10262230.0	10475880.0
		ALL THRU LANES	11162750.0	12874040.0	11396840.0	11433380.0	12605280.0	13968080.0	141756680.0
	TRANPLAN NETWORK	ALL ROADWAYS ON NETWORK	73909980.0	73258260.0	70934780.0	70854940.0	69988360.0	69833860.0	69829250.0

NOTE:

VMT is based on the TRANPLAN model of the LIE from Clearview Expressway to William Floyd Parkway and its environs

3.3.5 Modeling Limitations

The TRANPLAN modeling analysis conducted is limited by the capabilities of the model and the assumptions made to simulate AHS operations. The following is a list of the modeling constraints and suggestions for future analysis.

- The Long Island TRANPLAN model provides estimates based on a 24 hour period, and produces results that a specifically related to daily traffic flows. Therefore, more detailed peak hour analysis is not possible with this model.
- The MP of AHS equipped vehicles on Long Island's traffic distribution is assumed to be equally spread throughout the driver population in the TRANPLAN study. In reality MP may be affected by socioeconomic factors and proximity to the AHS facility. Future analyses should consider these factors when investigating MP.
- The TRANPLAN model cannot be adjusted to represent user costs for the AHS facility. A mechanism to investigate the impact of a user cost, if any, needs to be investigated in future analyses.

3.3.6 Conclusions

The TRANPLAN study shows the following:

- AHS utilization rises rapidly with MP. Approximately 50 percent of the utilization achieved with 100 percent MP is achieved with a MP of 20 percent and about 90 percent utilization is achieved with 40 percent MP.
- Modest reductions in VMT (approximately 4 percent) were obtained on an areawide basis at high levels of MP for the LIE AHS.
- A small additional improvement in VMT (approximately 1 percent) was observed as the capacity of the AHS was increased from 4500 vehicles/hr to 7000 vehicles/hr. Further capacity increases had little effect on VMT.

It is important for the reader to understand that these conclusions are qualified by the limitations of the study (Section 3.3.5). The most important limitation is that the Long Island TRANPLAN model represents daily traffic averages; it is not a peak hour model. Thus, the conclusions stated above should be investigated further by the use of a series of data bases which are representative of various times of the day.

3.4 GENERAL EFFECTS OF TRAFFIC ON NON AHS ROADWAYS

The scenario evaluations presented in Section 3.2 describe the impact of the AHS on traffic on the general freeway lanes sharing the AHS right-of-way based on the traffic assignment assumptions described. Some examples of the impact of AHS traffic on surface street intersections were also shown.

The AHS MP study in Section 3.3 describes the effect of changing the availability of AHS to the public on the utilization of roadways on an areawide basis using a model of Long Island as an example. This section describes the mechanisms and causal factors which are the basis for these effects.

Figure 2-47 shows a simple model of a freeway containing an AHS and two parallel arterials. The AHS starts at Node 9. Separate access ramps are shown for each roadway on the diagram; however, the principles are the same when the AHS is accessed from the general lanes. A downstream AHS exit is represented by Node 10 and its intersection with the surface street by Node 5. The corresponding general lane exit is represented by Node 4.

3.4.1 Traffic Assignment and Diversion

The following discussion describes the traffic assignment and diversion process. It is described in terms of one set of origin-destination (OD) pairs. The total assignment model results from the sum of each OD assignment. Since the travel times are functions of the entire assignment, the process is iterative.

Consider traffic traveling along the lower arterial between Nodes 1 and 6. The introduction of the AHS will induce a component of traffic to divert. The diversion level is determined by three factors:

- Time saved by using the AHS route.
- Additional dollar cost of using AHS from any toll.
- Fraction of equipped vehicles.

Prior to construction of the AHS the motorist had two route choices, the freeway or the arterial. Under normal circumstances Arterial 2 would be used for this journey by only a small number of motorists. The introduction of the AHS represents a third important choice. It would normally be expected that the AHS lane would provide the fastest travel time. Traffic diversion from the general freeway lanes will improve travel time on those lanes. Thus, both the AHS and general lanes will divert additional traffic from the surface street path. Three travel times are possible. They are as follows:

- TT16 - Surface street travel time.
- TT123456 - Use of general freeway lanes.
- TT129(10)56 - Use of AHS.

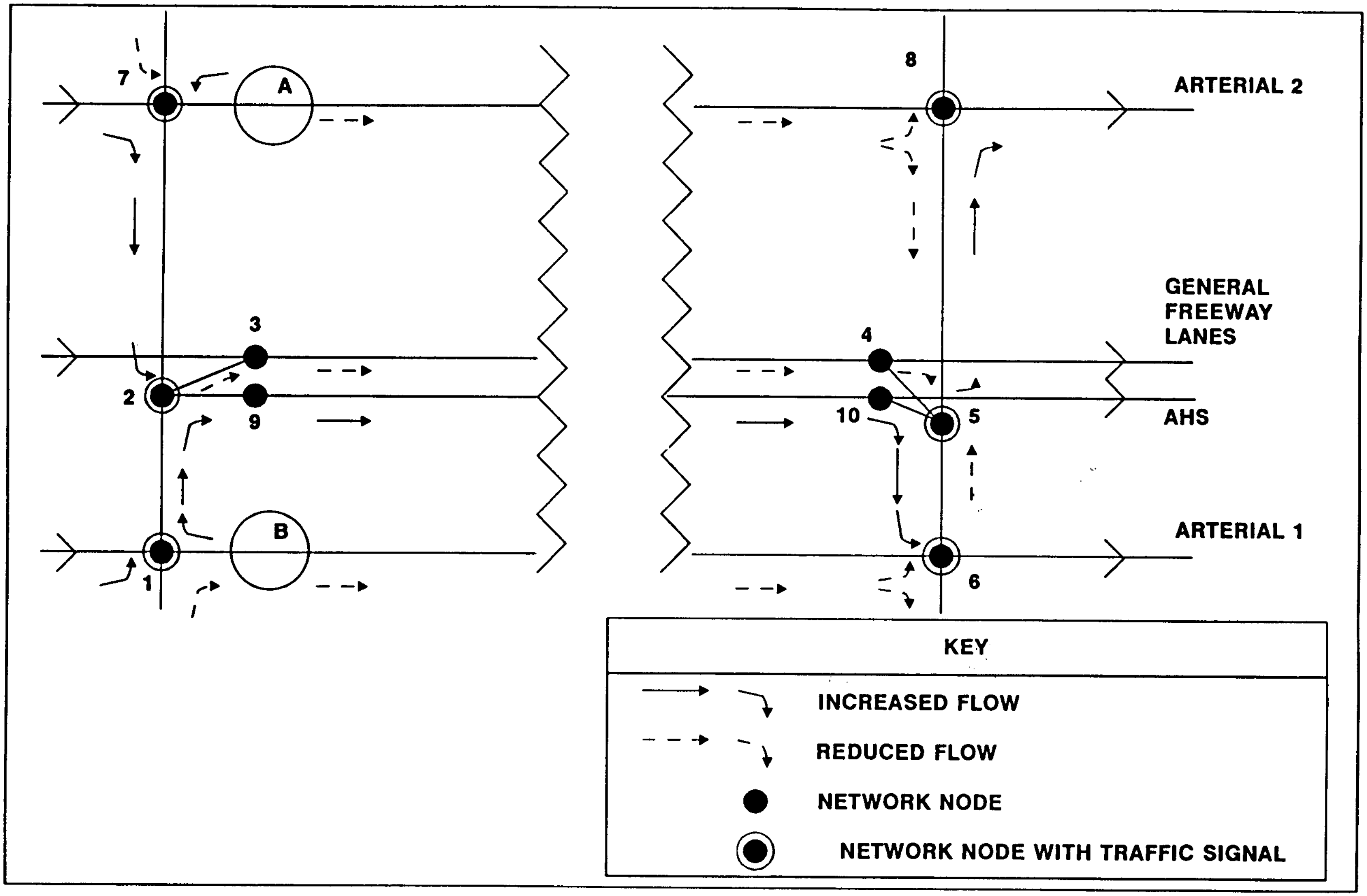


Figure 2-47.
Changes in surface Street and Freeway Traffic Patterns
Resulting From AHS Travel From Node 2 to Node 5

Since the AHS is to be constructed at some year well into the future, a trip generation estimate for this period is required. These trips must now be assigned to each of the three paths.

For AHS equipped vehicles the assignment is based on travel time and cost (tolls). Non-AHS equipped vehicles cannot be assigned to the AHS.

The multinomial logit model can be used to make such an assignment. The model is typically used in a disaggregate sense, i.e. a number of user demographic classes are defined, and assignments made separately for each class. For our purposes a utility function (Jessiman 1975) may be defined as follows:

$$U_{id} = K_{id} - K_{td} * TT_i - K_{cd} * C_i \qquad (2\text{-}1)$$

where:

i represents the trip path
i = 1 for the arterial
i = 2 for the freeway general lanes
i = 3 for the AHS

d represents the demographic attribute.
K_{id} is a coefficient for demographic attribute d for path I.
K_{td} is a coefficient representing the value of time for attribute d for path I.
K_{cd} is a coefficient representing the value of dollar cost for attribute d.
TT_i is the travel time for path i.
C_i is the cost for path i. C_i is zero for the surface streets and on-toll freeways.

If 100 percent of the vehicles are AHS equipped, the conventional multinomial logit model in Equation 2-2 identifies the probability P_{id} for each route class:

$$P_{id} = \frac{e^{U_{id}}}{\sum_{i=1}^{3} e^{U_{id}}} \qquad (2\text{-}2)$$

To account for fractional AHS MP, Equation 2-2 can be rewritten as follows:

$$P_{id} = \frac{f_{id} e^{U_{id}}}{\sum_{i=1}^{3} f_{id} e^{U_{id}}} \qquad (2\text{-}3)$$

where f_{1d} and f_{2d} are unity (all motorists have access to the freeway and surface streets), and f_{3d} represents the AHS MP for each demographic attribute. The volumes are obtained as the product of the probability and the number of motorists in each demographic class desiring to make the trip. Calibration of the coefficients is often performed by user surveys and regression analysis.

Note that the formulation of Equation 2-3 is different from the usual way in which MP is treated in AHS studies. It expresses the AHS penetration in terms of demographic attributes, and this is necessary for assignments which use the disaggregate modeling process.

3.4.2 Effect of AHS on Flow Patterns

Although the net result of the AHS is to reduce traffic along the arterials, as compared with the no build case, the routes and movements involving access to AHS/freeway combination will experience increased traffic. The solid arrows in Figure 2-47 show these increased traffic levels, and the dotted lines show reduced volumes for vehicles formerly taking the arterials and now choosing a freeway or AHS path from node 2 to node 5.

Note that certain areas such as A and B may show an increase in reverse traffic on portions of the arterial due to the attraction of the AHS/freeway to arterial traffic downstream of the access point. The diagram shows changes to many of the arterial flows and turning movements, and signal retiming will be required to accommodate these. Additional traffic engineering measures (e.g. right turn signal by-passes, double left hand turn lanes, will be required on a localized basis). The ability of surface street intersections such as Nodes 2 and 5 to accommodate additional traffic generated by the AHS depends on the volume of such traffic and on the capacity of the intersections.

3.5 GEOMETRIC STUDIES

The AHS design of Section 3.3 using two general lanes and one AHS lane was utilized to develop cross-sections and layouts for an RSC I2 and an RSC I3 infrastructure for the westbound segment of the LIE between Cross Island Parkway and Washington Avenue. The figures in Appendices F, G, and H illustrate the AHS design as applied to the LIE.

Appendix F, illustrates the cross-sections developed for the RSCs I2 and I3 options on the LIE. Construction and rights of way requirements are indicated on the diagrams. Retaining walls are required because of the location of the service roads.

Appendix G, illustrates the layout of ingress/egress of the RSCs I2 and I3. The I2 option utilizes the general lanes as collector/distributors. The I3 option utilizes the service roads and the general lanes as collector/distributors. A variety of similar options are indicated for the RSC I3 option. The selection of a particular I3 ingress/egress location, because of its complexity and impact on the overall operations, should only be made after extensive planning studies.

Appendix H, illustrates the layout of both RSCs I2 and I3 on the westbound segment of the LIE between Cross Island Parkway and Washington Avenue. These diagrams indicate the construction requirements requires for both RSCs I2 and I3. The layouts of RSC I2 and RSC I3 indicate that much more bridge reconstruction and pavement relocation is required for RSC I3.

4.0 CONCLUSIONS

The following can be concluded from these tasks:

- AHS deployments using RSCs I2 and I3 on congested urban and suburban freeways can significantly improve speed and travel time on these facilities. Travel time improvements ranging from approximately 19 percent to 38 percent were obtained for the cases studied. This is illustrated in Table 2-1, Section 1.3.2.
- AHS deployments using RSCs I2 and I3 on congested urban and suburban freeways may significantly increase facility capacity to respond to future year demand (Table 2-1 Section 1.3.2). Depending on the origin and destination requirements, the capacity of the remaining general lanes rather than the AHS lanes may limit capacity.
- In areas which experience traffic congestion such as Long Island, high levels of AHS utilization are obtained based on RSCs I2 and I3 type facilities at relatively low levels of AHS MP (15-25 percent). In congestion prone areas the AHS may generate significant changes in the utilization of parallel facilities which may be several miles away from the AHS.
- The need to access the AHS will, in many cases, cause saturation of surface street intersections. Geometric improvements and signal timing changes will be commonly required. The cost of the geometric improvements may be significant.
- Certain AHS control strategies call for queuing vehicles at AHS entry points (auxiliary lanes in the I2 configuration and ramps in the I3 configuration). When AHS traffic is properly managed, the queue delays and queue lengths are short.

Appendix A

Additional Details for LIE Case Study

This Appendix is a compilation of the roadway performance for the LIE scenarios. The LIE roadway is represented by links and nodes as illustrated in Figures 2-A1, 2-A2, and 2-A3. Figure 2-A1 illustrates the existing roadway and the four lane LIE, Figure 2-A2 illustrates the roadway with one AHS lane and I2 ramps, and Figure 2-A3 illustrates the roadway with one AHS lane and a combination of I2 and I3 ramps.

Tables 2-A1, 2-A2, and 2-A3 provide the INTEGRATION model output for the through traffic for the four lane LIE, the I2 scenario with two general use lanes, and the I2 scenario with three general use lanes, respectively. The integration model outputs for Tables 2-A1, 2-A2, and 2-A3 were generated using 2015 I2 scenario OD trip tables. Table 2-A4 provides the INTEGRATION model output for a combination I3 and I2 scenario. Tables 2-A4 was generated using 2015 I3 scenario OD trip tables.

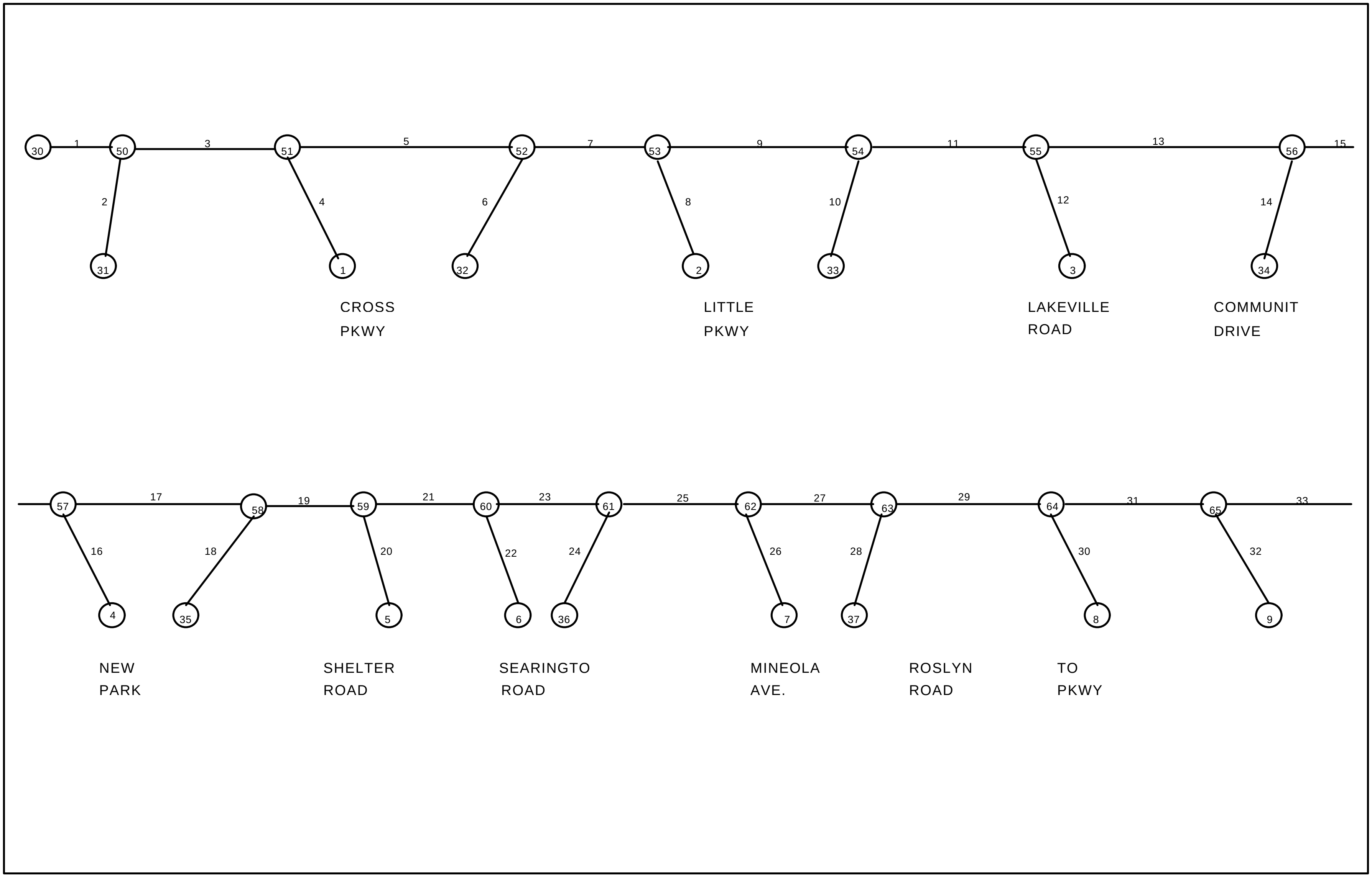


Figure 2-A1. LIE Existing Three Lane or Four Lane Link Node Diagram (sheet

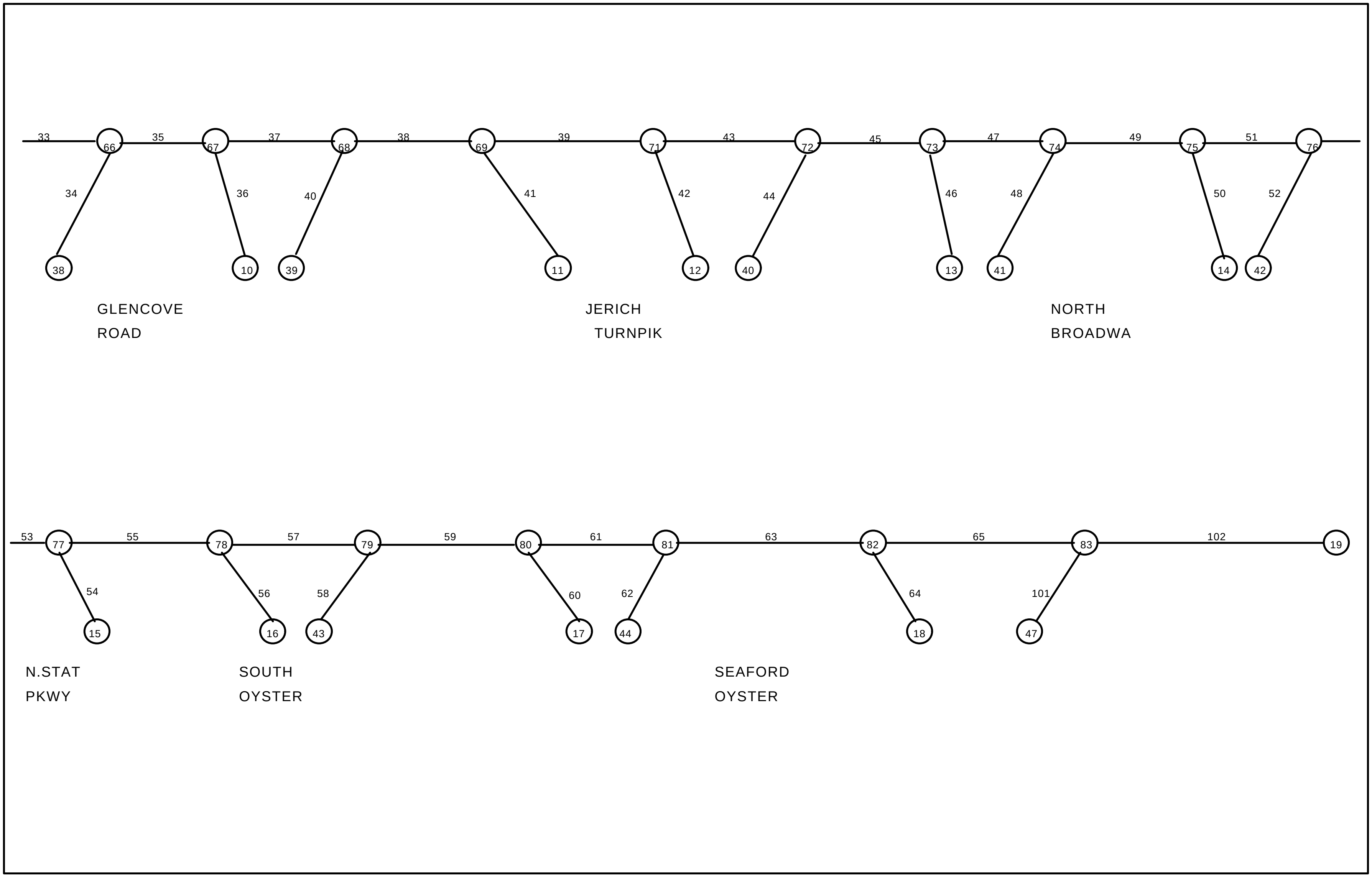


Figure 2-A1. LIE Existing Three Lane or Four Lane Link Node Diagram (sheet

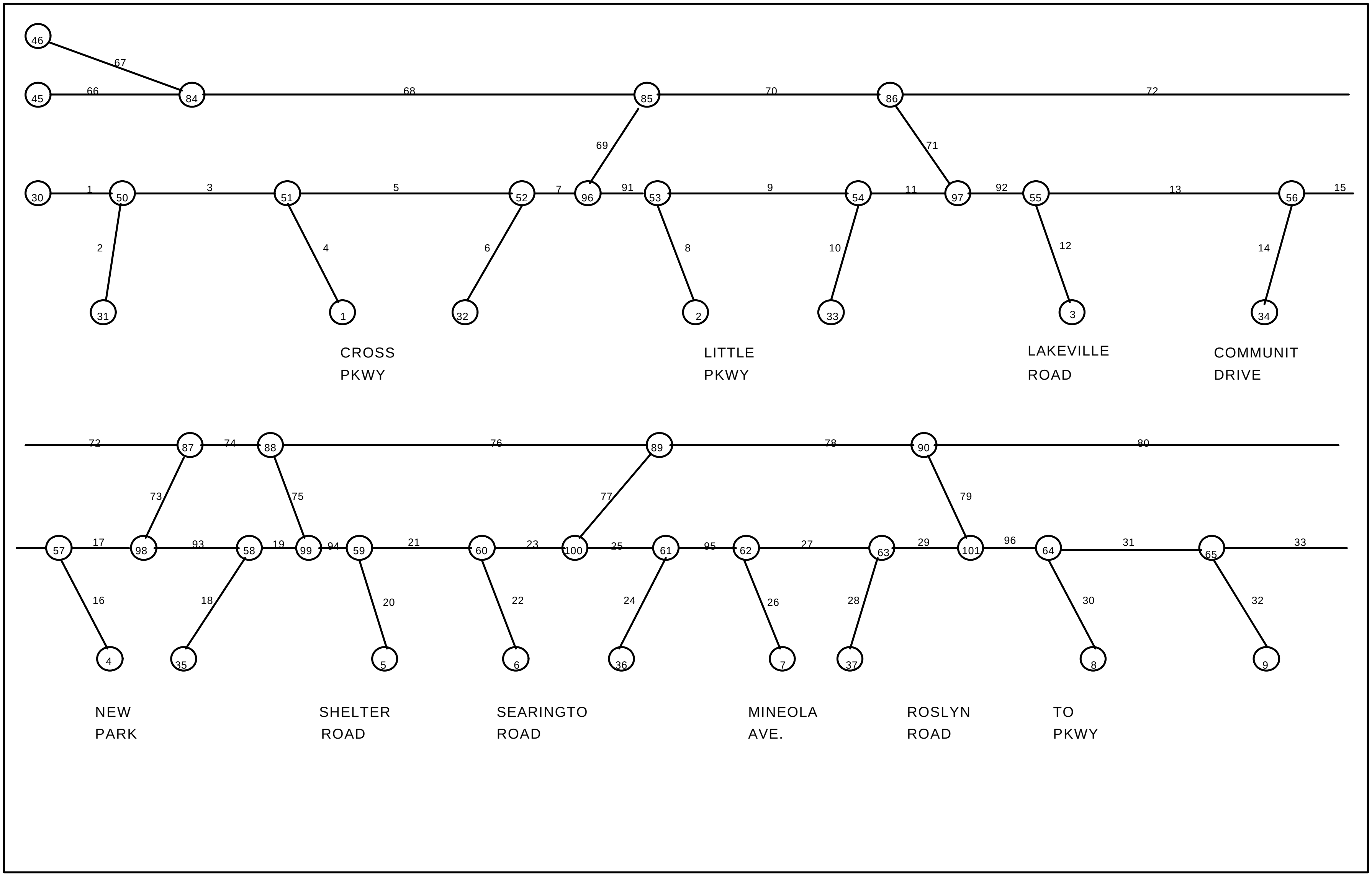


Figure 2-A2. LIE I2 Link Node Diagram (sheet 1

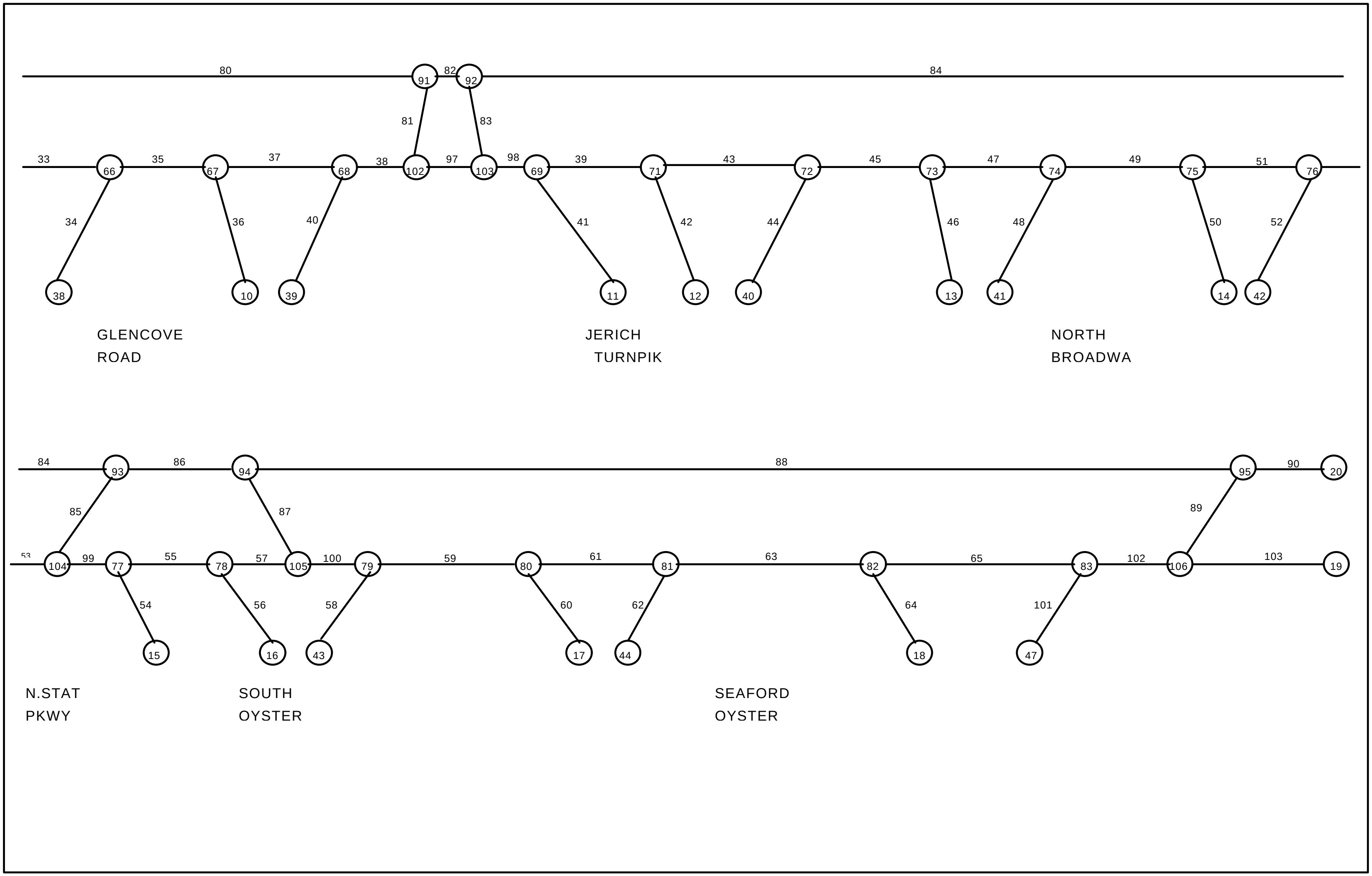


Figure 2-A2. LIE I2 Link Node Diagram (sheet 2

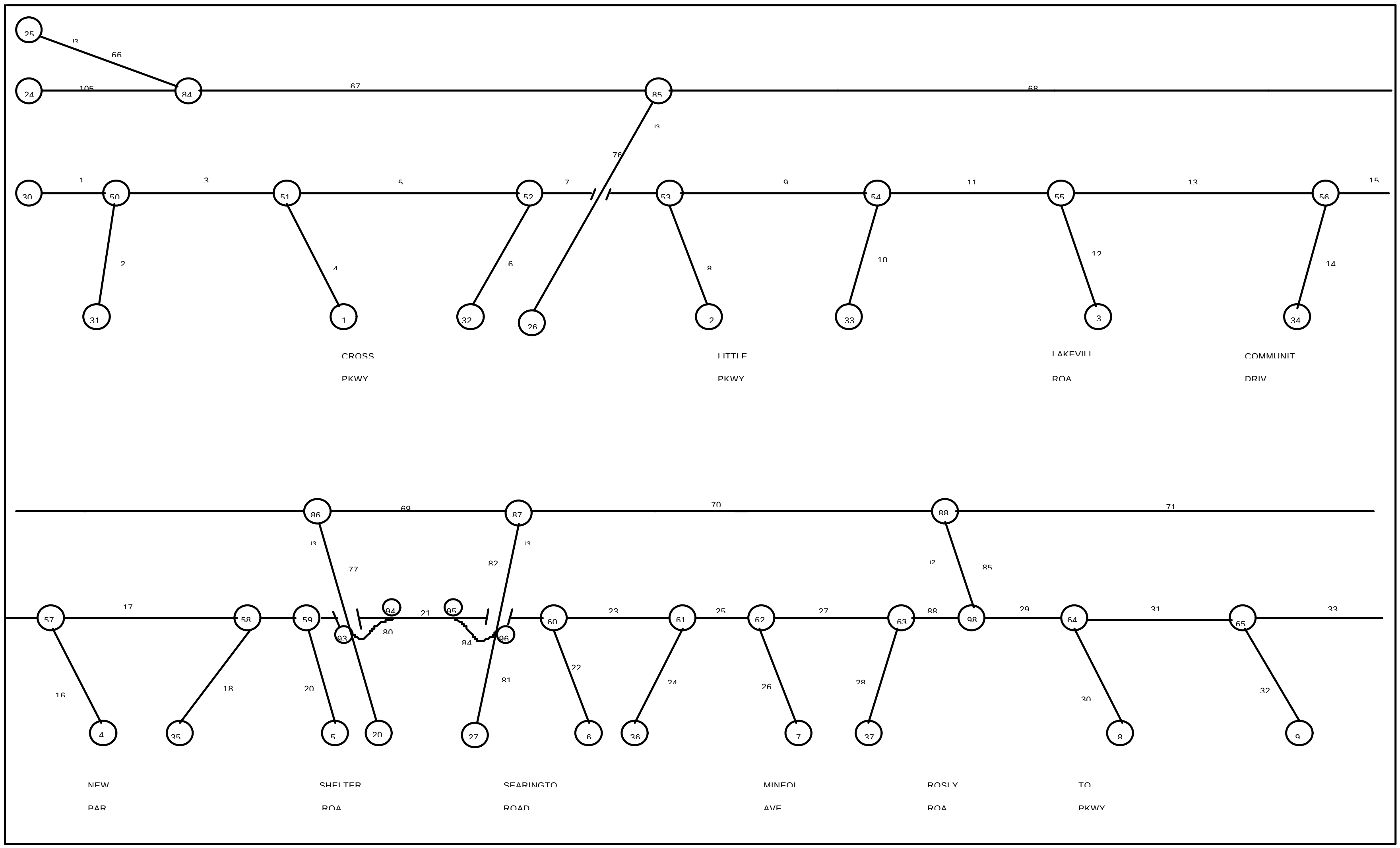


Figure 2-A3. LIE (I-495) Link Node Diagram for Combination of I2 and I3 (Sheet 1 of 2)

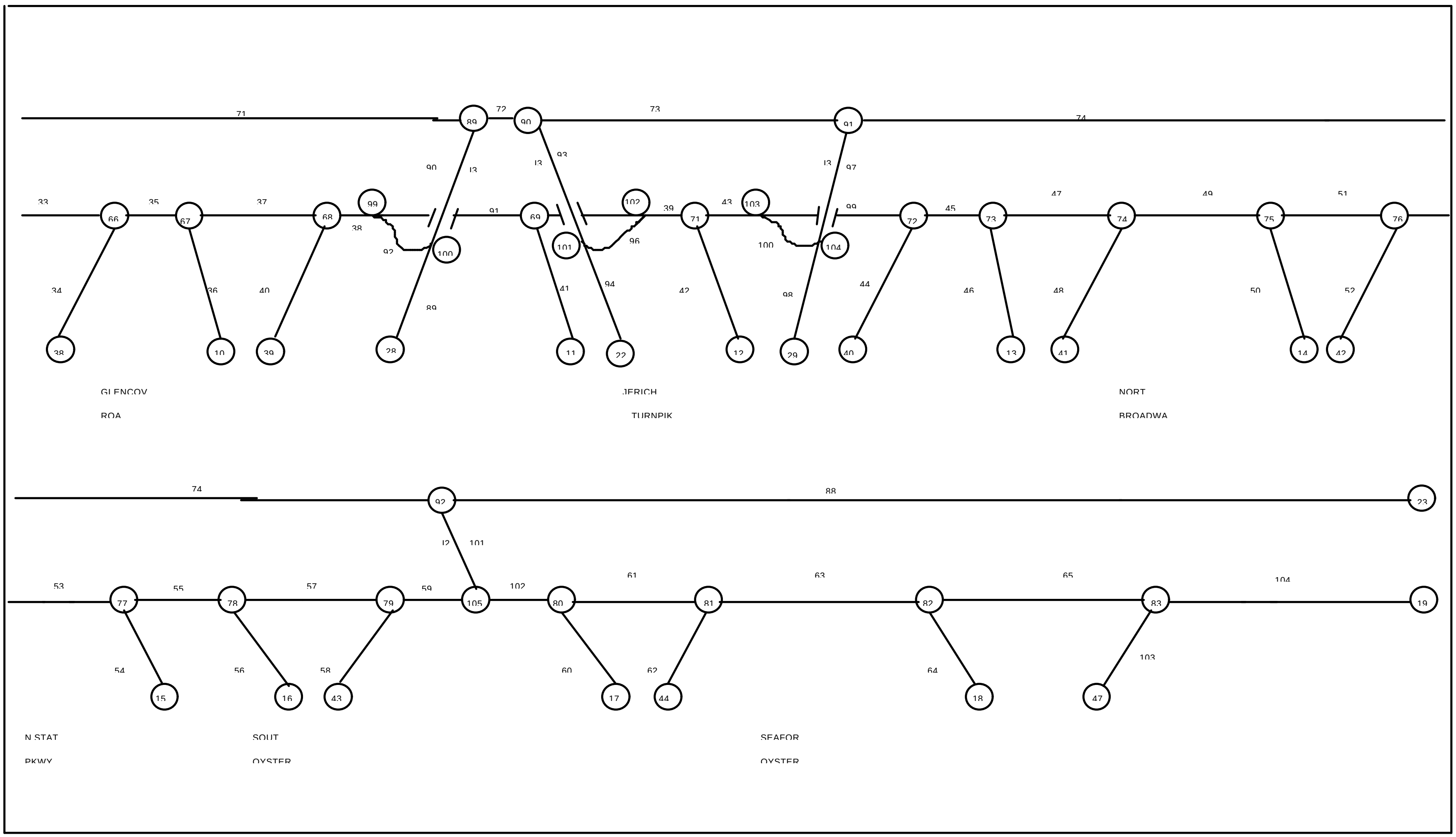


Figure 2-A3. LIE (I-495) Link Node Diagram for Combination of I2 and I3 (Sheet 2 of 2)

Table 2-A1. Long Island Expressway Four Lanes Integration Run Results (100%)

LINK (##)	Length (km)	Flow (vehs)	Total (min)	Free Flow (min)	Avg Flow (min)	Speed (kph)	Veh-Km
1	0.50	6401	12750	0.3	2.0	15.1	3200.5
3	0.19	7769	2876	0.1	0.4	30.5	1476.11
5	0.26	6654	2439	0.2	0.4	42.9	1730.04
7	1.31	7590	14465	0.9	1.9	41.2	9942.9
9	0.64	7086	8968	0.4	1.3	30.2	4535.04
11	1.10	7640	13992	0.7	1.8	36.0	8404
13	0.87	6836	11725	0.6	1.7	30.3	5947.32
15	0.50	7783	6169	0.3	0.8	37.7	3891.5
17	0.56	6871	3502	0.4	0.5	65.4	3847.76
19	1.45	7803	11691	1.0	1.5	58.2	11314.35
21	0.86	6988	6216	0.6	0.9	58.2	6009.68
23	0.62	6607	5911	0.4	0.9	41.3	4096.34
25	0.81	7334	9222	0.5	1.3	38.6	5940.54
27	0.43	6315	2321	0.3	0.4	70.2	2715.45
29	1.48	7099	10237	1.0	1.4	61.5	10506.52
31	0.28	6105	1429	0.2	0.2	71.3	1709.4
33	0.14	5632	613	0.1	0.1	74.5	788.48
35	0.17	5767	783	0.1	0.1	75.1	980.39
37	0.20	5672	897	0.1	0.2	75.9	1134.4
38	2.89	5547	12588	1.9	2.3	76.4	16030.83
39	2.87	5333	11971	1.9	2.2	76.7	15305.71
43	0.57	4860	2131	0.4	0.4	78.0	2770.2
45	1.03	5425	4423	0.7	0.8	75.8	5587.75
47	0.16	5082	628	0.1	0.1	76.3	813.12
49	0.24	5436	1055	0.2	0.2	75.5	1304.64
51	0.20	5142	805	0.1	0.2	76.7	1028.4
53	0.65	5696	3018	0.4	0.5	74.2	3702.4
55	1.70	4946	6471	1.1	1.3	77.7	8408.2
57	0.55	4829	2033	0.4	0.4	78.7	2655.95
59	0.66	5449	2857	0.4	0.5	75.5	3596.34
61	0.23	4876	853	0.2	0.2	77.8	1121.48
63	0.18	5213	758	0.1	0.1	76.0	938.34
65	0.22	4946	857	0.2	0.2	77.9	1088.12
104	1.61	5431	6882	1.1	1.3	76.0	8743.91
Sum			183536				161266.11
Total Veh-Mi		**100165.29**					
Total Veh-Hr3		**058.93**					

Note: This table is based on integration model run.

Table 2-A2. LIE AHS I2 With Two General Lanes Integration Run Results (100%)

General Use Lanes

Length (km)	Flow (vehs)	Total flow (min)	Speed (kph)	Veh-Km
0.50	3075	6804	13.6	1537.5
0.19	3719	1583	26.5	706.6
0.26	2867	2680	16.8	745.4
0.60	4209	3683	41.1	2525.4
0.64	2793	2715	39.3	1787.5
0.28	3470	1721	33.9	971.6
0.87	3010	6912	22.6	2618.7
0.50	4041	2947	41.0	2020.5
0.10	3202	319	60.2	320.2
0.96	3320	4142	46.4	3187.2
0.86	3046	4663	33.8	2619.6
0.31	2888	1898	28.1	895.3
0.31	2494	2039	22.6	773.1
0.43	2532	3333	19.6	1088.8
0.88	2712	7145	20.0	2386.6
0.28	3002	686	72.9	840.6
0.14	2486	259	77.9	348.0
0.17	2618	341	78.2	445.1
0.20	2440	372	78.7	488.0
0.60	3148	1524	74.4	1888.8
2.87	2376	5125	79.8	6819.1
0.57	1855	774	82.0	1057.4
1.03	2645	2114	77.3	2724.4
0.16	2318	279	78.2	370.9
0.24	2721	523	76.2	653.0
0.20	2402	372	77.4	480.4
0.59	3204	1565	72.5	1890.4
1.70	2203	2770	80.9	3745.1
0.25	2149	397	81.2	537.3
0.66	2880	1508	75.7	1900.8
0.23	2230	380	79.9	512.9
0.18	2593	373	76.8	466.7
0.22	2430	440	74.6	534.6
0.71	3072	1870	70.0	2181.1
0.82	3614	5181	34.3	2963.5
0.46	2810	1274	60.3	1292.6
0.49	3357	2572	38.4	1644.9
0.81	3376	5476	30.1	2734.6
0.60	3910	3307	42.6	2346.0
1.68	2399	3029	79.8	4030.3
0.60	2734	1274	77.3	1640.4
0.06	2484	116	77.4	149.0
0.30	2409	551	78.8	722.7
0.60	3638	2007	65.3	2182.8
1.00	2594	2002	78.1	2594.0
Sum		101045		74369.3

AHS Lane

LINK (##)	Length (km)	Flow (vehs)	Total flow (min)	Speed (kph)	Veh-Km
66	0.75	1976	954	93.2	1482.0
68	1.55	3300	3341	91.9	5115.0
69	0.75	1040	749	62.4	780.0
70	0.4	4324	1177	88.2	1729.6
71	0.48	271	109	71.8	130.1
72	3.5	3896	9094	90.0	13636.0
73	0.75	281	160	78.9	210.8
74	0.2	4167	565	88.5	833.4
75	0.48	138	54	74.1	66.2
76	2.89	3893	7514	89.7	11250.8
77	0.75	326	189	77.5	244.5
78	1.2	4162	3484	86.3	4994.4
79	0.48	1271	1273	28.8	610.1
80	3.22	2749	5770	92.0	8851.8
81	0.75	678	440	69.3	508.5
82	0.45	3406	1018	90.3	1532.7
83	0.48	354	143	71.2	169.9
84	0.25	3041	503	90.8	760.3
85	0.75	712	457	70.1	534.0
86	0.78	3715	1940	89.6	2897.7
87	0.48	272	103	76.4	130.6
88	3.05	3295	6630	90.8	10049.8
89	0.75	997	705	63.6	747.8
90	0.25	4278	749	87.4	1069.5
			47121		68335.2

Total Veh-Mi ***88636.323***
Total Veh-Hr ***2469.4333***

Note: This table is based on integration model run.

Table 2-A3. LIE AHS I2 With Three General Lanes Integration Run Results (100%)

General Use Lanes

LINK (##)	Length (km)	Flow (vehs)	Total flow (min)	Speed (kph)	Veh-Km
1	0.5	4940	6480	22.9	2470.0
3	0.19	5569	2337	26.9	1058.1
5	0.26	4244	974	68.5	1103.4
7	0.6	5839	3395	61.9	3503.4
9	0.64	4451	2224	76.4	2848.6
11	0.28	5159	1228	70.6	1444.5
13	0.87	4512	3128	75.0	3925.4
15	0.5	5589	3160	52.8	2794.5
17	0.1	4516	396	68.4	451.6
19	0.96	4805	3810	72.9	4612.8
21	0.86	4649	3234	74.4	3998.1
23	0.31	4416	1075	75.9	1369.0
25	0.31	4030	962	77.4	1249.3
27	0.43	3956	1345	75.9	1701.1
29	0.88	4233	3609	61.9	3725.0
31	0.28	4366	1007	72.3	1222.5
33	0.14	3710	391	76.8	519.4
35	0.17	3840	504	77.8	652.8
37	0.2	3580	544	78.9	716.0
38	0.6	4269	2020	76.1	2561.4
39	2.87	3286	7012	80.7	9430.8
43	0.57	2618	1085	82.5	1492.3
45	1.03	3403	2629	80.0	3505.1
47	0.16	2957	346	80.4	473.1
49	0.24	3359	617	79.7	806.2
51	0.2	2908	430	81.2	581.6
53	0.59	3706	1661	79.0	2186.5
55	1.7	2689	3292	83.1	4571.3
57	0.25	2588	465	83.4	647.0
59	0.66	3264	1597	80.9	2154.2
61	0.23	2493	409	83.0	573.4
63	0.18	2857	388	81.3	514.3
65	0.22	2618	426	82.9	576.0
91	0.71	4719	2703	74.4	3350.5
92	0.82	5295	3722	70.0	4341.9
93	0.46	4191	1512	75.8	1927.9
94	0.49	4961	2039	71.5	2430.9
95	0.81	4997	3632	67.2	4047.6
96	0.6	5451	5009	39.2	3270.6
97	1.68	3518	4439	79.9	5910.2
98	0.6	3810	1751	78.3	2286.0
99	0.06	3049	136	80.4	182.9
100	0.3	2801	612	82.4	840.3
102	0.6	3830	1758	78.4	2298.0
103	1	2783	2029	82.7	2783.0
Sum			91522		103108.6

AHS Lane

LINK (##)	Length (km)	Flow (vehs)	Total flow (min)	Speed (kph)	Veh-Km
66	0.75	1976	954	93.2	1482.0
68	1.55	3300	3341	91.9	5115.0
69	0.75	1058	764	62.3	793.5
70	0.4	4343	1183	88.1	1737.2
71	0.48	196	74	75.9	94.1
72	3.5	3985	9338	89.6	13947.5
73	0.75	291	167	78.2	218.3
74	0.2	4265	582	88.0	853.0
75	0.48	190	80	68.4	91.2
76	2.89	3934	7622	89.4	11369.3
77	0.75	363	211	77.3	272.3
78	1.2	4230	3614	84.6	5076.0
79	0.48	1321	924	41.2	634.1
80	3.22	2789	5874	91.7	8980.6
81	0.75	663	429	69.6	497.3
82	0.45	3426	1024	90.3	1541.7
83	0.48	330	128	74.2	158.4
84	0.25	3082	510	90.7	770.5
85	0.75	649	407	71.8	486.8
86	0.78	3694	1931	89.6	2881.3
87	0.48	223	81	79.0	107.0
88	3.05	3313	6675	90.7	10104.7
89	0.75	998	710	63.3	748.5
90	0.25	4296	753	87.2	1074.0
Sum			47376		69034.0

Total Veh-Mi	***106920.86***
Total Veh-Hr	***2314.9667***

Note: This table is based on integration model run.

2-A11

Table 2-A4 Long Island Expressway AHS (Combination of I2 and I3) Integration Run Results (100%)

General Use Lanes

Length (km)	Flow (vehs)	Total flow (min)	Free flow (min)	Avg flow (min)	Speed (kph)	Veh-Km
0.5	2228	6172	0.3	2.8	10.8	1114
0.19	2926	1818	0.1	0.6	18.2	555.94
0.26	2189	2511	0.2	1.1	13.7	569.14
1.31	2953	9377	0.9	3.2	24.8	3868.43
0.64	2369	5483	0.4	2.3	16.5	1516.16
1.1	2916	8138	0.7	2.8	23.6	3207.6
0.87	2220	6967	0.6	3.1	16.6	1931.4
0.5	2956	4359	0.3	1.5	20.3	1478
0.56	2064	5164	0.4	2.5	13.3	1155.84
1.45	2983	11140	1.0	3.7	23.4	4325.35
0.5	3475	3684	0.3	1.1	28.3	1737.5
0.62	2439	4163	0.4	1.7	21.7	1512.18
0.81	3203	5955	0.5	1.9	26.1	2594.43
0.43	2571	3685	0.3	1.4	18	1105.53
1.07	3947	6509	0.7	1.6	38.9	4223.29
0.28	2878	652	0.2	0.2	73.6	805.84
0.14	2362	245	0.1	0.1	78.2	330.68
0.17	2445	315	0.1	0.1	79.1	415.65
0.2	2246	345	0.1	0.2	78.1	449.2
0.64	3666	2091	0.4	0.6	67.3	2346.24
2.11	2542	4088	1.4	1.6	78.7	5363.62
0.29	2092	449	0.2	0.2	81	606.68
1.03	2850	2315	0.7	0.8	76.1	2935.5
0.16	2269	274	0.1	0.1	78	363.04
0.24	2767	535	0.2	0.2	75.7	664.08
0.2	2269	347	0.1	0.2	78.5	453.8
0.65	3032	1614	0.4	0.5	73.8	1970.8
1.7	2667	3486	1.1	1.3	77.8	4533.9
0.55	1965	799	0.4	0.4	81.5	1080.75
0.66	2304	1179	0.4	0.5	77.4	1520.64
0.23	2571	478	0.2	0.2	73.3	591.33
0.18	2716	405	0.1	0.1	74.1	488.88
0.14	2315	239	0.1	0.1	78.3	324.1
0.13	2553	1319.	0.1	0.5	15.1	331.89
0.13	2966	0.13	0.1	0.3	28.4	385.58
0.41	3218	3455	0.3	1.1	22.9	1319.38
2.24	2114	3484	1.5	1.6	81.5	4735.36
0.76	1799	965	0.5	0.5	83.3	1367.24
0.28	2083	435	0.2	0.2	80.5	583.24
0.46	1321	444	0.3	0.3	82.2	607.66
1.6	1651	1887	1.1	1.1	84	2641.6
26.39						
Sum		115671.13				68111.47

AHS Lane

LINK (##)	Length (km)	Flow (vehs)	Total flow (min)	Free flow (min)	Avg flow (min)	Speed (kph)	Veh-Km
67	1.55	3161	2965	0.9	0.9	99.1	4899.55
68	4.95	3873	12389	3.0	3.2	92.8	19171.35
69	1	2639	1607	0.6	0.6	98.5	2639
70	2	3948	4789	1.2	1.2	98.9	7896
71	3	2999	5437	1.8	1.8	99.3	8997
72	2.5	4383	7502	1.5	1.7	87.6	10957.5
73	2.9	3273	5716	1.7	1.7	99.6	9491.7
74	4.45	3882	10431	2.7	2.7	99.4	17274.9
75	2.9	2473	4317	1.7	1.7	99.7	7171.7
105	0.75	1901	875	0.4	0.5	97.8	1425.75
Sum	26		56028				89924.45

Total Veh-Mi ***98158.96***
Total Veh-Hr ***2861.652***

Note: This table is based on integration model run.

Appendix B

Additional Details for Boston I-93 Case Study

The QUEENSOD model (Appendix E) was used to generate the OD trip tables shown in Table 2-B1 from available mainline and ramp data counts. Figure 2-B1 shows an example of the flow model developed. Table 2-B2 also shows this data. Tables 2-B3, 2-B4 and 2-B5 shows examples of the INTEGRATION Model output for the combined AHS and general lane facility for three different sets of input volumes.

Table 2-B1.

Boston I-93 Southeast Expressway OD Volume Table

(North Bound)

Origin	Destination							
	Exit 8	Exit 9	Exit11	Exit 13	Exit 14	Exit 15	Exit 16	Main Line After Exit 16
Main Line Before Exit 8	650	711	250	138	517	621	438	4801
Enter 8		38	20	12	31	34	27	238
Enter 9			31	20	47	52	42	59
Enter 11				17	46	52	40	194
Enter (Neponset Ave)				13	55	70	50	906
Enter 15							18	930

NOTES:

This table is based on running queens-od model.

2-B3

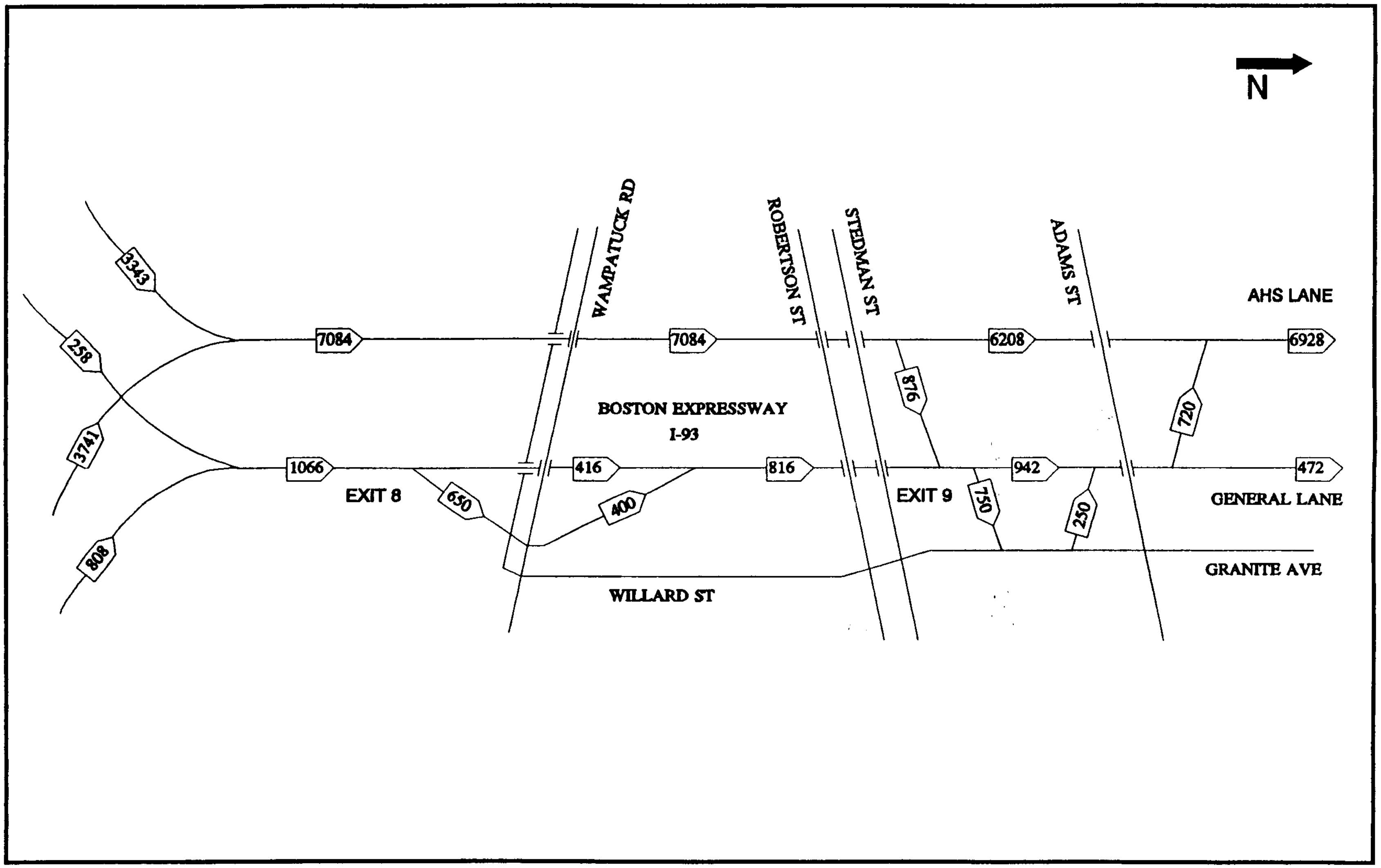


Figure 2-B1. Traffic Flow Diagram For AHS I-93 Expressway

Existing 6-7 AM Volume With Two AHS Lanes And One General Lane

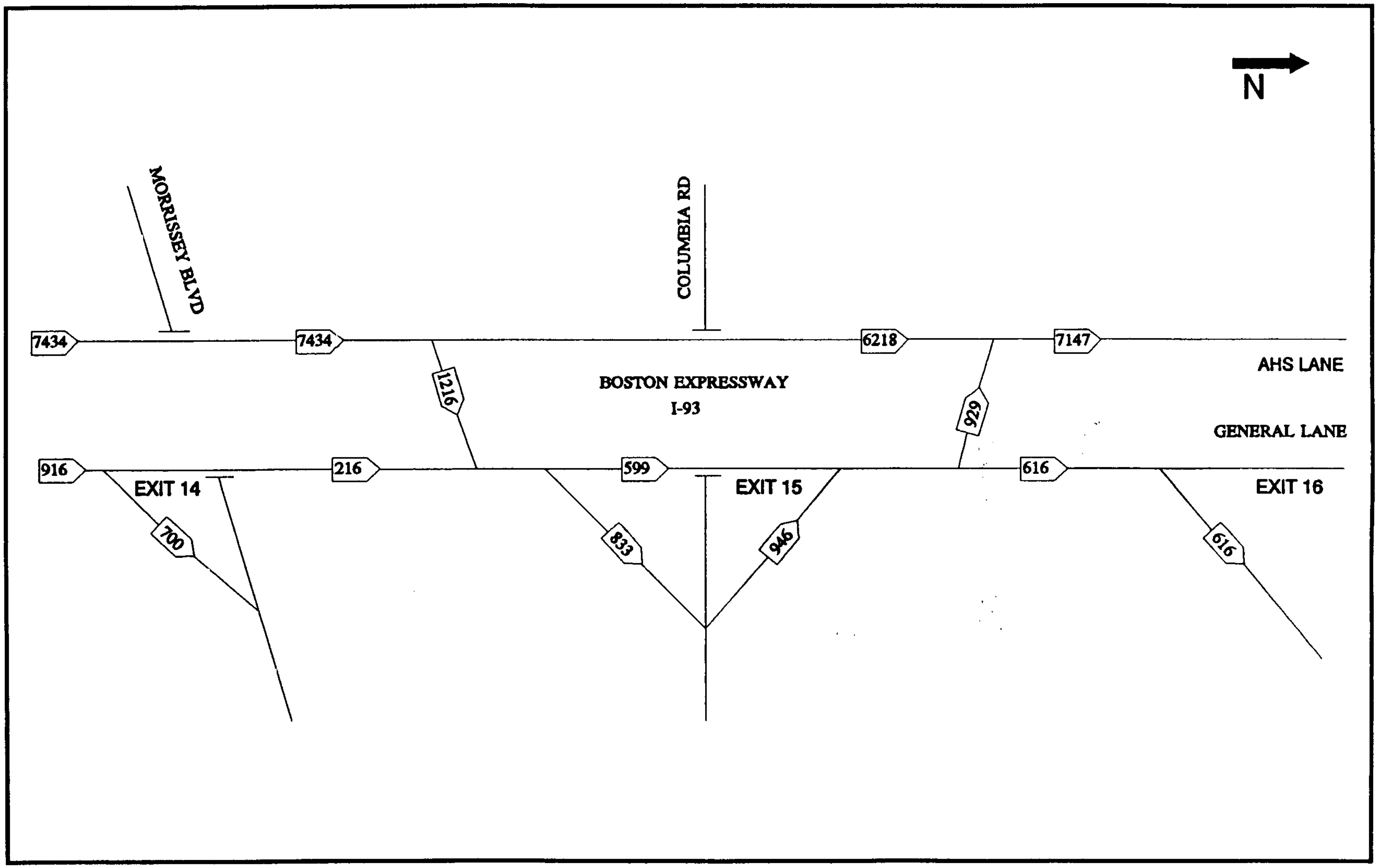


Figure 2-B1. Traffic Flow Diagram For AHS I-93 Expressway

Existing 6-7 AM Volume With Two AHS Lanes And One General Lane

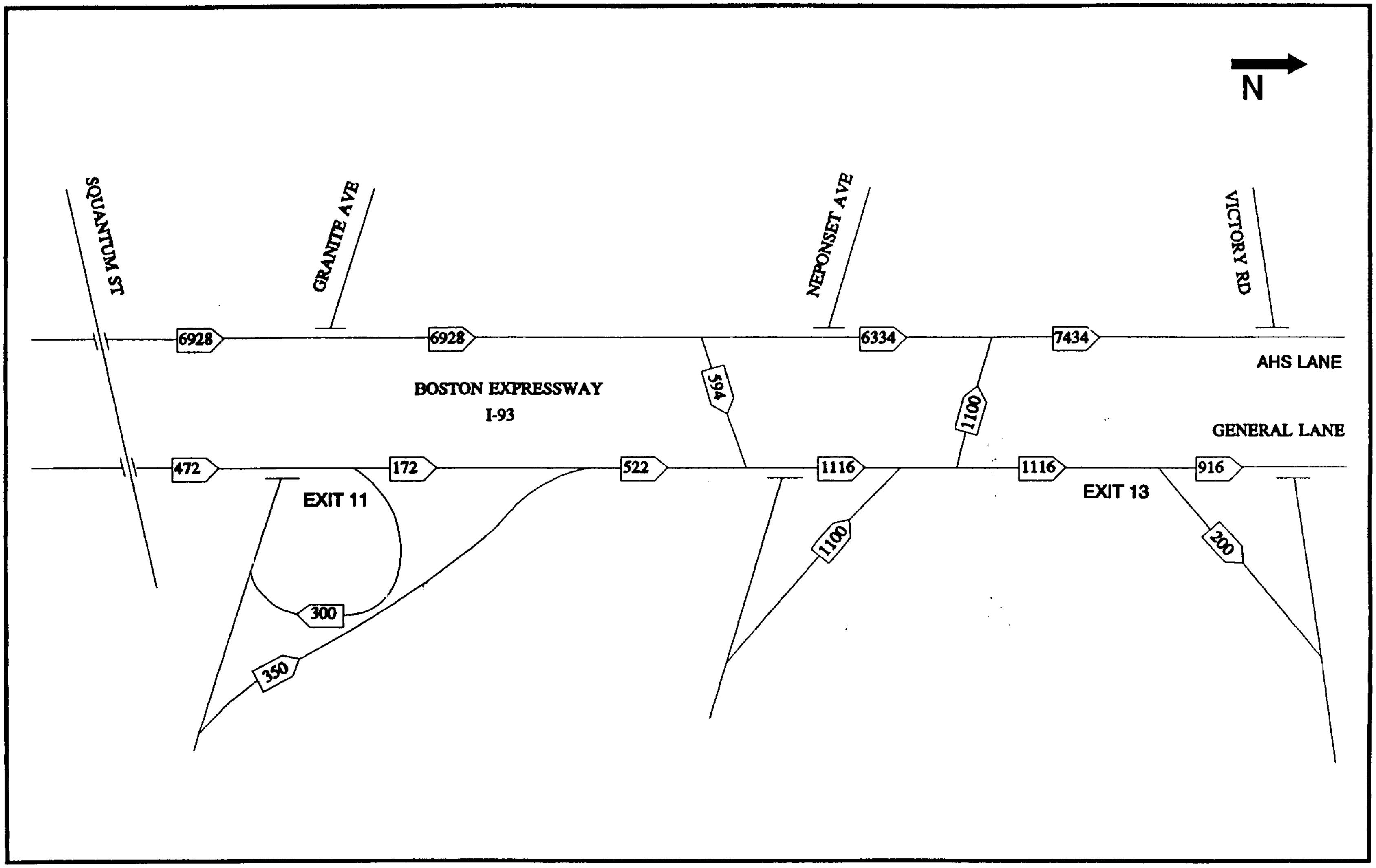


Figure 2-B1. Traffic Flow Diagram For AHS I-93 Expressway

Existing 6-7 AM Volume With Two AHS Lanes And One General Lane

Table 2-B2.
Boston I-93 Expressway Traffic Flow Table
Existing Facility (4 LANES) AND AHS Facility (Two AHS Lanes & Two General Lanes)
1992 Peak Hour Volume With 20% Increase

Locations	Int.	Existing Facility (4 Lanes)			AHS Facility (2 AHS Lanes & 2 Gen. Lanes)				
		Distance (Feet)	Ramp Vol.	Thru Lane	AHS Ramp	AHS Ramp Vol.	AHS Thru Vol.	Gen Ramp Vol.	Gen Thru Vol.
Merge Of Rt128 & Rt3									
		3960		9780			8501		1279
Furmace Brook Pwy	*Exit 8*		-780				8501	-780	
		2640		9000			8501		499
Furmace Brook Pwy	*Enter 8*		480				8501	480	
				9480			8501		979
		4224		9480	Exit A	-1051			
E. Milton	*Exit 9*		-900				7450	-116	
		1056		8580			7450		1130
E. Milton	*Enter 9*		300				7450	300	
		7920		8880	Enter B	864			
							8314		566
Granite Ave	*Exit 11*		-360				8314	-360	
		790		8520			8314		206
Granite Ave	*Enter 11*		420				8314	420	
							8314		626
		5280		8940	Exit C	-713			
							7601		1339
Neponset Ave.	*Enter 13*		1320				7601	226	
				10260	Enter D	1320			
		2640		10260	(2 Lanes)		8921		1339
Freeport	*Exit 13*		-240				8921	-240	
		1320		10020			8921		1099
Morrisey Blvd	*Exit 14*		-840				8921	-840	
							8921		259
		7128		9180	Exit E	-1459			
Columbia	*Exit 15*		-1000		(2 Lanes)		7462	-1000	
		1320		8180			7462		719
Columbia	*Enter 15*		1134				7462	20	
		2112		9314	Enter F	1115			
				9134			8576		739
Southampton	*Exit 16*		-739				8576	-739	
				8575					

NOTE: Negative volume is the exit volume.

Table 2-B3.
Boston I-93 AHS 90% of Existing Volume (NB)
Two AHS Lanes & Two General Lanes

AHS					General Lane					
Section	*Length (Km)*	*Volume*	*Veh-Min*	*Veh-Km*	*Section*	*Length (Km)*	*Volume*	*Veh-Km*	*Veh-Min*	*V/C*
1	0.5	5763	1739	2881.5	*1*	1.21	939	1136.19	802	0.23
2	0.3	5795	1053	1738.5	*2*	0.81	366	296.46	201	0.09
3	2.23	4981	6677	11107.63	*3*	1.3	700	910	627	0.17
4	1.15	6075	4221	6986.25	*4*	0.3	616	184.8	128	0.15
5	0.3	6145	1111	1843.5	*5*	0.2	805	161	113	0.2
6	2.41	5182	7501	12488.62	*6*	0.3	764	229.2	160	0.19
7	1.05	5822	3689	6113.1	*7*	2.38	389	925.82	630	0.09
8	0.42	5293	1350	2223.06	*8*	0.3	139	41.7	28	0.03
9	1.85	5320	5932	9842	*9*	0.81	444	359.64	245	0.11
10	2.61	6192	9820	16161.12	*10*	0.69	940	648.6	455	0.23
11	0.4	5880	1423	2352	*11*	0.2	769	153.8	107	0.19
					12	0.76	924	702.24	490	0.23
Sum	13.22		44516	73737.28	*13*	0.4	753	301.2	208	0.18
					14	2.12	175	371	250	0.04
					15	0.3	466	139.8	96	0.11
					16	0.3	1039	311.7	222	0.25
					17	0.2	464	92.8	64	0.11
					18	0.6	476	285.6	197	0.11
					19	0.15	463	69.45	48	0.11
Total Veh-Km		81299.18			*20*	0.3	803	240.9	167	0.2
Total Veh-Mi		50504.04								
Total Veh-Hr		829.2333			*Sum*	13.63		7561.9	5238	

Table 2-B4.
Boston I-93 AHS 100% of Existing Volume (NB)
Two AHS Lanes & Two General Lanes

AHS					General Lane					
Section	Length (Km)	Volume	Veh-Min	Veh-Km	Section	Length (Km)	Volume	Veh-Km	Veh-Min	V/C
1	0.5	6396	1933	3198	1	1.21	1036	1253.56	891	0.25
2	0.3	6436	1174	1930.8	2	0.81	397	321.57	219	0.09
3	2.23	5537	7425	12347.51	3	1.3	772	1003.6	693	0.19
4	1.15	6734	4681	7744.1	4	0.3	678	203.4	141	0.16
5	0.3	6816	1233	2044.8	5	0.2	884	176.8	124	0.22
6	2.41	5753	8331	13864.73	6	0.3	843	252.9	177	0.21
7	1.05	6453	4127	6775.65	7	2.38	419	997.22	680	0.1
8	0.42	5882	1501	2470.44	8	0.3	149	44.7	30	0.03
9	1.85	5906	6589	10926.1	9	0.81	489	396.09	270	0.12
10	2.61	6854	10907	17888.94	10	0.69	1031	711.39	501	0.25
11	0.4	6536	1587	2614.4	11	0.2	837	167.4	117	0.2
					12	0.76	1011	768.36	538	0.25
Sum	13.22		49488	81805.47	13	0.4	827	330.8	230	0.2
					14	2.12	199	421.88	285	0.04
					15	0.3	524	157.2	109	0.13
					16	0.3	1150	345	247	0.28
					17	0.2	524	104.8	72	0.13
					18	0.6	536	321.6	222	0.13
					19	0.15	523	78.45	54	0.13
Total Veh-Km		90126.79			20	0.3	882	264.6	184	0.22
Total Veh-Mi		55987.85								
Total Veh-Hr		921.2			Sum	13.63		8321.32	5784	

Table 2-B5.
Boston I-93 AHS 120% of Existing Volume (NB)
Two AHS Lanes & Two General Lanes

AHS					General Lane					
Section	*Length (Km)*	*Volume*	*Veh-Min*	*Veh-Km*	*Section*	*Length (Km)*	*Volume*	*Veh-Km*	*Veh-Min*	*V/C*
1	0.5	7646	2323	3823	*1*	1.21	1258	1522.18	1100	0.31
2	0.3	7695	1438	2308.5	*2*	0.81	488	395.28	270	0.12
3	2.23	6619	8892	14760.37	*3*	1.3	947	1231.1	857	0.23
4	1.15	8090	5660	9303.5	*4*	0.3	832	249.6	174	0.2
5	0.3	8198	1484	2459.4	*5*	0.2	1086	217.2	154	0.27
6	2.41	6916	10024	16667.56	*6*	0.3	1026	307.8	220	0.25
7	1.05	7765	5122	8153.25	*7*	2.38	528	1256.64	861	0.13
8	0.42	7068	1807	2968.56	*8*	0.3	190	57	39	0.04
9	1.85	7087	7921	13110.95	*9*	0.81	592	479.52	328	0.14
10	2.61	8248	13647	21527.28	*10*	0.69	1249	861.81	612	0.31
11	0.4	7851	1940	3140.4	*11*	0.2	1017	203.4	143	0.25
					12	0.76	1227	932.52	660	0.3
Sum	13.22		60258	98222.77	*13*	0.4	1008	403.2	283	0.25
					14	2.12	239	506.68	344	0.05
					15	0.3	644	193.2	135	0.16
					16	0.3	1401	420.3	312	0.35
					17	0.2	644	128.8	89	0.16
					18	0.15	644	96.6	67	0.16
					19	0.6	659	395.4	276	0.16
Total Veh-Km		108405.6			*20*	0.3	1082	324.6	228	0.27
Total Veh-Mi		67342.87								
Total Veh-Hr		1123.5			*Sum*	13.63		10182.83	7152	

Appendix C

Additional Details for Capital Beltway I-495 Case Study

This Appendix is a compilation of the roadway characteristics and OD demands applied in the Capital Beltway I-495 Scenario. The roadway is represented by links and nodes as illustrated in Figures 2-C1 and 2-C2. Figure 2-C1 illustrates the existing roadway and Figure 2-C2 illustrates the roadway with one AHS lane.

The roadway characteristics were determined by on-site visits and video tape analysis of the study area. Tables 2-C1 and 2-C2 illustrate the roadway characteristics as applied to the existing Capital Beltway I-495 and the AHS Capital Beltway I-495 respectively.

The OD demands obtained from the QUEENSOD model were factored to represent a range of travel demands. Tables 2-C3 and 2-C4 illustrate the results of applying these factors to the existing Capital Beltway I-495 and the AHS Capital Beltway I-495 respectively.

The traffic flow on the AHS Capital Beltway I-495 with the existing demand is illustrated in Figures 2-C3. These figures illustrate the reduction in the demands versus capacity on the mainline general lanes as a result of the AHS lane.

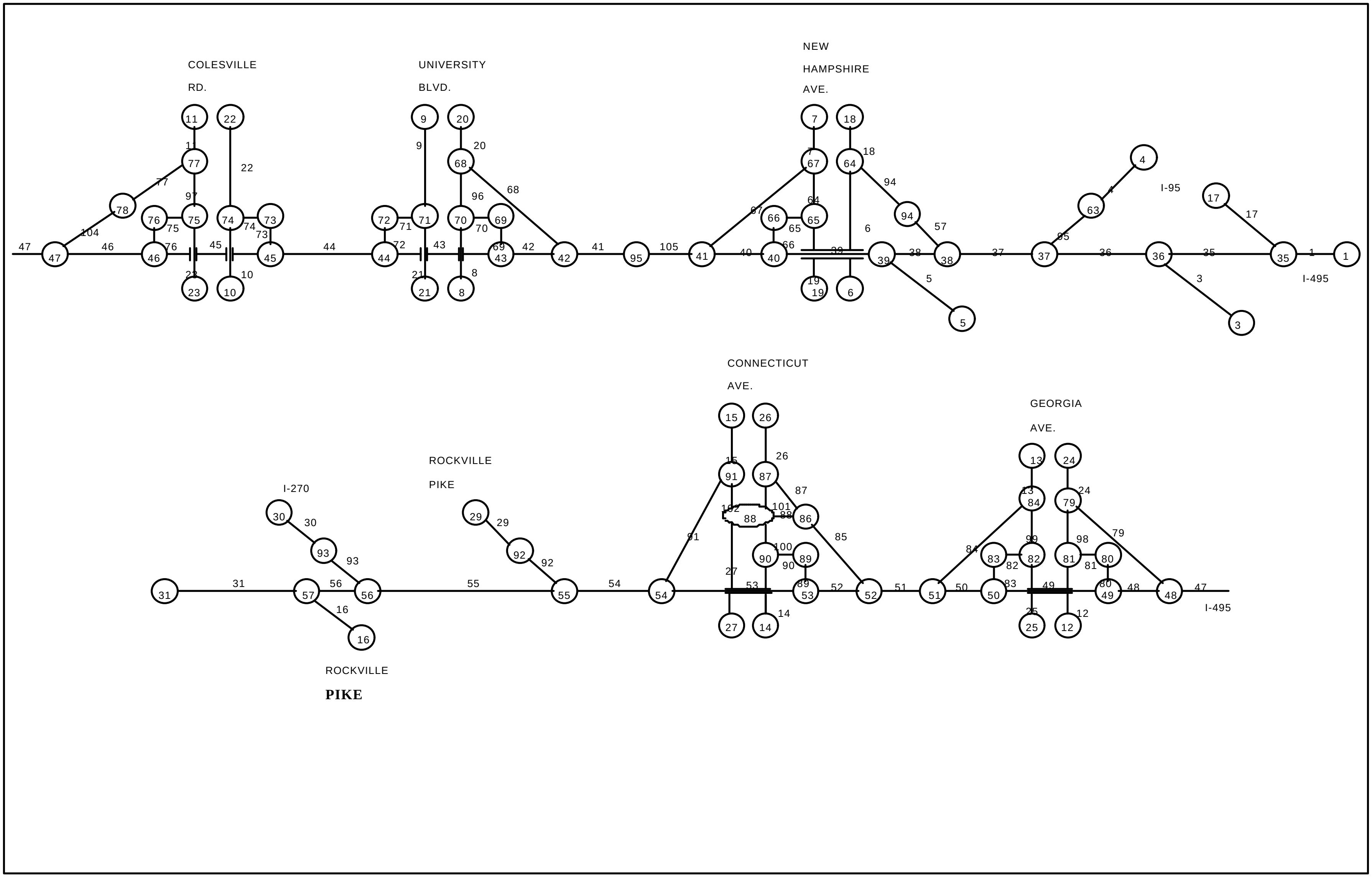


Figure 2-C1. Capital Beltway (I-495) Link Node

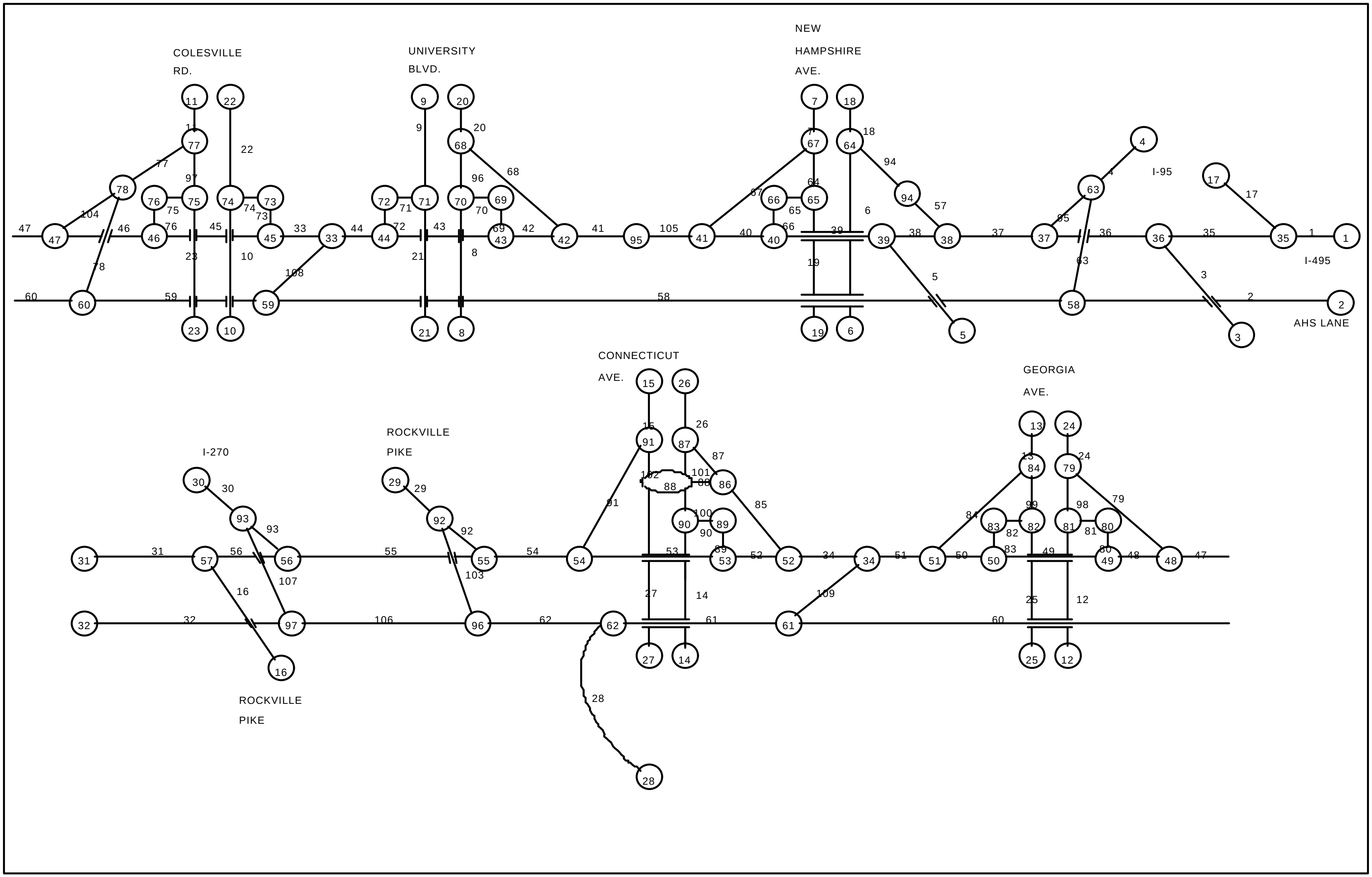


Figure 2-C2. Capital Beltway (I-495) AHS Link Node

Table 2-C1 (sheet 1 of 2)
Capital Beltway Existing Roadway Characteristics by Link

LINK	NODE A	NODE B	LANES	LANE SATURATION	LENGTH (KM)	LENGTH (MI)	SPEED (KM/HR)	SPEED (MI/HR)
1	1	35	6	2200	0.80	0.50	100	62
3	3	36	1	1700	0.20	0.12	80	50
4	4	63	2	2000	0.10	0.06	100	62
5	5	39	1	1700	0.40	0.25	68	42
6	6	64	3	1700	0.30	0.19	68	42
7	7	67	4	1700	0.10	0.06	68	42
8	8	70	4	1700	0.28	0.17	68	42
9	9	71	3	1700	0.20	0.12	68	42
10	10	74	4	1700	0.28	0.17	68	42
11	11	77	3	1700	0.10	0.06	68	42
12	12	81	4	1700	0.28	0.17	68	42
13	13	84	3	1700	0.10	0.06	68	42
14	14	90	4	1700	0.38	0.24	68	42
15	15	91	3	1700	0.10	0.06	68	42
16	16	57	1	2000	0.20	0.12	100	62
17	35	17	3	2000	0.20	0.12	100	62
18	64	18	3	1700	0.10	0.06	68	42
19	65	19	4	1700	0.18	0.11	68	42
20	68	20	3	1700	0.10	0.06	68	42
21	71	21	4	1700	0.28	0.17	68	42
22	74	22	3	1700	0.20	0.12	68	42
23	75	23	4	1700	0.28	0.17	68	42
24	79	24	3	1700	0.10	0.06	68	42
25	82	25	4	1700	0.28	0.17	68	42
26	87	26	3	1700	0.10	0.06	68	42
27	88	27	3	1700	0.48	0.30	68	42
29	92	29	1	2000	0.10	0.06	80	50
30	93	30	3	2000	0.10	0.06	100	62
31	57	31	3	2200	2.36	1.47	100	62
35	35	36	4	2200	0.40	0.25	100	62
36	36	37	5	2200	0.71	0.44	100	62
37	37	38	6	2200	1.41	0.88	100	62
38	38	39	5	2200	0.40	0.25	100	62
39	39	40	6	2200	0.20	0.12	100	62
40	40	41	5	2200	0.20	0.12	100	62
41	95	42	4	2200	1.11	0.69	100	62
42	42	43	4	2200	0.20	0.12	100	62
43	43	44	5	2200	0.22	0.14	100	62
44	44	45	4	2200	0.70	0.43	100	62
45	45	46	5	2200	0.22	0.14	100	62
46	46	47	4	2200	0.20	0.12	100	62
47	47	48	4	2200	1.71	1.06	100	62
48	48	49	4	2200	0.16	0.10	100	62
49	49	50	5	2200	0.19	0.12	100	62
50	50	51	4	2200	0.14	0.09	100	62
51	51	52	4	2200	2.81	1.75	100	62

NOTE:
See Figure 1 for link layout
Speed is typical for a given roadway type
Capacity is typical for a given roadway type

Table 2-C1 (sheet 2 of 2)

Capital Beltway Existing Roadway Characteristics by Link

LINK	NODE A	NODE B	LANES	LANE SATURATION	LENGTH (KM)	LENGTH (MI)	SPEED (KM/HR)	SPEED (MI/HR)
52	52	53	4	2200	0.43	0.27	100	62
53	53	54	4	2200	0.44	0.27	100	62
54	54	55	4	2200	2.22	1.38	100	62
55	55	56	4	2200	0.30	0.19	100	62
56	56	57	4	2200	0.02	0.01	100	62
57	38	94	1	1700	0.34	0.21	68	42
64	67	65	3	1700	0.10	0.06	68	42
65	66	65	1	1700	0.10	0.06	68	42
66	40	66	1	1700	0.10	0.06	68	42
67	67	41	1	1700	0.36	0.22	80	50
68	42	68	1	1700	0.39	0.24	68	42
69	69	43	1	1700	0.10	0.06	80	50
70	70	69	1	1700	0.10	0.06	68	42
71	72	71	1	1700	0.10	0.06	68	42
72	44	72	1	1700	0.10	0.06	68	42
73	73	45	1	1700	0.10	0.06	80	50
74	74	73	1	1700	0.10	0.06	68	42
75	76	75	1	1700	0.10	0.06	68	42
76	46	76	1	1700	0.10	0.06	68	42
77	77	78	1	1700	0.26	0.16	80	50
79	48	79	1	1700	0.30	0.19	68	42
80	80	49	1	1700	0.10	0.06	80	50
81	81	80	1	1700	0.07	0.04	68	42
82	83	82	1	1700	0.10	0.06	68	42
83	50	83	1	1700	0.10	0.06	80	50
84	84	51	1	1700	0.36	0.22	80	50
85	52	85	2	1700	0.28	0.17	80	50
86	85	86	3	1700	0.28	0.17	68	42
87	86	87	1	1700	0.19	0.12	68	42
88	86	88	2	1700	0.16	0.10	68	42
89	89	53	1	1700	0.20	0.12	80	50
90	90	89	1	1700	0.20	0.12	68	42
91	91	54	1	1700	0.46	0.29	80	50
92	55	92	1	1700	0.10	0.06	80	50
93	56	93	2	1700	0.10	0.06	100	62
94	94	64	2	1700	0.20	0.12	68	42
95	63	37	2	1700	0.10	0.06	100	62
96	70	68	3	1700	0.10	0.06	68	42
97	77	75	3	1700	0.10	0.06	68	42
98	81	79	3	1700	0.10	0.06	68	42
99	84	82	3	1700	0.10	0.06	68	42
100	90	88	3	1700	0.10	0.06	68	42
101	88	87	3	1700	0.10	0.06	68	42
102	91	88	3	1700	0.10	0.06	68	42
104	78	47	1	1700	0.10	0.06	80	50
105	41	95	5	2200	0.80	0.50	100	62

NOTE:
See Figure 1 for link layout
Speed is typical for a given roadway type
Capacity is typical for a given roadway type

Table 2-C2 (sheet 1 of 2)

Capital Beltway AHS Roadway Characteristics by Link

LINK	NODE A	NODE B	LANES	LANE SATURATION	LENGTH (KM)	LENGTH (MI)	SPEED (KM/HR)	SPEED (MI/HR)
1	1	35	5	2200	0.80	0.50	100	62
2	2	58	4	2200	2.60	1.61	100	62
3	3	36	1	1700	0.20	0.12	80	50
4	4	63	2	2000	0.10	0.06	100	62
5	5	39	1	1700	0.40	0.25	68	42
6	6	64	3	1700	0.30	0.19	68	42
7	7	67	4	1700	0.10	0.06	68	42
8	8	70	4	1700	0.28	0.17	68	42
9	9	71	3	1700	0.20	0.12	68	42
10	10	74	4	1700	0.28	0.17	68	42
11	11	77	3	1700	0.10	0.06	68	42
12	12	81	4	1700	0.28	0.17	68	42
13	13	84	3	1700	0.10	0.06	68	42
14	14	90	4	1700	0.38	0.24	68	42
15	15	91	3	1700	0.10	0.06	68	42
16	16	57	1	2000	0.20	0.12	100	62
17	35	17	3	2000	0.20	0.12	100	62
18	64	18	3	1700	0.10	0.06	68	42
19	65	19	4	1700	0.18	0.11	68	42
20	68	20	3	1700	0.10	0.06	68	42
21	71	21	4	1700	0.28	0.17	68	42
22	74	22	3	1700	0.20	0.12	68	42
23	75	23	4	1700	0.28	0.17	68	42
24	79	24	3	1700	0.10	0.06	68	42
25	82	25	4	1700	0.28	0.17	68	42
26	87	26	3	1700	0.10	0.06	68	42
27	88	27	3	1700	0.48	0.30	68	42
28	62	28	1	2200	0.77	0.48	100	62
29	92	29	1	2000	0.10	0.06	80	50
30	93	30	3	2000	0.10	0.06	100	62
31	57	31	2	2200	2.36	1.47	100	62
32	97	32	4	2200	3.07	1.91	100	62
33	33	45	3	2200	0.20	0.12	100	62
34	34	52	3	2200	1.40	0.87	100	62
35	35	36	3	2200	0.40	0.25	100	62
36	36	37	4	2200	0.71	0.44	100	62
37	37	38	5	2200	1.41	0.88	100	62
38	38	39	4	2200	0.40	0.25	100	62
39	39	40	5	2200	0.20	0.12	100	62
40	40	41	4	2200	0.20	0.12	100	62
41	95	42	3	2200	1.11	0.69	100	62
42	42	43	3	2200	0.20	0.12	100	62
43	43	44	4	2200	0.22	0.14	100	62
44	44	33	3	2200	0.50	0.31	100	62
45	45	46	4	2200	0.22	0.14	100	62
46	46	47	3	2200	0.20	0.12	100	62
47	47	48	3	2200	1.71	1.06	100	62
48	48	49	3	2200	0.16	0.10	100	62
49	49	50	4	2200	0.19	0.12	100	62
50	50	51	3	2200	0.14	0.09	100	62
51	51	34	3	2200	1.41	0.88	100	62
52	52	53	3	2200	0.43	0.27	100	62
53	53	54	3	2200	0.44	0.27	100	62
54	54	55	3	2200	2.22	1.38	100	62

NOTE:

See Figure 2 for link layout

Speed is typical for a given roadway type

Capacity is typical for a given roadway type

AHS capacity provided by increasing the number of lanes to provide unconstrained flow

Table 2-C2 (sheet 2 of 2)
Capital Beltway AHS Roadway Characteristics by Link

LINK	NODE A	NODE B	LANES	LANE SATURATION	LENGTH (KM)	LENGTH (MI)	SPEED (KM/HR)	SPEED (MI/HR)
55	55	56	3	2200	0.30	0.19	100	62
56	56	57	3	2200	0.02	0.01	100	62
57	38	94	1	1700	0.34	0.21	68	42
58	58	59	4	2200	5.10	3.17	100	62
59	59	60	4	2200	0.56	0.35	100	62
60	60	61	4	2200	3.67	2.28	100	62
61	61	62	4	2200	1.08	0.67	100	62
62	62	96	4	2200	1.97	1.22	100	62
63	63	58	1	2200	0.77	0.48	100	62
64	67	65	3	1700	0.10	0.06	68	42
65	66	65	1	1700	0.10	0.06	68	42
66	40	66	1	1700	0.10	0.06	68	42
67	67	41	1	1700	0.36	0.22	80	50
68	42	68	1	1700	0.39	0.24	68	42
69	69	43	1	1700	0.10	0.06	80	50
70	70	69	1	1700	0.10	0.06	68	42
71	72	71	1	1700	0.10	0.06	68	42
72	44	72	1	1700	0.10	0.06	68	42
73	73	45	1	1700	0.10	0.06	80	50
74	74	73	1	1700	0.10	0.06	68	42
75	76	75	1	1700	0.10	0.06	68	42
76	46	76	1	1700	0.10	0.06	68	42
77	77	78	1	1700	0.26	0.16	80	50
78	78	80	1	2200	0.77	0.48	100	62
79	48	79	1	1700	0.30	0.19	68	42
80	80	49	1	1700	0.10	0.06	80	50
81	81	80	1	1700	0.07	0.04	68	42
82	83	82	1	1700	0.10	0.06	68	42
83	50	83	1	1700	0.10	0.06	80	50
84	84	51	1	1700	0.36	0.22	80	50
85	52	85	2	1700	0.28	0.17	80	50
86	85	86	3	1700	0.28	0.17	68	42
87	86	87	1	1700	0.19	0.12	68	42
88	86	88	2	1700	0.16	0.10	68	42
89	89	53	1	1700	0.20	0.12	80	50
90	90	89	1	1700	0.20	0.12	68	42
91	91	54	1	1700	0.46	0.29	80	50
92	55	92	1	1700	0.10	0.06	80	50
93	56	93	2	1700	0.10	0.06	100	62
94	94	64	2	1700	0.20	0.12	68	42
95	63	37	2	1700	0.10	0.06	100	62
96	70	68	3	1700	0.10	0.06	68	42
97	77	75	3	1700	0.10	0.06	68	42
98	81	79	3	1700	0.10	0.06	68	42
99	84	82	3	1700	0.10	0.06	68	42
100	90	88	3	1700	0.10	0.06	68	42
101	88	87	3	1700	0.10	0.06	68	42
102	91	88	3	1700	0.10	0.06	68	42
103	96	92	1	2200	0.77	0.48	100	62
104	78	47	1	1700	0.10	0.06	80	50
105	41	95	4	2200	0.80	0.50	100	62
106	96	97	4	2200	0.30	0.19	100	62
107	97	93	1	2200	0.77	0.48	100	62
108	33	59	1	2200	0.75	0.47	100	62
109	34	61	1	2200	0.75	0.47	100	62

NOTE:
See Figure 2 for link layout
Speed is typical for a given roadway type
Capacity is typical for a given roadway type
AHS capacity provided by increasing the number of lanes to provide unconstrained flow

Table 2-C3 (sheet 1 of 2)
Existing Capital Beltway Hourly OD Pairs

ORIGIN NODE	DESTINATION NODE	EXISTING VOLUME	VOLUME 5%	VOLUME 20%	VOLUME 35%	VOLUME 50%	VOLUME 65%	VOLUME 80%	VOLUME 90%	VOLUME 110%
1	17	1597	80	319	559	799	1038	1278	1437	1757
1	18	290	15	58	102	145	189	232	261	319
1	19	309	15	62	108	155	201	247	278	340
1	20	186	9	37	65	93	121	149	167	205
1	21	96	5	19	34	48	62	77	86	106
1	23	438	22	88	153	219	285	350	394	482
1	24	147	7	29	51	74	96	118	132	162
1	25	237	12	47	83	119	154	190	213	261
1	26	246	12	49	86	123	160	197	221	271
1	27	452	23	90	158	226	294	362	407	497
1	29	464	23	93	162	232	302	371	418	510
1	30	526	26	105	184	263	342	421	473	579
1	31	606	30	121	212	303	394	485	545	667
3	27	22	1	4	8	11	14	18	20	24
3	29	18	1	4	6	9	12	14	16	20
3	30	23	1	5	8	12	15	18	21	25
3	31	24	1	5	8	12	16	19	22	26
4	18	99	5	20	35	50	64	79	89	109
4	19	168	8	34	59	84	109	134	151	185
4	20	74	4	15	26	37	48	59	67	81
4	21	3	0	1	1	2	2	2	3	3
4	23	380	19	76	133	190	247	304	342	418
4	24	74	4	15	26	37	48	59	67	81
4	25	179	9	36	63	90	116	143	161	197
4	26	196	10	39	69	98	127	157	176	216
4	27	412	21	82	144	206	268	330	371	453
4	29	427	21	85	149	214	278	342	384	470
4	30	493	25	99	173	247	320	394	444	542
4	31	577	29	115	202	289	375	462	519	635
5	27	51	3	10	18	26	33	41	46	56
5	29	84	4	17	29	42	55	67	76	92
5	30	176	9	35	62	88	114	141	158	194
5	31	273	14	55	96	137	177	218	246	300
6	18	1091	55	218	382	546	709	873	982	1200

NOTE:
See Figure 1 for node layout
OD data developed using the QUEENSOD model
Existing traffic volume refers to 1992 traffic volumes

Table 2-C3 (sheet 2 of 2)
Existing Capital Beltway Hourly OD Pairs

ORIGIN NODE	DESTINATION NODE	EXISTING VOLUME	VOLUME 5%	VOLUME 20%	VOLUME 35%	VOLUME 50%	VOLUME 65%	VOLUME 80%	VOLUME 90%	VOLUME 110%
7	19	2824	141	565	988	1412	1836	2259	2542	3106
7	27	40	2	8	14	20	26	32	36	44
7	29	75	4	15	26	38	49	60	68	83
7	30	172	9	34	60	86	112	138	155	189
7	31	274	14	55	96	137	178	219	247	301
8	20	329	16	66	115	165	214	263	296	362
8	27	122	6	24	43	61	79	98	110	134
8	29	157	8	31	55	79	102	126	141	173
8	30	262	13	52	92	131	170	210	236	288
8	31	376	19	75	132	188	244	301	338	414
9	21	1273	64	255	446	637	827	1018	1146	1400
10	22	1023	51	205	358	512	665	818	921	1125
10	30	64	3	13	22	32	42	51	58	70
10	31	193	10	39	68	97	125	154	174	212
11	23	2233	112	447	782	1117	1451	1786	2010	2456
11	27	277	14	55	97	139	180	222	249	305
11	29	313	16	63	110	157	203	250	282	344
11	30	439	22	88	154	220	285	351	395	483
11	31	589	29	118	206	295	383	471	530	648
12	24	333	17	67	117	167	216	266	300	366
12	27	83	4	17	29	42	54	66	75	91
12	29	63	3	13	22	32	41	50	57	69
12	30	266	13	53	93	133	173	213	239	293
12	31	453	23	91	159	227	294	362	408	498
13	25	3622	181	724	1268	1811	2354	2898	3260	3984
13	30	259	13	52	91	130	168	207	233	285
13	31	511	26	102	179	256	332	409	460	562
14	26	874	44	175	306	437	568	699	787	961
14	30	140	7	28	49	70	91	112	126	154
14	31	427	21	85	149	214	278	342	384	470
15	27	2259	113	452	791	1130	1468	1807	2033	2485
15	30	301	15	60	105	151	196	241	271	331
15	31	687	34	137	240	344	447	550	618	756
16	31	358	18	72	125	179	233	286	322	394

NOTE:
See Figure 1 for node layout
OD data developed using the QUEENSOD model
Existing traffic volume refers to 1992 traffic volumes

Table 2-C4 (sheet 1 of 2)
Capital Beltway One AHS Lane Hourly OD Pairs

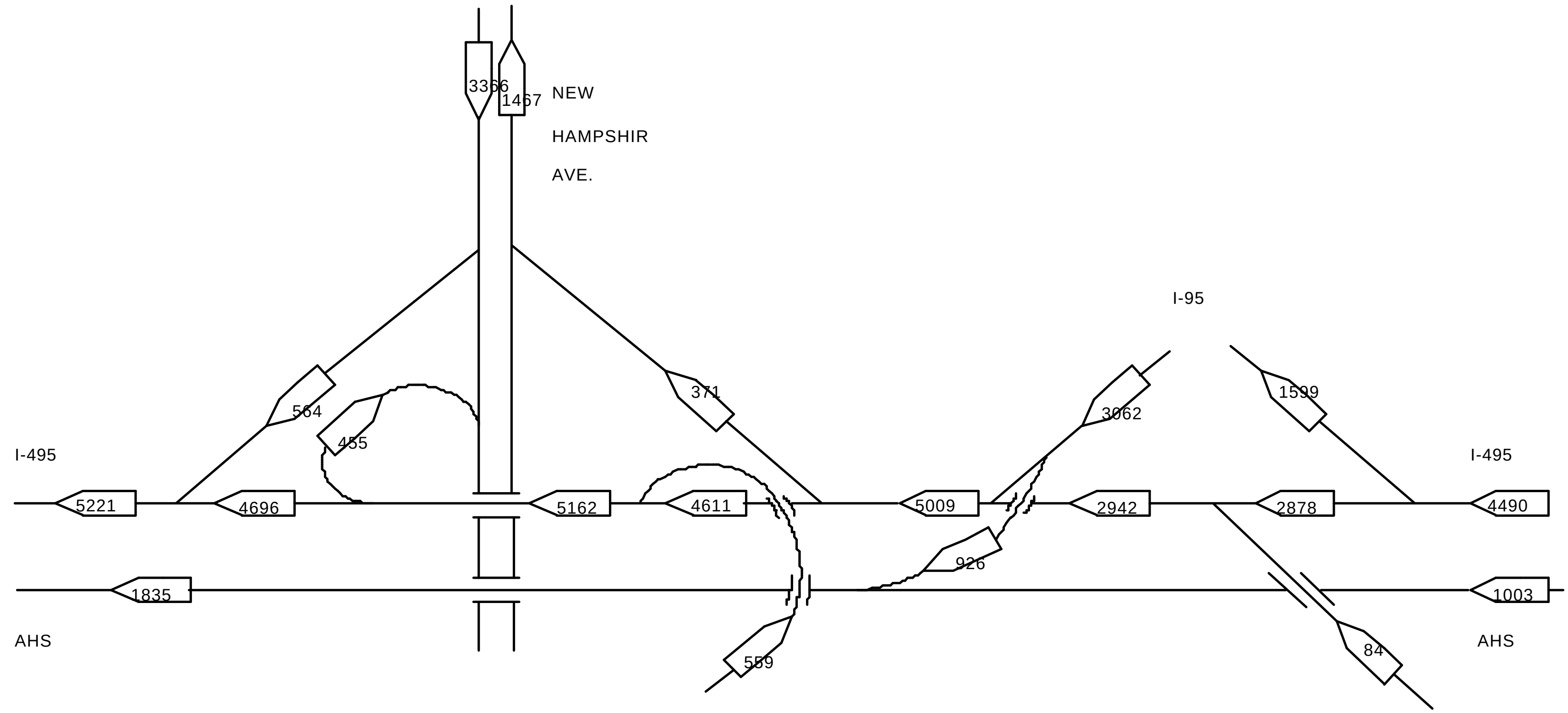
ORIGIN NODE	DESTINATION NODE	EXISTING VOLUME	VOLUME 5%	VOLUME 20%	VOLUME 35%	VOLUME 50%	VOLUME 65%	VOLUME 80%	VOLUME 90%	VOLUME 110%
1	17	1597	80	319	559	799	1038	1278	1437	1757
1	18	290	15	58	102	145	189	232	261	319
1	19	309	15	62	108	155	201	247	278	340
1	20	186	9	37	65	93	121	149	167	205
1	21	96	5	19	34	48	62	77	86	106
1	23	438	22	88	153	219	285	350	394	482
1	24	147	7	29	51	74	96	118	132	162
1	25	237	12	47	83	119	154	190	213	261
1	26	246	12	49	86	123	160	197	221	271
1	27	226	11	45	79	113	147	181	203	249
1	29	232	12	46	81	116	151	186	209	255
1	30	263	13	53	92	132	171	210	237	289
1	31	303	15	61	106	152	197	242	273	333
2	28	226	11	45	79	113	147	181	203	249
2	29	232	12	46	81	116	151	186	209	255
2	30	263	13	53	92	132	171	210	237	289
2	32	303	15	61	106	152	197	242	273	333
3	27	22	1	4	8	11	14	18	20	24
3	29	18	1	4	6	9	12	14	16	20
3	30	23	1	5	8	12	15	18	21	25
3	31	24	1	5	8	12	16	19	22	26
4	18	99	5	20	35	50	64	79	89	109
4	19	168	8	34	59	84	109	134	151	185
4	20	74	4	15	26	37	48	59	67	81
4	21	3	0	1	1	2	2	2	3	3
4	23	380	19	76	133	190	247	304	342	418
4	24	74	4	15	26	37	48	59	67	81
4	25	179	9	36	63	90	116	143	161	197
4	26	196	10	39	69	98	127	157	176	216
4	27	206	10	41	72	103	134	165	185	227
4	28	206	10	41	72	103	134	165	185	227
4	29	427	21	85	149	214	278	342	384	470
4	30	493	25	99	173	247	320	394	444	542
4	31	289	14	58	101	144	188	231	260	317
4	32	289	14	58	101	144	188	231	260	317
5	27	26	1	5	9	13	17	20	23	28
5	28	26	1	5	9	13	17	20	23	28
5	29	84	4	17	29	42	55	67	76	92
5	30	176	9	35	62	88	114	141	158	194
5	31	137	7	27	48	68	89	109	123	150
5	32	137	7	27	48	68	89	109	123	150
6	18	1091	55	218	382	546	709	873	982	1200

NOTE:
See Figure 2 for node layout
OD data developed using the QUEENSOD model
Existing traffic volume refers to 1992 traffic volumes

Table 2-C4 (sheet 2 of 2)
Capital Beltway One AHS Lane Hourly OD Pairs

ORIGIN NODE	DESTINATION NODE	EXISTING VOLUME	VOLUME 5%	VOLUME 20%	VOLUME 35%	VOLUME 50%	VOLUME 65%	VOLUME 80%	VOLUME 90%	VOLUME 110%
7	19	2824	141	565	988	1412	1836	2259	2542	3106
7	27	20	1	4	7	10	13	16	18	22
7	28	20	1	4	7	10	13	16	18	22
7	29	75	4	15	26	38	49	60	68	83
7	30	172	9	34	60	86	112	138	155	189
7	31	137	7	27	48	69	89	110	123	151
7	32	137	7	27	48	69	89	110	123	151
8	20	329	16	66	115	165	214	263	296	362
8	27	61	3	12	21	31	40	49	55	67
8	28	61	3	12	21	31	40	49	55	67
8	29	157	8	31	55	79	102	126	141	173
8	30	262	13	52	92	131	170	210	236	288
8	31	188	9	38	66	94	122	150	169	207
8	32	188	9	38	66	94	122	150	169	207
9	21	1273	64	255	446	637	827	1018	1146	1400
10	22	1023	51	205	358	512	665	818	921	1125
10	30	64	3	13	22	32	42	51	58	70
10	31	97	5	19	34	48	63	77	87	106
10	32	97	5	19	34	48	63	77	87	106
11	23	2233	112	447	782	1117	1451	1786	2010	2456
11	27	139	7	28	48	69	90	111	125	152
11	28	139	7	28	48	69	90	111	125	152
11	29	313	16	63	110	157	203	250	282	344
11	30	439	22	88	154	220	285	351	395	483
11	31	295	15	59	103	147	191	236	265	324
11	32	295	15	59	103	147	191	236	265	324
12	24	333	17	67	117	167	216	266	300	366
12	27	42	2	8	15	21	27	33	37	46
12	28	42	2	8	15	21	27	33	37	46
12	29	63	3	13	22	32	41	50	57	69
12	30	266	13	53	93	133	173	213	239	293
12	31	227	11	45	79	113	147	181	204	249
12	32	227	11	45	79	113	147	181	204	249
13	25	3622	181	724	1268	1811	2354	2898	3260	3984
13	30	259	13	52	91	130	168	207	233	285
13	31	256	13	51	89	128	166	204	230	281
13	32	256	13	51	89	128	166	204	230	281
14	26	874	44	175	306	437	568	699	787	961
14	30	140	7	28	49	70	91	112	126	154
14	31	427	21	85	149	214	278	342	384	470
15	27	2259	113	452	791	1130	1468	1807	2033	2485
15	30	301	15	60	105	151	196	241	271	331
15	31	687	34	137	240	344	447	550	618	756
16	31	358	18	72	125	179	233	286	322	394

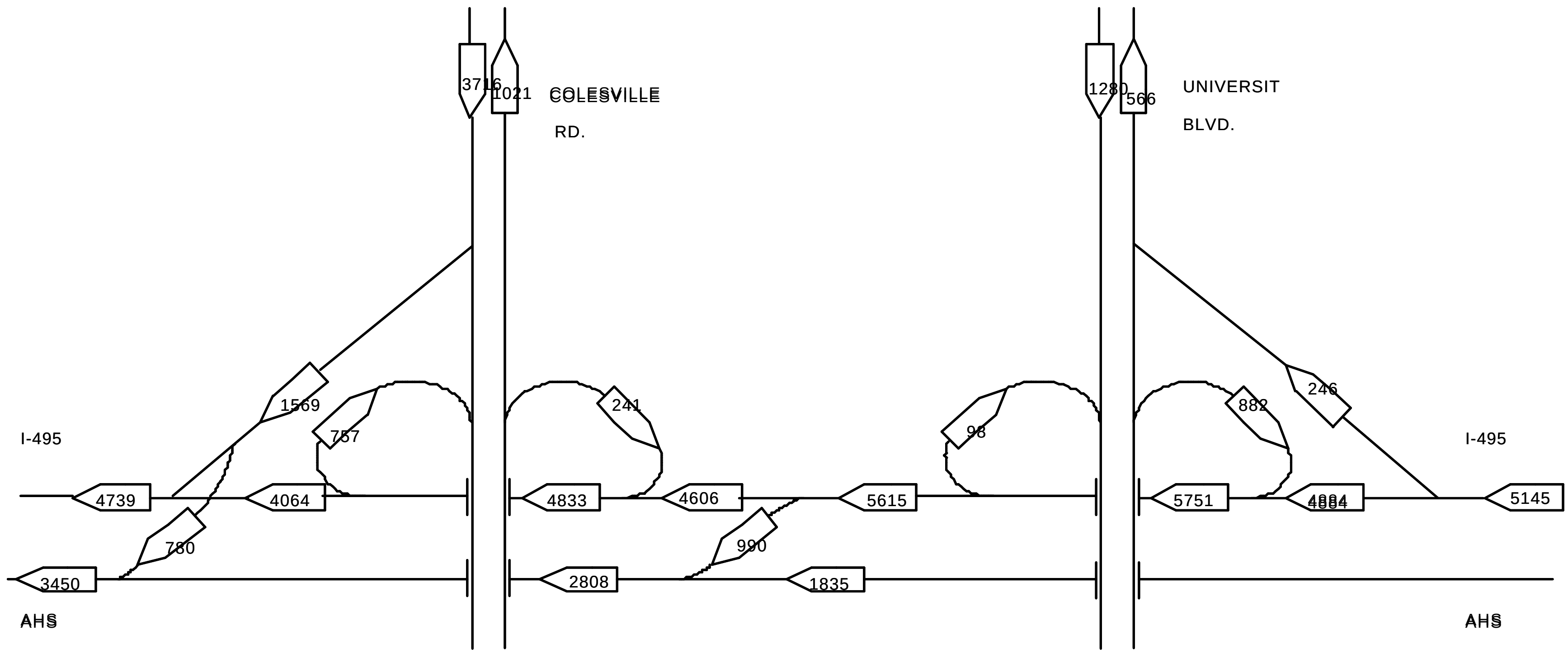
NOTE:
See Figure 2 for node layout
OD data developed using the QUEENSOD model
Existing traffic volume refers to 1992 traffic volumes



NOTE:

Existing volume distributed on

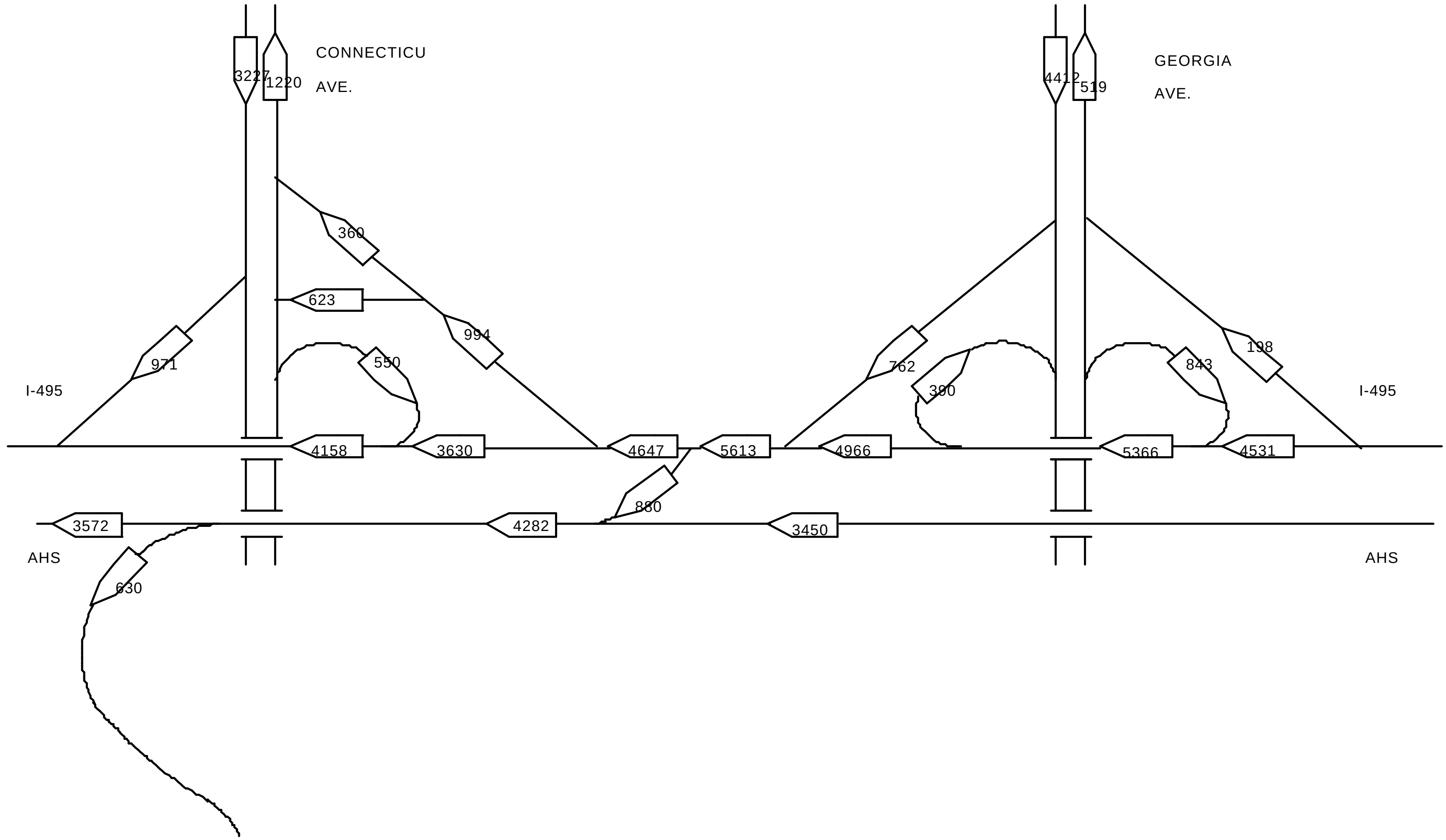
Figure 2-C3. Capital Beltway (I-495) Westbound With AHS Lane (sheet



NOTE:

Existing volume distributed on

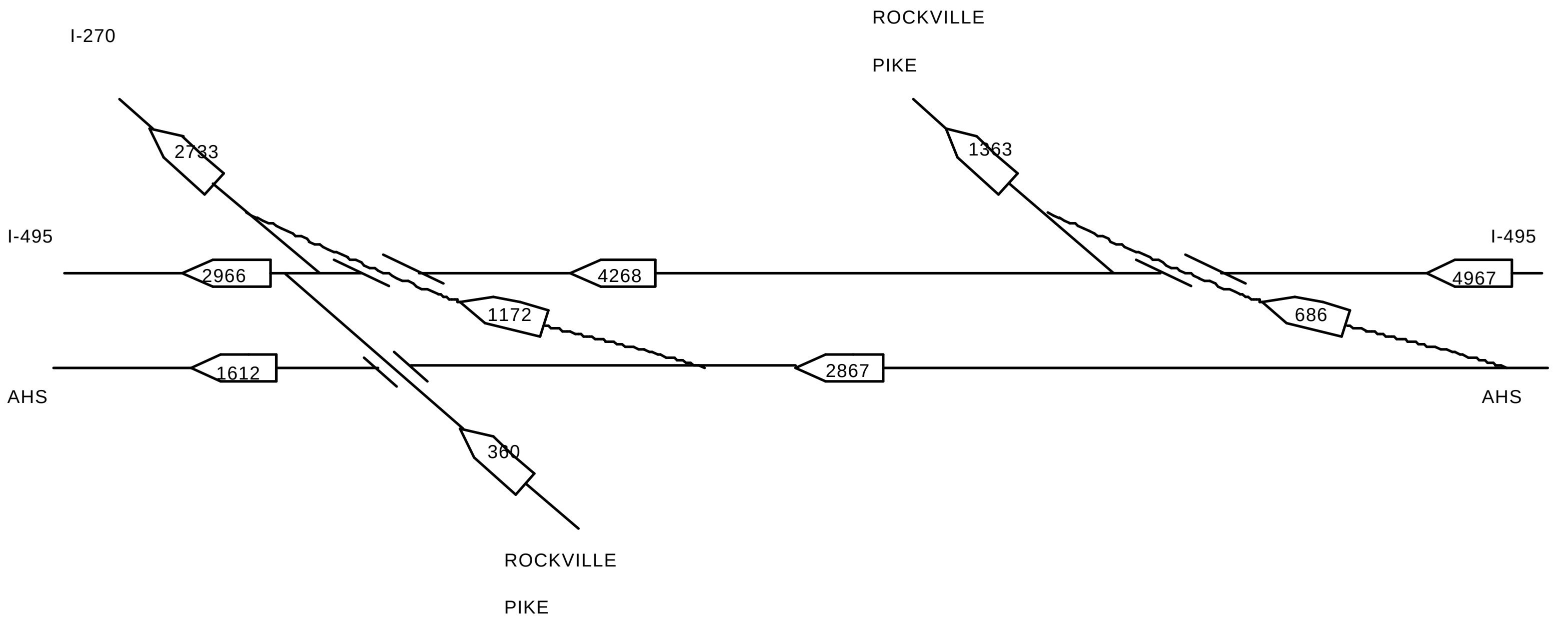
Figure 2-C3. Capital Beltway (I-495) Westbound With AHS Lane (sheet



NOTE:

Existing volume distributed on

Figure 2-C3. Capital Beltway (I-495) Westbound With AHS Lane (sheet



NOTE:

Existing volume distributed on

Figure 2-C3. Capital Beltway (I-495) Westbound With AHS Lane (sheet

Appendix D

Additional Details for New York State Thruway Case Study

Table 2-D1 provides the peak hour trip table OD volumes. Table 2-D2 and Figure 2-D1 represents the scenario flow model. Tables 2-D3 and 2-D4 provide the vehicle hours and throughput for the baseline condition. Tables 2-D5 and 2-D6 provide this data for the combined general lanes and 62 mi/hr AHS. Tables 2-D7 and 2-D8 provide this data for the 80 mi/hr AHS case.

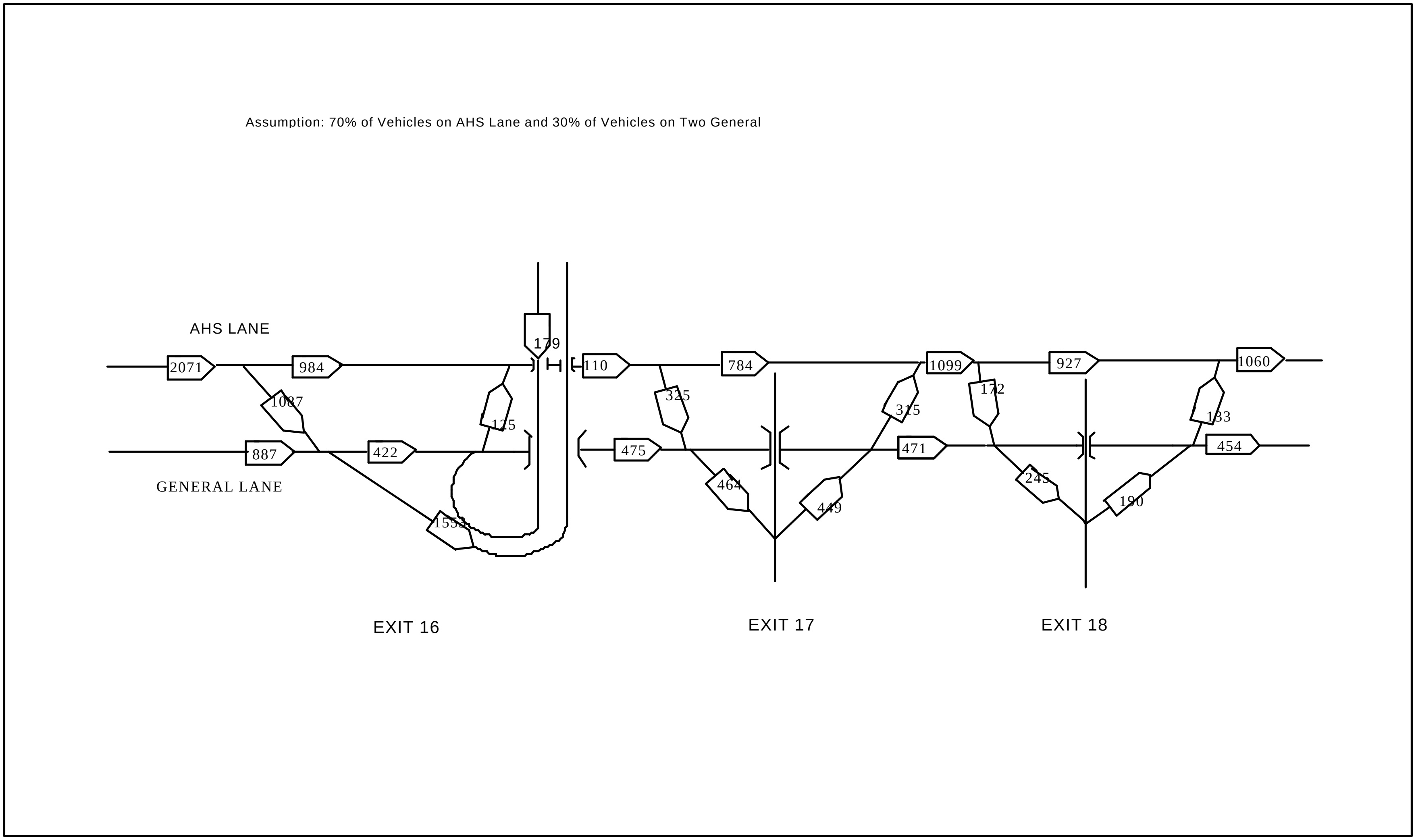


Figure 2-D1. N.Y.S. Thruway Traffic Flow Map (NB)

One AHS Lane and Two General Lanes

Table 2-D1.

N.Y.S Thruway Peak Hour OD Volume

Entry Volume	Exit Volume			
	Exit 16	Exit 17	Exit 18	Main Line After Exit 18
Main line before exit 16	1553	385	129	892
Exit 16		80	25	74
Exit 17			91	358
Exit 18				190

Table 2-D2. N.Y.S. Thruway Traffic Peak Hour Volumes
Existing Facility (Two Lanes) and AHS Facility (One AHS Lane & Two General Lanes)

Locations	Existing Network(2 Lanes)				AHS Network(1 AHS Lane & 2 General Lanes)			
	Ramp	Distance	Ramp Vol.	Thru. vol.	AHS Ramp Vol.	AHS Thru. Vol.	Gen. Ramp Vol.	Gen. Thru. vol.
				2958		2071		887
Exit 16	*Off Ramp*		-1553		-1087		-1553	
				1406		984		422
Exit 16	*On Ramp*		179		125		179	
		15 Mi		1584		1109		475
Exit 17	*Off Ramp*		-464		-325		-464	
				1120		784		336
Exit 17	*On Ramp*		449		315		449	
		16 Mi		1570		1099		471
Exit 18	*Off Ramp*		-245		-172		-245	
				1325		927		398
Exit 18	*On Ramp*		190		133		190	
				1514		1060		454

Note:

Negative volume represents exit volume.

2-D5

Table 2-D3.
N.Y.S. Thruway Existing Facility Veh-Hrs for Various Percentages of Existing Volume

Km	Vehicle-Hours							
	130%	125%	120%	115%	110%	100%	80%	60%
1.6	5752	5271	4857	4405	4073	3517	2608	1854
0.4	1022	979	932	886	838	755	589	432
0.6	712	683	659	623	598	536	423	310
0.4	509	490	474	449	430	389	309	229
3.6	4580	4423	4255	4057	3797	3429	2705	2007
4	4831	4622	4452	4288	3989	3664	2858	2148
4	4565	4429	4187	4052	3739	3476	2770	2047
4	4294	4199	3960	3852	3548	3308	2597	1955
4	4055	4000	3782	3640	3316	3110	2442	1870
2.6	2528	2496	2371	2274	2068	1944	1540	1163
0.4	372	367	350	336	307	290	231	176
1.26	820	810	785	745	670	646	505	387
0.4	406	398	381	364	336	315	249	189
3.6	3594	3557	3371	3174	2941	2740	2152	1636
4	3766	3688	3528	3306	3054	2852	2285	1726
4	3500	3426	3265	3096	2876	2648	2131	1626
4.31	3501	3420	3214	3117	2894	2688	2127	1643
0.4	263	252	245	239	219	207	168	133
1.26	708	666	641	615	570	538	433	346
0.4	281	265	255	246	229	215	173	137
3	2029	1915	1824	1775	1619	1546	1229	969
4	3005	2885	2767	2690	2535	2310	1834	1438
4	2758	2636	2551	2485	2276	2137	1720	1355
Veh-Mins	*57851*	*55877*	*53106*	*50714*	*46922*	*43260*	*34078*	*25776*
Veh-Hrs	*964.18*	*931.28*	*885.10*	*845.23*	*782.03*	*721.00*	*567.97*	*429.60*

Note:
This table is based on integration run.

Table 2-D4.

N.Y.S. Thruway Existing Facility Throughput for Various Percentages of Existing Volume

Km	130%		125%		120%		115%		110%		100%		80%		60%	
	Vol.	Veh-Km	Vol.	Veh-Km	Vol.	Veh-Km	Vol.	Veh-Km	Vol.	Veh-Km	Vol.	Veh-Km	Vol.	Veh-Km	Vol.	Veh-Km
1.6	3670	5872	3552	5683.2	3411	5457.6	3274	5238.4	3118	4988.8	2853	4564.8	2279	3646.4	1706	2729.6
0.4	3653	1461.2	3535	1414	3397	1358.8	3260	1304	3106	1242.4	2840	1136	2270	908	1698	679.2
0.6	1748	1048.8	1690	1014	1640	984	1559	935.4	1498	898.8	1359	815.4	1093	655.8	815	489
0.4	1967	786.8	1899	759.6	1843	737.2	1752	700.8	1679	671.6	1530	612	1227	490.8	918	367.2
3.6	1889	6800.4	1831	6591.6	1774	6386.4	1700	6120	1599	5756.4	1460	5256	1173	4222.8	886	3189.6
4	1804	7216	1734	6936	1681	6724	1625	6500	1521	6084	1411	5644	1121	4484	856	3424
4	1709	6836	1664	6656	1586	6344	1540	6160	1431	5724	1342	5368	1088	4352	817	3268
4	1611	6444	1579	6316	1502	6008	1465	5860	1359	5436	1278	5112	1022	4088	781	3124
4	1523	6092	1504	6016	1434	5736	1386	5544	1273	5092	1203	4812	962	3848	747	2988
2.6	1463	3803.8	1446	3759.6	1384	3598.4	1334	3468.4	1223	3179.8	1158	3010.8	934	2428.4	716	1861.6
0.4	1453	581.2	1438	575.2	1376	550.4	1326	530.4	1216	486.4	1152	460.8	928	371.2	712	284.8
1.26	1009	1271.34	997	1256.22	970	1222.2	923	1162.98	835	1052.1	808	1018.08	640	806.4	495	623.7
0.4	1575	630	1546	618.4	1487	594.8	1426	570.4	1319	527.6	1240	496	992	396.8	758	303.2
3.6	1501	5403.6	1486	5349.6	1420	5112	1349	4856.4	1256	4521.6	1176	4233.6	943	3394.8	726	2613.6
4	1420	5680	1393	5572	1342	5368	1269	5076	1179	4716	1106	4424	903	3612	691	2764
4	1324	5296	1298	5192	1246	4984	1191	4764	1112	4448	1030	4120	844	3376	652	2608
4.31	1231	5305.61	1205	5193.55	1143	4926.33	1114	4801.34	1040	4482.4	971	4185.01	783	3374.73	612	2637.72
0.4	1041	416.4	1000	400	972	388.8	951	380.4	876	350.4	828	331.2	679	271.6	541	216.4
1.26	867	1092.42	820	1033.2	791	996.66	763	961.38	712	897.12	673	847.98	550	693	443	558.18
0.4	1104	441.6	1045	418	1008	403.2	973	389.2	909	363.6	856	342.4	695	278	551	220.4
3	1037	3111	983	2949	941	2823	918	2754	846	2538	807	2421	653	1959	518	1554
4	1140	4560	1100	4400	1061	4244	1037	4148	981	3924	900	3600	728	2912	577	2308
4	1049	4196	1008	4032	980	3920	960	3840	886	3544	834	3336	683	2732	544	2176
Veh-Km		*84346.2*		*82135.2*		*78867.8*		*76065.5*		*70925*		*66147.1*		*53301.7*		*40988.2*
Veh-Mi		*52388.9*		*51015.6*		*48986.2*		*47245.7*		*44052.8*		*41085.1*		*33106.7*		*25458.5*

Note:

This table is based on integration run.

Table 2-D5.
N.Y.S. Thruway AHS Network Veh-Hrs for Various Percentages of Existing Volume

For AHS Speed of 62 Mi/Hr

Km	Vehicle-Hours							
	60%	80%	100%	110%	115%	120%	125%	130%
0.99	339	452	571	632	661	678	717	748
4.82	1971	2626	3266	3646	3811	4005	4104	4289
1	730	977	1239	1373	1452	1510	1579	1646
1	166	226	281	312	326	335	348	366
1	230	311	386	426	444	460	480	501
4.82	1870	2455	3084	3506	3645	3778	3877	4117
3	376	548	657	719	754	759	779	843
4	477	702	859	922	961	968	992	1082
4	453	675	815	880	912	934	946	1031
4	433	641	776	847	868	897	898	999
4	407	590	733	781	835	851	852	929
2	202	286	361	376	412	408	415	452
4.82	1775	2339	2898	3347	3457	3552	3694	3909
1	210	283	366	397	420	434	440	471
1.26	109	143	182	198	210	219	223	240
1	245	323	411	447	476	490	510	539
3	369	495	659	697	746	754	788	857
4	470	627	832	878	951	961	990	1089
4.55	507	682	883	933	1002	1032	1035	1167
2.05	190	247	336	350	376	381	397	430
4.55	468	622	820	870	938	952	963	1107
1	146	183	243	265	272	281	291	313
1.26	99	118	166	178	186	190	201	204
1	145	181	243	262	275	283	299	306
4.55	435	578	770	812	881	889	922	1005
2.4	228	269	379	402	424	437	462	471
4.302	1426	1955	2422	2666	2846	2927	3003	3115
4.82	1685	2187	2752	3153	3269	3373	3458	3670
4.97	1121	1428	1798	2064	2157	2171	2255	2330
5.11	1639	2063	2634	2922	3061	3143	3269	3389
5.5	940	1217	1560	1709	1890	1946	2025	3012
0.98	208	271	352	380	419	433	449	450
5.11	1538	1952	2403	2753	2876	2882	3066	3167
5.11	1424	1780	2265	2532	2661	2698	2885	2931
5.86	1464	1830	2393	2576	2794	2865	3009	3027
Veh-Mins	*24495*	*32262*	*40795*	*45211*	*47668*	*48876*	*50621*	*54202*
Veh-Hrs	*408.25*	*537.70*	*679.92*	*753.52*	*794.47*	*814.60*	*843.68*	*903.37*

Note:
This table is based on integration run.

Table 2-D6.
N.Y.S. Thruway AHS Network Throughput for Various Percentages of Existing Volume
For AHS Speed of 62 Mi/Hr

Km	60%		80%		100%		110%		115%		120%		125%		130%	
	Vol.	Veh-Km	Vol.	Veh-Km	Vol.	Veh-Km	Vol.	Veh-Km	Vol.	Veh-Km	Vol.	Veh-Km	Vol.	Veh-KM	Vol.	Veh-Km
0.99	560	554.4	743	735.57	934	924.66	1029	1018.71	1075	1064.25	1117	1105.83	1161	1149.39	1212	1199.88
4.82	681	3282.42	903	4352.46	1128	5436.96	1259	6068.38	1316	6343.12	1383	6666.06	1417	6829.94	1481	7138.42
1	1191	1191	1581	1581	1964	1964	2179	2179	2294	2294	2374	2374	2466	2466	2551	2551
1	275	275	373	373	464	464	514	514	537	537	553	553	574	574	603	603
1	381	381	513	513	635	635	701	701	730	730	757	757	788	788	823	823
4.82	646	3113.72	848	4087.36	1065	5133.3	1212	5841.84	1259	6068.38	1305	6290.1	1339	6453.98	1422	6854.04
3	208	624	303	909	363	1089	397	1191	416	1248	419	1257	430	1290	465	1395
4	198	792	291	1164	356	1424	382	1528	398	1592	401	1604	411	1644	448	1792
4	188	752	280	1120	338	1352	365	1460	378	1512	387	1548	392	1568	427	1708
4	180	720	266	1064	322	1288	351	1404	360	1440	372	1488	372	1488	414	1656
4	169	676	245	980	304	1216	324	1296	346	1384	353	1412	353	1412	385	1540
2	168	336	237	474	299	598	312	624	341	682	338	676	344	688	374	748
4.82	613	2954.66	808	3894.56	1001	4824.82	1156	5571.92	1194	5755.08	1127	5432.14	1276	6150.32	1350	6507
1	346	346	466	466	601	601	653	653	689	689	711	711	721	721	772	772
1.26	144	181.44	188	236.88	240	302.4	261	328.86	277	349.02	288	362.88	293	369.18	316	398.16
1	404	404	532	532	677	677	735	735	782	782	806	806	838	838	885	885
3	204	612	274	822	364	1092	385	1155	412	1236	416	1248	435	1305	473	1419
4	195	780	260	1040	345	1380	364	1456	394	1576	398	1592	410	1640	451	1804
4.55	185	841.75	249	1132.95	322	1465.1	340	1547	365	1660.75	376	1710.8	377	1715.35	425	1933.75
2.05	154	315.7	200	410	272	557.6	283	580.15	304	623.2	308	631.4	321	658.05	348	713.4
4.55	171	778.05	227	1032.85	299	1360.45	317	1442.35	342	1556.1	347	1578.85	351	1597.05	403	1833.65
1	241	241	303	303	400	400	436	436	448	448	462	462	478	478	514	514
1.26	131	165.06	156	196.56	219	275.94	234	294.84	245	308.7	250	315	264	332.64	269	338.94
1	240	240	299	299	402	402	432	432	454	454	467	467	494	494	504	504
4.55	159	723.45	211	960.05	281	1278.55	296	1346.8	321	1460.55	324	1474.2	336	1528.8	366	1665.3
2.4	158	379.2	186	446.4	262	628.8	278	667.2	293	703.2	302	724.8	319	765.6	325	780
4.302	552	2374.704	756	3252.312	936	4026.672	1030	4431.06	1099	4727.898	1130	4861.26	1159	4986.018	1202	5171.004
4.82	582	2805.24	755	3639.1	950	4579	1088	5244.16	1128	5436.96	1164	5610.48	1193	5750.26	1266	6102.12
4.97	376	1868.72	479	2380.63	603	2996.91	692	3439.24	723	3593.31	728	3618.16	756	3757.32	781	3881.57
5.11	534	2728.74	672	3433.92	858	4384.38	952	4864.72	997	5094.67	1024	5232.64	1065	5442.15	1104	5641.44
5.5	285	1567.5	369	2029.5	473	2601.5	518	2849	573	3151.5	590	3245	614	3377	610	3355
0.98	354	346.92	462	452.76	599	587.02	648	635.04	713	698.74	737	722.26	764	748.72	766	750.68
5.11	501	2560.11	636	3249.96	783	4001.13	897	4583.67	937	4788.07	939	4798.29	999	5104.89	1032	5273.52
5.11	464	2371.04	580	2963.8	738	3771.18	825	4215.75	867	4430.37	879	4491.69	940	4803.4	955	4880.05
5.86	416	2437.76	520	3047.2	680	3984.8	732	4289.52	794	4652.84	814	4770.04	855	5010.3	860	5039.6
Veh-Km		*40720.6*		*53574.8*		*67723.2*		*75024.2*		*79070.7*		*80596.9*		*83924.4*		*88171.5*
Veh-Mi		*25292.3*		*33276.3*		*42064.1*		*46598.9*		*49112.2*		*50060.2*		*52126.9*		*54764.9*

Note:
This table is based on integration run.

Table 2-D7.

N.Y.S. Thruway AHS Network Veh-Hr for Various Percentages of Existing Volume

For AHS Speed of 80 Mi/Hr

Km	Vehicle-Hours							
	60%	80%	100%	110%	115%	120%	125%	130%
0.99	339	452	571	632	661	678	716	749
4.82	1556	2054	2580	2885	3036	3146	3252	3393
1	731	987	1239	1373	1453	1512	1581	1647
1	166	226	281	311	326	335	348	366
1	230	311	385	426	444	460	480	501
4.82	1486	1973	2478	2804	2909	3050	3102	3275
3	376	546	657	721	754	759	779	843
4	477	699	859	922	961	968	992	1082
4	453	673	815	880	912	934	946	1031
4	433	641	776	847	868	897	898	999
4	407	590	733	781	835	851	852	929
2	202	286	361	376	412	409	415	452
4.82	1439	1874	2375	2705	2815	2893	2990	3169
1	219	295	373	410	435	450	458	489
1.26	109	143	182	198	210	219	223	240
1	245	323	411	447	476	490	510	539
3	369	495	659	695	746	754	788	857
4	470	627	832	876	951	961	990	1089
4.55	507	682	883	933	1002	1092	1035	1167
2.05	190	247	336	350	376	381	397	430
4.55	468	622	820	870	938	952	963	1107
1	157	190	256	279	287	290	307	327
1.26	99	118	166	178	186	190	201	204
1	145	181	243	262	275	283	299	306
4.55	435	578	770	812	881	889	922	1005
2.4	228	269	379	402	424	437	462	471
4.302	1123	1956	1908	2097	2226	2300	2361	2451
4.82	1383	1787	2253	2602	2704	2754	2886	3046
4.97	931	1200	1505	1725	1792	1815	1896	2005
5.11	1354	1713	2165	2461	2537	2620	2725	2830
5.5	905	1146	1473	1655	1775	1770	1903	1916
0.98	193	248	320	353	377	384	408	415
5.11	1294	1620	2065	2337	2427	2486	2620	2643
5.11	1237	1554	1989	2208	2284	2360	2472	2534
5.86	1326	1689	2090	2398	2499	2508	2658	2745
Veh-Mins	*21682*	*28995*	*36188*	*40211*	*42194*	*43277*	*44835*	*47252*
Veh-Hrs	*361.37*	*483.25*	*603.13*	*670.18*	*703.23*	*721.28*	*747.25*	*787.53*

Note:
This table is based on integration run.

Table 2-D8.

N.Y.S. Thruway AHS Network Throughput for Various Percentages of Existing Volume

For AHS Speed of 80 Mi/Hr

Km	60%		80%		100%		110%		115%		120%		125%		130%	
	Vol.	Veh-Km	Vol.	Veh-Km	Vol.	Veh-Km	Vol.	Veh-Km	Vol.	Veh-Km	Vol.	Veh-Km	Vol.	Veh-Km	Vol.	Veh-Km
0.99	560	554.4	743	735.57	934	924.66	1029	1018.71	1075	1064.25	1117	1105.83	1161	1149.39	1213	1200.87
4.82	693	3340.26	915	4410.3	1149	5538.18	1285	6193.7	1352	6516.64	1404	6767.28	1448	6979.36	1511	7283.02
1	1192	1192	1581	1581	1984	1984	2180	2180	2294	2294	2375	2375	2466	2466	2552	2552
1	275	275	373	373	464	464	514	514	537	537	553	553	574	574	603	603
1	381	381	513	513	634	634	701	701	730	730	757	757	788	788	823	823
4.82	662	3190.84	879	4236.78	1104	5321.28	1249	6020.18	1296	6246.72	1359	6550.38	1382	6661.24	1459	7032.38
3	208	624	302	906	363	1089	398	1194	416	1248	419	1257	430	1290	465	1395
4	198	792	290	1160	356	1424	382	1528	398	1592	401	1604	411	1644	448	1792
4	188	752	279	1116	338	1352	365	1460	378	1512	387	1548	392	1568	427	1708
4	180	720	266	1064	322	1288	351	1404	360	1440	372	1488	372	1488	414	1656
4	169	676	245	980	304	1216	324	1296	346	1384	353	1412	353	1412	385	1540
2	168	336	237	474	299	598	312	624	341	682	339	678	344	688	374	748
4.82	641	3089.62	835	4024.7	1058	5099.56	1205	5808.1	1254	6044.28	1289	6212.98	1332	6420.24	1412	6805.84
1	361	361	486	486	614	614	674	674	715	715	738	738	751	751	802	802
1.26	144	181.44	188	236.88	240	302.4	261	328.86	277	349.02	288	362.88	293	369.18	316	398.16
1	404	404	532	532	677	677	735	735	782	782	806	806	838	838	885	885
3	204	612	274	822	364	1092	384	1152	412	1236	416	1248	435	1305	473	1419
4	195	780	260	1040	345	1380	363	1452	394	1576	398	1592	410	1640	451	1804
4.55	185	841.75	249	1132.95	322	1465.1	340	1547	365	1660.75	375	1706.25	377	1715.35	425	1933.75
2.05	154	315.7	200	410	272	557.6	283	580.15	304	623.2	308	631.4	321	658.05	348	713.4
4.55	171	778.05	227	1032.85	299	1360.45	317	1442.35	342	1556.1	347	1578.85	351	1597.05	403	1833.65
1	259	259	314	314	421	421	459	459	472	472	478	478	506	506	537	537
1.26	131	165.06	156	196.56	219	275.94	234	294.84	245	308.7	250	315	264	332.64	269	338.94
1	240	240	299	299	402	402	432	432	454	454	467	467	494	494	504	504
4.55	159	723.45	211	960.05	281	1278.55	296	1346.8	321	1460.55	324	1474.2	336	1528.8	366	1665.3
2.4	158	379.2	186	446.4	262	628.8	278	667.2	293	703.2	302	724.8	319	765.6	325	780
4.302	560	2409.12	756	3252.312	949	4082.598	1042	4482.684	1105	4753.71	1141	4908.582	1170	5033.34	1214	5222.628
4.82	616	2969.12	796	3836.72	1003	4834.46	1158	5581.56	1203	5798.46	1225	5904.5	1284	6188.88	1355	6531.1
4.97	403	2002.91	519	2579.43	651	3235.47	746	3707.62	775	3851.75	785	3901.45	820	4075.4	867	4308.99
5.11	569	2907.59	720	3679.2	910	4650.1	1034	5283.74	1066	5447.26	1101	5626.11	1145	5850.95	1189	6075.79
5.5	354	1947	448	2464	576	3168	647	3558.5	694	3817	692	3806	744	4092	749	4119.5
0.98	424	415.52	544	533.12	703	688.94	776	760.48	829	812.42	842	825.16	896	878.08	910	891.8
5.11	544	2779.84	681	3479.91	868	4435.48	982	5018.02	1020	5212.2	1045	5339.95	1101	5626.11	1111	5677.21
5.11	520	2657.2	653	3336.83	836	4271.96	928	4742.08	960	4905.6	992	5069.12	1039	5309.29	1065	5442.15
5.86	486	2847.96	619	3627.34	766	4488.76	879	5150.94	916	5367.76	919	5385.34	974	5707.64	1006	5895.16
Veh-Km		*42900*		*56271.9*		*71243.3*		*79338.5*		*83153.6*		*85197.1*		*88390.6*		*92917.6*
Veh-Mi		*26646*		*34951.5*		*44250.5*		*49278.6*		*51648.2*		*52917.4*		*54901*		*57712.8*

Note:

This table is based on integration run.

Appendix E

Simulation Methodology Used for Case Study Evaluation

This appendix describes the simulation methodology using the INTEGRATION model to evaluate the Capital Beltway I-495 case study. This model and similar techniques were used to evaluate the other three case studies.

The tool utilized to analyze the Capital Beltway scenarios was the INTEGRATION computer simulation model, developed at Waterloo and Queen's Universities in cooperation with the Ontario Ministry of Transportation. The INTEGRATION model combines the ability to simulate deterministic traffic flow with the ability to replicate dynamic route choice behavior (traffic assignment). This allows the users to study the long-term effects of alternative scenarios on similar facilities and surrounding street system. Also, instantaneous traffic diversion in reaction to prevailing conditions, and the provision of real-time route information to drivers can be studied. The INTEGRATION model can represent several different types of users, each having different access to real-time information.

INTEGRATION has five vehicle types that may be used in simulation. Table 2-E1 contains descriptions of these five vehicle types (Van Aerde 1994). Type 5 vehicles, special facility users, can be considered as AHS vehicles, and links in the network can be coded as AHS links. In this way, only AHS vehicles can use these AHS links. Modeling Type 5 vehicles as AHS provides a way of distributing traffic flow only, however, other unique AHS characteristics can only be simulated in a simplistic manner. An additional feature of Type 5 vehicles is that they can also be given the route choice capabilities of type 2 vehicles and can choose the shortest route to their destination which may include both AHS and non-AHS lanes. The quality of information received by every vehicle type may be varied by using two parameters. One parameter determines the frequency, in seconds, that information is updated. The other parameter controls the error introduced into the information update.

There are five required and four optional input files to the INTEGRATION model. These nine input files are listed in Table 2-E2. To model the existing beltway scenario only input files 1 to 5 were required. To determine the input necessary for these files, the study area was broken up into link-node segments as illustrated in Figures 2-C1 and 2-C2 in Appendix C. The links represent roads

Table 2-E1. The Five Vehicle Types Of INTEGRATION

Vehicle Type	Description
1	Background Vehicles - Route choice based on free flow speed unless historic information or specified path trees are provided.
2	Guided Vehicles - Have access to real-time information at every node or at selected locations on which to base their route choice.
3	Drivers with Anticipatory Knowledge - Can use both real-time information and historical information.
4	Trav-Tek Vehicles - Have advanced route guidance systems within the vehicle.
5	Special Facility Users - Have exclusive access to selected links in the network (i.e. AHS vehicles). Can base route choice on specified path trees or on real-time information.

Note: Vehicle type 1 and type 5 utilized in Beltway AHS study.

Table 2-E2. Input Files Of INTEGRATION

Input File	Description
1 (required)	Node File - Specifies x and y coordinates of all nodes in the network for purposes of graphical display.
2 (required)	Link File - Contains start and end nodes and physical characteristics of the links.
3 (required)	Signal File - Signal timing plans.
4 (required)	Origin-Destination Traffic Demand File - Specifies demand rates for all OD pairs for each time slice.
5 (required)	Incident File - Includes length, severity and location of any incidents during the simulation.
6 (optional)	Average Travel Times File - Provides average travel times for all links for use as historical information.
7 (optional)	Time Series of Anticipated Travel Times - The same as file 6 except that travel time information is given for each user-specified time slice.
8 (optional)	Static Path Tree File - This file has the user-specified path trees for type 5 vehicles.
9 (optional)	Time Series of Multipath Background Traffic Routings - The same as file 8 but used for type 1 vehicles.

Note: Optional Input File 8 used to specify AHS vehicle route.

and are assigned characteristics to identify the quality and type of the facility. The characteristics of each link are listed in Tables 2-C1 and 2-C2 in Appendix C. This information was input into the Link file.

The Signal file was used to provide timing plans for the signalized intersections. Both signalized intersections modeled in this study were treated as isolated intersections. The method of signal timing utilized was an automatic signal re-timing plan. This procedure allocates green time based on the approach's volume/saturation flow ratios, according to procedures specified in the Canadian Capacity Guide. This method of signal timing, modeled within INTEGRATION, works best for isolated signals. This option was also chosen because the OD demands were varied over a great range from scenario to scenario.

The OD breakdown for the study area was required for input file number 4. The OD breakdown was developed using the QUEENSOD model. The QUEENSOD model estimates OD traffic demands based on observed link traffic flow, link travel times, and drivers' route choices. QUEENSOD is a supporting model for the INTEGRATION model and shares the same data file structures and formats. The input files for the QUEENSOD model are listed in Table 2-E3.

The OD data developed for the study area (see Table 2-C3 of Appendix C) is for the existing beltway scenario. This OD was factored using a spreadsheet to produce OD data for different percentage trips as illustrated in Table 2-C3 of Appendix C. The percentage of OD usage was entered into the OD pairs file of the INTEGRATION model to run each scenario. The main thrust of this analysis is to investigate the performance of an AHS on the Capital Beltway. The AHS design concept involves a one lane AHS system separate from the traditional freeway system. To provide the AHS lane, one general use lane was assumed to be converted to an exclusive AHS lane. The operation of the AHS lane is assumed to be totally controlled with a "hands-off" and "feet-off" operation. The removal of the human from the vehicle operations loop allows for a simplistic simulation of the AHS lane. This means that as long as the capacity or speed on the AHS lane is not exceeded it would operate at level of service (LOS) A. Therefore, if the traffic volume on the AHS is kept below capacity it can be inferred that the AHS would function at optimal speed.

Table 2-E3. Input Files Of QUEENSOD

Input File	Description
1 (required)	Node File - Specifies x and y coordinates of all nodes in the network for purposes of graphical display.
2 (required)	Link File - Contains start and end nodes and physical characteristics of the links.
3 (optional)	Actual OD file - Specifies the actual OD demand for comparison with the estimated OD demand.
4 (optional)	Seed OD file - Specifies the initial OD demand matrix to maximize errors between the resulting link flows and the observed link flows.
5 (required)	Link traffic flow file - Link traffic flow and travel time information.
6 (required)	Path utilized by traffic - This file contains the paths utilized on the network.
7 (optional)	Link flow reliability factors - Specifies the reliability of the link flow data utilized in file 5.
15 (optional)	Seed demand reliability file - Specifies the accuracy of the seed matrix utilized in file 4.

To develop the AHS scenario to be modeled, layout and link node diagrams were developed as shown in Figures 2-C1 and 2-C2 of Appendix C. The AHS layout (placement of AHS entry and exit ramps) was developed by heuristically analyzing the ODs such that maximum AHS utilization is achieved with the fewest AHS entry and exit locations. The OD table developed for the existing Capital Beltway was appropriately modified to allow AHS equipped vehicles to utilize the AHS facility. The low ramp volumes and high through volumes observed on the existing facility and as indicated by the existing ODs, provided the basis for the AHS design. One AHS lane with AHS access ramps in the beginning of the study area and egress ramps at the latter portion of the study area proved to be adequate for the traffic distribution. I3 AHS access and egress ramps were placed to provide easy utilization of the AHS lane at points of heavy entry and exit flow to the Beltway. Additional I2 ramps were placed to provide access by the cumulative inflow of traffic volumes from low volume on-ramps.

The Capital Beltway scenario assumed a 50 percent MP. Therefore, at each AHS entry point only 50 percent of the vehicles with OD pairs that allowed use of the AHS lane are permitted in the AHS lane. To provide an effective split on the network the vehicles were divided into type 1 and type 5 vehicles. The AHS facility was modeled to be out of bounds for the type 1 vehicles and the type 5 vehicles were directed to the AHS facility at the closest entry point. The path of the type 5 vehicles were ensured by using Input file 8 (Table 2-E2) to specify the vehicle path through the network.

The hourly volume flow on the AHS lane was monitored to confirm it was always below the useable AHS lane capacity of 4500 vehicles/hr to allow for smooth operation. The AHS ramp volumes were all monitored to operate below 1400 vehicles/hr.

It should be noted that the model assigns traffic in a stochastic manner and that the number of vehicles generated in the simulation often differs slightly from what is specified in the OD file. As a result of this, the percentage of AHS vehicles and traditional vehicles in the simulation often differed slightly from the desired amount. For reasons of clarity, OD percent referred to in the analysis give the desired percentage, not the actual percentages. Also, the model's account of potential weaving problems with the I2 configuration is unclear. These weaving problems may occur between right side entrance and exit ramps for the general use expressway ramps, and the left side entrance and exit ramps for the AHS facility. The weaving problems that arise between expressway ramps and the I2 ramps are reduced by providing an adequate distance between these two ramp types.

Modeling Limitations

The INTEGRATION modeling analysis conducted in this study considered mainline traffic flow and manipulated existing volumes to represent variations in road use. The following is a list of additional analyses that were not considered with the INTEGRATION model.

- In a detailed planning study roadways that run parallel to the study area must be considered for any impact because of AHS implementation. The study areas of the Capital Beltway (I-495), Boston I-93, and the New York State Thruway did not have any major roadways in close proximity running parallel for a significant fraction of the AHS length. However, on roadways which are currently congested, some fraction of motorists utilize a series of non major roadways to form networks of parallel roadways. This could only be determined from additional areawide analysis. It is likely that some commuters on the Capital Beltway and Boston I-93 who use this route on a daily basis might use alternate parallel routes when the roadway becomes congested. The availability of the AHS facility with decreased travel times would certainly attract vehicles from these parallel roadways and thus increase the volume and vehicular demand on the combined AHS/General Use Expressway facility. While the INTEGRATION modeling included higher volumes than the baseline condition, the higher demand was an assumed percentage increase and not a dynamic modeling of trip attraction.
- MP of AHS equipped vehicles could impact on the utilization of the AHS facility in unpredictable ways; therefore, some consideration of MP must be made especially when a larger study area that considers parallel roadways is being analyzed. Additionally, the relationship between MP and socioeconomic factors should be considered in this analysis.
- The additional capacity of the AHS facility could generate additional trips. Additional trip generation could, also, be affected by the MP because MP would affect the capacity available on the AHS facility.

Appendix F

LIE Cross-Section Illustrations

This Appendix illustrates the cross-sections developed for the RSCs I2 and I3 options on the LIE. Construction and rights of way requirements are indicated on the diagrams.

2-F2

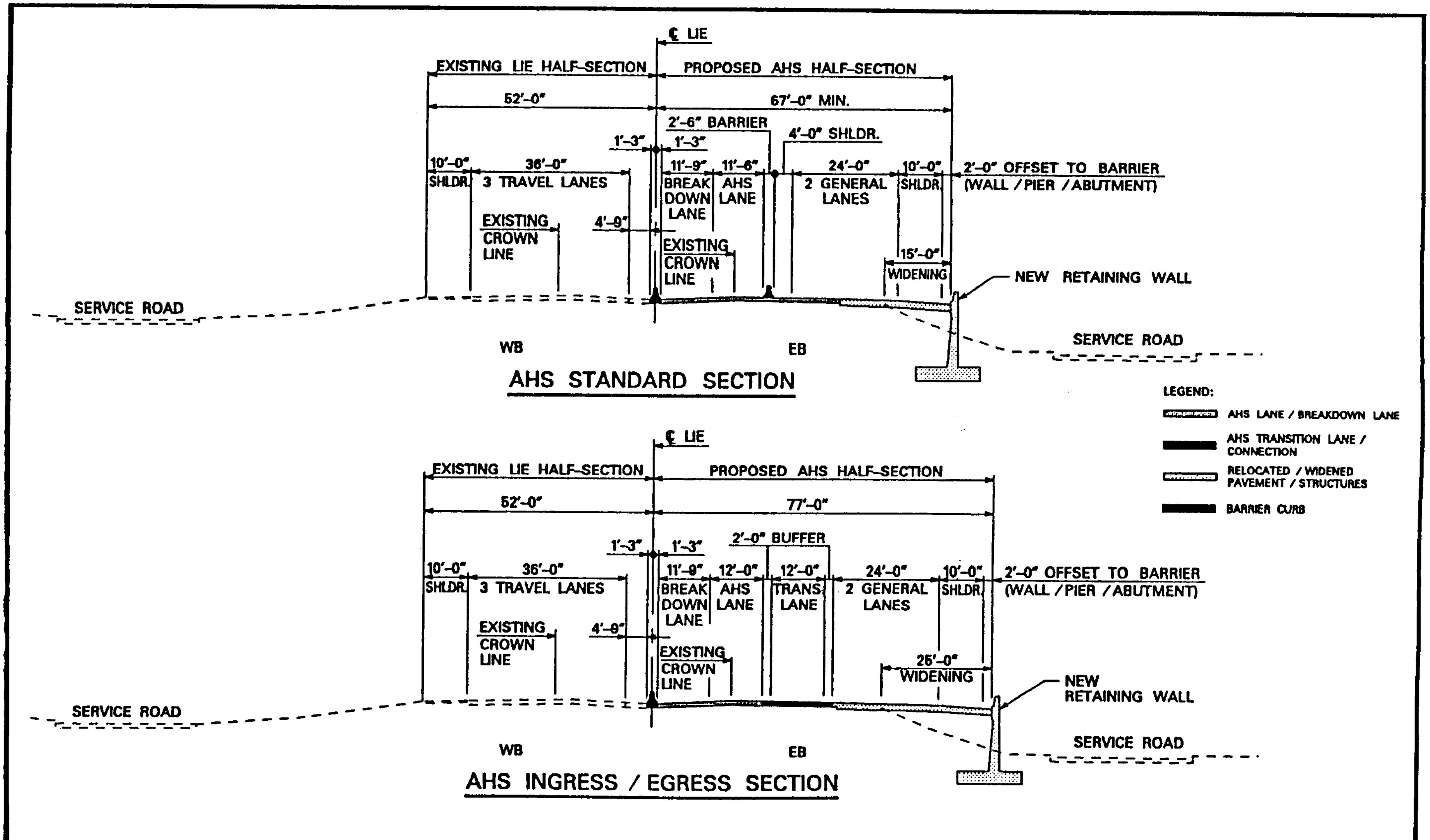


FIGURE 2 – F1	LONG ISLAND EXPRESSWAY SCENARIO AUTOMATED HIGHWAY SYSTEM (AHS)	I-2 / I-3 CONCEPT STUDY (LIE EASTBOUND DIRECTION ONLY) AHS MINIMUM TYPICAL SECTIONS – AREA 1 CROSS ISLAND PARKWAY TO JERICHO TURNPIKE

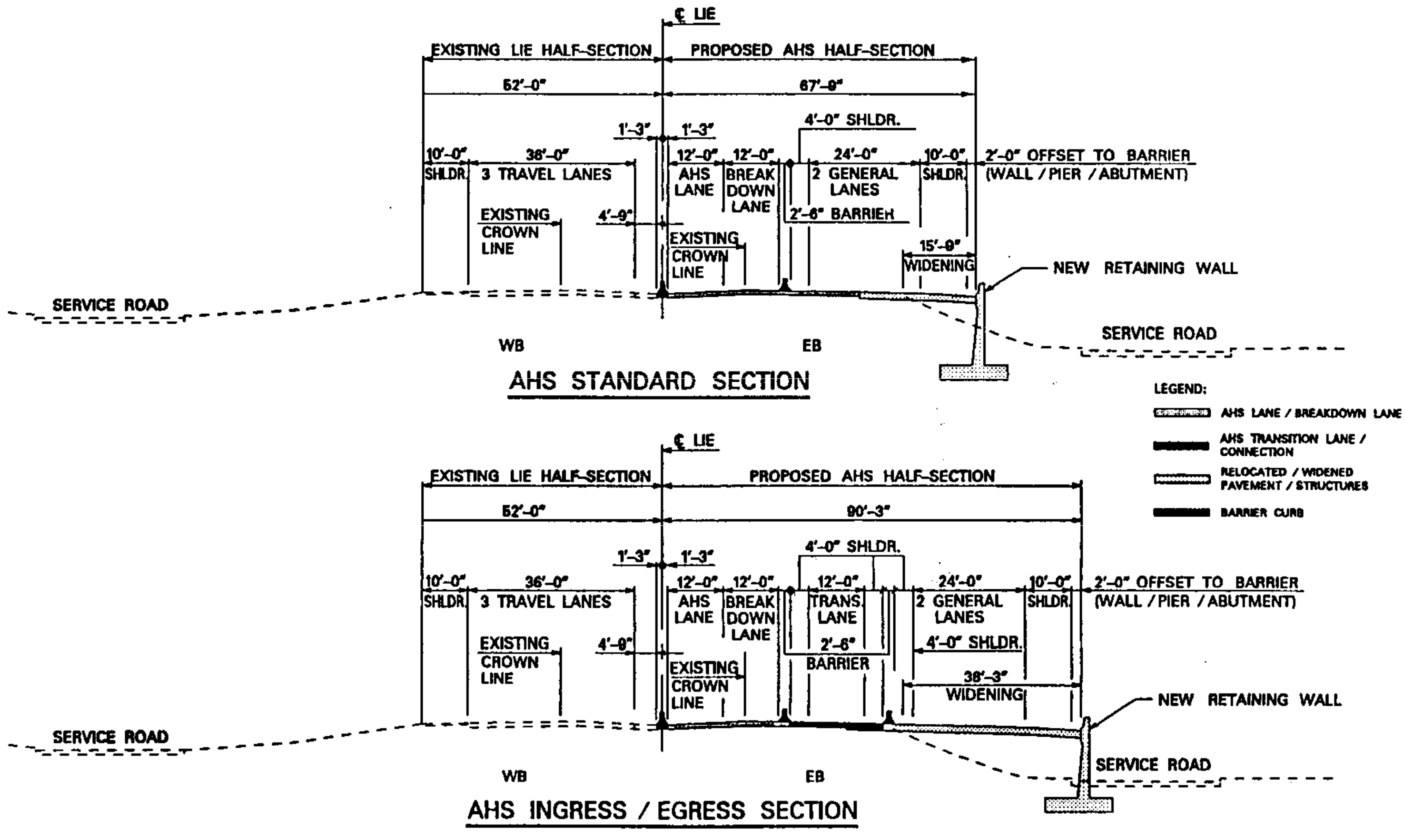


FIGURE 2 – F2	LONG ISLAND EXPRESSWAY SCENARIO AUTOMATED HIGHWAY SYSTEM (AHS)	I-2 / I-3 CONCEPT STUDY (LIE EASTBOUND DIRECTION ONLY) AHS DESIRED TYPICAL SECTIONS – AREA 1 CROSS ISLAND PARKWAY TO JERICHO TURNPIKE

2-F4

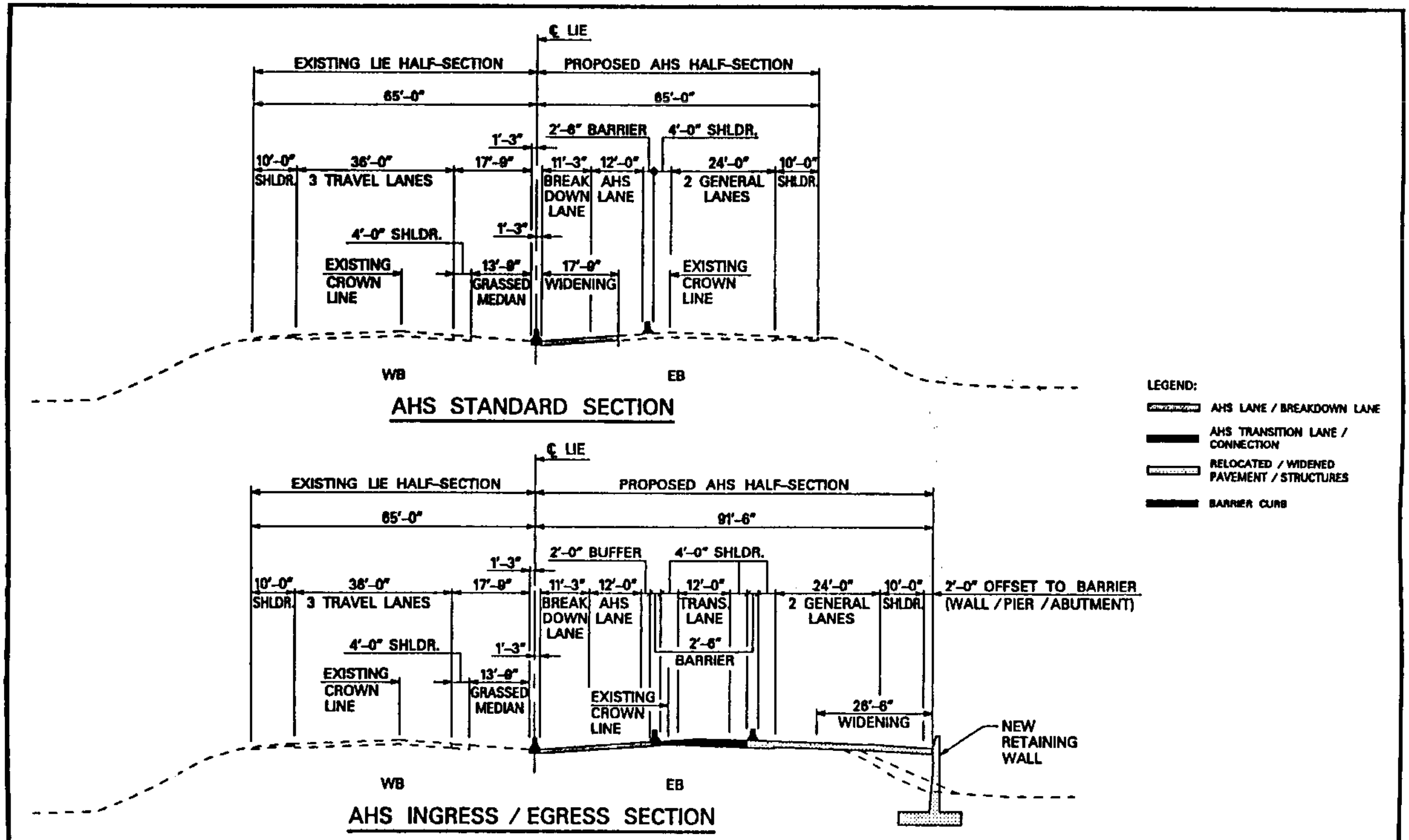


FIGURE 2 – F3	LONG ISLAND EXPRESSWAY SCENARIO AUTOMATED HIGHWAY SYSTEM (AHS)	I-2 / I-3 CONCEPT STUDY (LIE EASTBOUND DIRECTION ONLY) AHS TYPICAL SECTIONS – AREA 2 JERICHO TURNPIKE TO SEAFORD / OYSTER BAY EXPRESSWAY

Appendix G

Typical RSCs I2 and I3 Layout

This Appendix illustrates the layout of ingress/egress of the RSCs I2 and I3. The I2 option utilizes the general lanes as collector/distributors. The I3 option utilizes the service roads and the general lanes as collector/distributors. A variety of similar options are indicated for the RSC I3 option.

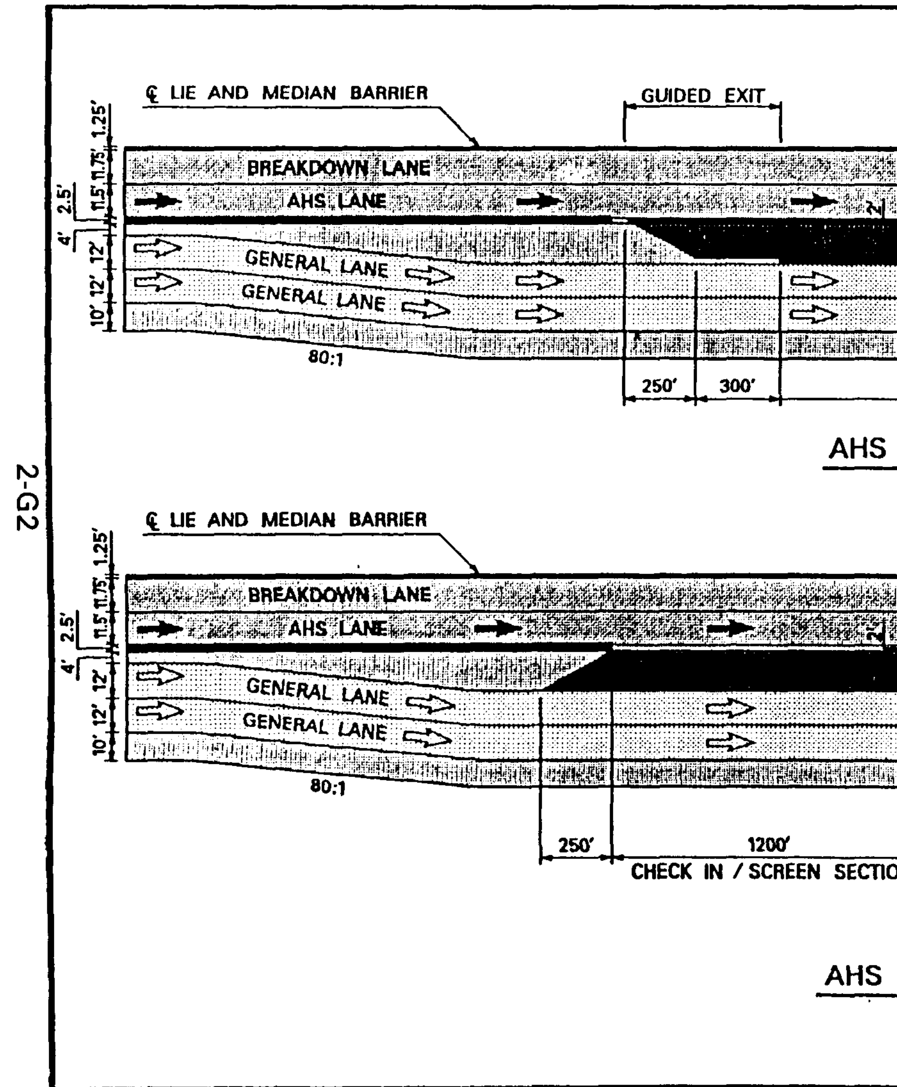


FIGURE 2 – G1

LONG ISLAND
AUTOMATED H

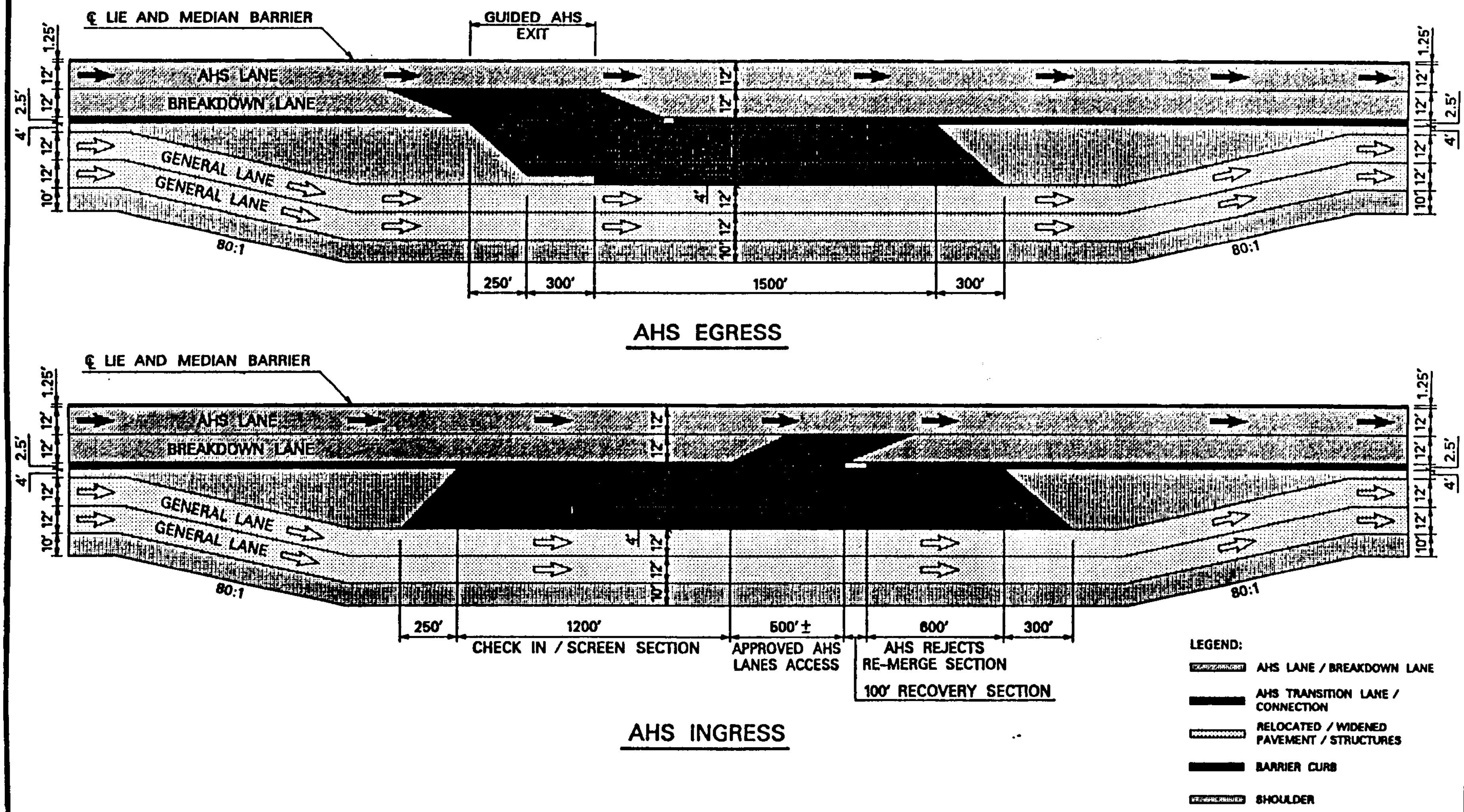


FIGURE 2 – G2	LONG ISLAND EXPRESSWAY SCENARIO AUTOMATED HIGHWAY SYSTEM (AHS)	I-2 CONCEPT STUDY (LIE EASTBOUND DIRECTION ONLY) AHS DESIRED INGRESS / EGRESS SCHEMATICS – AREA 1 CROSS ISLAND PKWY. TO JERICHO TPK.

2G-4

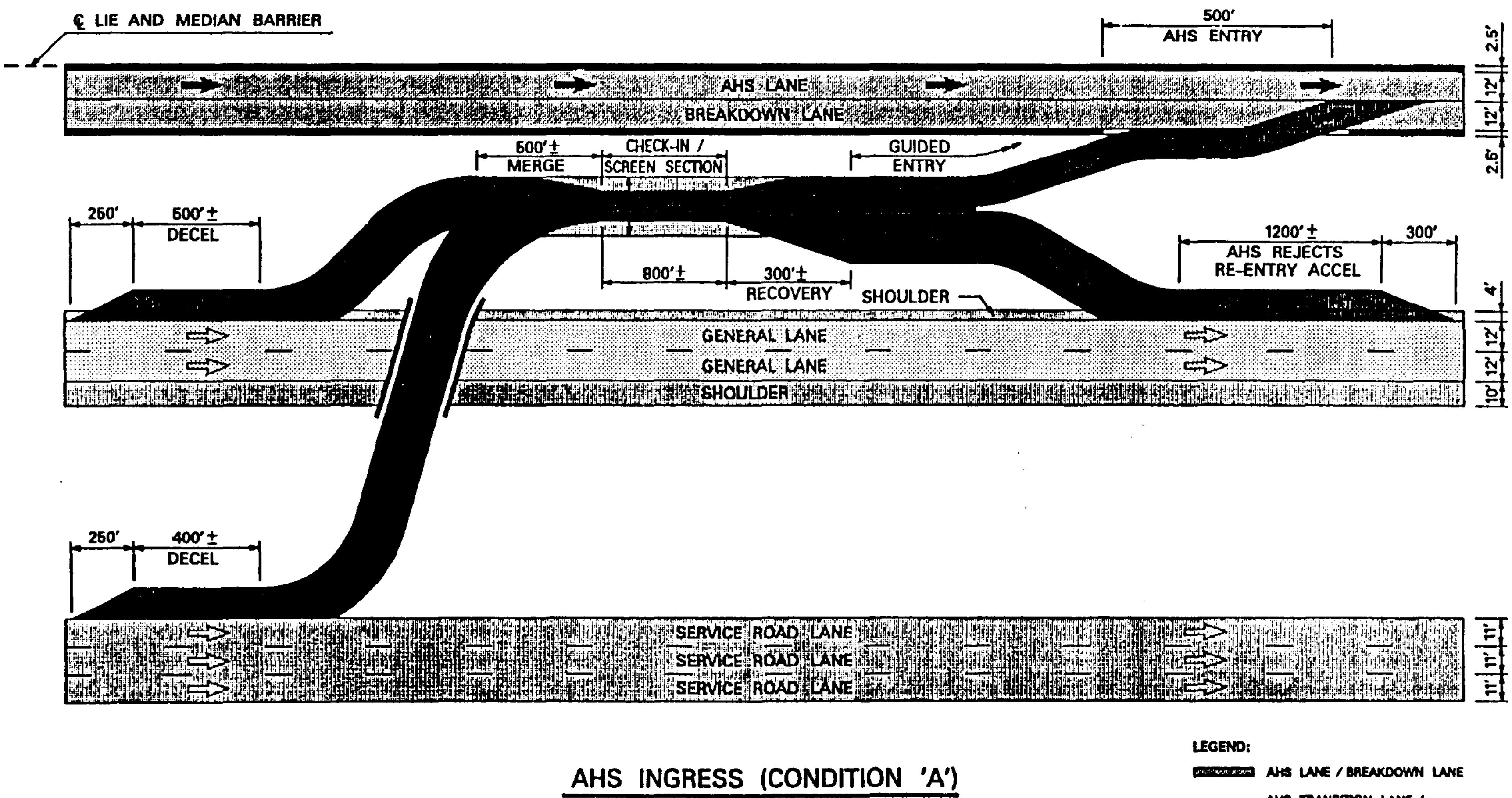


FIGURE 2 – G3

LONG ISLAND EXPRESSWAY SCENARIO
AUTOMATED HIGHWAY SYSTEM (AHS)

I-3 CONCEPT STUDY
(LIE EASTBOUND DIRECTION ONLY)

AHS INGRESS SCHEMATIC – AREAS 1 AND 2
CROSS ISLAND PARKWAY TO SEAFORD / OYSTER BAY EXPRES

2G-5

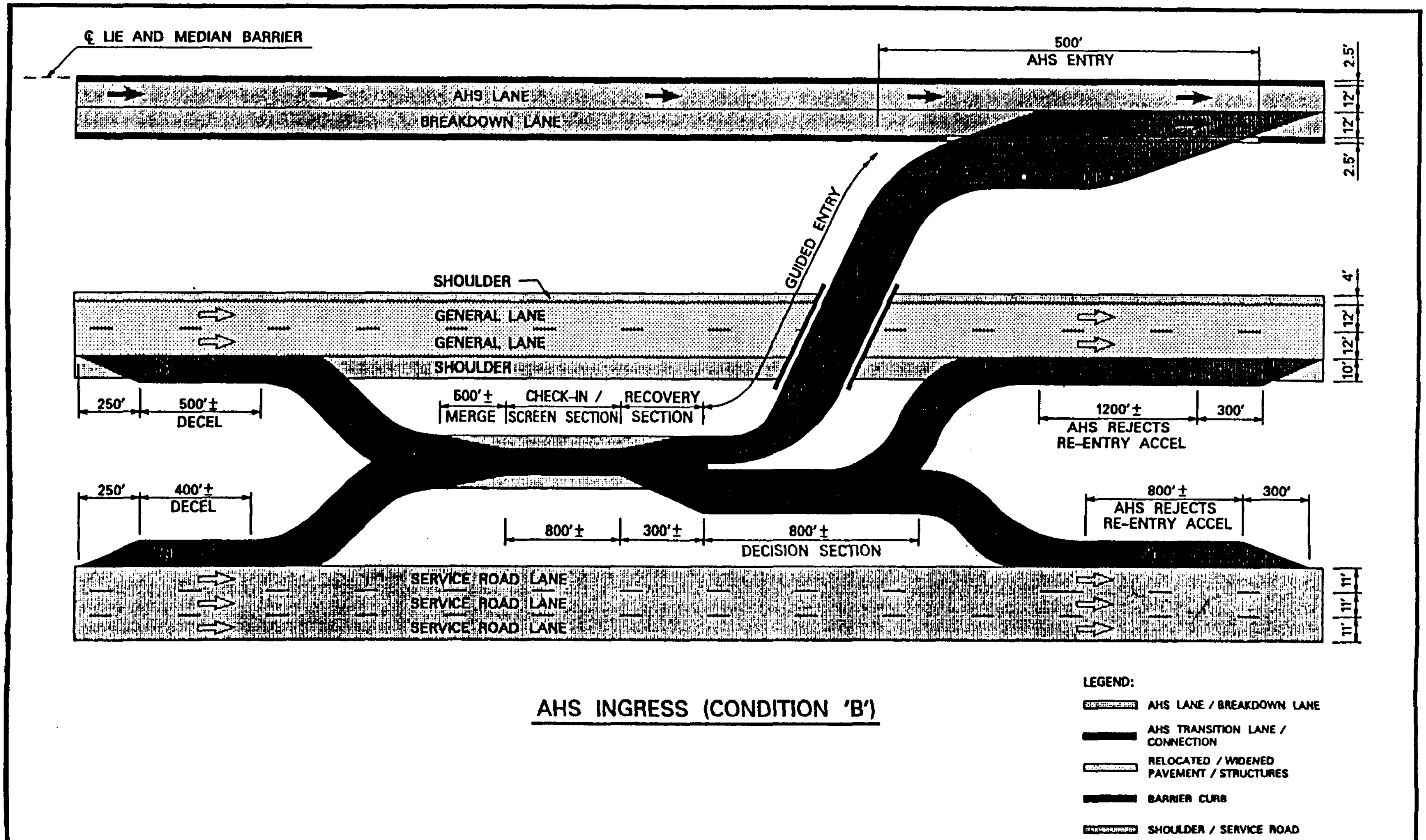


FIGURE 2 – G4

LONG ISLAND EXPRESSWAY SCENARIO
AUTOMATED HIGHWAY SYSTEM (AHS)

I-3 CONCEPT STUDY
(LIE EASTBOUND DIRECTION ONLY)

AHS INGRESS SCHEMATIC – AREAS 1 AND 2
CROSS ISLAND PARKWAY TO SEAFORD / OYSTER BAY EXPRESSWAY

2G-6

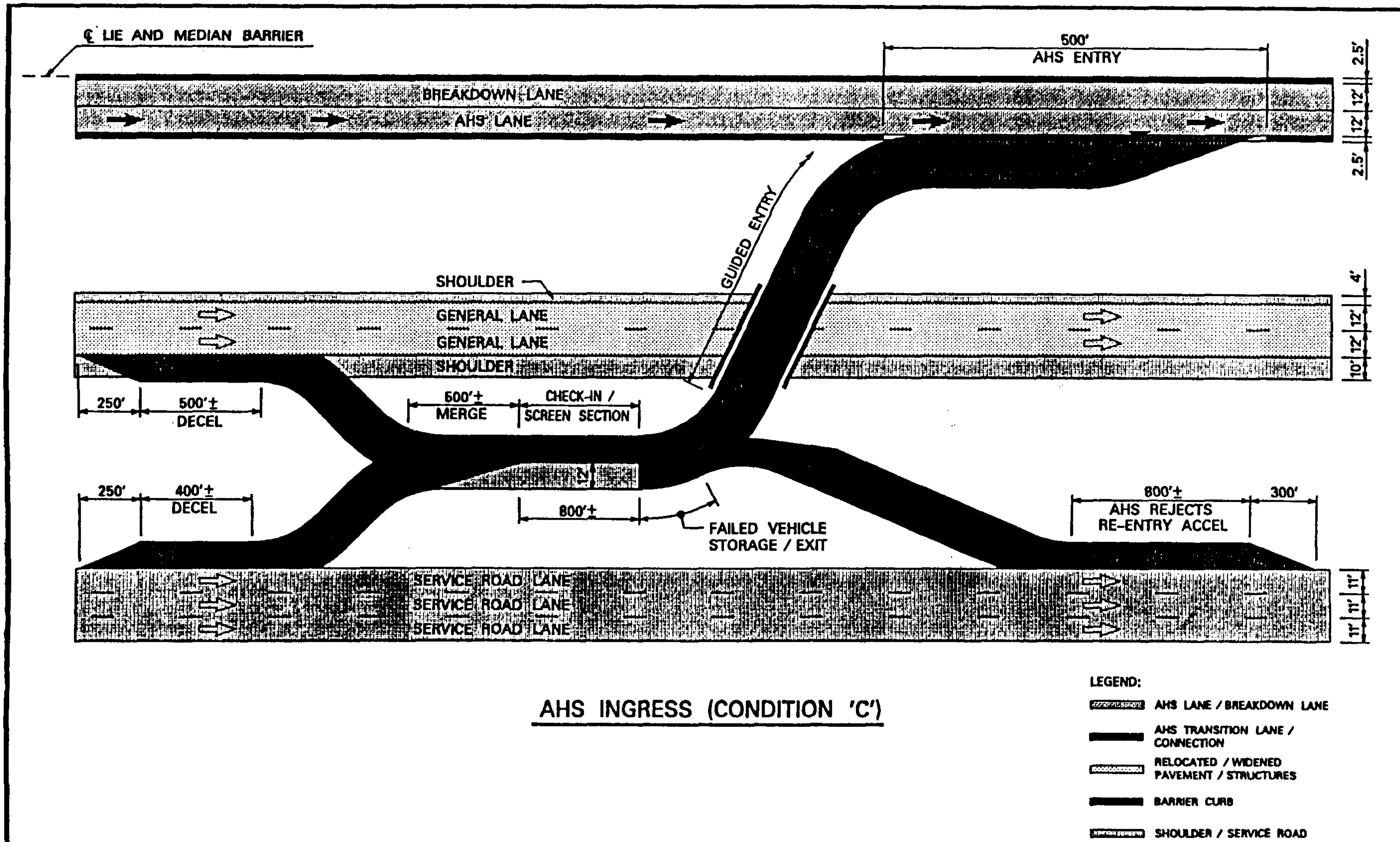


FIGURE 2 – G5

LONG ISLAND EXPRESSWAY SCENARIO
AUTOMATED HIGHWAY SYSTEM (AHS)

I-3 CONCEPT STUDY
(LIE EASTBOUND DIRECTION ONLY)

AHS INGRESS SCHEMATIC – AREAS 1 AND 2
CROSS ISLAND PARKWAY TO SEAFORD / OYSTER BAY EXPRESSW

2G-7

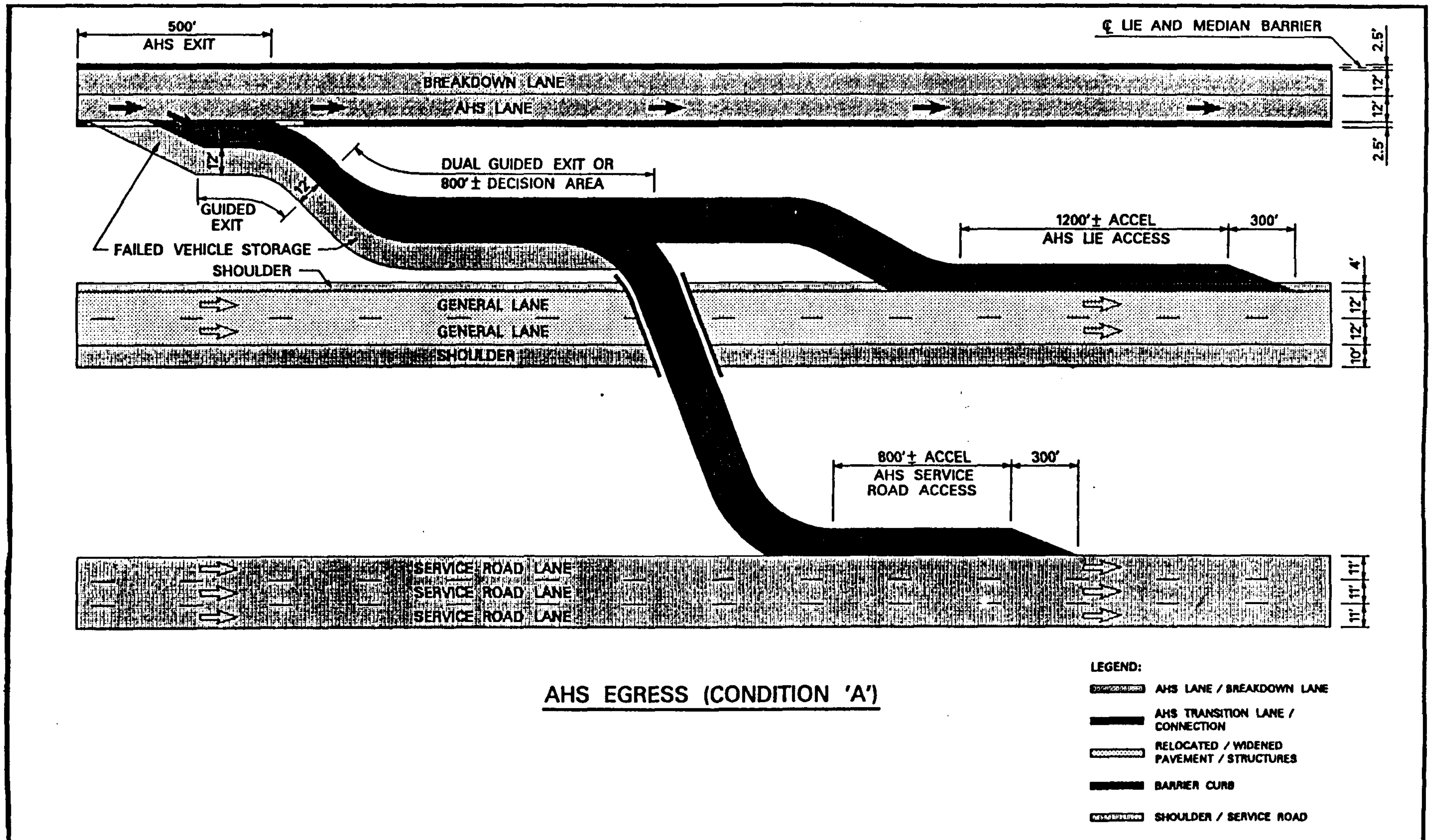


FIGURE 2 – G6

LONG ISLAND EXPRESSWAY SCENARIO
AUTOMATED HIGHWAY SYSTEM (AHS)

I-3 CONCEPT STUDY
(LIE EASTBOUND DIRECTION ONLY)

AHS EGRESS SCHEMATIC – AREAS 1 AND 2
CROSS ISLAND PARKWAY TO SEAFORD / OYSTER BAY EXPRESSWAY

2G-8

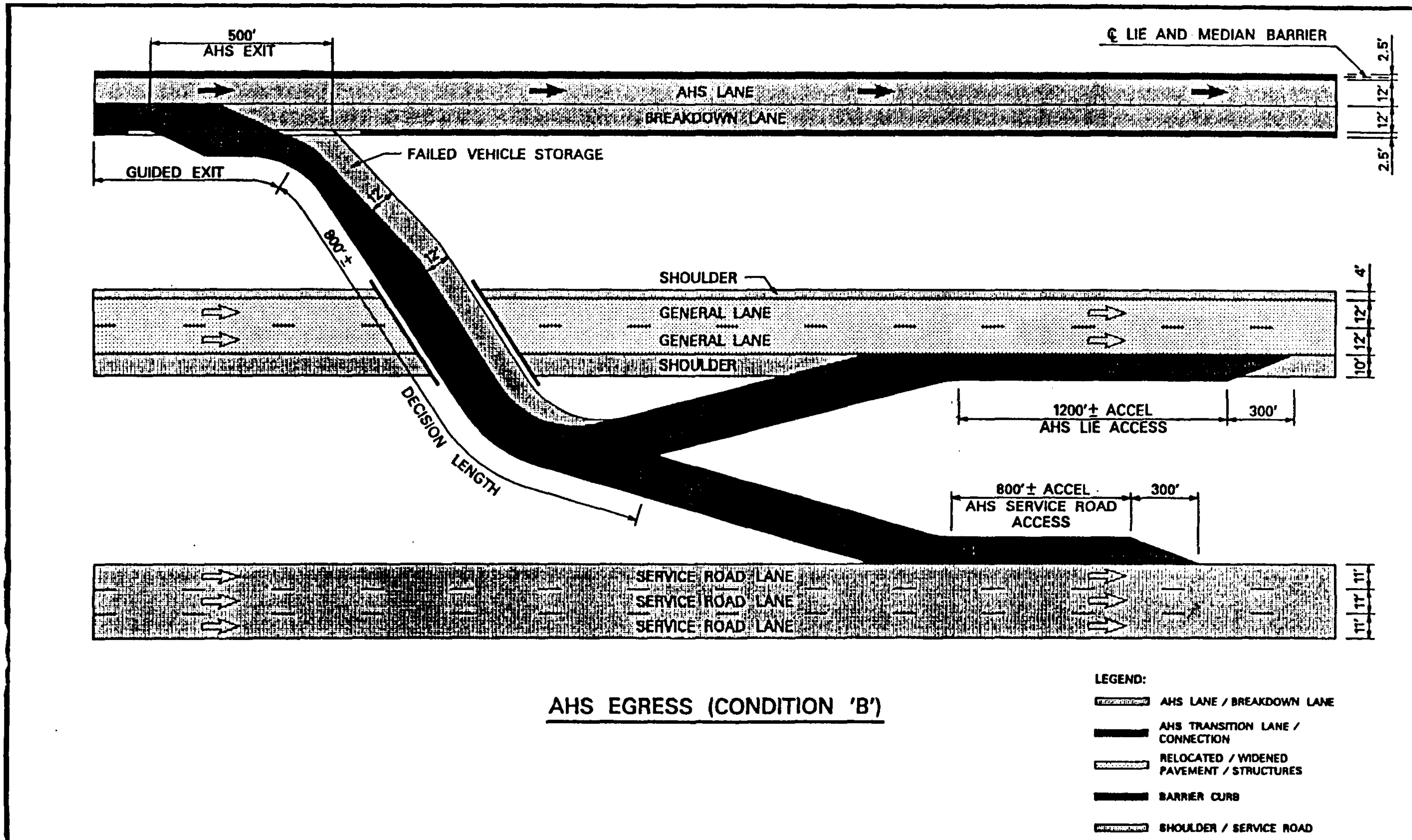


FIGURE 2 – G7

LONG ISLAND EXPRESSWAY SCENARIO
AUTOMATED HIGHWAY SYSTEM (AHS)

I-3 CONCEPT STUDY
(LIE EASTBOUND DIRECTION ONLY)

AHS EGRESS SCHEMATIC – AREAS 1 AND 2
CROSS ISLAND PARKWAY TO SEAFORD / OYSTER BAY EXPRESSWA

Appendix H

LIE RSCs I2 and I3 Layout Illustrations

This Appendix illustrates the layout of both RSCs I2 and I3 on the westbound segment of the LIE between Cross Island Parkway and Washington Avenue. These diagrams indicate the construction requirements required for both RSCs I2 and I3.

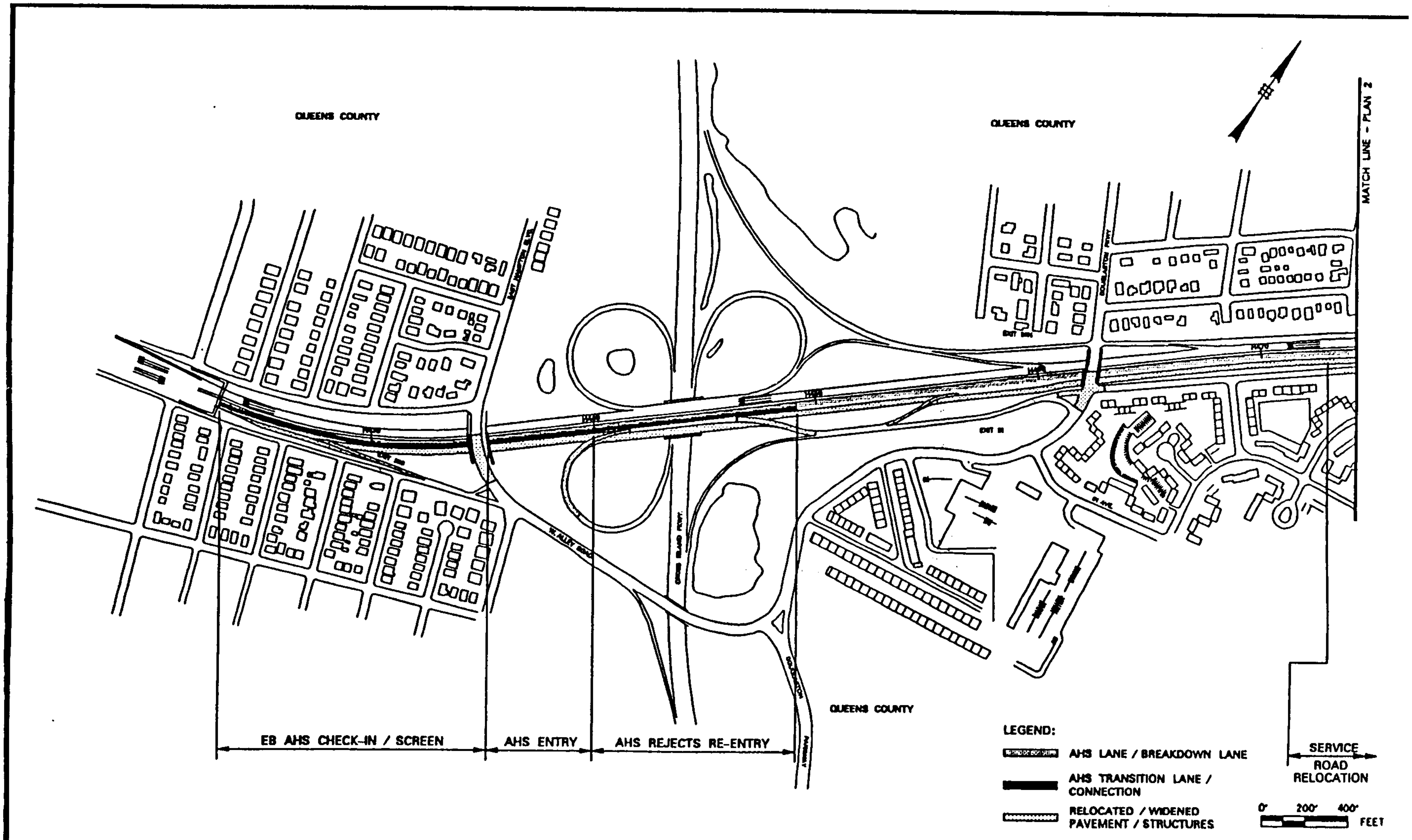
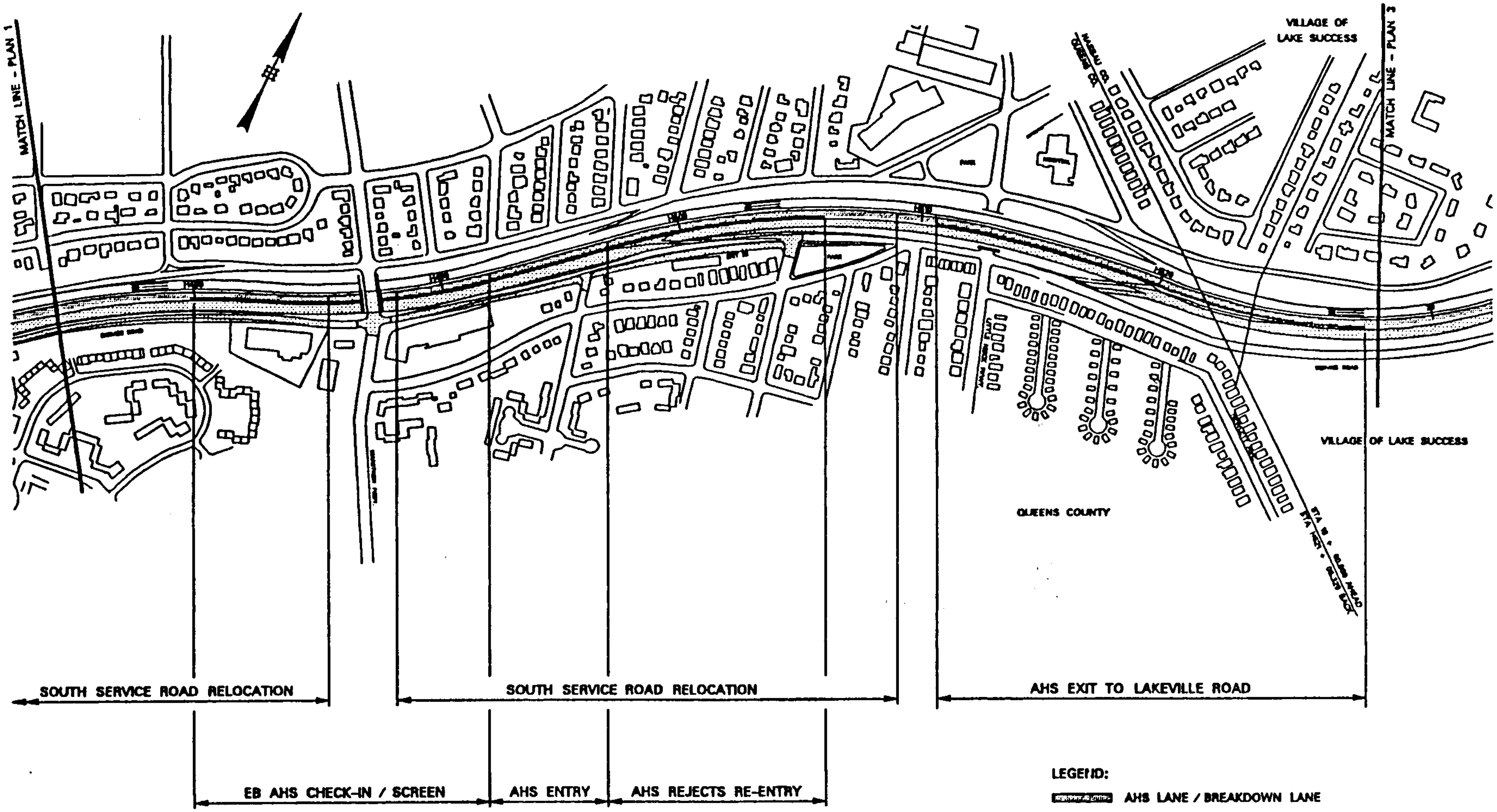


FIGURE 2 – H1	LONG ISLAND EXPRESSWAY SCENARIO AUTOMATED HIGHWAY SYSTEM (AHS)	I-2 CONCEPT STUDY (LIE EASTBOUND DIRECTION ONLY) PLAN 1 OF 17



LEGEND:

- AHS LANE / BREAKDOWN LANE
- AHS TRANSITION LANE / CONNECTION
- RELOCATED / WIDENED PAVEMENT / STRUCTURES

0' 200' 400' FEET

FIGURE 2 – H1	LONG ISLAND EXPRESSWAY SCENARIO AUTOMATED HIGHWAY SYSTEM (AHS)	I-2 CONCEPT STUDY (LIE EASTBOUND DIRECTION ONLY) PLAN 2 OF 17

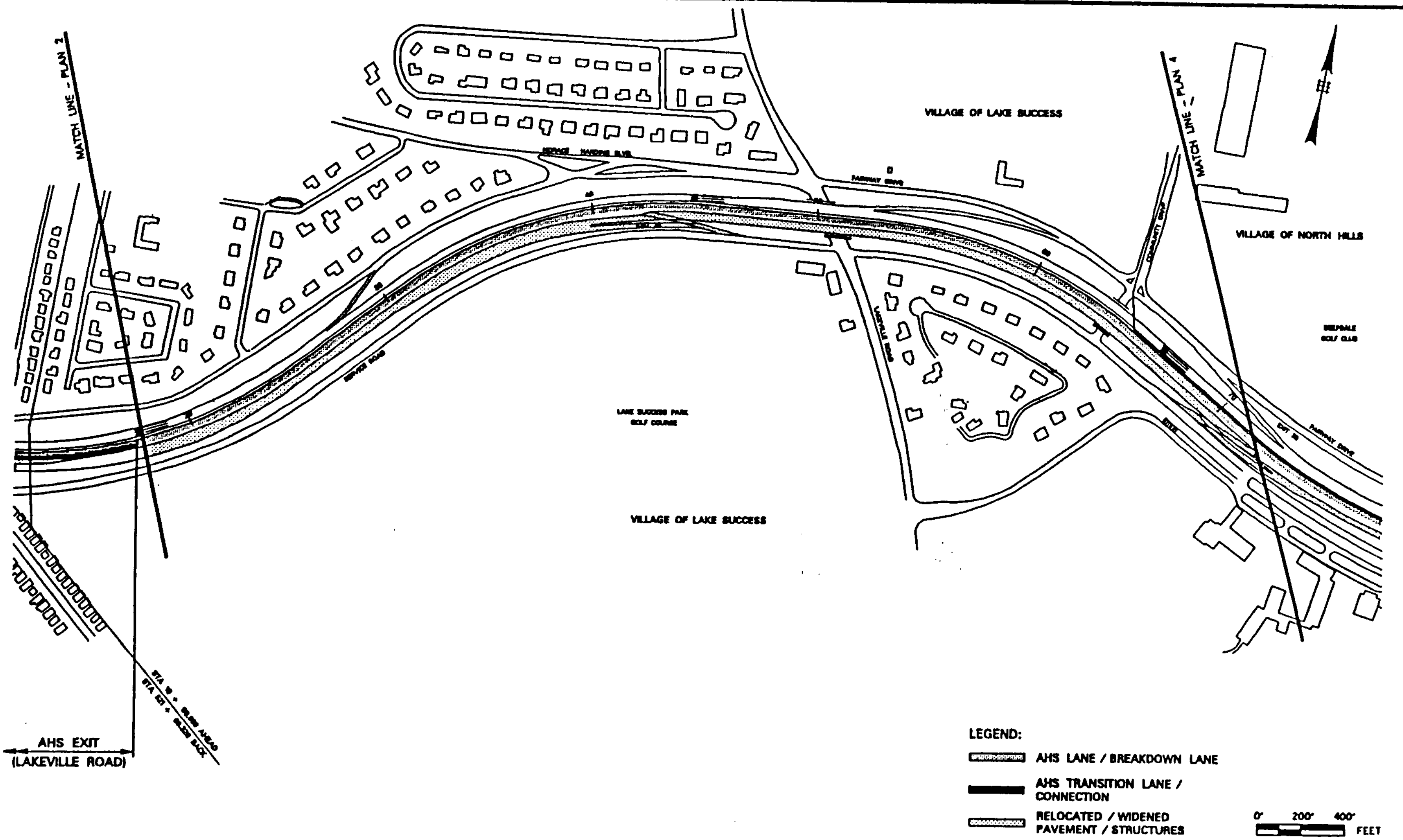


FIGURE 2 – H1	LONG ISLAND EXPRESSWAY SCENARIO AUTOMATED HIGHWAY SYSTEM (AHS)	I-2 CONCEPT STUDY (LIE EASTBOUND DIRECTION ONLY) PLAN 3 OF 17

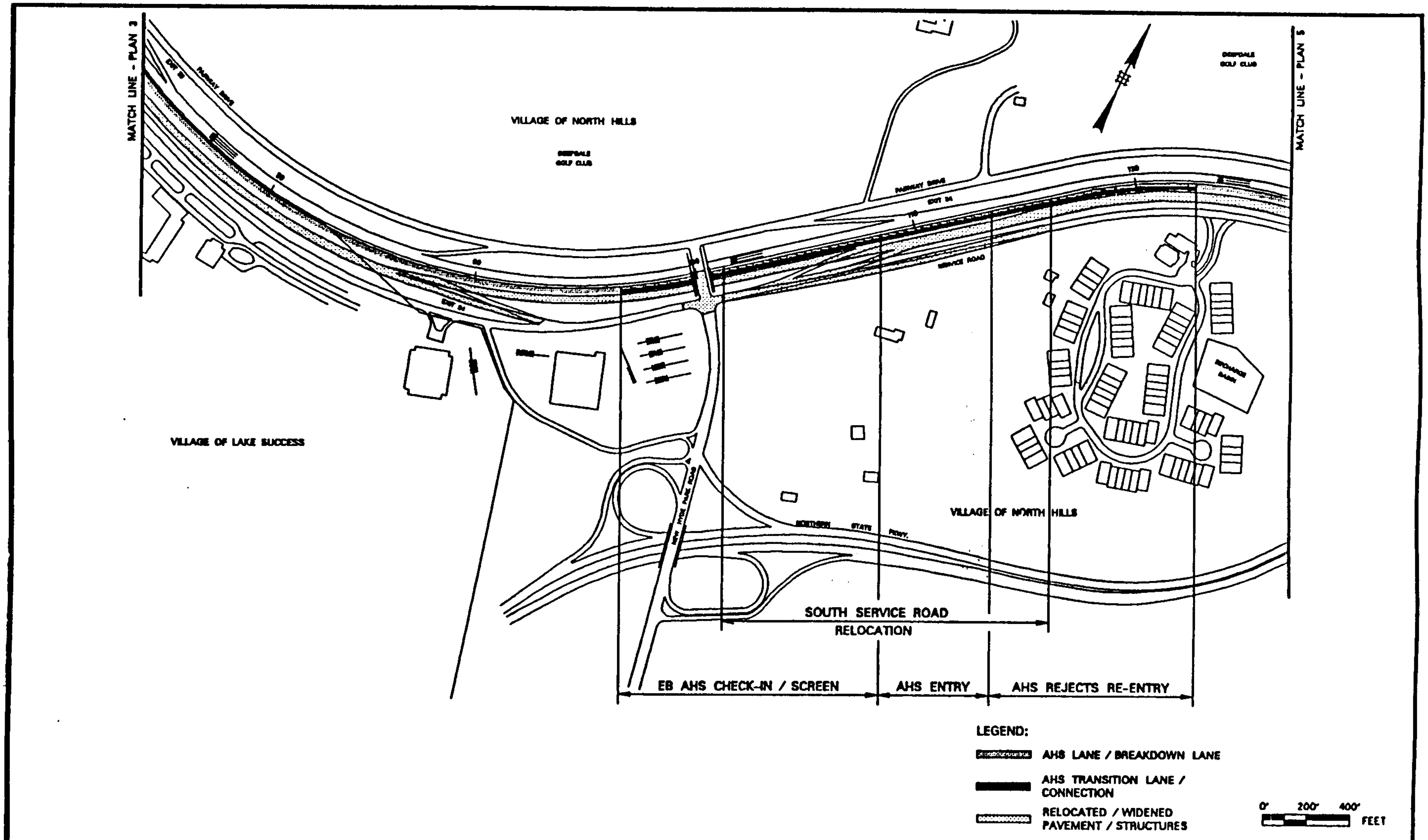


FIGURE 2 – H1	LONG ISLAND EXPRESSWAY SCENARIO AUTOMATED HIGHWAY SYSTEM (AHS)	I-2 CONCEPT STUDY (LIE EASTBOUND DIRECTION ONLY) PLAN 4 OF 17

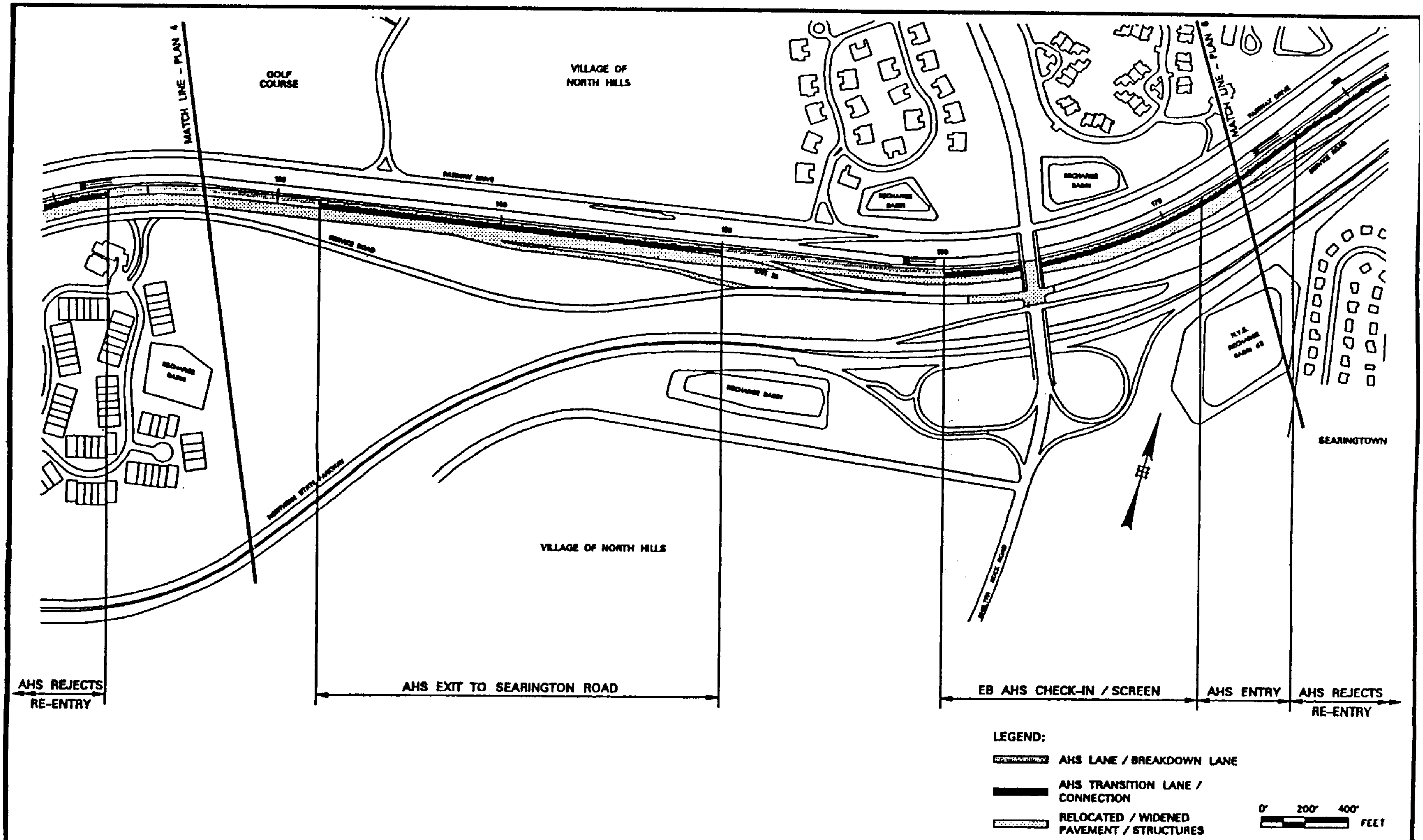


FIGURE 2 – H1

LONG ISLAND EXPRESSWAY SCENARIO
AUTOMATED HIGHWAY SYSTEM (AHS)

I-2 CONCEPT STUDY
(LIE EASTBOUND DIRECTION ONLY)

PLAN 5 OF 17

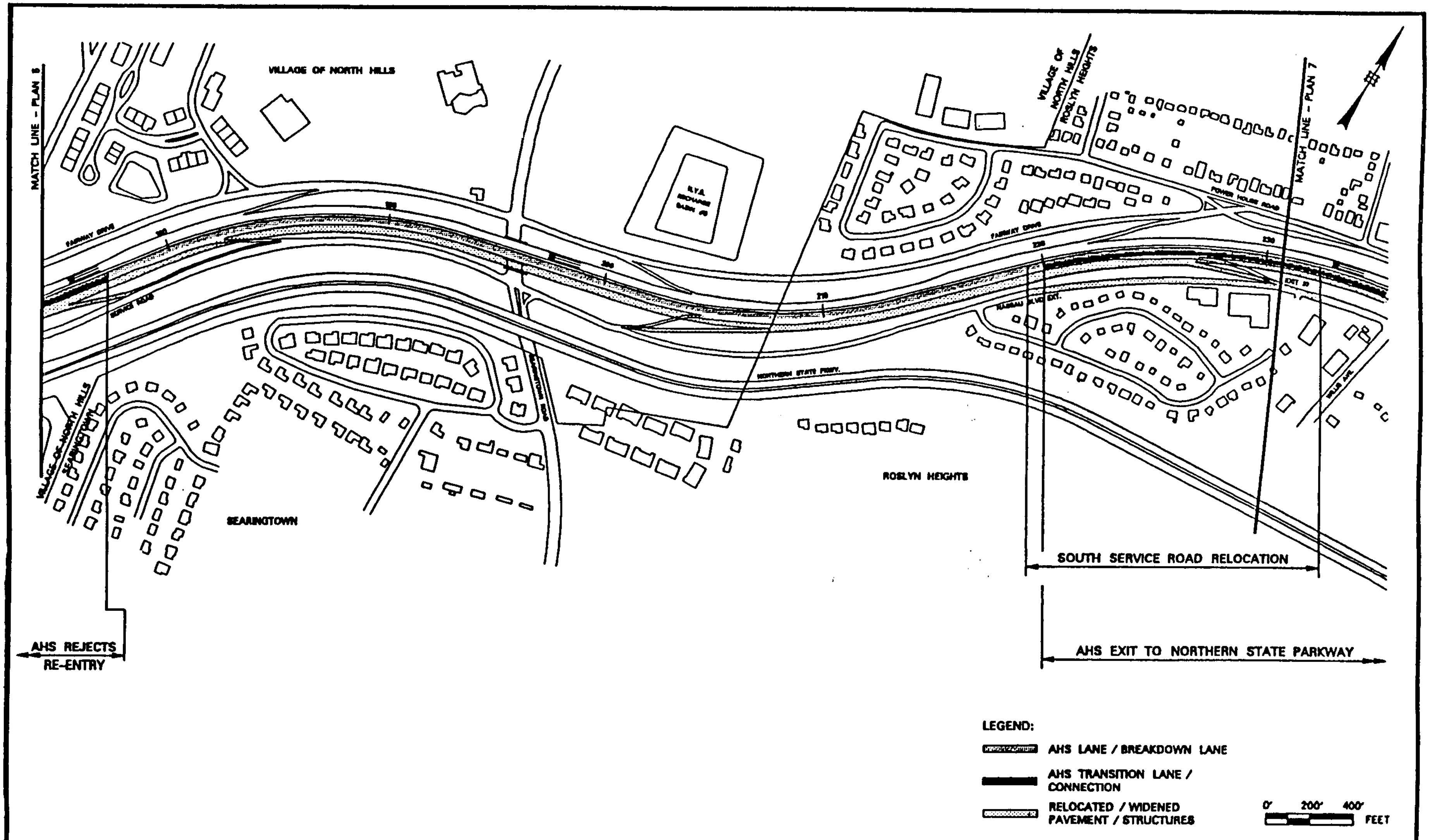


FIGURE 2 – H1	LONG ISLAND EXPRESSWAY SCENARIO AUTOMATED HIGHWAY SYSTEM (AHS)	I-2 CONCEPT STUDY (LIE EASTBOUND DIRECTION ONLY) PLAN 6 OF 17

2-H7

2-H8

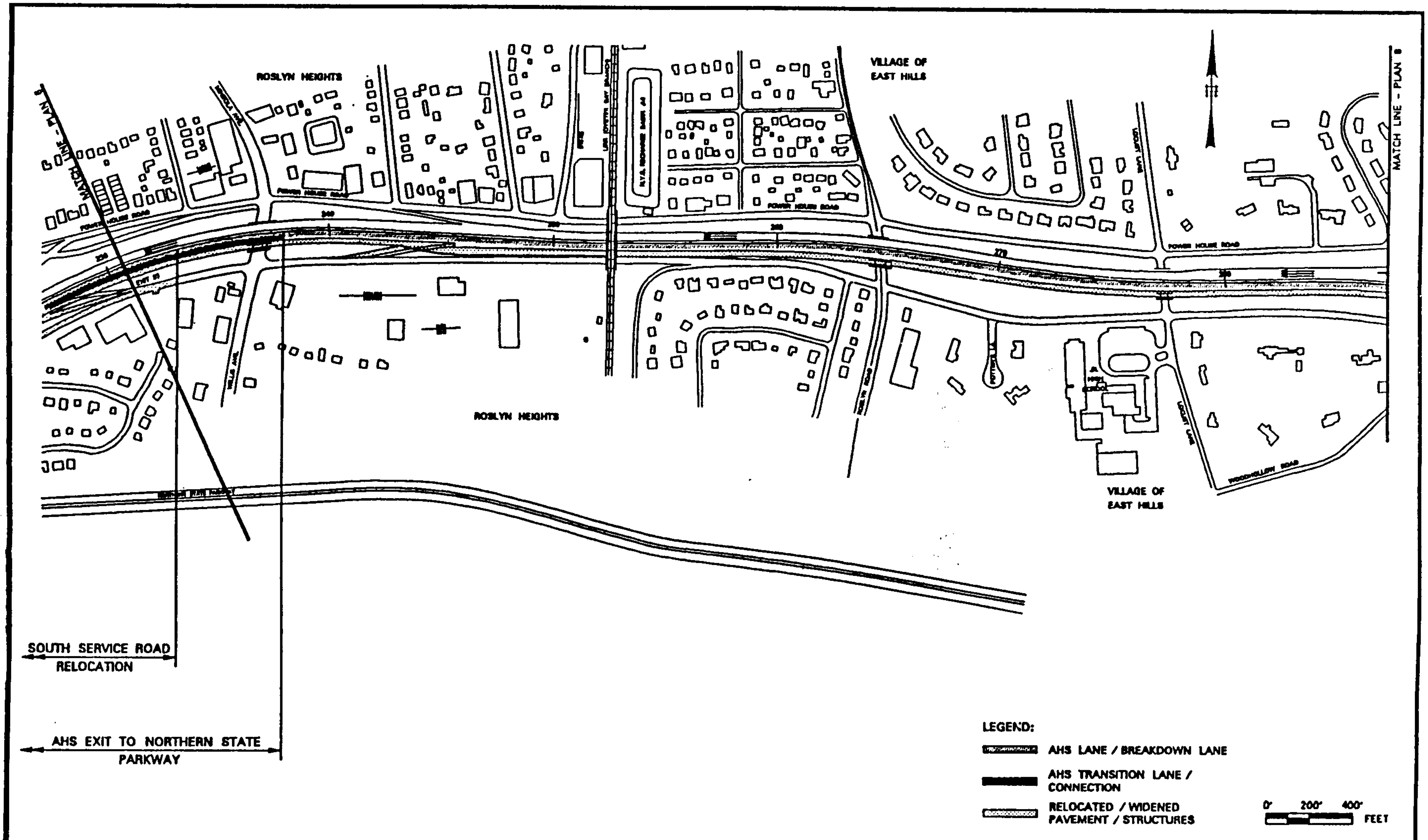


FIGURE 2 – H1	LONG ISLAND EXPRESSWAY SCENARIO AUTOMATED HIGHWAY SYSTEM (AHS)	I-2 CONCEPT STUDY (LIE EASTBOUND DIRECTION ONLY) PLAN 7 OF 17

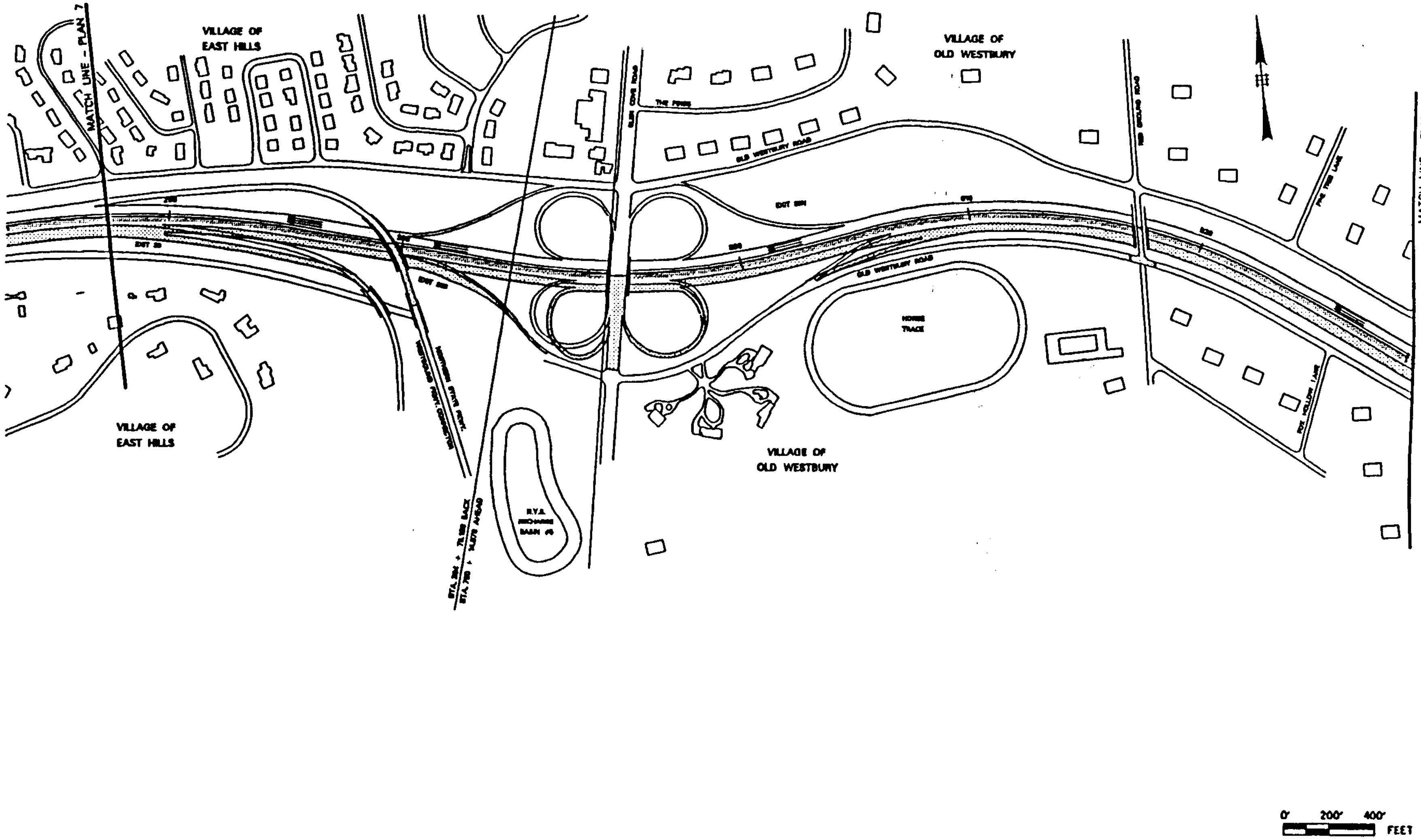


FIGURE 2 – H1	LONG ISLAND EXPRESSWAY SCENARIO AUTOMATED HIGHWAY SYSTEM (AHS)	I-2 CONCEPT STUDY (LIE EASTBOUND DIRECTION ONLY) PLAN 8 OF 17

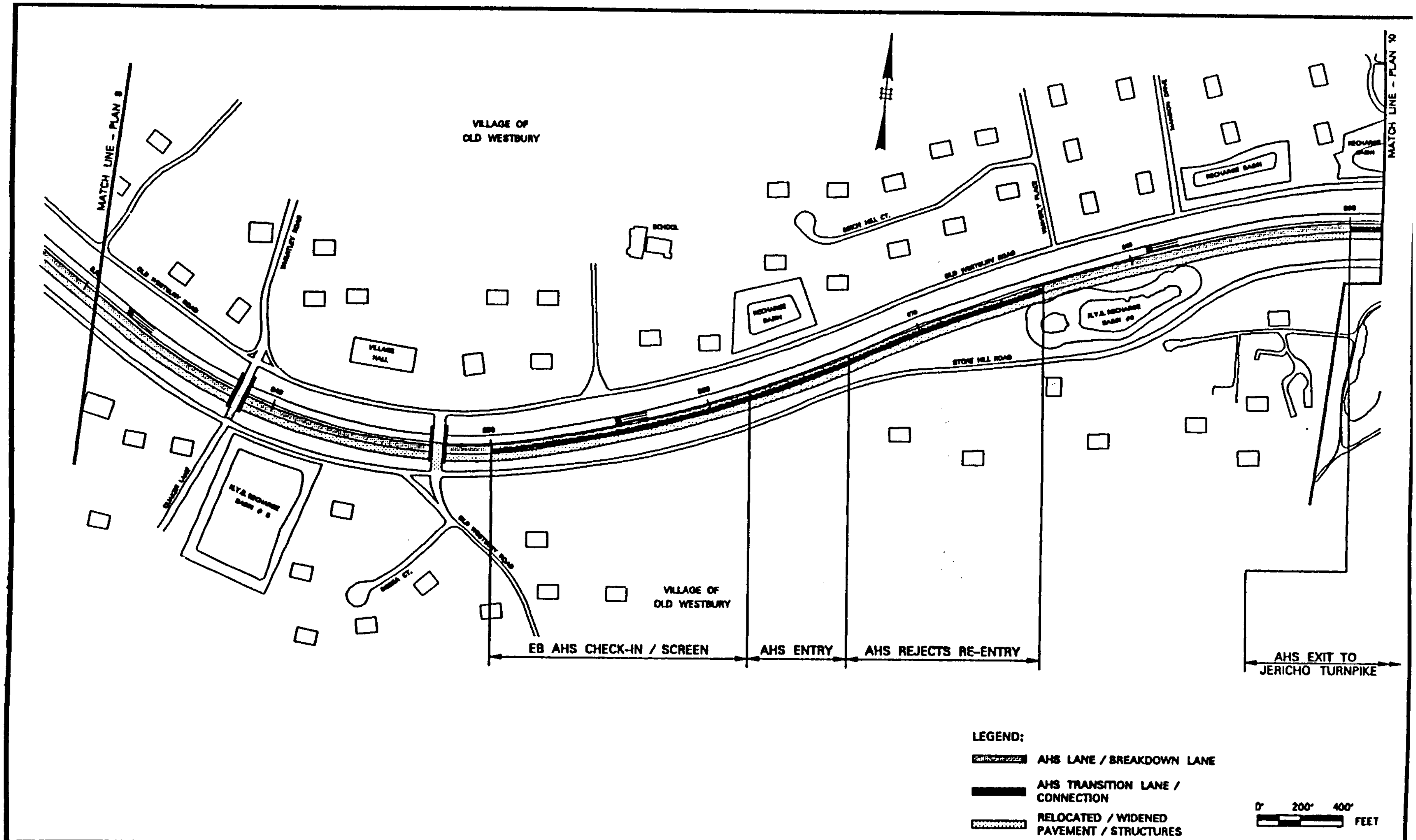


FIGURE 2 – H1	LONG ISLAND EXPRESSWAY SCENARIO AUTOMATED HIGHWAY SYSTEM (AHS)	I-2 CONCEPT STUDY (LIE EASTBOUND DIRECTION ONLY) PLAN 9 OF 17

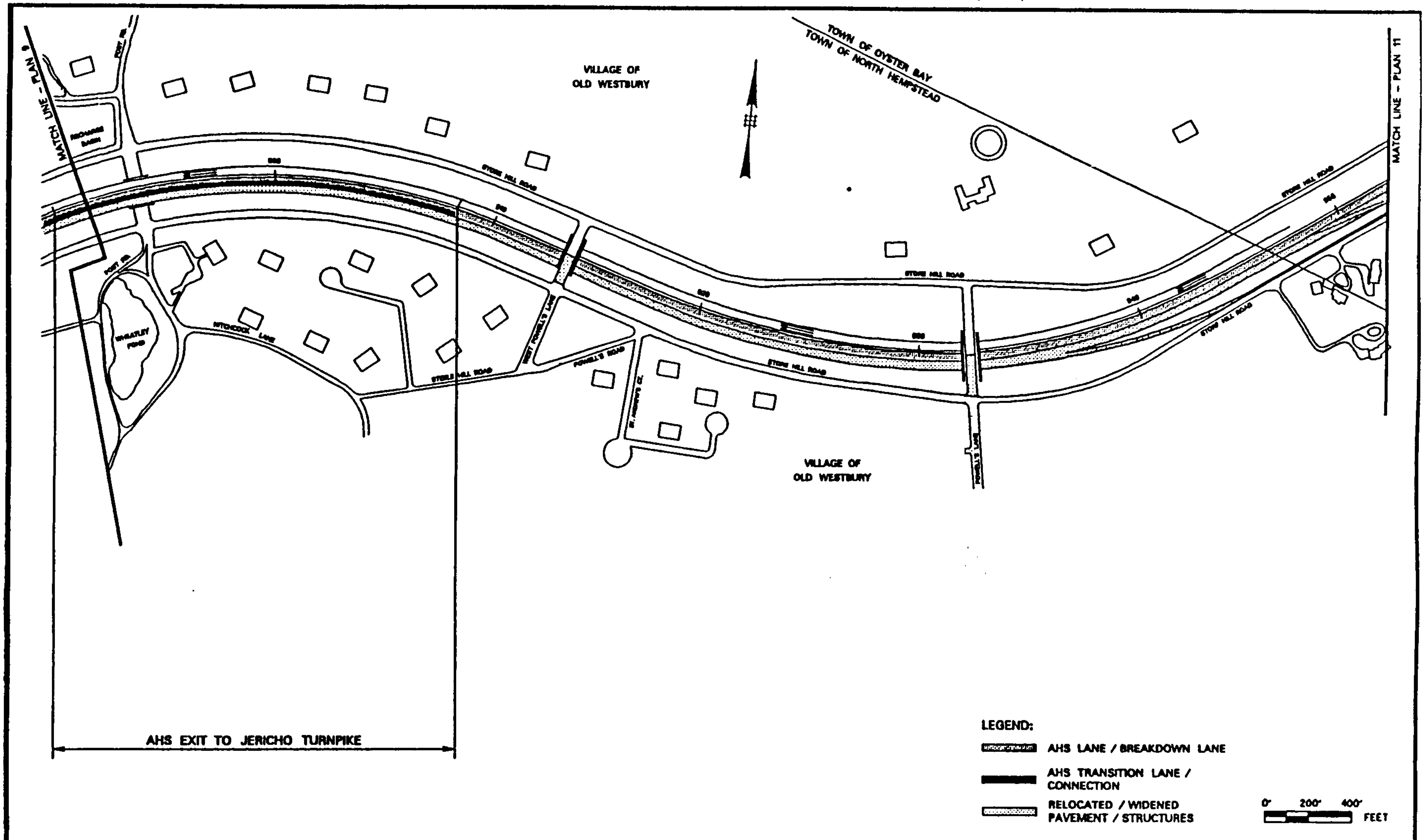


FIGURE 2 – H1	LONG ISLAND EXPRESSWAY SCENARIO AUTOMATED HIGHWAY SYSTEM (AHS)	I-2 CONCEPT STUDY (LIE EASTBOUND DIRECTION ONLY) PLAN 10 OF 17

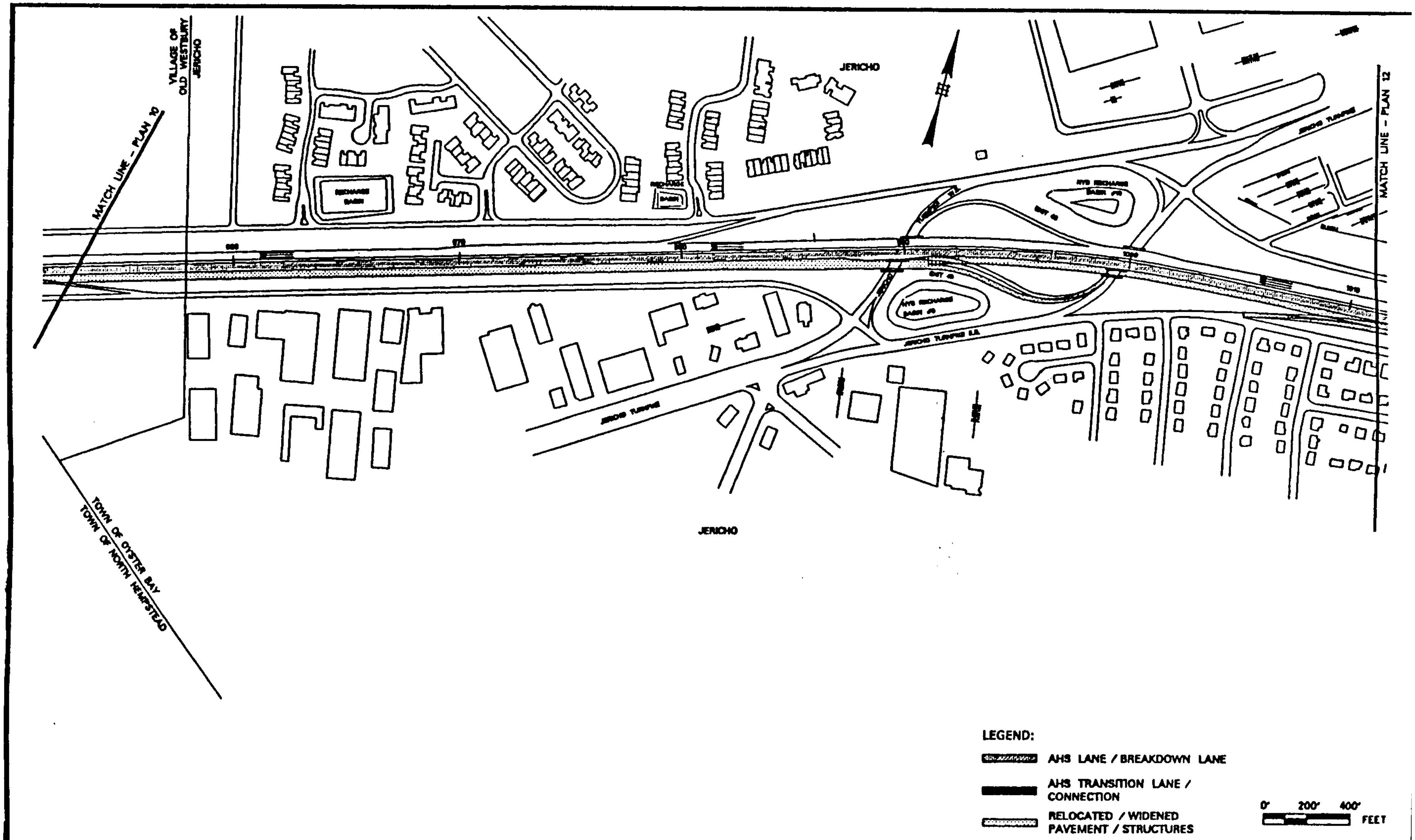


FIGURE 2 – H1	LONG ISLAND EXPRESSWAY SCENARIO AUTOMATED HIGHWAY SYSTEM (AHS)	I-2 CONCEPT STUDY (LIE EASTBOUND DIRECTION ONLY) PLAN 11 OF 17

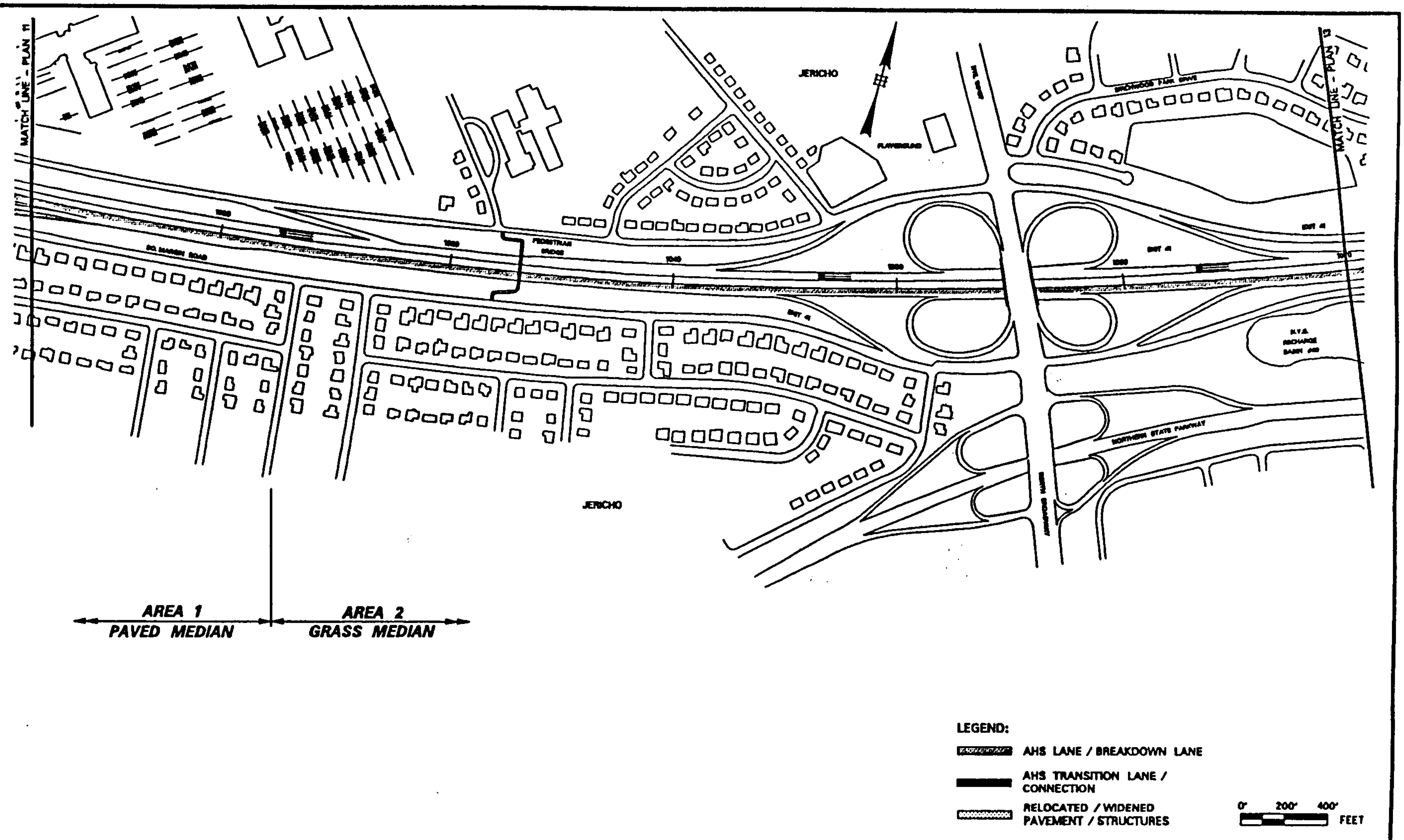


FIGURE 2 - H1	LONG ISLAND EXPRESSWAY SCENARIO AUTOMATED HIGHWAY SYSTEM (AHS)	I-2 CONCEPT STUDY (LIE EASTBOUND DIRECTION ONLY) PLAN 12 OF 17

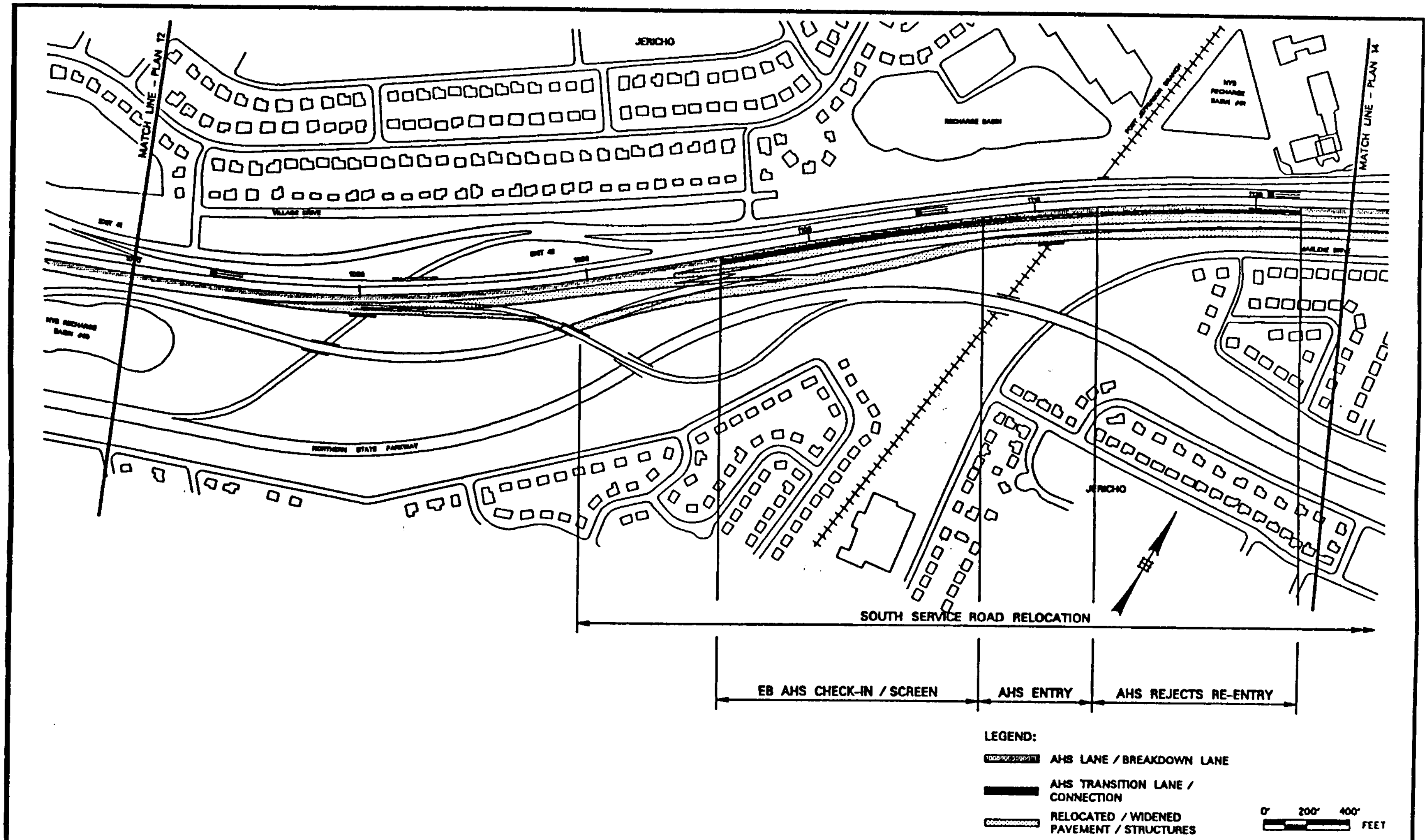


FIGURE 2 – H1	LONG ISLAND EXPRESSWAY SCENARIO AUTOMATED HIGHWAY SYSTEM (AHS)	I-2 CONCEPT STUDY (LIE EASTBOUND DIRECTION ONLY) PLAN 13 OF 17

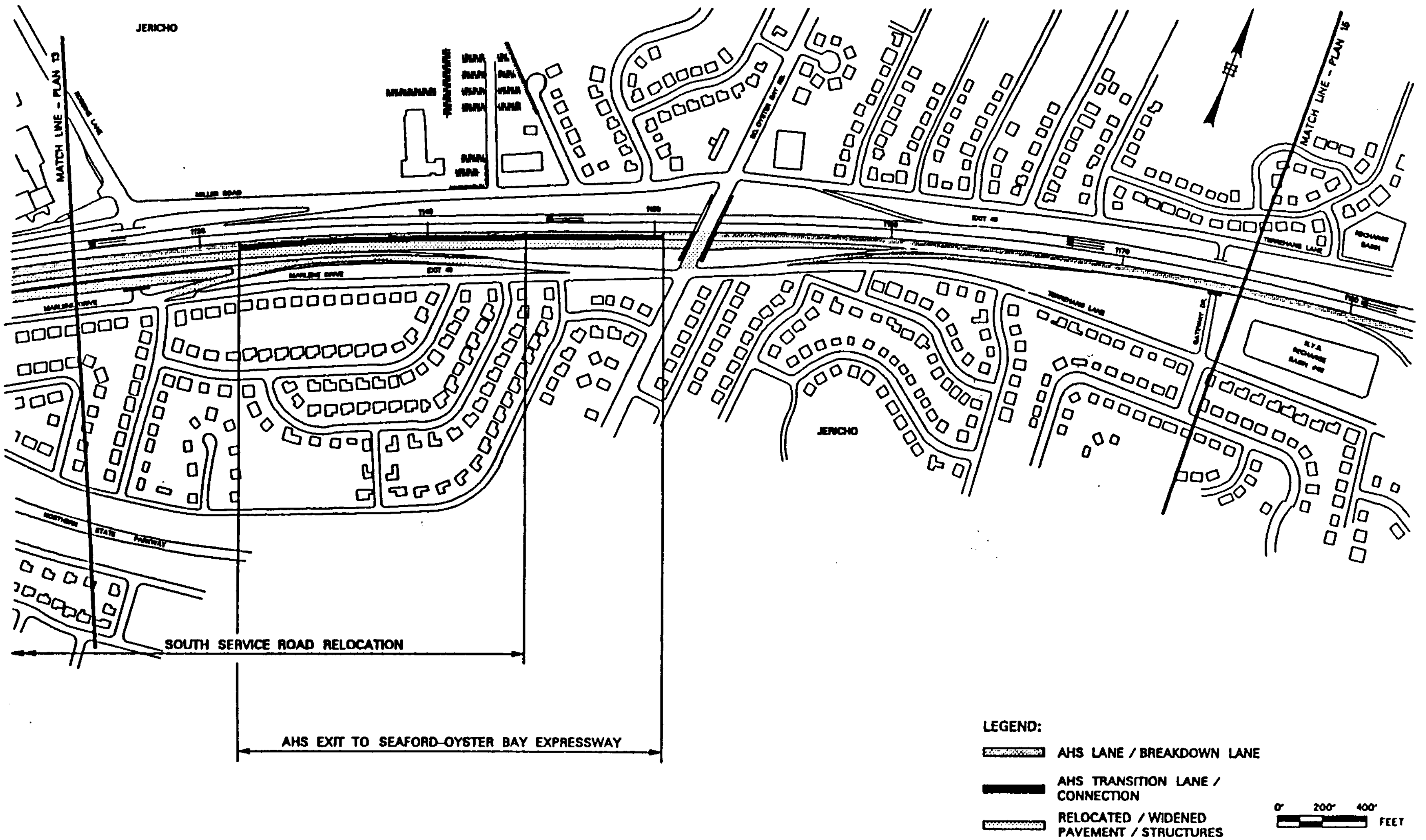


FIGURE 2 – H1	LONG ISLAND EXPRESSWAY SCENARIO AUTOMATED HIGHWAY SYSTEM (AHS)	I-2 CONCEPT STUDY (LIE EASTBOUND DIRECTION ONLY) PLAN 14 OF 17

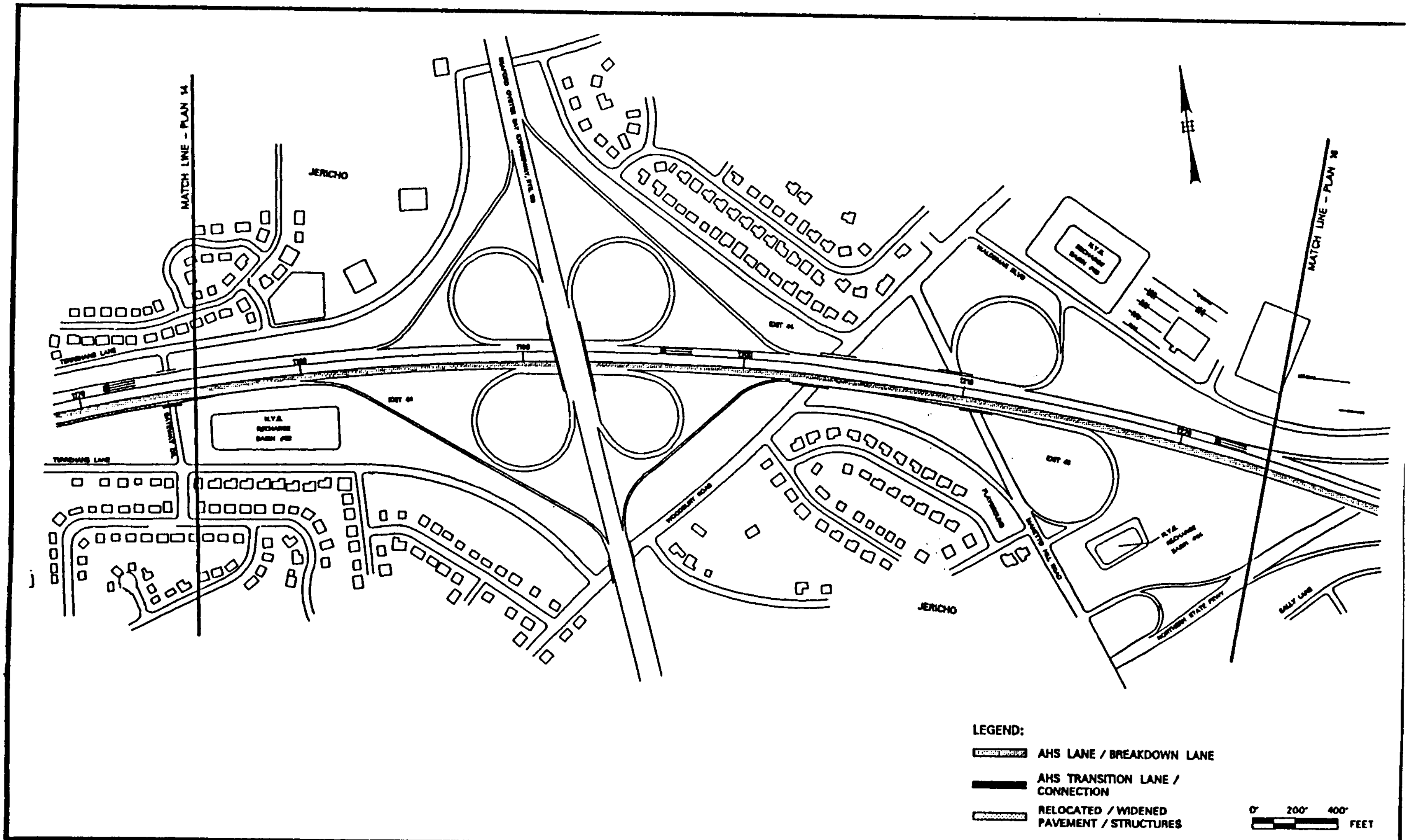


FIGURE 2 – H1	LONG ISLAND EXPRESSWAY SCENARIO AUTOMATED HIGHWAY SYSTEM (AHS)	I-2 CONCEPT STUDY (LIE EASTBOUND DIRECTION ONLY) PLAN 15 OF 17

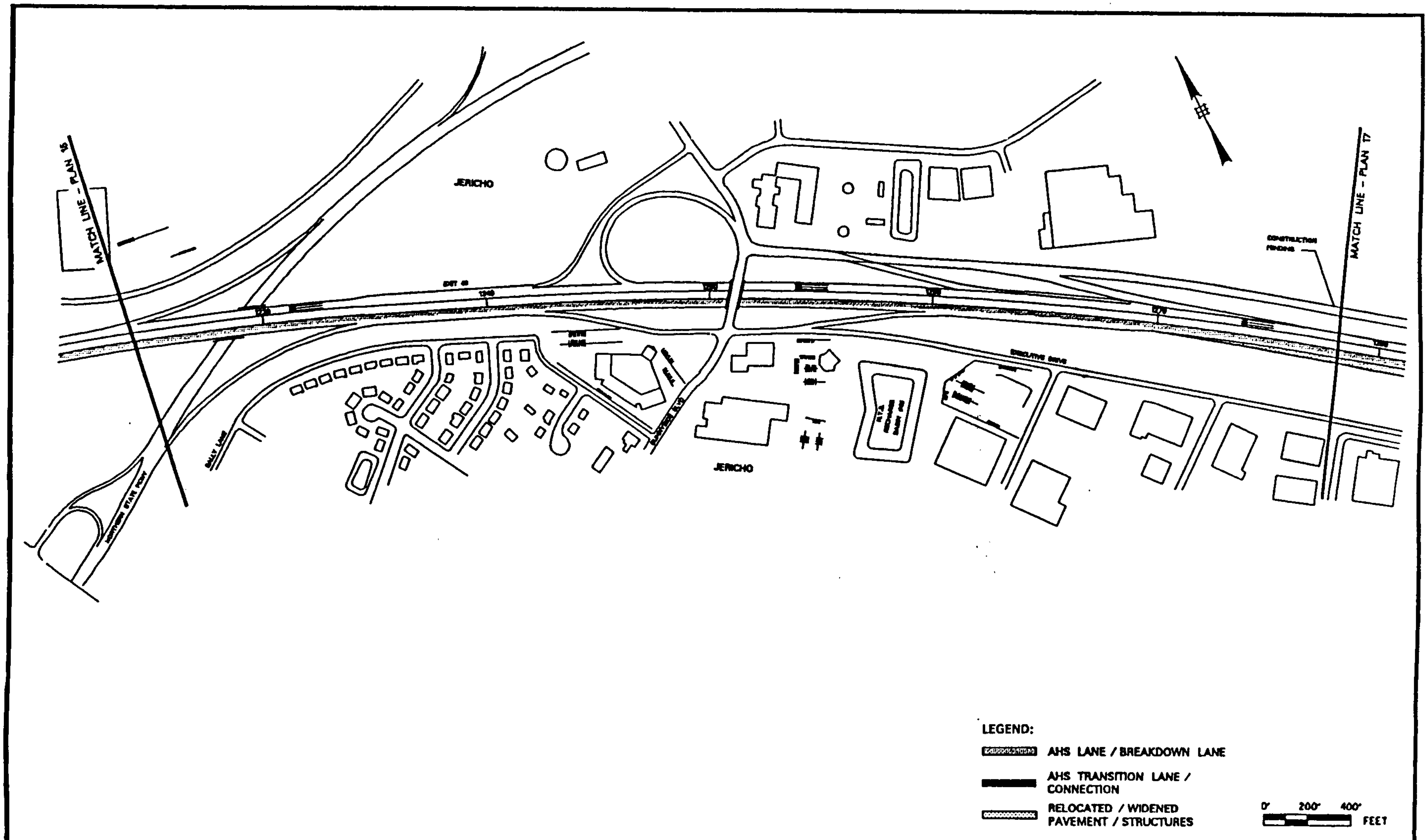


FIGURE 2 – H1	LONG ISLAND EXPRESSWAY SCENARIO AUTOMATED HIGHWAY SYSTEM (AHS)	I-2 CONCEPT STUDY (LIE EASTBOUND DIRECTION ONLY) PLAN 16 OF 17

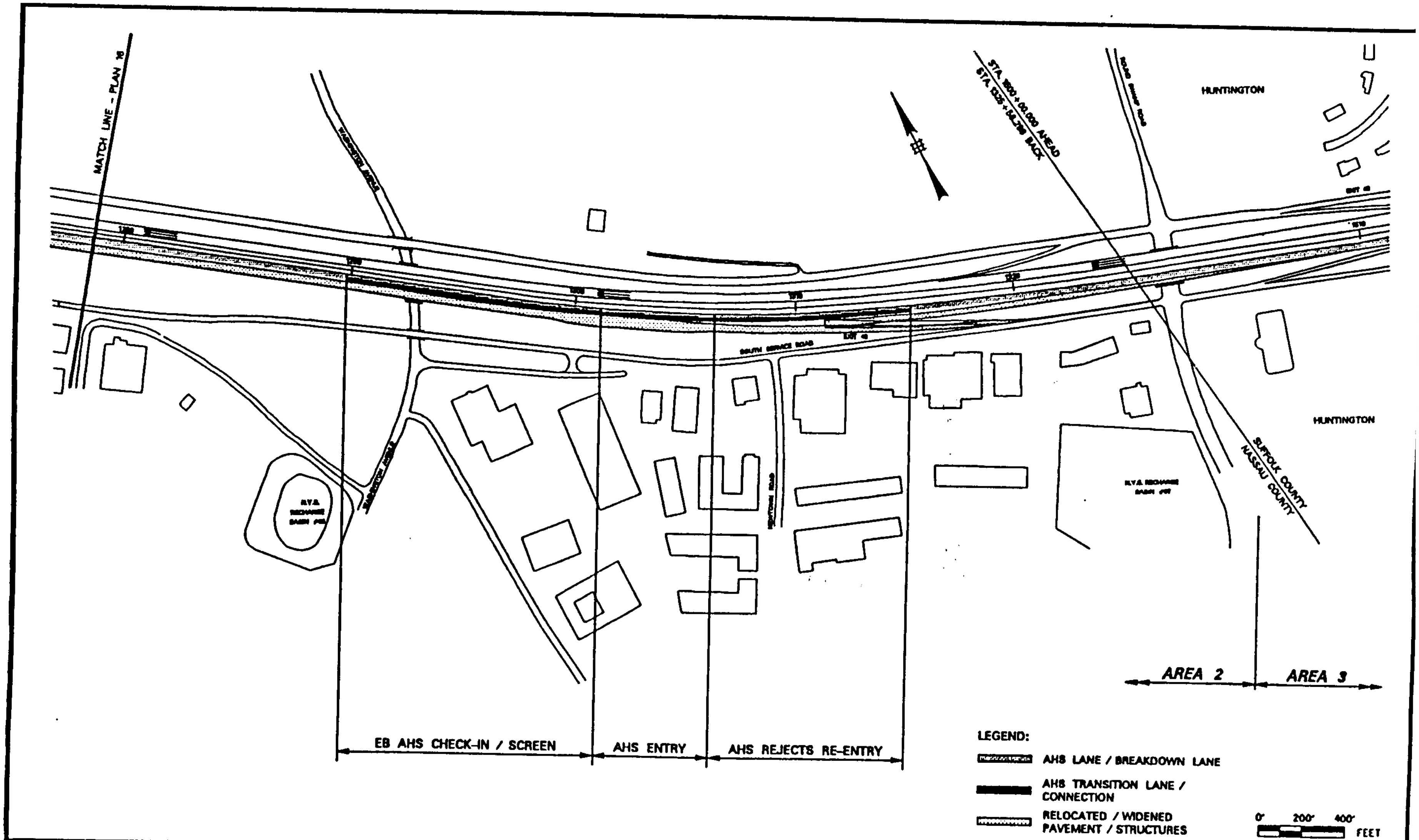


FIGURE 2 – H1	LONG ISLAND EXPRESSWAY SCENARIO AUTOMATED HIGHWAY SYSTEM (AHS)	I-2 CONCEPT STUDY (LIE EASTBOUND DIRECTION ONLY) PLAN 17 OF 17

2-H19

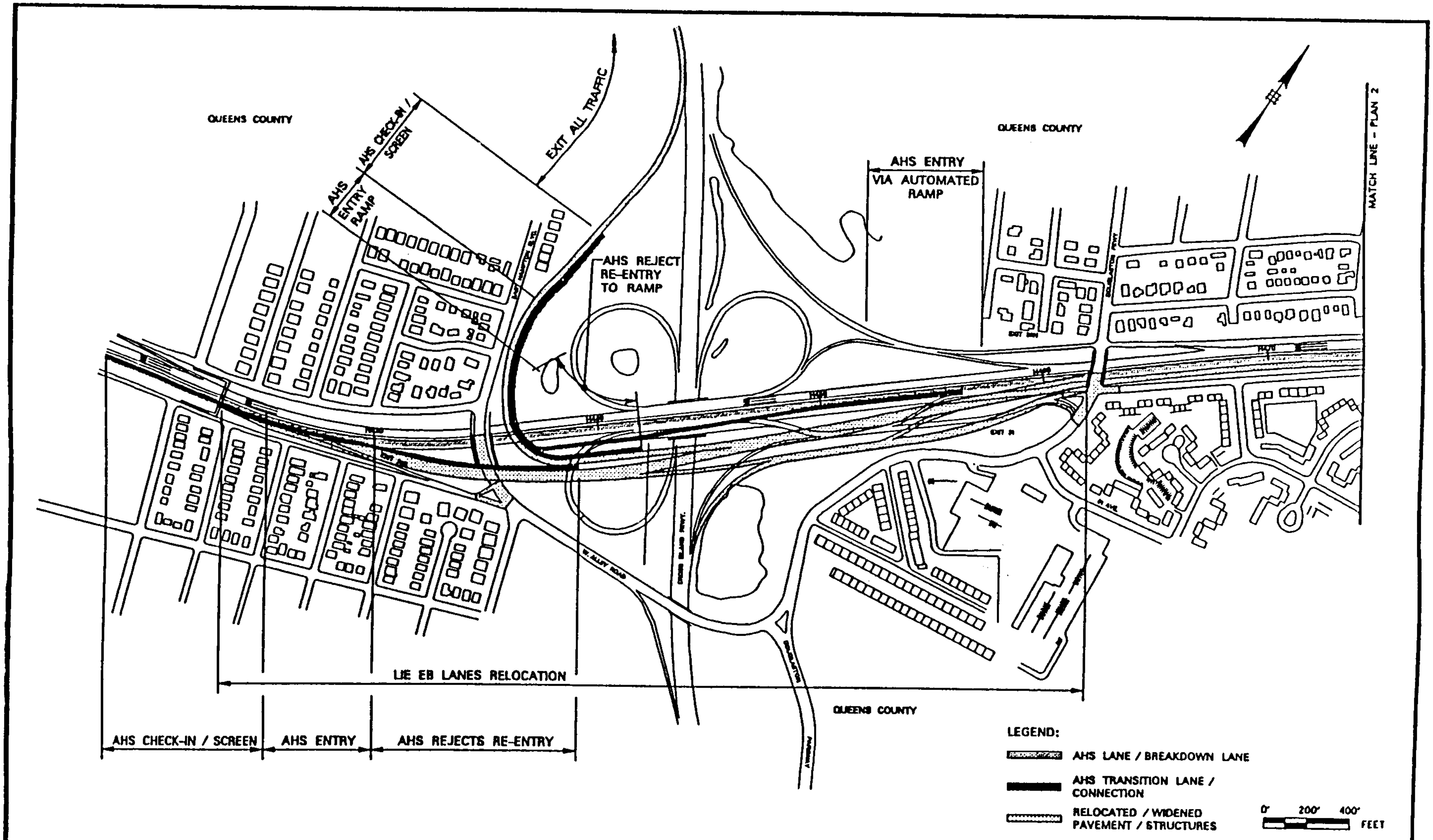


FIGURE 2 – H2	LONG ISLAND EXPRESSWAY SCENARIO AUTOMATED HIGHWAY SYSTEM (AHS)	I-3 CONCEPT STUDY (LIE EASTBOUND DIRECTION ONLY) PLAN 1 OF 17

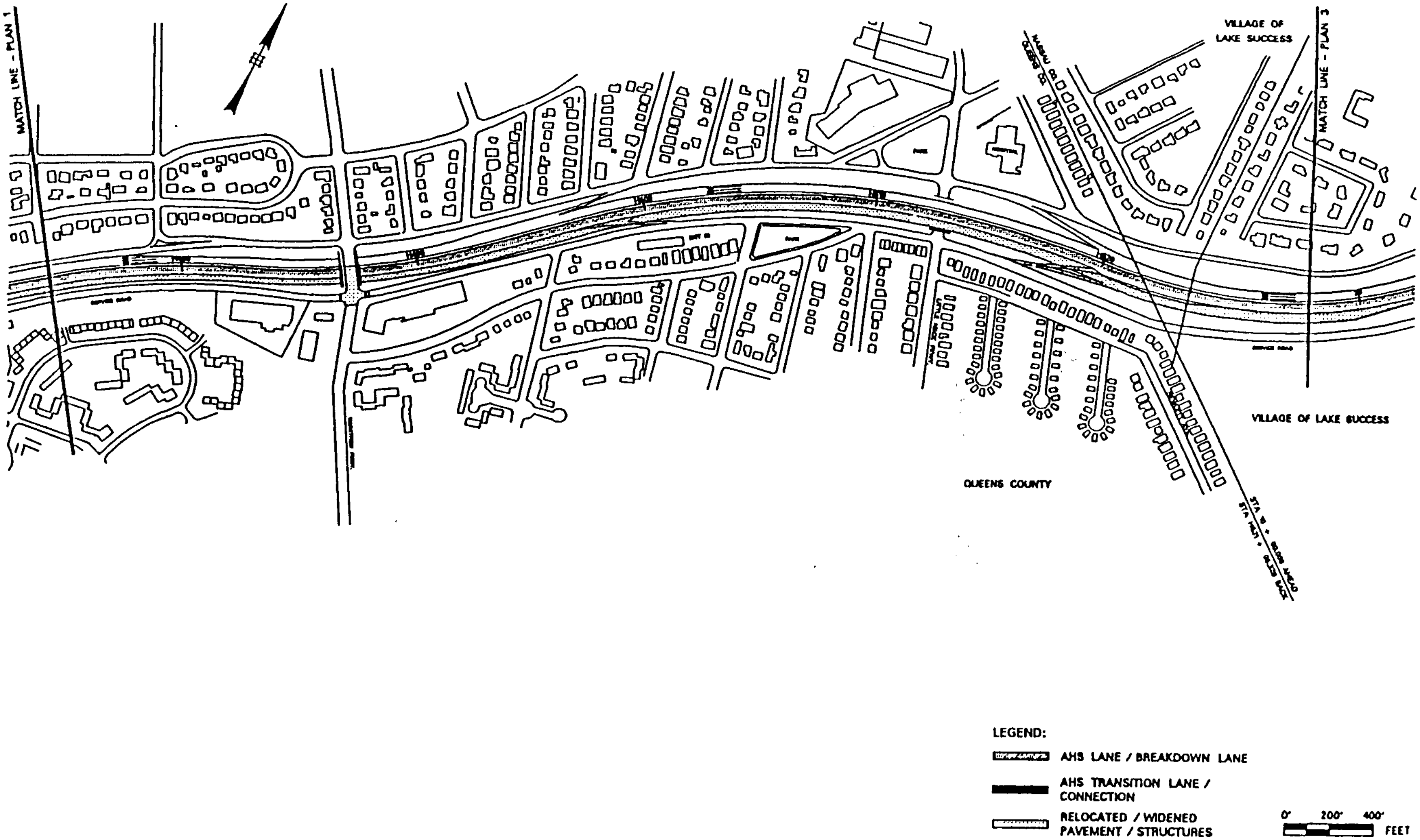


FIGURE 2 – H2	LONG ISLAND EXPRESSWAY SCENARIO AUTOMATED HIGHWAY SYSTEM (AHS)	I-3 CONCEPT STUDY (LIE EASTBOUND DIRECTION ONLY) PLAN 2 OF 17

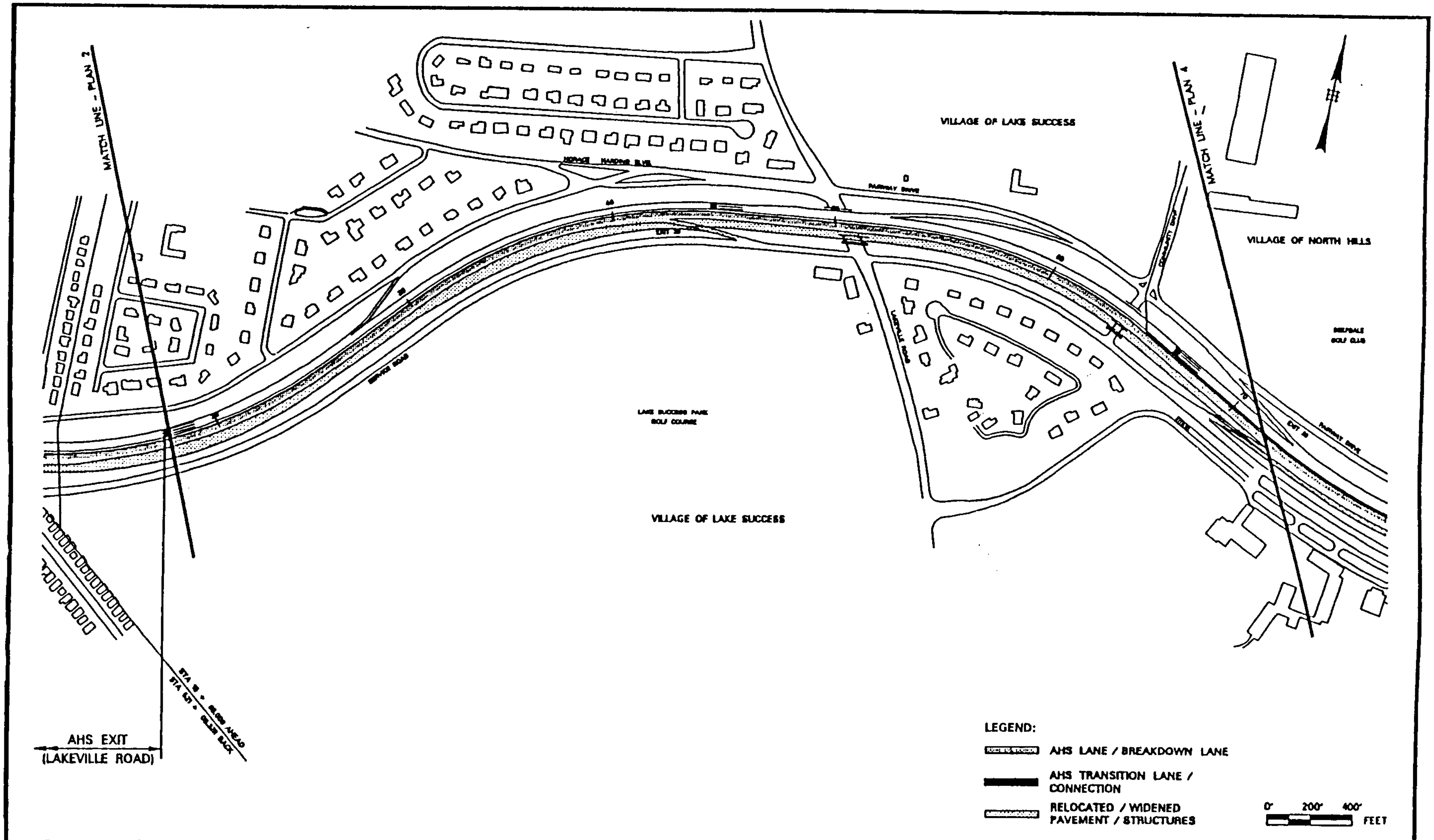


FIGURE 2 – H2	LONG ISLAND EXPRESSWAY SCENARIO AUTOMATED HIGHWAY SYSTEM (AHS)	I-3 CONCEPT STUDY (LIE EASTBOUND DIRECTION ONLY) PLAN 3 OF 17

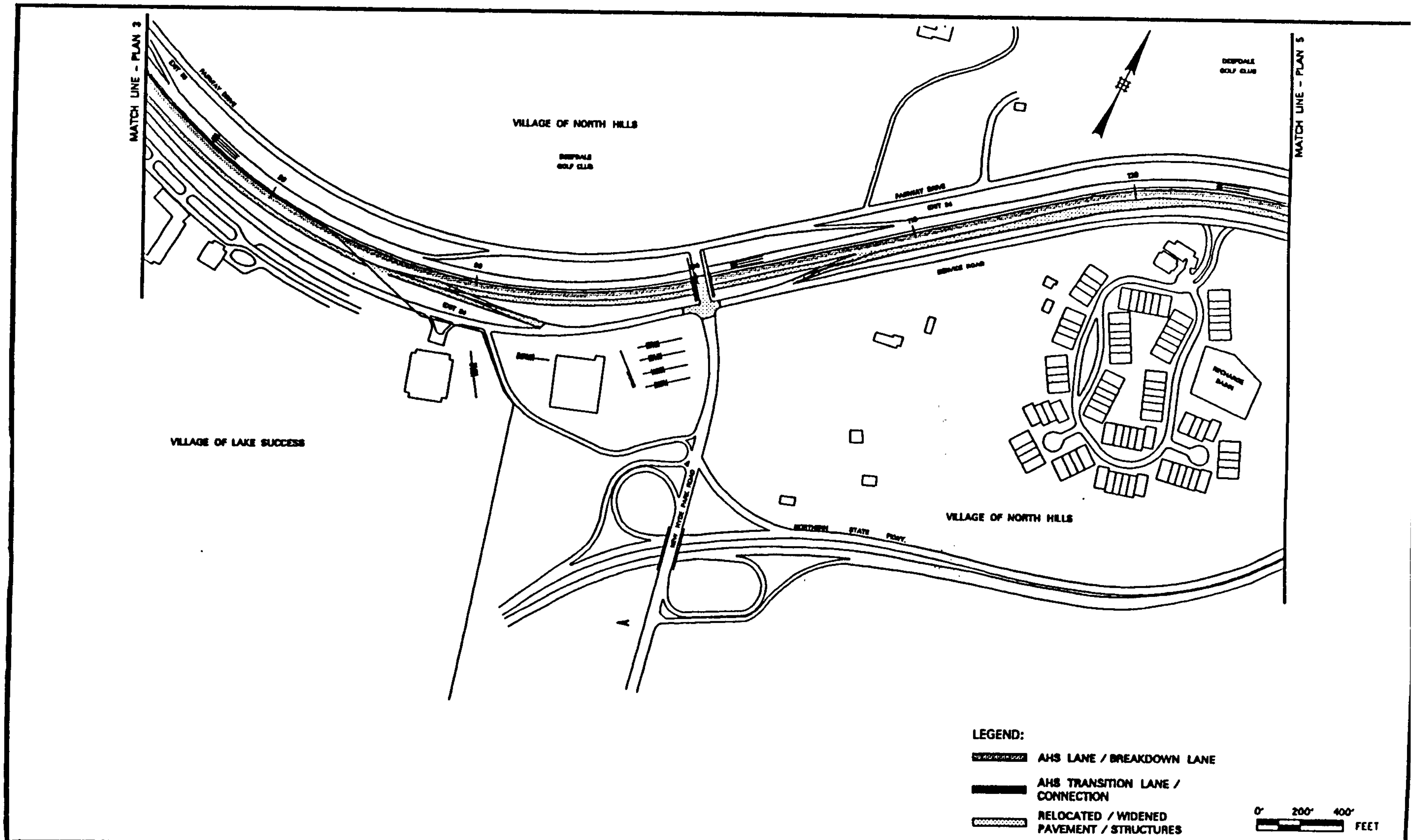


FIGURE 2 - H2	LONG ISLAND EXPRESSWAY SCENARIO AUTOMATED HIGHWAY SYSTEM (AHS)	I-3 CONCEPT STUDY (LIE EASTBOUND DIRECTION ONLY) PLAN 4 OF 17

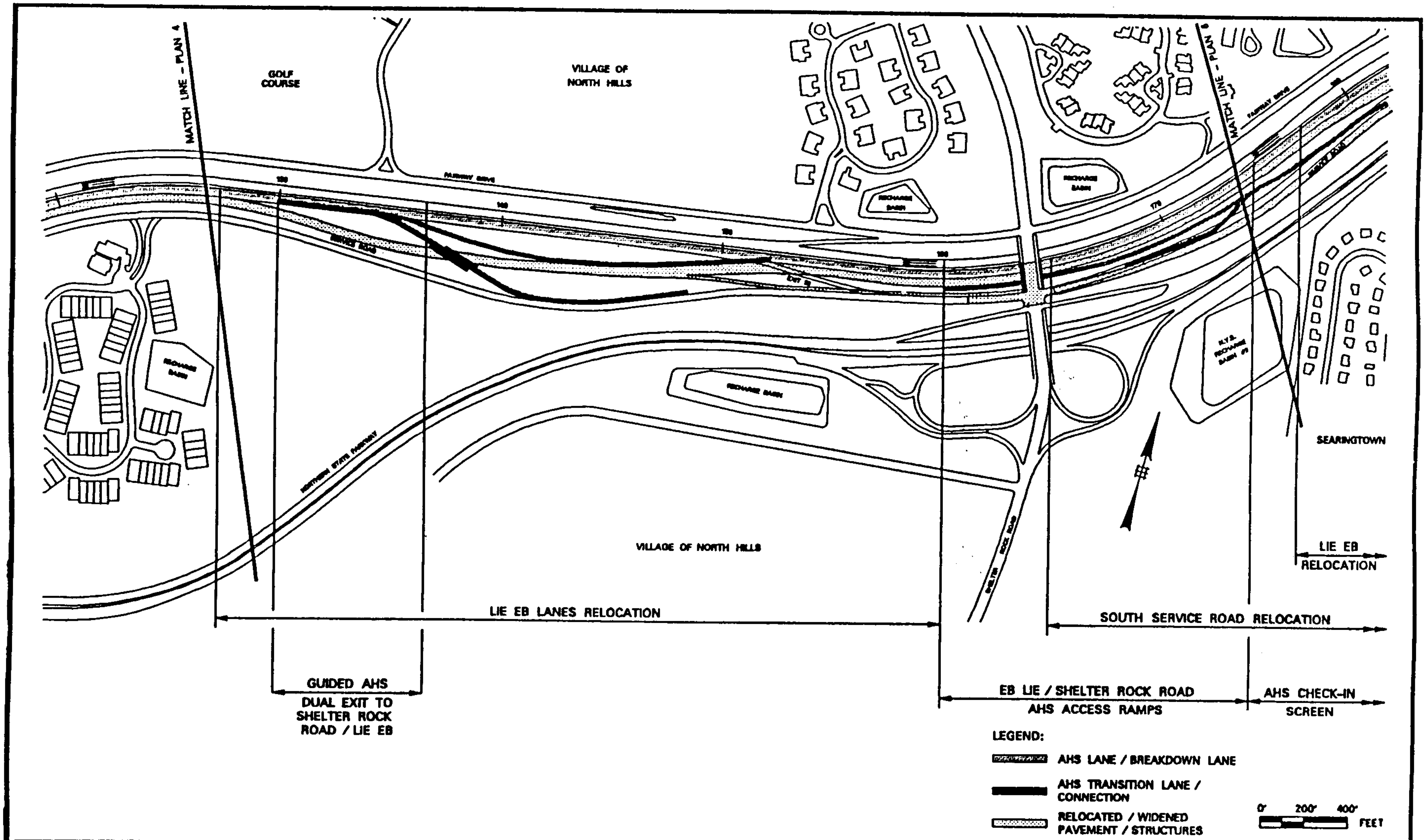


FIGURE 2 – H2	LONG ISLAND EXPRESSWAY SCENARIO AUTOMATED HIGHWAY SYSTEM (AHS)	I-3 CONCEPT STUDY (LIE EASTBOUND DIRECTION ONLY) PLAN 5 OF 17

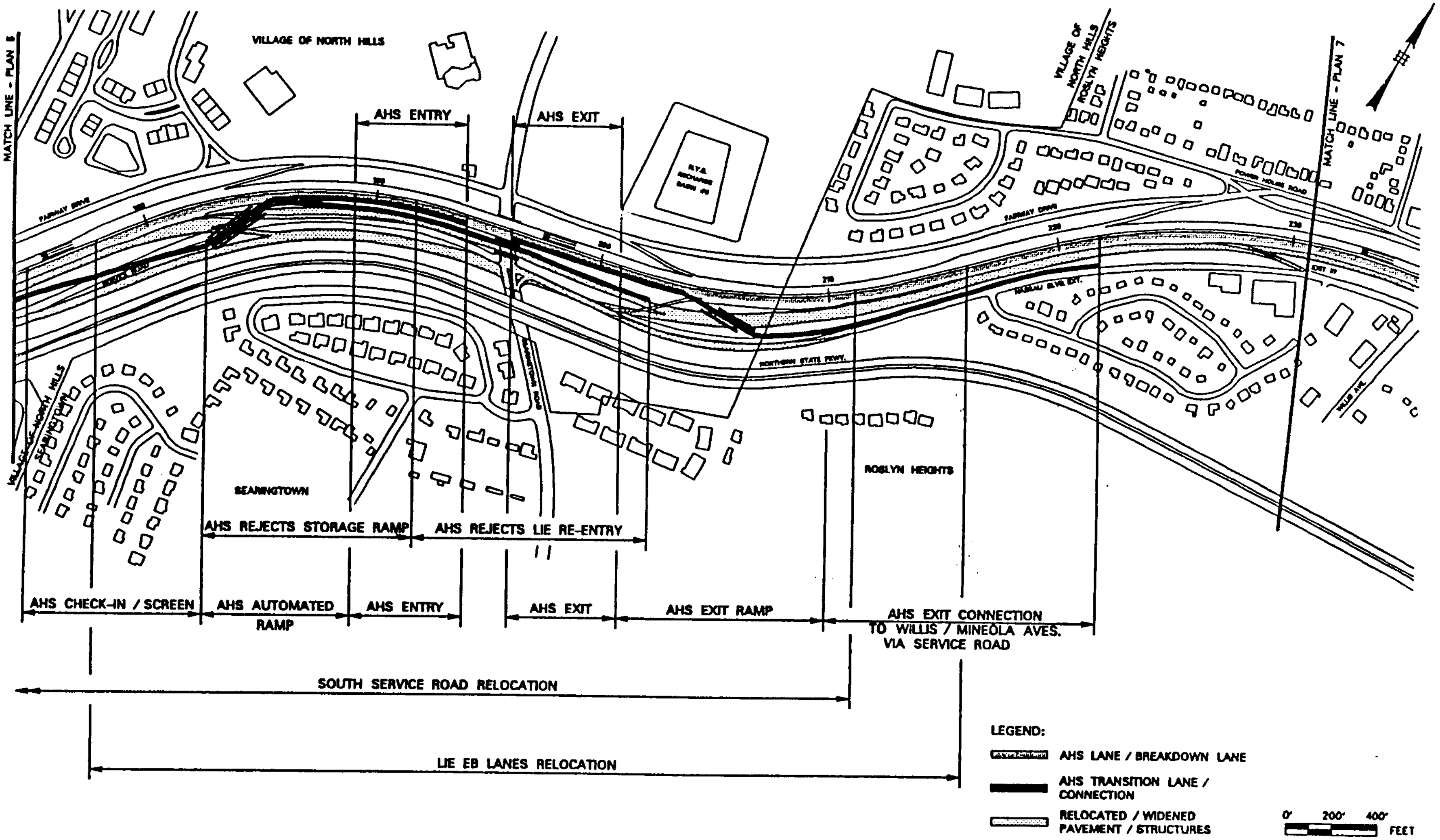


FIGURE 2 – H2	LONG ISLAND EXPRESSWAY SCENARIO AUTOMATED HIGHWAY SYSTEM (AHS)	I-3 CONCEPT STUDY (LIE EASTBOUND DIRECTION ONLY) PLAN 6 OF 17

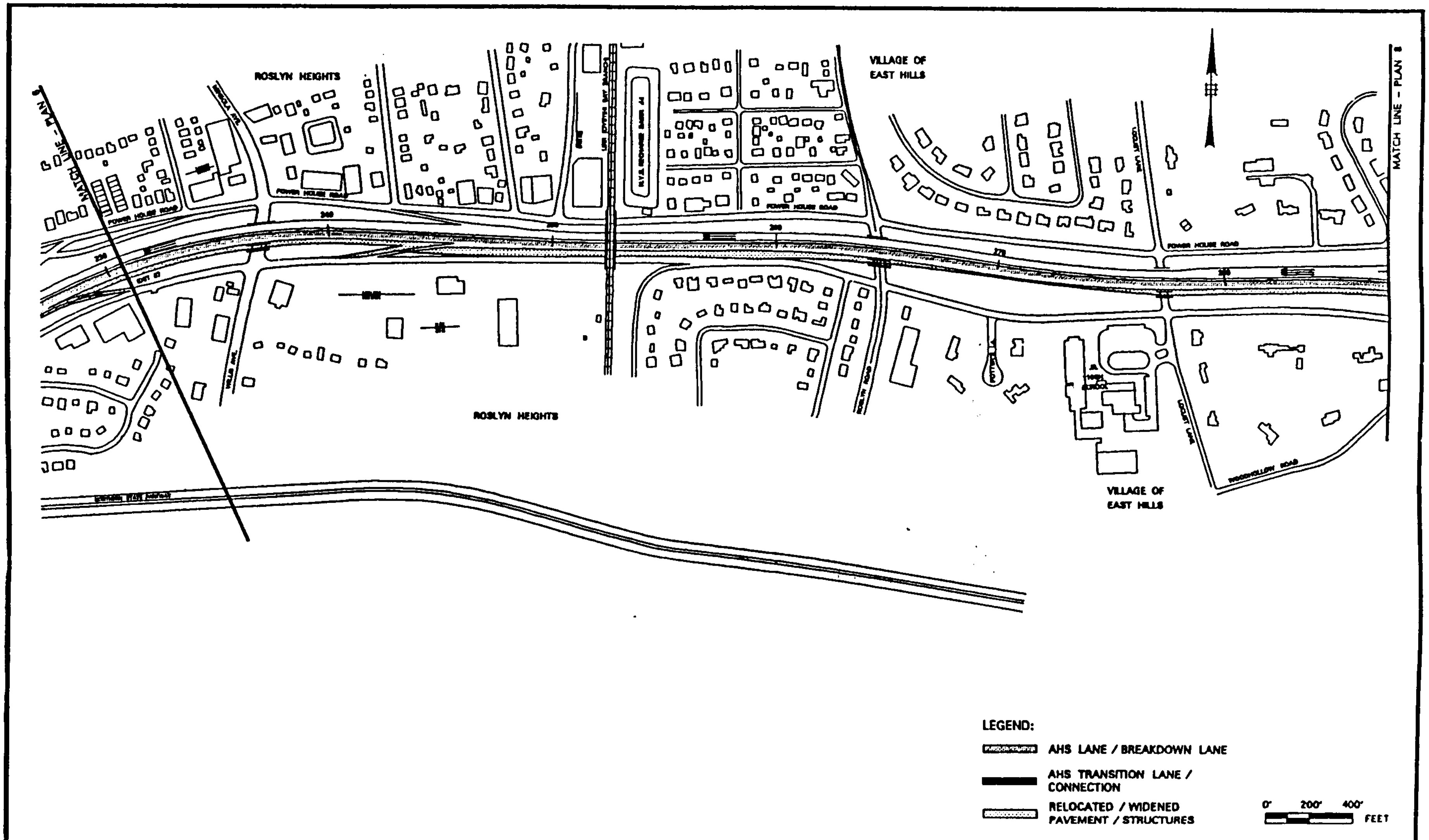


FIGURE 2 - H2	LONG ISLAND EXPRESSWAY SCENARIO AUTOMATED HIGHWAY SYSTEM (AHS)	I-3 CONCEPT STUDY (LIE EASTBOUND DIRECTION ONLY) PLAN 7 OF 17

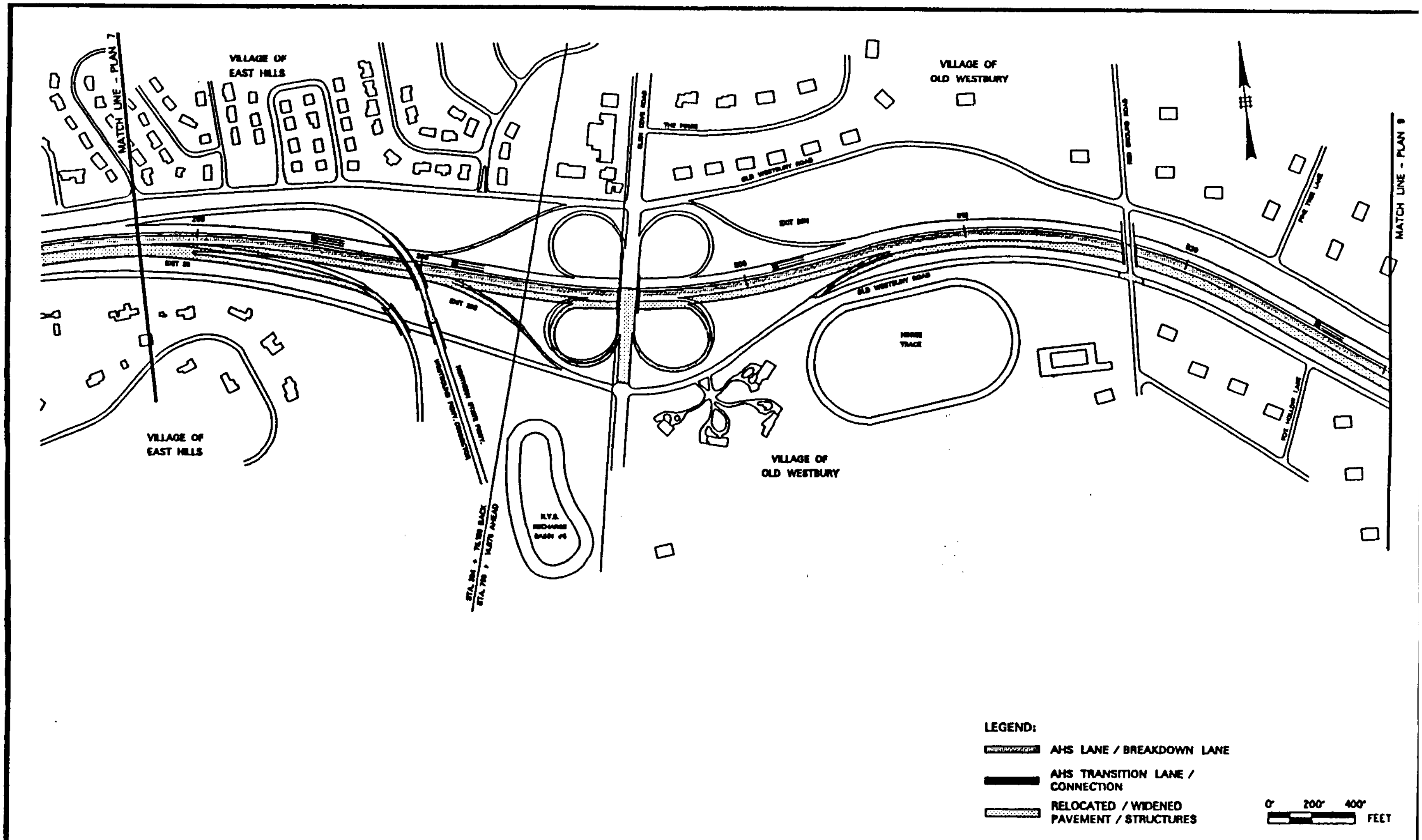


FIGURE 2 – H2	LONG ISLAND EXPRESSWAY SCENARIO AUTOMATED HIGHWAY SYSTEM (AHS)	I-3 CONCEPT STUDY (LIE EASTBOUND DIRECTION ONLY) PLAN 8 OF 17

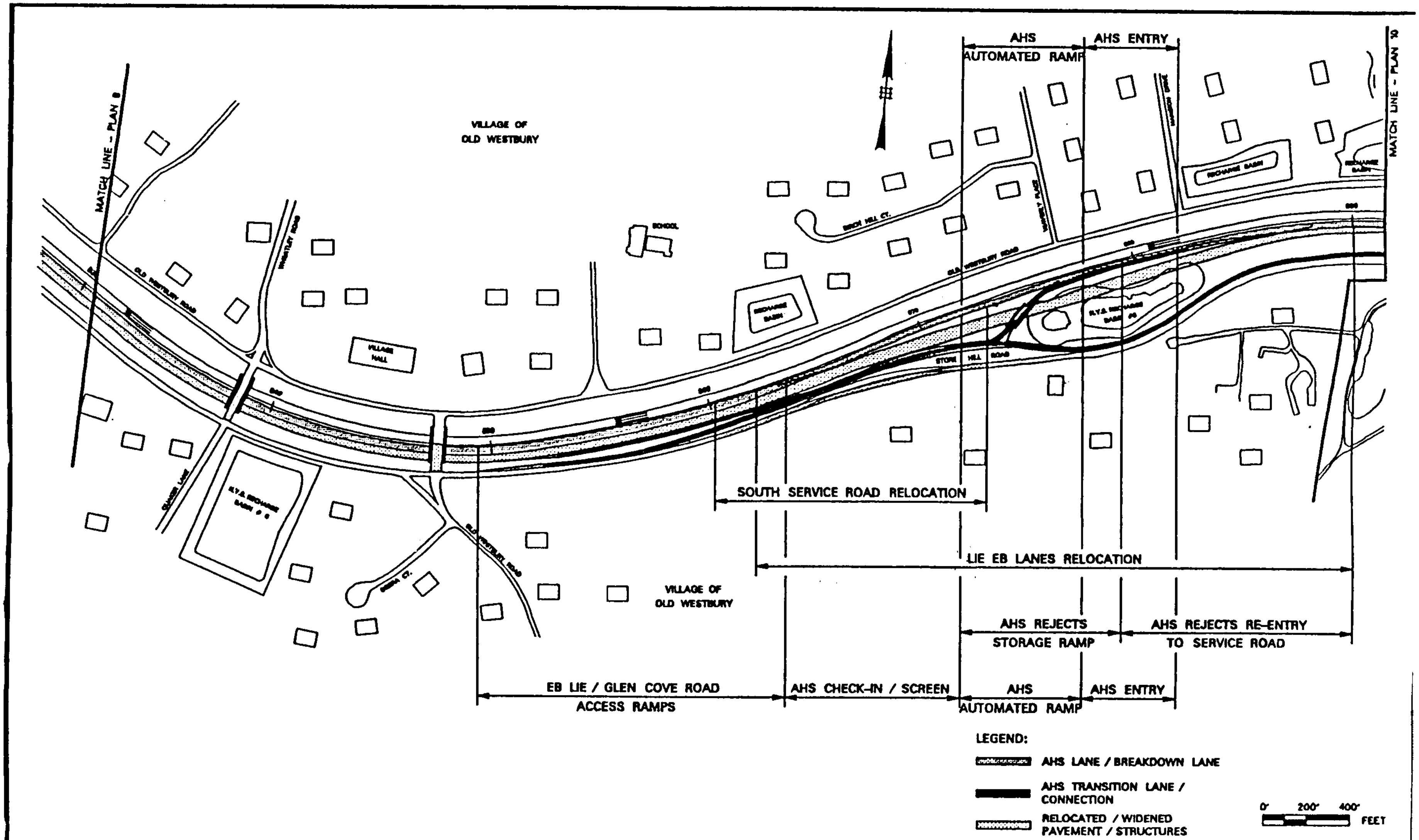


FIGURE 2 – H2	LONG ISLAND EXPRESSWAY SCENARIO AUTOMATED HIGHWAY SYSTEM (AHS)	I-3 CONCEPT STUDY (LIE EASTBOUND DIRECTION ONLY) PLAN 9 OF 17

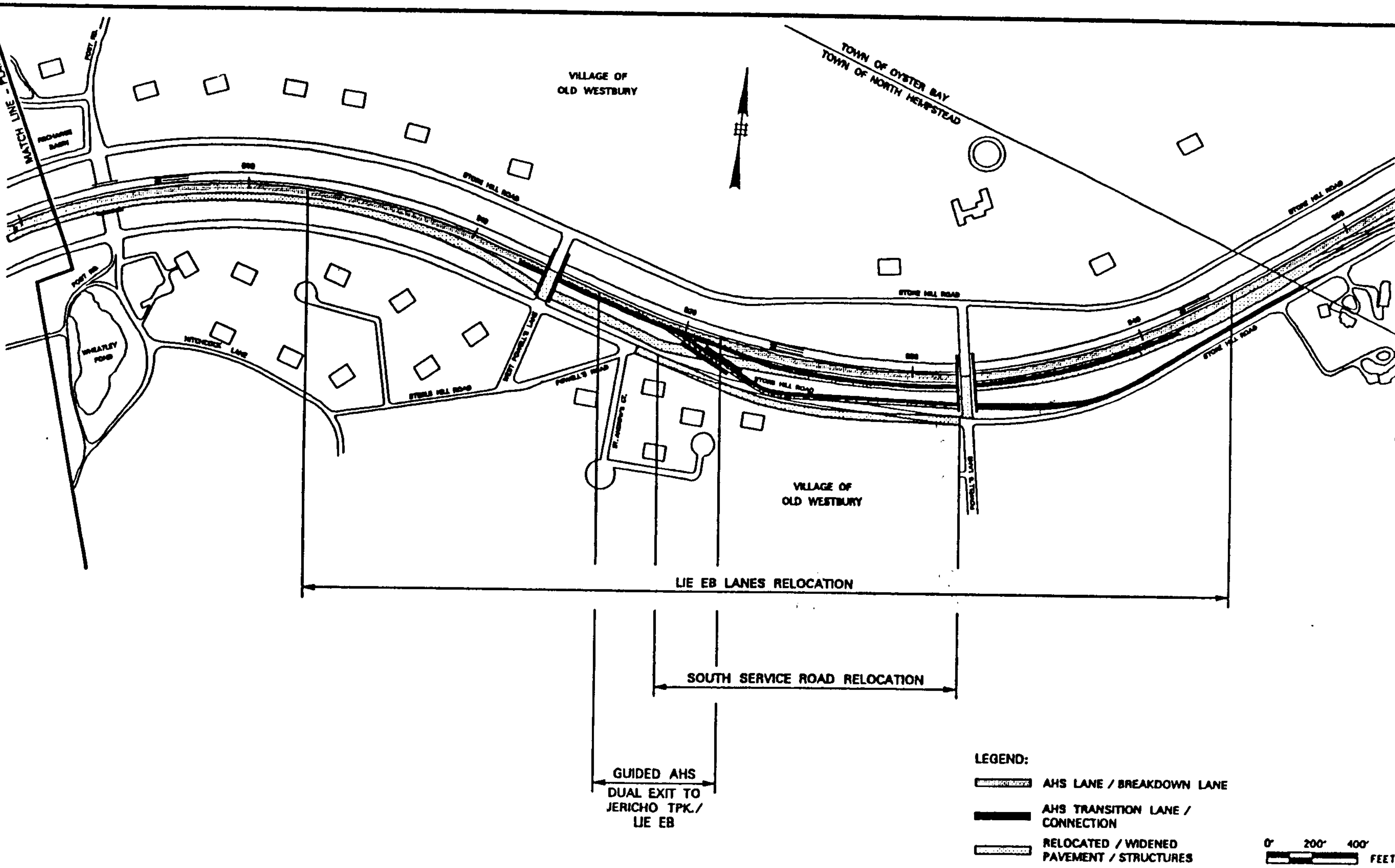


FIGURE 2 - H2	LONG ISLAND EXPRESSWAY SCENARIO AUTOMATED HIGHWAY SYSTEM (AHS)	I-3 CONCEPT STUDY (LIE EASTBOUND DIRECTION ONLY) PLAN 10 OF 17

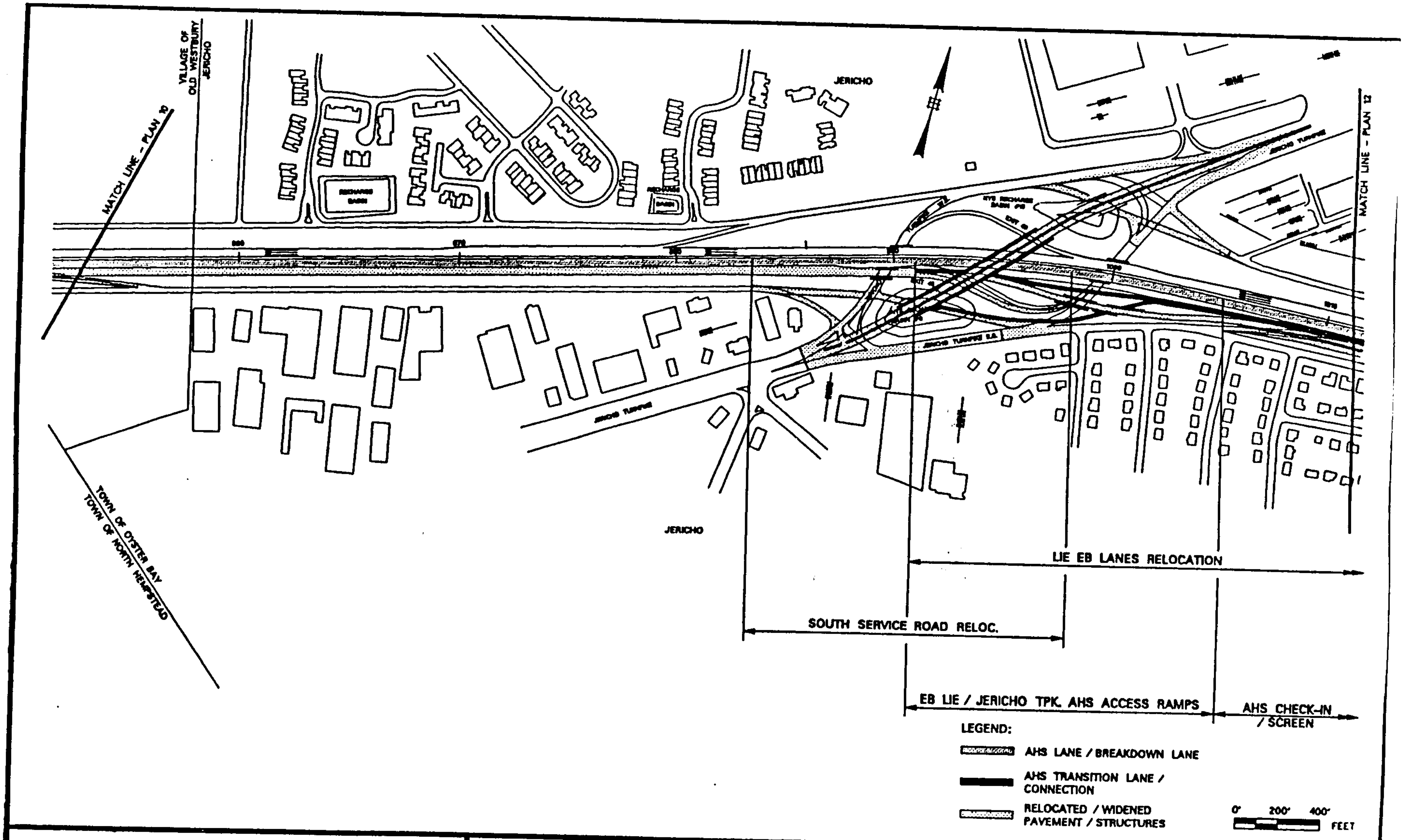


FIGURE 2 – H2

LONG ISLAND EXPRESSWAY SCENARIO
AUTOMATED HIGHWAY SYSTEM (AHS)

I-3 CONCEPT STUDY
(LIE EASTBOUND DIRECTION ONLY)

PLAN 11 OF 17

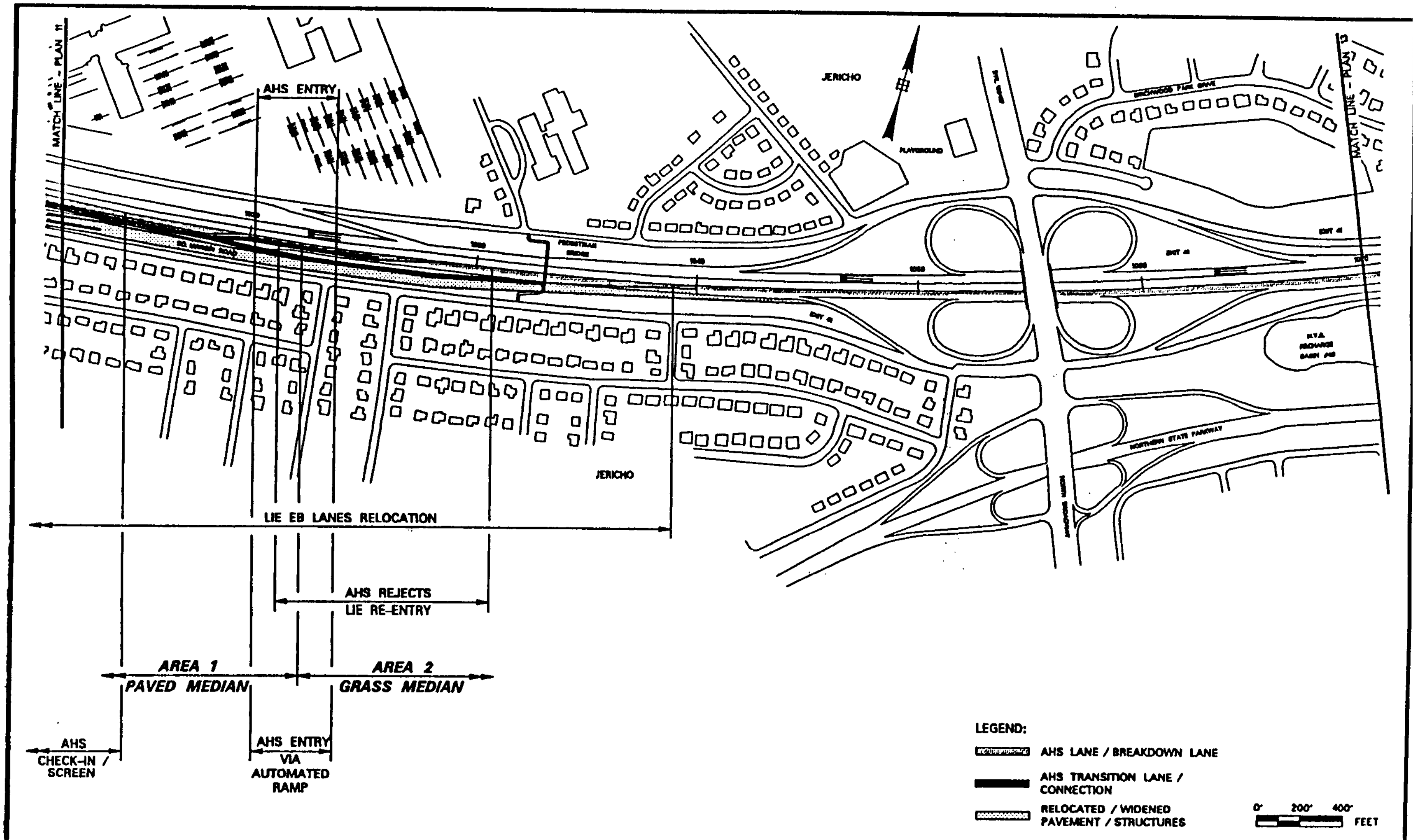


FIGURE 2 – H2	LONG ISLAND EXPRESSWAY SCENARIO AUTOMATED HIGHWAY SYSTEM (AHS)	I-3 CONCEPT STUDY (LIE EASTBOUND DIRECTION ONLY) PLAN 12 OF 17

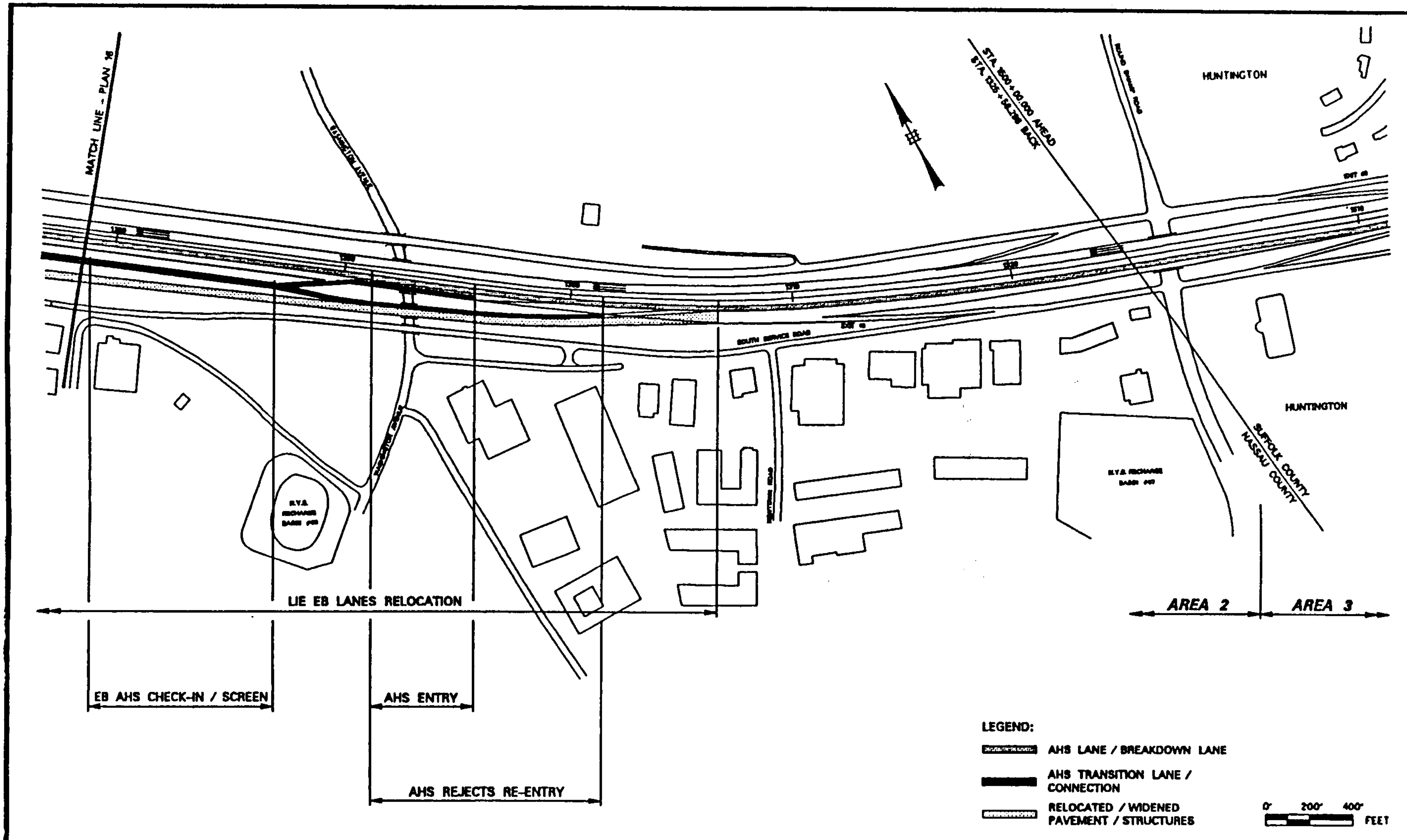


FIGURE 2 – H2	LONG ISLAND EXPRESSWAY SCENARIO AUTOMATED HIGHWAY SYSTEM (AHS)	I-3 CONCEPT STUDY (LIE EASTBOUND DIRECTION ONLY) PLAN 17 OF 17

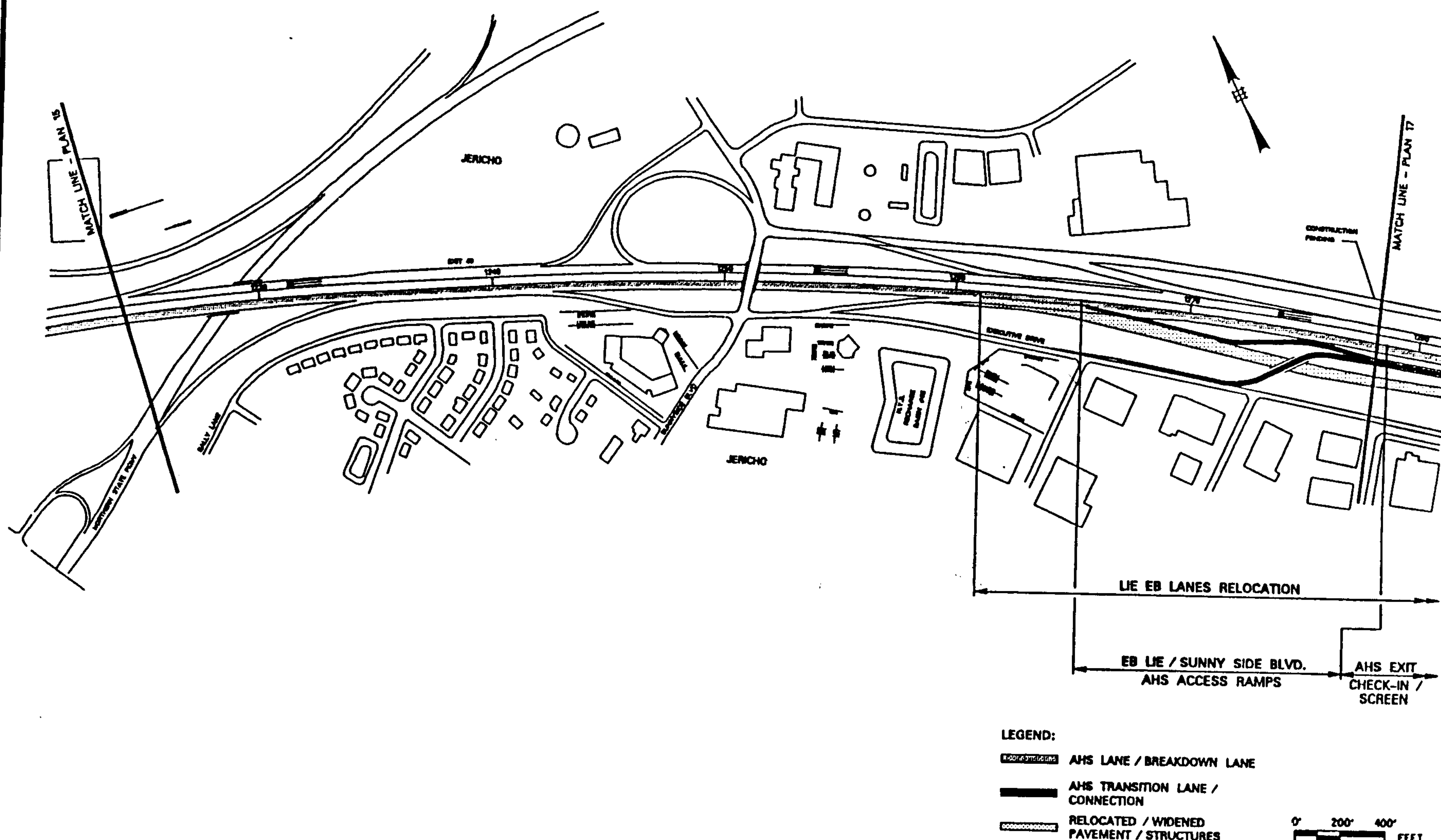


FIGURE 2 – H2	LONG ISLAND EXPRESSWAY SCENARIO AUTOMATED HIGHWAY SYSTEM (AHS)	I-3 CONCEPT STUDY (LIE EASTBOUND DIRECTION ONLY) PLAN 16 OF 17

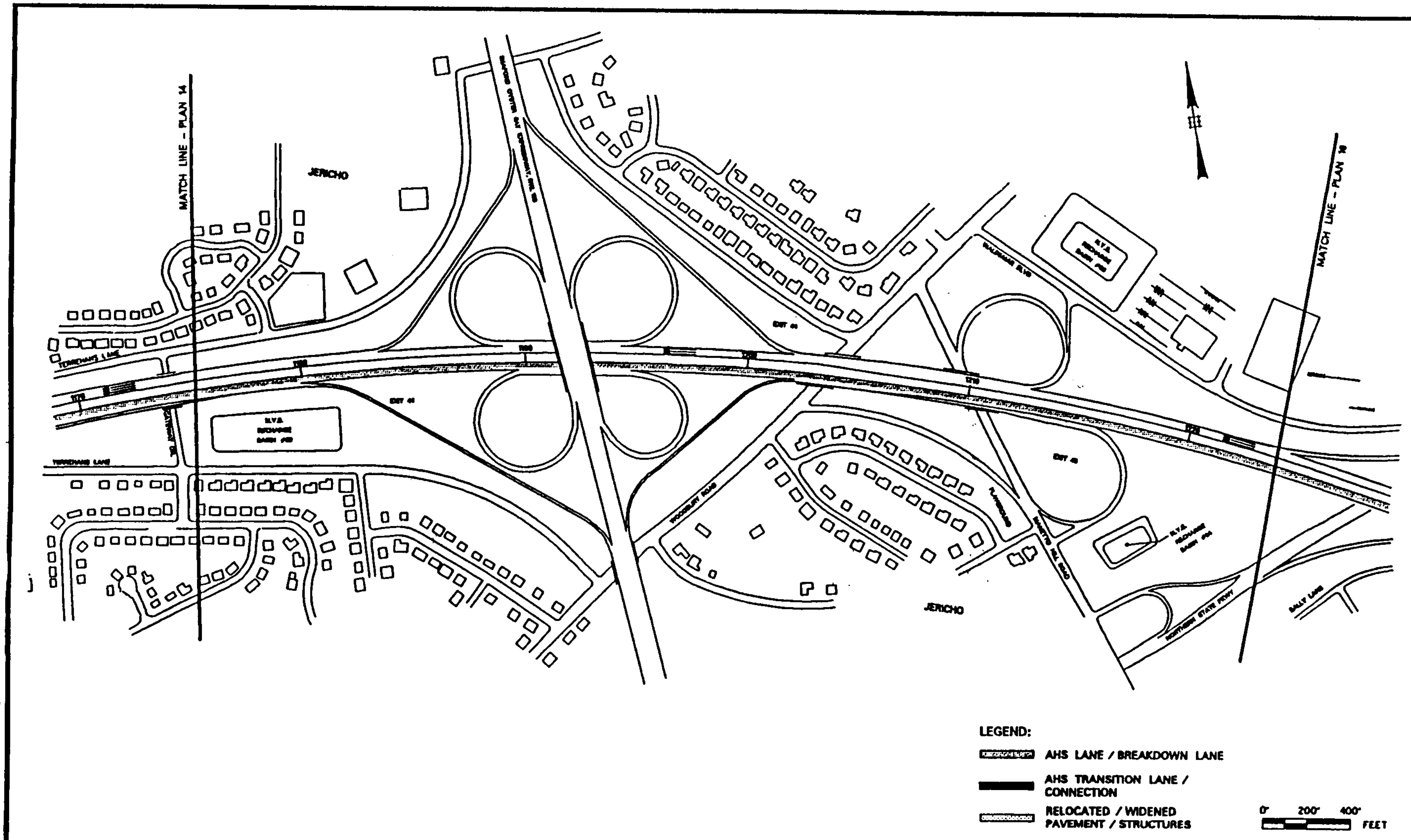
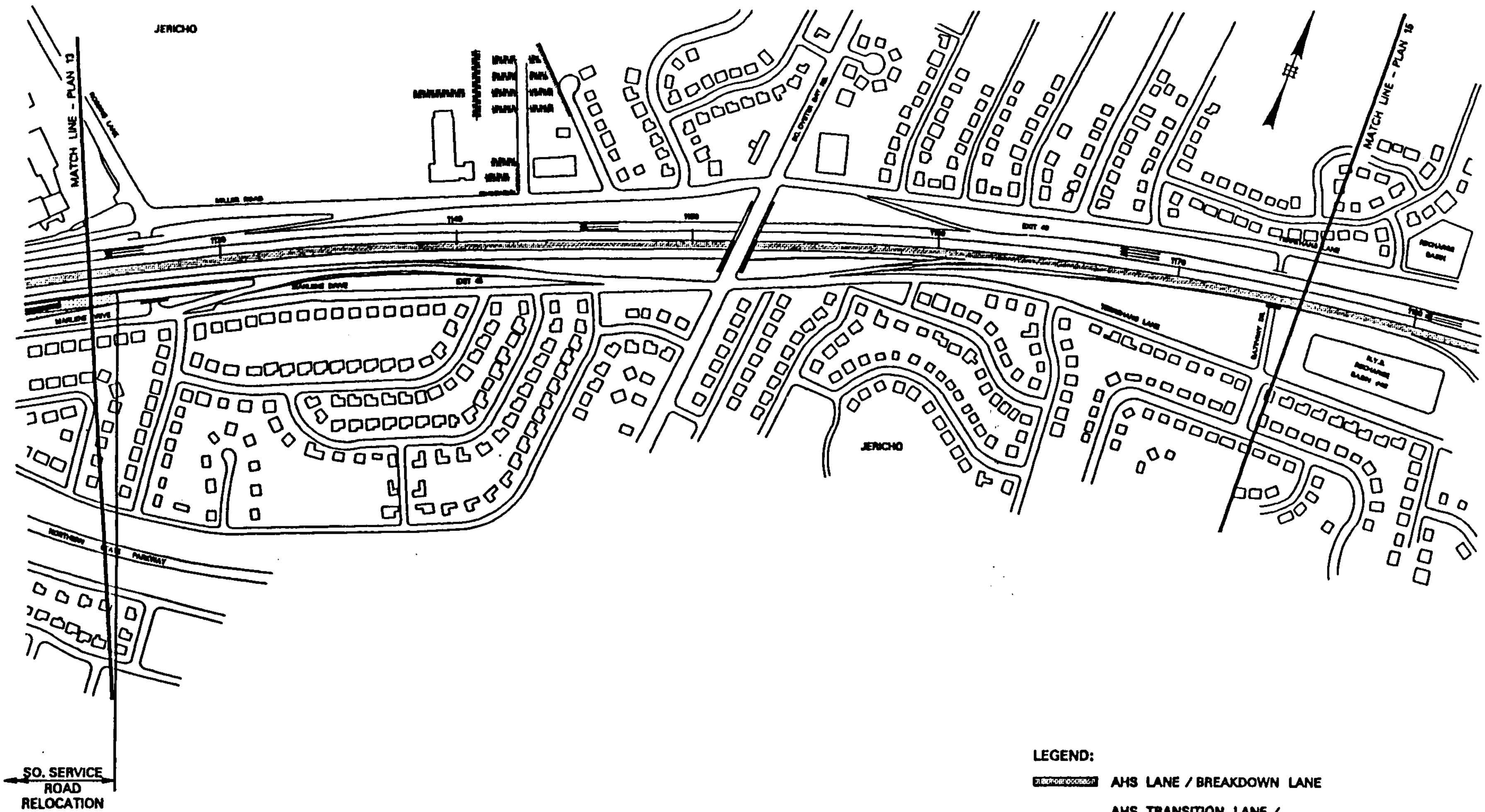


FIGURE 2 - H2	LONG ISLAND EXPRESSWAY SCENARIO AUTOMATED HIGHWAY SYSTEM (AHS)	I-3 CONCEPT STUDY (LIE EASTBOUND DIRECTION ONLY) PLAN 15 OF 17



LEGEND:

- AHS LANE / BREAKDOWN LANE
- AHS TRANSITION LANE / CONNECTION
- RELOCATED / WIDENED PAVEMENT / STRUCTURES

0' 200' 400' FEET

FIGURE 2 – H2	LONG ISLAND EXPRESSWAY SCENARIO AUTOMATED HIGHWAY SYSTEM (AHS)	I-3 CONCEPT STUDY (LIE EASTBOUND DIRECTION ONLY) PLAN 14 OF 17

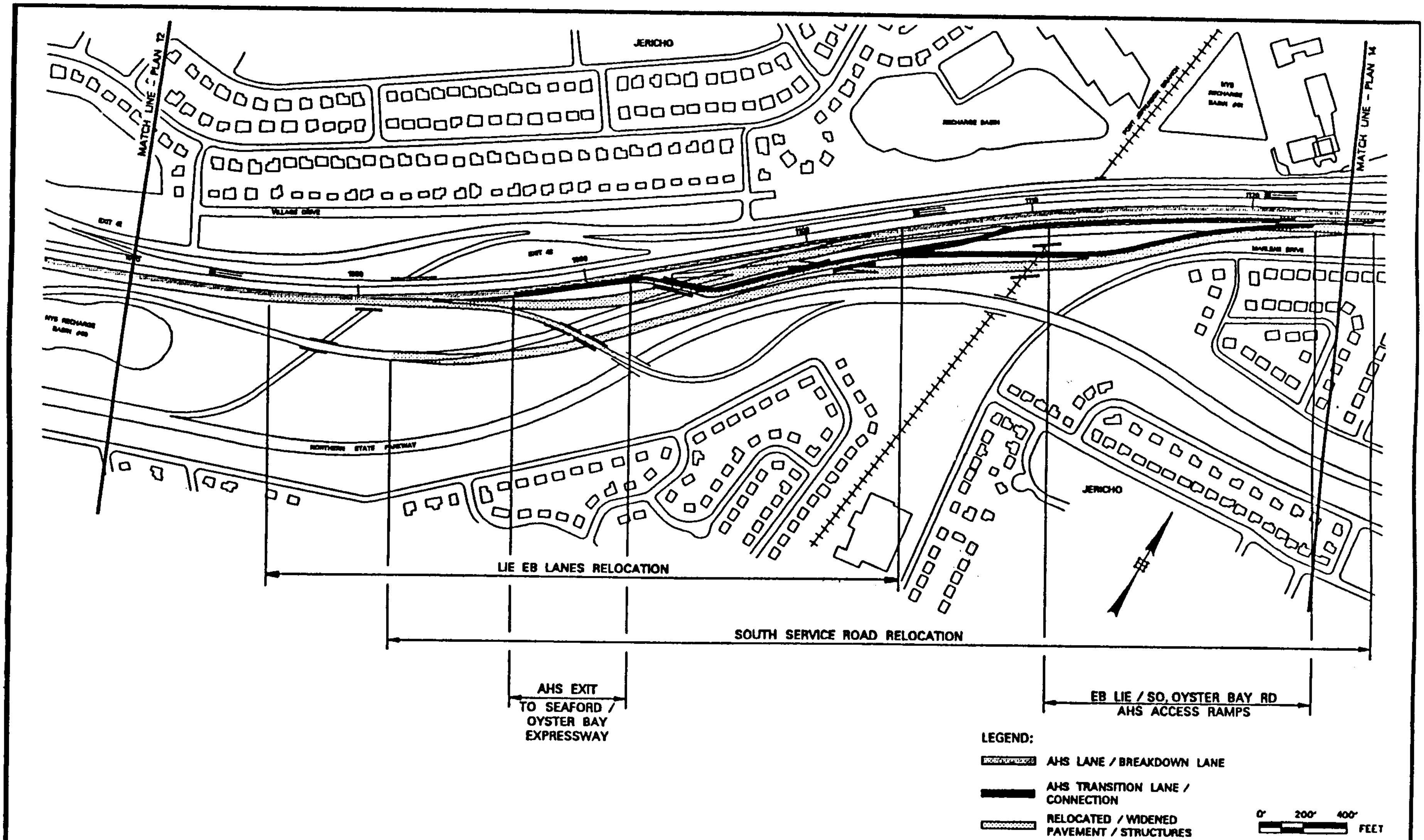


FIGURE 2 – H2	LONG ISLAND EXPRESSWAY SCENARIO AUTOMATED HIGHWAY SYSTEM (AHS)	I-3 CONCEPT STUDY (LIE EASTBOUND DIRECTION ONLY) PLAN 13 OF 17

Appendix G

Typical RSCs I2 and I3 Layout

This Appendix illustrates the layout of ingress/egress of the RSCs I2 and I3. The I2 option utilizes the general lanes as collector/distributors. The I3 option utilizes the service roads and the general lanes as collector/distributors. A variety of similar options are indicated for the RSC I3 option.

Appendix H

LIE RSCs I2 and I3 Layout Illustrations

This Appendix illustrates the layout of both RSCs I2 and I3 on the westbound segment of the LIE between Cross Island Parkway and Washington Avenue. These diagrams indicate the construction requirements required for both RSCs I2 and I3.

Table 2-2. General Characteristics of LIE Scenario

1. Location & length	Long Island Expressway from Cross Island Expressway to Seaford Oyster Bay; EB; PM peak hour; approximately 16.1 mi.
2. Type of highway	Suburban highway, high volumes, existing congestion, most traffic bound for CBD or OBD.
3. Condition without AHS implementation	4 Eastbound lanes, ramp locations shown in Figure 2-11.
4. AHS ramp configuration	Predominantly I2 for I2 scenario, and I3 and I2 mix for I3 scenario illustrated in Figures 2-12 and 2-13.
5. Condition after AHS implementation	One AHS lane, two general use lanes for one implementing and three general use lanes for a second implementation. Ramp locations; lane configurations shown on Figures 2-12 and 2-13 for the two general lane implementation.
6. AHS capacity and speed	62.1 mph constant speed up to capacity. Capacity defined as 5000 vph (vehicle spacing criteria) with useable capacity up to 4500 vph.
7. Percent of AHS equipped vehicles on facility	100%
8. Assumptions for traffic assignment to AHS lanes.	All AHS equipped vehicles (100%) are assigned to AHS up to useable capacity if their destination includes at least one AHS exit ramp from the AHS entry point.
9. Source of trip tables	The QUEENSOD model was used to convert ramp volumes to trip tables.

Table 2-4. Summary of Boston I-93 Scenario Characteristics

1. Location & Length	Boston I-93 from Rt. 128/Rt. 3 to Exit 16 (Southampton St.); NB; AM peak hr.; approximately 8.1 mi
2. Type of Highway	Urban highway, high volumes, existing congestion, most traffic bound for CBD or OBD.
3. Condition before AHS implementation	4 northbound lanes, ramp locations show in Figure 2-16.
4. AHS ramp configuration	I2 and I3 entry as shown in Figure 2-18.
5. Condition after AHS implementation	Two AHS lanes, 2 general lanes.
6. AHS entry and exit spacings	Average 2.0 mi. spacing between entry ramps and 2.0 mi. spacing between exit ramps.
7. AHS capacity and speed	62.1 mph constant speed up to capacity. Capacity defined as 5000 vph (vehicle spacing criteria) with useable capacity up to 4500 vph.
8. Percent of AHS equipped vehicles on facility (manual & automated lanes)	100%
9. Assumptions for traffic assignment to AHS lanes	All AHS equipped vehicles (100%) are assigned to AHS up to useable capacity if their destination includes at least two AHS exit ramps from the AHS entry point.
10. Source of trip tables	The QUEENSOD model was used to convert ramp volumes to trip tables.

Table 2-6. General Characteristics of Maryland I-495 Scenario

1. Location & length	Maryland I-495 (Washington DC Beltway) from I-95 to I-270; WB; A.M. peak hour; approximately 9.3 mi.
2. Type of highway	Suburban highway, high volumes, existing congestion, most traffic not bound for CBD or OBD.
3. Condition before AHS implementation	Ramp locations; current volumes; lane configurations shown on Figure 2-23 and 2-25.
4. AHS ramp configuration	Predominantly I3, some I2 as shown on Figure 2-24.
5. Condition after AHS implementation	One AHS lane, one less general use lane than current configuration. Scenario configuration shown in Figure 2-24.
6. AHS entry and exit spacings	Average 2.3mi. spacing between entry ramps and 3. mi. spacing between exit ramps.
7. AHS capacity and speed	62.1 mph constant speed up to capacity. Capacity defined as 5000 vph (vehicle spacing criteria) with useable capacity up to 4500 vph.
8. Percent of AHS equipped vehicles on facility	50 percent
9. Assumptions for traffic assignment to AHS lanes.	All AHS equipped vehicles (50 percent) are assigned to AHS up to useable capacity if their destination includes at least one AHS exit ramp from the AHS entry point.
10. Source of trip tables	The QUEENSOD model was used to convert ramp volumes to trip tables.

Table 2-9. Summary NY State Thruway Scenario Characteristics

1. Location & length	New York State Thruway (I-87) from Exit 16 (Harriman) to Exit 18 (New Paltz); NB, AM peak hr; Approx. 31 mi.
2. Type of highway	Rural highway, relatively low volumes, little congestion, most traffic not local.
3. Condition before AHS implementation	2 northbound lanes, ramp locations & current volumes shown on Figures 2-29 and 2-30.
4. AHS ramp configuration	I2 as illustrated in Figure 2-31.
5. Condition after AHS implementation	One AHS lanes, 2 general lanes, scenario uses current volumes. Variations up to 130% of current volumes.
6. AHS entry and exit spacings	Average 15.5 mi spacing between entry ramps and 15.5 mi spacing between exit ramps.
7. AHS capacity and speed	a. 62.1 MPH constant speed up to capacity (5000 VPH with 4500 VPH useable capacity). b. 80 MPH constant speed up to capacity (3000 VPH with 2700 VPH useable capacity).
8. Percent of AHS equipped vehicles on facility	70%
9. Assumptions for traffic assignment to AHS lanes.	All AHS equipped vehicles (70%) are assigned to AHS up to useable capacity.
10. Source of trip tables	NYS Thruway data.

TABLE 2-11

TRANPLAN Roadway Characteristics

ROADWAY DESCRIPTION			CAPACITY vplpd	SPEED (M.P.H.)	ASSIGNMENT GROUP
Long Island Expressway			21,000	65	1
Parkways (4 lanes)			18,000	60	1
Parkways (6 lanes)			18,800	65	1
Centroid Connectors			15,000	30	9
Arterial Multilane Highways					
Multilane Type	Signals	Lateral Clearance			
1. Divided	Yes	Unrestricted	7,800	30-50	5-8
2. Divided	Yes	Restricted	6,900	30-50	5-8
3. Divided	No	Unrestricted	16,900	35-55	5-8
4. Divided	No	Restricted	14,600	35-55	5-8
5. Undivided	Yes	Unrestricted	7,500	30-45	5-8
6. Undivided	Yes	Restricted	6,600	30-45	5-8
7. Undivided	No	Unrestricted	15,900	35-55	5-8
8. Undivided	No	Restricted	14,000	35-55	5-8

Notes: vplpd — vehicle per lane per day
Divided — a. Raised Median
b. Flush Median greater than 9 feet and 4 feet for all other highways
Unrestricted shoulder 6 feet or more in width
Assignment Group designates the relationship between speed and volume for a particular road within the TRANPLAN Model

Source: NYS Route 347 Corridor Study