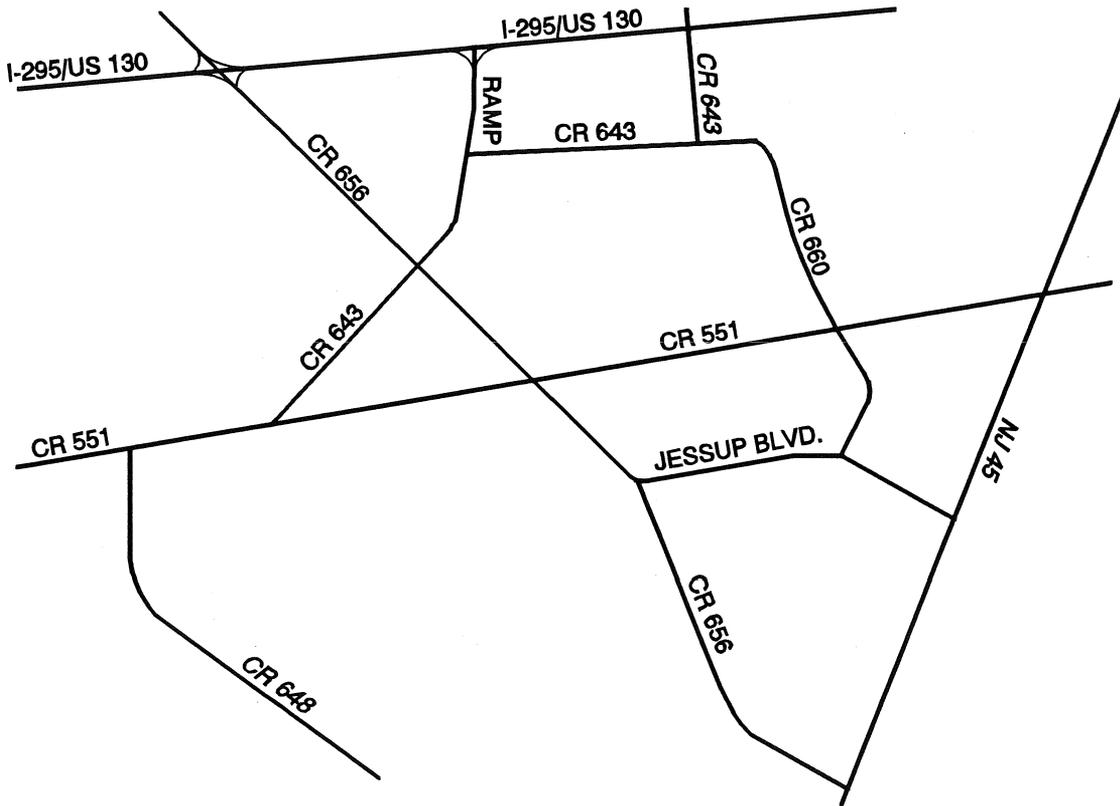


# KINGS HIGHWAY CORRIDOR TRAFFIC ANALYSIS WEST DEPTFORD TOWNSHIP

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FEBRUARY 1993

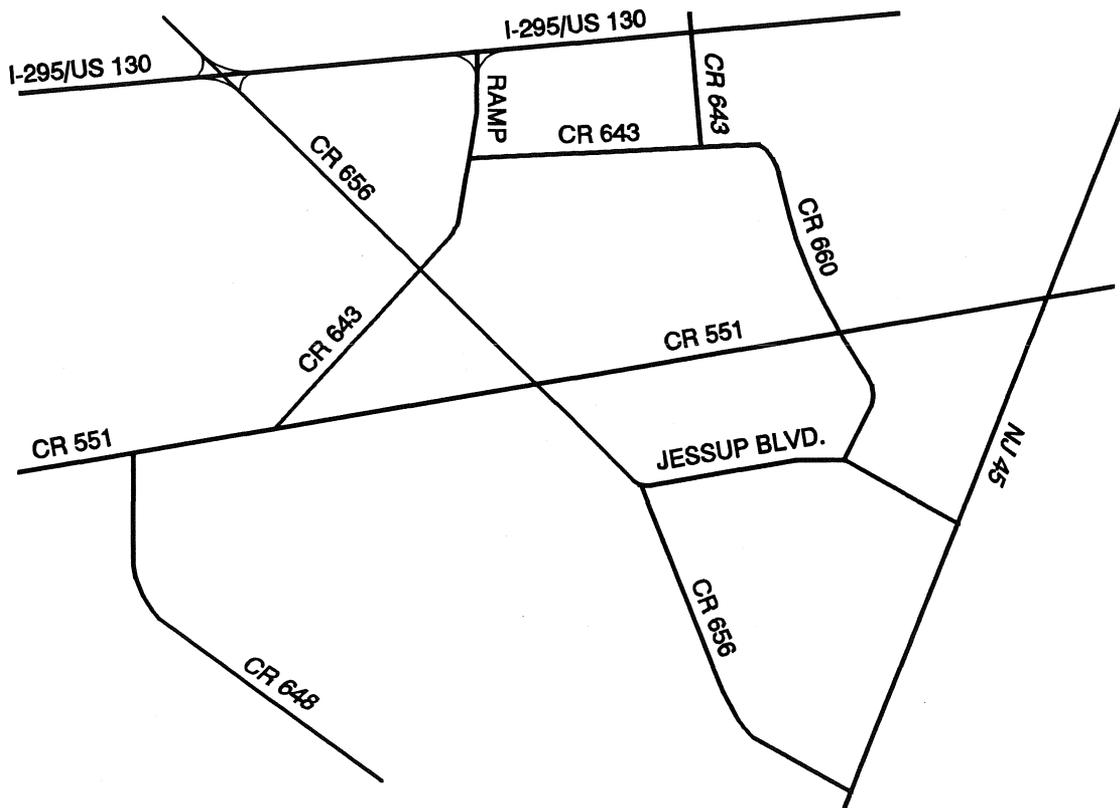


DELAWARE VALLEY  
REGIONAL PLANNING COMMISSION



# KINGS HIGHWAY CORRIDOR TRAFFIC ANALYSIS WEST DEPTFORD TOWNSHIP

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FEBRUARY 1993



DELAWARE VALLEY  
REGIONAL PLANNING COMMISSION  
21 SOUTH FIFTH ST.  
PHILADELPHIA, PA. 19106



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*Created in 1965, the Delaware Valley Regional Planning Commission (DVRPC) is an interstate, intercounty and intercity agency which provides continuing, comprehensive and coordinated planning for the orderly growth and development of the Delaware Valley region. The region includes Bucks, Chester, Delaware, and Montgomery counties as well as the City of Philadelphia in Pennsylvania and Burlington, Camden, Gloucester, and Mercer counties in New Jersey. The Commission is an advisory agency which divides its planning and service functions among the Office of the Executive Director, the Office of Public Affairs, and three line Divisions: Transportation Planning, Regional Information Services Center, which includes the Office of Regional Planning, and the Office of Finance. DVRPC's mission for the 1990s is to emphasize technical assistance and services and to conduct high priority studies for member state and local governments, while determining and meeting the needs of the private sector.*



*The DVRPC logo is adapted from the official seal of the Commission and is designed as a stylized image of the Delaware Valley. The outer ring symbolizes the region as a whole while the diagonal bar signifies the Delaware River flowing through it. The two adjoining crescents represent the Commonwealth of Pennsylvania and the State of New Jersey. The logo combines these elements to depict the areas served by DVRPC.*

# DELAWARE VALLEY REGIONAL PLANNING COMMISSION

## Publication Abstract

<b>TITLE</b>	<b>Date Published:</b> February 1993
KINGS HIGHWAY CORRIDOR TRAFFIC ANALYSIS <i>West Deptford Township</i>	
	<b>Publication No.</b> 93006

### Geographic Area Covered:

The study focuses on the section of Kings Highway (CR 551) located in West Deptford Township, Gloucester County, New Jersey.

### Key Words:

Demographics, traffic simulation models, traffic zones, traffic volumes, turning movement counts, level of service analysis, traffic projections, improvement recommendations

## ABSTRACT

*This study addresses the section of the Kings Highway Corridor in West Deptford, Gloucester County, New Jersey. The study area is largely undeveloped, yet it is anticipated that this area will experience moderate growth in the next 20 years due partly to the completion of the Blue Route (I-476) in Pennsylvania and the reconstruction of I-295 in Gloucester County. Existing demographics and traffic conditions in the study area are described. Traffic volumes and levels of service are projected for the Year 2010 based on anticipated growth trends. Recommendations are presented which address the deficiencies in the county highway system.*

*For More Information Contact:*

 Delaware Valley Regional Planning Commission  
Regional Information Services Center  
The Bourse Building  
21 South 5th Street  
Philadelphia Pa. 19106  
(215) 592-1800



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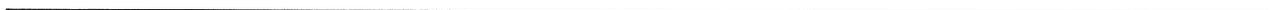
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## **I. EXECUTIVE SUMMARY**

The purpose of this study is threefold: 1) to determine, based on the study area's current development scenario and its population and employment projections, what the future traffic volumes are expected to be on Kings Highway (CR 551) and the surrounding county highway network in West Deptford Township; 2) to determine if this road network will be able to accommodate the amount of traffic which is expected to use these roads in the future; and 3) what improvements will be required if the existing highway capacity is not adequate to service the expected demand. Traffic was projected to a 20 year horizon using the Quick Response System II traffic simulation model.

Currently the study area is largely undeveloped but has the potential to become one of Gloucester County's growth areas due to the recent completion of I-476 (Blue Route) in Pennsylvania and the reconstruction and interchange improvements to I-295 in West Deptford and East Greenwich Townships.

CR 551 is a two lane road carrying one travel lane and a paved shoulder throughout most of the study area. The other roads in the study area are similarly configured and most carry considerably less traffic than CR 551. The existing demographics of the study area are presented along with the current traffic volumes and the operating conditions of the highway network. The demographics, volumes and operating conditions are projected to the Year 2010 based on anticipated growth.

All roads in the network currently operate at acceptable levels of service, however some deficiencies exist on various intersection approaches during the peak hours. The projected volumes represent a modest growth in traffic and for the most part, the highway network will continue to operate with acceptable levels of service in the Year 2010. Neither the projected volumes nor the resulting operating conditions warrant widening this road to four lanes. Even with the level of anticipated growth, the resulting traffic can, in most locations, be easily absorbed by the existing highway network. Most of these facilities operate so much under capacity that, for the most part, major physical improvements are not necessary. However, minor improvements such as minor widening for the construction of shoulders, addition of left turn lanes and traffic signal retiming should provide congestion relief to the level for which it is needed.

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## II. INTRODUCTION

This report focuses on the 2.8 mile section of Kings Highway (CR 551) from NJ 45 to the East Greenwich Township line. This study is the second of three to address improvements to the Kings Highway Corridor which extends from the City of Woodbury to the Salem County line. The first report addressed the section of the corridor in Woolwich Township and the Borough of Swedesboro. The study area for this section of the Kings Highway Corridor is West Deptford Township. The remaining study will focus on East Greenwich Township. A map of the study area is presented in Figure 1. The purpose of this report is to develop an improvement plan for county-owned roads in the study area which is bounded by I-295, the Woodbury City line, the New Jersey Turnpike and the East Greenwich Township line.

The reconstruction of I-295 in Gloucester County and the completion of I-476 (Blue Route) in Delaware County, Pennsylvania is expected to accelerate development in this part of Gloucester County. The Gloucester County Planning Department, concerned about the effects of this development on the road network, requested the Delaware Valley Regional Planning Commission (DVRPC) assist them in developing an improvement plan to address these concerns.

A description of the corridor will be presented in the next section of this report. This will include the existing physical and operating conditions of the existing highway network in the study area. Existing traffic volumes on this network are also presented. A level of service analysis will be performed on key roads and intersections.

The next section documents the travel forecasting methodology with a discussion of the Quick Response System II (QRS II) Model used to develop the traffic projections for the year 2010. Input data such as the population and employment projections of the study area which are essential to the simulation process are also presented.

The following section presents the results of the travel forecast. These results document the projected daily traffic volumes for Kings Highway and the surrounding network for the year 2010. A level of service analysis with the projected volumes is also presented in this section.

The final section of this report presents recommendations intended to address any deficiencies identified in the previous analyses. These recommendations will be used by the county in developing an improvement plan for the county-owned road network.

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### **III. CORRIDOR AND NETWORK DESCRIPTION**

#### **Existing Physical Conditions of the Highway Network**

This section of the report examines the existing physical conditions on a network of county owned roads in West Deptford Township. Figure 2 displays the network of county roads which are analyzed in this report. Descriptions of these roads are presented below.

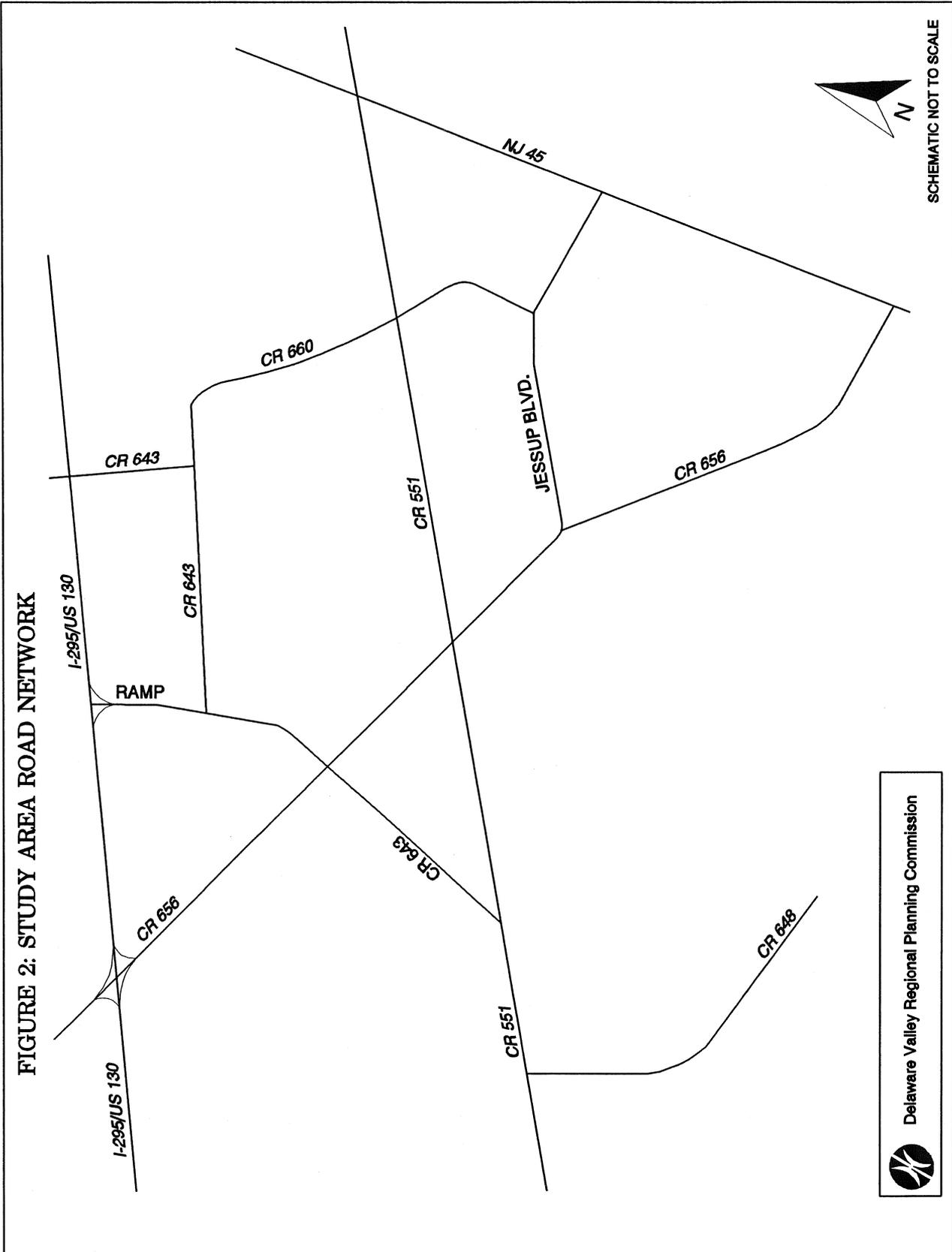
Kings Highway (CR 551) runs generally parallel to and is centered between I-295 and NJ 45. For this reason, Kings Highway carries trips predominantly of a more local nature while I-295 and NJ 45 carry more regional or through trips.

Kings Highway is owned and maintained by Gloucester County. This road is classified as a minor arterial under the county's functional classification system and maintains one travel lane in each direction throughout its entire length. Within the study area, the cartway width and speed limit vary as the adjacent land uses change. Between NJ 45 and CR 660, Kings Highway has a 15 foot travel lane in each direction and no designated shoulder. The posted speed limit along the majority of this segment is 40 MPH. The land use is scattered residential uses and commercial developments. Between CR 660 and CR 656, the lanes narrow to 13 feet but a two foot shoulder is provided in each direction. The posted speed limit is increased to 50 MPH in this section. The section of Kings Highway from CR 656 to the East Greenwich Township line carries a 12 foot travel lane and a three foot shoulder in each direction. The speed limit is posted at 40 MPH in this section. The land use in this section is a mix of undeveloped parcels, scattered residential uses and a tank farm.

CR 660 (Jessup Road), classified as a major collector, connects Kings Highway with CR 643 (Grove Road) just south of I-295. This two-lane road has a 13 foot travel lane and a 7 foot shoulder in each direction. The land use is mostly undeveloped or scattered residential with a few commercial/light industrial uses. Its intersection with Kings Highway is a four-legged intersection controlled by a traffic signal.

CR 656 (Mantua Grove Road) is a two lane road which runs in a general north-south direction across the study area and intersects Kings Highway at a signalized four-legged intersection. This road is classified as a major collector and connects NJ 45 to I-295. The

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section between NJ 45 and Kings Highway carries an 11 foot lane and a one foot shoulder in each direction. The posted speed limit along this section is 45 MPH. The land use is mostly undeveloped or agricultural uses with some scattered residential uses. The three-legged intersection with Jessup Boulevard was recently realigned to provide a free flow movement for southbound CR 656. The section between Kings Highway and I-295 carries a 12 foot lane and four foot shoulder in each direction. The speed limit is posted at 50 MPH along this section. The land use is mostly vacant or agricultural with some scattered industrial uses. In addition to the intersection with Kings Highway, another traffic signal can be found at the intersection with CR 643. A full interchange exists with I-295.

CR 643 (Grove Road) connects Kings Highway to I-295 and NJ 44. This major collector carries a 12 foot travel lane in each direction and the variable shoulder width has been measured up to 11 feet in some areas. This road intersects Kings Highway at an unsignalized three-legged intersection and has a partial interchange (northbound on and off) with I-295. The speed limit is posted at 50 MPH. The land use is characterized by mostly vacant or agricultural parcels with a number of light industrial sites and a few scattered residential uses.

CR 648 (Ogden Station Road), classified as a local collector, connects Kings Highway to NJ 45. This two-lane road has a 26 foot travelway with no designated shoulder area. The posted speed limit is 50 MPH. The dominant land use is undeveloped land however there are several residential developments located near NJ 45. This road intersects Kings Highway at an unsignalized three-legged intersection.

In addition to those roads listed above, several state-owned and municipal-owned roads were included in a network which was used in the process to project future traffic volumes. No analysis of the state and local roads was conducted.

This report will also examine the nine intersections created by this network. The physical condition of these intersections are described below:

CR 551 (Kings Highway) and NJ 45 (Mantua Pike) - this is a signalized five-legged intersection. Two of the legs operate as one-way streets taking traffic away from the intersection effectively making it operate as a three-legged intersection. The other three legs carry traffic in both directions. The eastbound CR 551 approach carries one lane and intersects NJ 45 at an oblique angle. The northbound approach on NJ 45 consists

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of a shared through/left turn lane and a shared through/right turn lane. Southbound on NJ 45, there is a shared through/left turn lane, a through lane and a channelized right turn lane. The intersection is controlled by a two-phase actuated signal.

CR 551 (Kings Highway) and CR 660 (Jessup Road) - both approaches of CR 551 consist of a one lane approach, however paved shoulders allow through and right turn movements to bypass vehicles queued up to turn left. The northbound Jessup Road approach consists of one twelve foot travel lane and no shoulder. Southbound on CR 660 there is a channelized right turn lane in addition to a shared through/left turn lane. The intersection is controlled by a two-phase actuated signal.

CR 551 (Kings Highway) and CR 656 (Mantua Grove Road) - both CR 551 approaches to this intersection contain a shared through/left turn lane and a right turn lane. The northbound CR 656 approach also contains a shared through/left turn lane and a right turn lane. The configuration of the southbound CR 656 approach works differently however, it contains a shared through/right turn lane and a left turn lane. The intersection is controlled by a two-phase actuated signal.

CR 551 (Kings Highway) and CR 643 (Grove Road) - this is a three-legged unsignalized intersection. Both approaches on CR 551 consist of one travel lane and a paved shoulder. Vehicles travelling eastbound on CR 551 can utilize the shoulder to bypass vehicles queued up to turn left onto CR 643. The one lane approach of CR 643 intersects CR 551 at an oblique angle and is controlled by a stop sign.

CR 551 (Kings Highway) and CR 648 (Ogden Road) - this is a three-legged unsignalized intersection. Both approaches on CR 551 consist of one lane and a paved shoulder. Vehicles travelling westbound on CR 551 can utilize the shoulder to pass around vehicles queued up to turn left onto CR 648. The one lane approach of CR 648 is controlled by a stop sign.

CR 656 (Mantua Grove Road) and CR 643 (Grove Road) - this is a four-legged signalized intersection. The westbound CR 656 approach consists of a right turn lane and a shared through/left turn lane. The eastbound CR 656 approach is striped as one lane but is wide enough to easily allow through and right turn traffic to bypass vehicles queued up to turn left. The northbound CR 643 approach consists of one travel lane, a

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paved shoulder permits through and right turn traffic to bypass vehicles queued up to turn left onto westbound CR 656. The southbound CR 643 approach is striped for one lane however a paved 11 foot shoulder acts as a right turn lane. The intersection is controlled by a two-phase actuated signal.

CR 643 (Grove Road) and I-295 NB Entrance/Exit Ramp - CR 643 intersects an entrance/exit ramp to NB I-295 at an unsignalized T intersection where the southern and eastern legs of the intersection carry CR 643 and the northern leg serves as access to and from NB I-295. The westbound CR 643 approach is yield controlled and the left turn movement from the I-295 exit ramp onto northbound CR 643 is controlled by a stop sign.

CR 643 (Grove Road) and CR 660 (Jessup Road) - CR 643 intersects CR 660 at an unsignalized T intersection where the western and northern legs of the intersection carry CR 643 and the eastern leg carries CR 660. Southbound right turns and westbound right turns are controlled by yield signs. The southbound left turns from CR 643 to CR 660 are stop controlled.

CR 656 (Parkville Road) and Jessup Boulevard - this is an unsignalized T intersection in which the western and southern legs carry CR 656 and the eastern leg carries Jessup Boulevard. The right turns from the eastbound approach utilize a channelized free flow right turn lane. A 13 foot lane is provided at the intersection for through movements from eastbound CR 656 to Jessup Boulevard. The northbound CR 656 approach consists of one lane to accommodate both right and left turn movements. This approach is stop controlled. A stop sign controls the one lane approach on Jessup Blvd.

### **Existing Traffic Volumes**

The DVRPC staff, with assistance from the Gloucester County Engineer's Office, has collected and analyzed the existing traffic volumes and travel patterns for the Kings Highway Corridor and surrounding road network. Two types of traffic data have been collected during this phase of the study: average annual daily traffic (AADT) and peak hour turning movements.

The AADT counts were taken in February and March 1991. The raw daily traffic counts were converted into average annual daily traffic volumes to account for day of week and seasonal fluctuations in traffic levels. AADT volumes represent the average daily traffic on a

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road segment over the course of an entire year.

The existing AADT volumes are presented in Figure 3. The volumes on CR 551 range from 10,200 vehicles per day near NJ 45 to 14,300 vehicles per day near CR 660. The 14,300 vehicles per day is the highest count in the study area. The lowest volume in the study area is the 2,400 vehicles counted on CR 648.

Manual turning movement counts were conducted at nine intersections in the study area during 1990 and 1991. Four signalized and five unsignalized intersections were counted. The counts were conducted in the AM peak period between 7:00 and 9:00 and in the PM peak period between 4:00 and 6:00. Peak hour traffic volumes (the four highest consecutive 15-minute periods) are presented in Figures 4 and 5. The following is a list of those intersections which were counted:

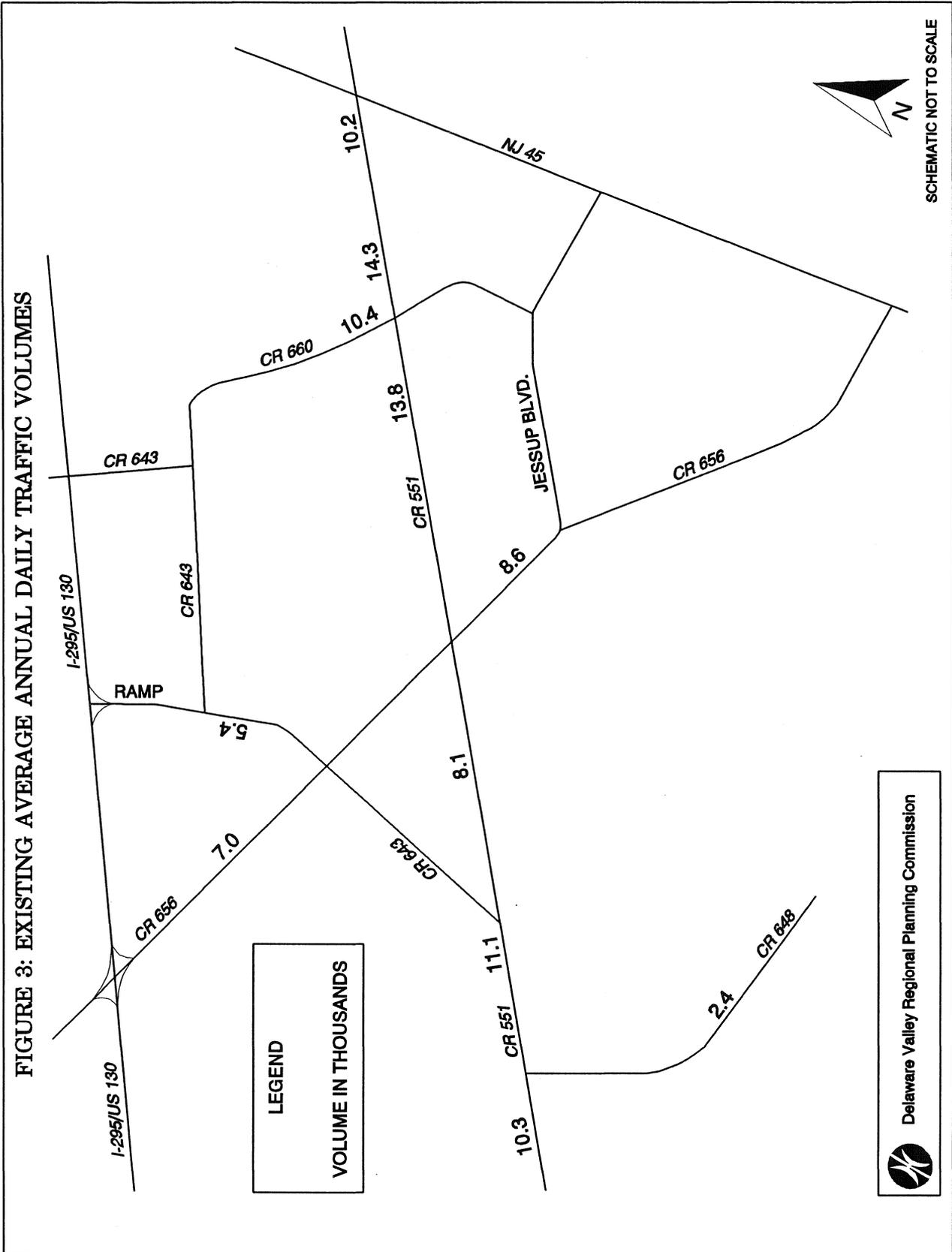
- CR 551 and NJ 45
- CR 551 and CR 660
- CR 551 and CR 656
- CR 551 and CR 643
- CR 551 and CR 648
- CR 656 and CR 643
- CR 643 and I-295 ramp
- CR 643 and CR 660
- CR 656 and Jessup Blvd.

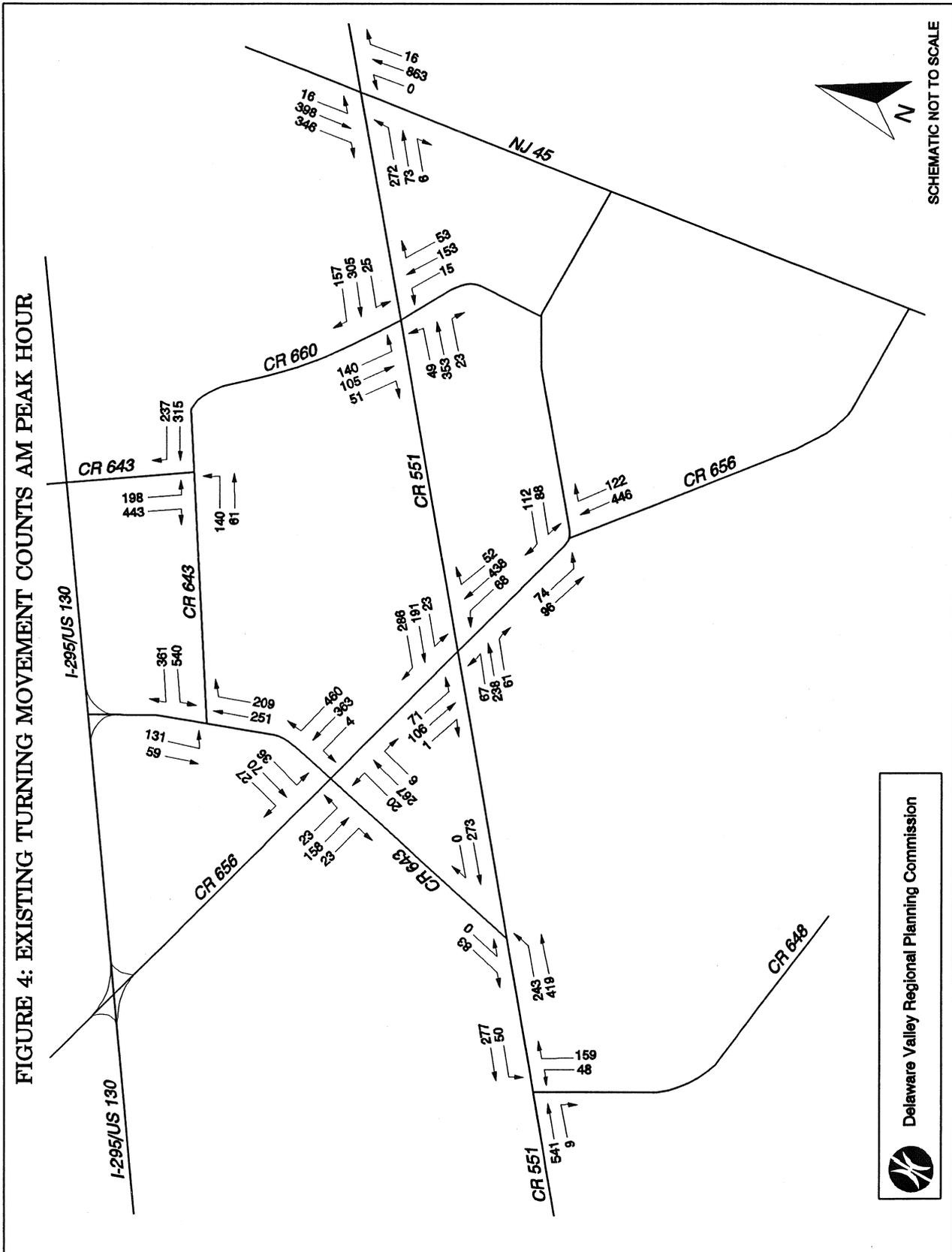
### **Existing Level of Service**

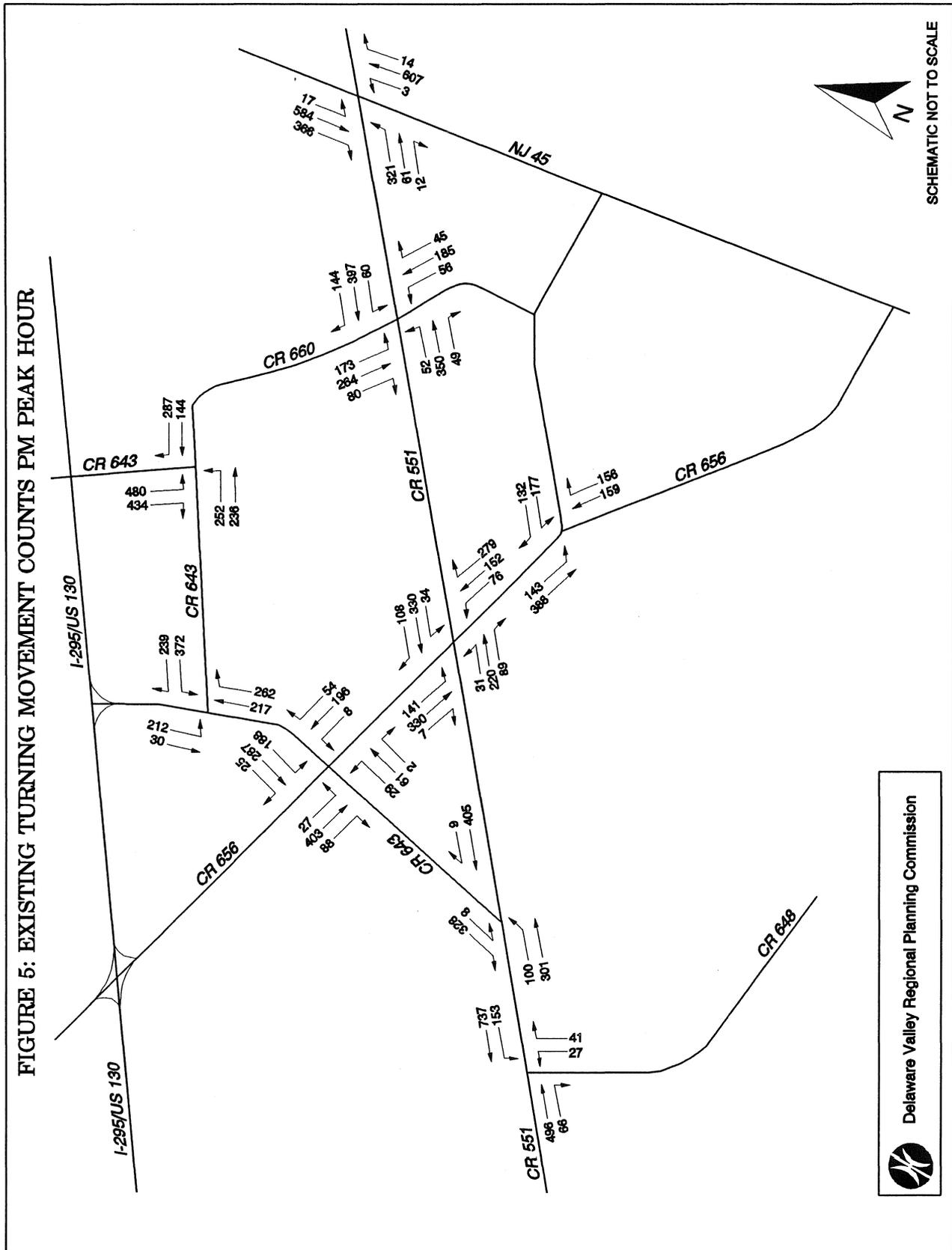
A level of service (LOS) analysis was performed for those nine intersections as well as for selected road segments of the highway network. The results of the LOS analysis are presented in Figures 6, 7 and 8.

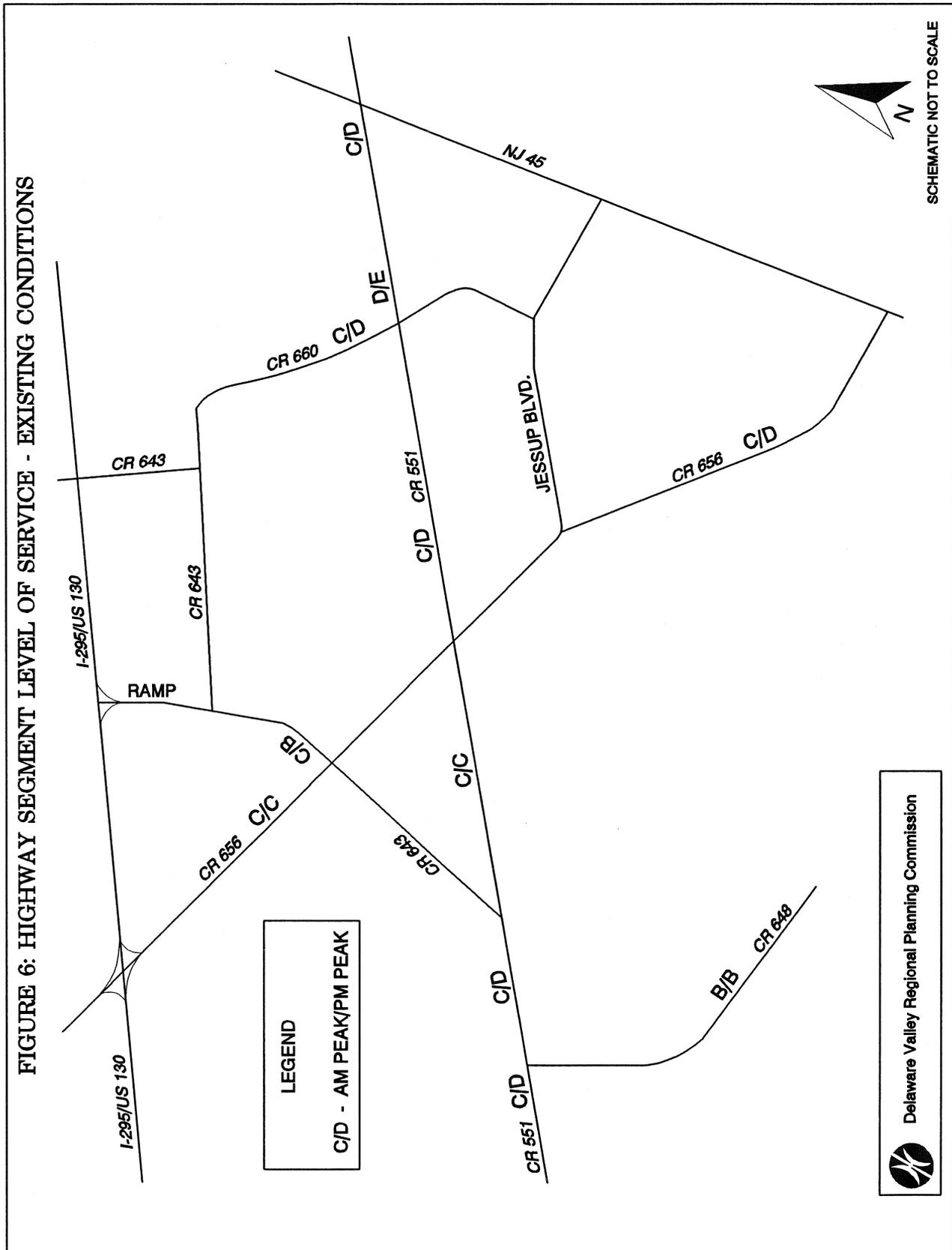
The concept of level of service is a qualitative measure describing operational conditions within a traffic stream and their perception by motorists in terms of speed and travel time, traffic interruptions, freedom to maneuver, comfort, and convenience. Six levels of service are defined; they are given letter designations, A to F, with level of service A representing the best operating conditions and level of service F the worst.

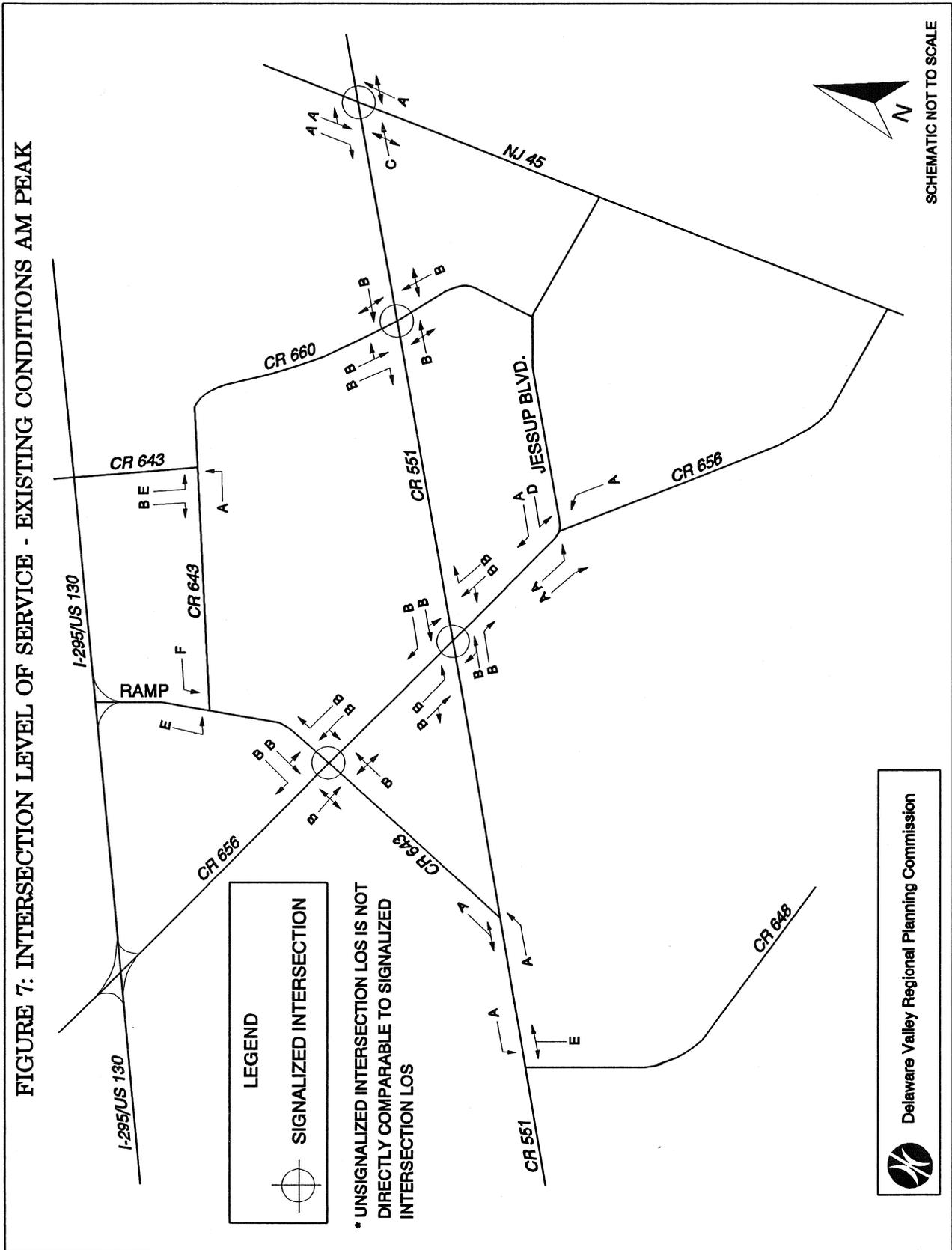
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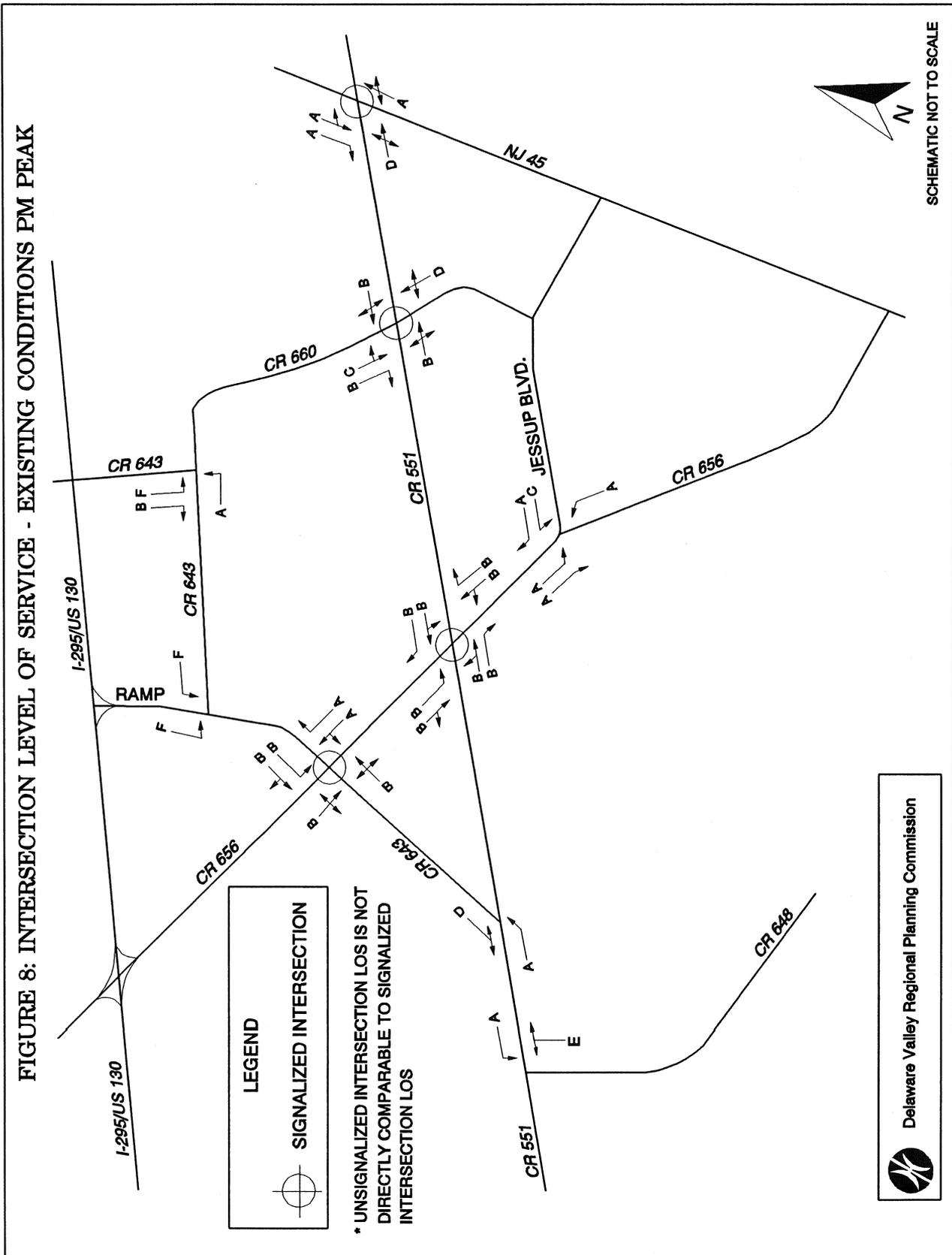












Methodology to determine level of service is presented in the Highway Capacity Manual, Transportation Research Board Special Report 209. Different methodologies are specified for two lane roadways, signalized and unsignalized intersections.

Two-lane highways operate under uninterrupted flow conditions when the distance between traffic signals or stop signs exceeds two miles. When the roadway segment is less than two miles in length, the intersection where flow is interrupted is the primary determinant of level of service. When uninterrupted flow conditions occur, the level of service for a two lane-highway is defined in terms of average travel speed or, more frequently, utilization of capacity, namely the ratio of the demand volume to the capacity of the roadway (v/c ratio). The capacity of a highway is a function of a number of factors including: lane and shoulder widths, percentage of "no passing zone", truck percentage, directional split in traffic flow, and roadway grade. A subjective description of each level of service is given in Table 1. It is important to note that because of the complex relationship between travel speed, percent "no passing zone", roadway grade and level of service, it is not possible to simply list a v/c ratio for each level of service. Service flows at each service level are expressed for ideal conditions. Any deviation from these conditions (for example a lane width of less than 12 feet) will reduce the service flow volume.

A level of service analysis for two-lane highways was conducted on eleven links of the highway network in the study area. The results of this analysis indicate generally acceptable operating conditions on all links. However, the segment of Kings Highway just east of CR 660 experiences LOS D in the AM peak period and E in the PM peak period. This location coincides with the location of the highest daily traffic count in the study area. This link has a flow rate of 845 vehicles, total both directions in the AM peak hour and 1182 vehicles, total both directions in the PM peak hour.

Level of service for signalized intersections is defined in terms of delay. Delay is a measure of driver discomfort, frustration, fuel consumption, and lost travel time. Delay is a complex measure dependent upon a number of variables, including the quality of signal progression, cycle length, and the volume to capacity (V/C) ratio. Level of service criteria is stated in terms of the average stopped delay per vehicle on an approach or lane basis. Table 2 gives a subjective description of each level of service and its delay range. It is important to note that delay (i.e., level of service) is not related to capacity in a simple fashion. Thus, the designation of level of service F does not automatically imply the approach is overloaded. Long

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cycle length and poor signal progression can result in excessive delays. Conversely, an overloaded approach with a short cycle length may result in a high level of service.

A level of service analysis was prepared for the existing conditions at the four signalized intersections in both the AM and PM peak periods. All four intersections operate at acceptable levels of service in both peak periods. The following is a summary of the findings of the level of service analysis for the existing conditions for each of the signalized intersections.

CR 551 (Kings Highway) and NJ 45 (Mantua Pike) - in the AM peak, both approaches of NJ 45 operate at LOS A and the eastbound CR 551 approach operates at LOS C. The other Kings Highway leg is one-way away from the intersection. In the PM peak, the NJ 45 approaches operate at LOS A and the Kings Highway approach operates at LOS D.

CR 551 (Kings Highway) and CR 660 (Jessup Road) - all legs of the intersection operate at LOS B during the AM peak. In the PM peak, the northbound Jessup Road approach operates at LOS D. This may be a result of the inability of the through and right turn movements to bypass the vehicles queued to turn left and an inefficient signal timing. The southbound Jessup Road shared through and left turn lane operates at LOS C in the PM peak.

CR 551 (Kings Highway) and CR 656 (Mantua Grove Road) - all legs of the intersection operate at LOS B in both the AM peak and the PM peak.

CR 656 (Mantua Grove Road) and CR 643 (Grove Road) - in the AM peak, all approaches operate at LOS B. During the PM peak, the northbound CR 656 approach operates at LOS A and all other approaches experience LOS B.

Level of service criteria for unsignalized intersections are defined in terms of reserved or unused capacity. Reserve capacity is related to general delay ranges (see Table 3). Since delay is stated in general terms, without specific numeric values, it is not possible to compare or associate unsignalized level of service with signalized level of service. The potential capacity of a lane is based upon two factors: (1) distribution of gaps in the cross traffic stream and (2) driver judgement in selecting gaps through which to execute the desired maneuvers. Reserve capacity represents the difference between the approach volume and potential capacity. The analysis focuses on lanes on the minor stopped street and left turn maneuvers from the major

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street.

A level of service analysis was prepared for the existing conditions at the five unsignalized intersections in both the AM and PM peak periods. The following is a summary of the findings of that analysis.

CR 551 (Kings Highway) and CR 643 (Grove Road) - in the AM peak, the intersection operates extremely well. The CR 643 approach operates at LOS D in the PM peak. The eastbound CR 551 left turns operate at LOS A in both peak periods.

CR 551 (Kings Highway) and CR 648 (Ogden Road) - the westbound left turns from CR 551 operate at LOS A in both the AM and PM peak period. However, deficiencies exist on the CR 648 approach. This approach experiences LOS E in both peak periods.

CR 643 (Grove Road) and I-295 NB Entrance/Exit Ramp - in the AM peak, the left turn movement from the I-295 exit ramp onto northbound CR 643 experiences LOS E and the left turns from southbound CR 643 operates at LOS F. Both critical approaches experience LOS F in the PM peak.

CR 643 (Grove Road) and CR 660 (Jessup Road) - The southbound CR 643 left turns onto CR 660 experience LOS E in the AM peak and F in the PM peak. The other critical approaches operate satisfactorily.

CR 656 (Parkville Road) and Jessup Boulevard - in the AM peak, the westbound left turn movement from Jessup Blvd. experiences LOS D. All other critical approaches operate satisfactorily in both peak periods.

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**TABLE 1: Level of Service Criteria - Two Lane Highways**

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Level of service A - average speeds at or above speed limit. The passing frequency required to maintain these speeds has not reached a demanding level. Passing demand is well below passing capacity; almost no platoons of three or more vehicles are observed. A maximum flow rate of 420 vehicles per hour, total in both directions, may be achieved under ideal conditions.

Level of service B - passing demands needed to maintain desired speeds become significant and approximately equals passing capacity at the lower boundary of level of service B. The number of platoons forming in the traffic stream begins to increase dramatically. Service flow rates of 750 vehicles per hour, total in both directions, can be achieved under ideal conditions.

Level of service C - noticeable increase in platoon formation, platoon size, and frequency of passing impediment. Unrestricted passing demand exceeds passing capacity. At higher volume levels, chaining of platoons and significant reductions in passing capacity begin to occur. While traffic flow is stable, it is becoming susceptible to congestion due to turning traffic and slow-moving vehicles. A service flow rate of up to 1,200 vehicles per hour, total in both directions, can be accommodated under ideal conditions.

Level of service D - unstable flow is approached. The two opposing traffic streams essentially begin to operate separately at higher volume levels, as passing becomes extremely difficult. The fraction of no passing zones along the roadway usually has little influence on passing. Turning vehicles and/or roadside distractions cause major shock waves in the traffic stream. This is the highest flow rate that can be maintained for any length of time without a high probability of a breakdown. A service flow rate of up to 1,800 vehicles per hour, total in both directions, can be accommodated under ideal conditions.

Level of service E - passing is virtually impossible and platooning becomes intense when slower vehicles or other interruptions are encountered. The highest volume attainable under level of service E defines the capacity of the highway. Under ideal conditions, capacity is 2,800 vehicles per hour total in both directions. For other conditions, capacity is lower.

Level of service F - represents heavily congested flow with traffic demand exceeding capacity. Frequently, perturbations in traffic flow as level E is approached cause a rapid transition to level of service F.

Source: Highway Capacity Manual, Transportation Research Board, Special Report 209, 1985

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**TABLE 2: Level of Service Criteria - Signalized Intersections**

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LEVEL OF SERVICE A - Very low delay, good progression; most vehicles do not stop at intersection. Delay less than 5 seconds per vehicle.

LEVEL OF SERVICE B - Generally good signal progression and/or short cycle length; more vehicles stop at intersection than Level of Service A. Delay range 5-15 seconds per vehicle.

LEVEL OF SERVICE C - Fair progression and/or longer cycle length; significant number of vehicles stop at intersection. Delay range 15-25 seconds per vehicle.

LEVEL OF SERVICE D - Congestion becomes noticeable; individual cycle failures; longer delays from unfavorable progression, long cycle length, or high volume/capacity ratios; many vehicles stop at signal. Delay range 25-40 seconds per vehicle.

LEVEL OF SERVICE E - Considered limit of acceptable delay, indicative of poor progression, long cycle length, high volume/capacity ratio; frequent individual cycle failures. Delay range 40-60 seconds per vehicle.

LEVEL OF SERVICE F - Unacceptable delay, indication of oversaturation (i.e., arrival flow exceeds capacity). Average delay exceeds 60 seconds per vehicle.

Source: Highway Capacity Manual, Transportation Research Board, Special Report 209, 1985

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**TABLE 3: Level of Service Criteria - Unsignalized Intersections**


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<u>Level of Service</u>	<u>Reserve Capacity</u>	<u>Expected Delay to Minor Street Traffic</u>
A	Greater than 400	Little or no delay
B	300-400	Short traffic delays
C	200-299	Average traffic delays
D	100-199	Long traffic delays
E	0-99	Very long traffic delays
F	*	*

\*When demand volume exceeds the capacity of the lane, extreme delays will be encountered with queuing which may cause severe congestion affecting other traffic movements in the intersection.

Source: Highway Capacity Manual, Transportation Research Board, Special Report 209, 1985

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#### **IV. TRAVEL FORECASTING PROCEDURES**

The process used to generate Year 2010 traffic forecasts for the Kings Highway Corridor is an application of the Quick Response System II (QRS II) travel simulation model and the Turnflow Program. The QRS II model is a computer program commonly used for forecasting impacts of development on highway traffic and will provide projected daily traffic volumes on the identified highway network. The Turnflow Program is a spreadsheet template which utilizes the output of the QRS II model to project turning movement volumes at specified intersections.

##### **Traffic Simulation Model**

QRS was first introduced as a set of manual techniques in 1978. The original QRS, as documented in National Cooperative Highway Research Program (NCHRP) Report number 187, described several related analysis techniques: trip generation, trip distribution, mode choice, conversion of all-day person-trips to vehicle trips, traffic assignment, capacity analysis and highway spacing. The techniques principally addressed planning problems that were too small to warrant analysis with the cumbersome computer programs available at the time.

In 1981, the Federal Highway Administration (FHWA) released the first microcomputer version of QRS. QRS I served to facilitate some of the manual calculations. QRS's implementation on a microcomputer meant that somewhat larger planning problems could be handled.

The DOS version of QRS II was first released in 1987. It could be used to perform routine calculations of the manual techniques or it could be used to perform detailed analysis comparable to those done with mainframe programs such as UTPS. QRS II was interfaced to a powerful program for data entry called the General Network Editor (GNE). GNE permits the user to draw a network on the microcomputer screen, enter verbal descriptions and numerical data about each element of the network, edit the network and its data, compute intermediate results through a series of worksheets and search for network elements that meet certain criteria. GNE can also be used for displaying results from QRS II. All data for QRS II are entered through GNE.

To accurately simulate trip making in this area, the study area was expanded to encompass

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nine other municipalities around West Deptford and a designated network of roadways. The study area is described by a set of zones. Zones may vary greatly in size but they cover the whole study area without overlaps and without leaving any gaps. The traffic zone system is based on Gloucester County census tracts which have been separated into smaller zones to focus on a fine grain highway network. This results in 73 traffic zones for the expanded study area. Zones have attributes that are important to QRS II. The most important attributes of a zone are the population and employment in that zone.

The highway system is described by a network. A network consists mainly of representations of streets and intersections. Streets are shown as links and intersections are shown as nodes. Streets and intersections have attributes also. The most important attribute of a street segment (link) is the time it takes to travel from one end to the other.

Before any analysis can occur, the highway network and the set of zones must be integrated. This is accomplished by representing each zone as a special type of node called a centroid. Centroids are attached to the highway network by a special type of link called a centroid connector. QRS II uses this integrated network to find the travel times and the exact sequence of links along the shortest paths between every pair of centroids.

The process used to generate Year 2010 travel forecasts for the Kings Highway corridor is an application of the standard four step transportation modelling process.

#### Four Step Modeling Process

*Trip Generation* - QRS II accomplishes its forecasts by first determining the number of person-trips that are produced at and attracted to each zone. Estimates of internal trip productions and attractions by zone are established on the basis of trip rates applied to the zonal estimates of population and employment data. QRS II separately determines trip productions and trip attractions for each zone for three purposes: home-based work, home-based nonwork and nonhome-based.

*Trip Distribution* - The second step in the forecast is to determine for each purpose the number of person-trips that go from any given production zone to any given attraction zone. Two such zones are referred to as an O-D (origin-destination) pair. An O-D pair receives a relatively large allocation of trips if 1) the trip productions in the production zone are large, 2) the trip

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attractions in the attraction zone are large or 3) the travel time between the zones is small.

*Mode Split* - If transit ridership forecasts are needed, QRS II performs a third step called modal split. During this step, the model determines for each O-D pair the number of person-trips for transit and the number of person-trips for automobiles. Since transit service is extremely limited in the study area, this process was not used in this analysis.

*Traffic Assignment* - This step converts highway person-trips to vehicle-trips, which are assigned to the links in the highway network following the shortest paths previously found in the trip distribution step. Traffic volumes may be estimated for any part of the day. QRS II finds the number of person-trips for each O-D pair that occurs during each hour of a requested time period, converts these hourly person-trips to hourly vehicle-trips and sums the vehicle trips over all hours in the time period.

As part of the traffic assignment step, QRS II estimates the amount of delay expected on each link and at each intersection. QRS II has delay relationships for both two-lane and multi-lane uncontrolled road segments. QRS II also has separate delay relationships for signalized intersections, two-way stop intersections and all-way stop intersections. These delays can be incorporated into the forecast to assure that traffic volumes will be consistent with intersection geometry and traffic control.

A calibration run of the QRS II model was performed to insure that the model could replicate the existing volumes counted on the road network. The model was run with data representing the existing conditions and the output was compared to the existing traffic volumes. The calibration run was conducted, making minor adjustments to input data, so that the output volumes closely matched the existing counts. When the model was calibrated, demographic data for the Year 2010 was entered and the model was rerun to project future volumes.

To convert the projected daily traffic volumes into turning movements at intersections, a program called Turnflow was used. The Turnflow Program was written as a spreadsheet template for use with Lotus 1-2-3<sub>(TM)</sub> Release 2 and is based on the algorithm and technique described by Hauer, Pagitsas and Shin (Estimation of Turning Flows from Automatic Counts, Transportation Research Record 795 1981). The algorithm and technique provides a balanced set of intersection turning flows from a set of pre-specified inbound and outbound intersection flows and an estimate of the probable turning proportions at each approach. The inbound and

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outbound intersection flows are derived by applying the K factor and D factor of the existing AADT to the corresponding future daily traffic projection. The estimate of probable turning movement proportions are taken from the turning movement proportions of the corresponding existing intersection turning movement count.

### **Socio-Economic Projections**

Travel forecasting models require that the estimates of population and employment data be made for small areas or zones. For the QRS II model this requires estimates for each of the following variables:

- population
- retail employment
- non-retail employment

This requirement is derived from the need to assign trip making associated with households and businesses to the streets serving them.

As part of ongoing regional planning activities completed by DVRPC, staff has prepared Year 2010 zonal forecasts of the socio-demographic inputs to the regional travel simulation process. These 2010 projections form the basis for the Kings Highway corridor travel projections included in this report.

In these forecasts, the population of the DVRPC region is expected to grow 9.6 percent in the 20 years between 1990 and 2010. The population of Gloucester County is expected to increase by 22 percent. Within the study area, the population is expected to grow by 11.6 percent. Table 4 displays the forecasted population growth for each of the municipalities in the study area.

Employment across the region is expected to grow consistent with the regional population growth rate. The regional increase is projected to be 10 percent. An increase in employment of 27.8 percent is expected for Gloucester County. The study area employment is projected to experience a 21.9 percent growth. Table 5 displays the forecasted employment growth for each of the municipalities in the study area.

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**TABLE 4: Population Growth in the Kings Highway Study Area**

Municipality	1990	2010	Change	
	US Census	DVRPC Forecast	Number	Percent
Deptford	24,137	27,184	3,034	12.6%
East Greenwich	5,258	6,137	879	16.7%
Greenwich	5,102	5,172	70	1.4%
Mantua	10,074	12,350	2,276	22.6%
National Park	3,413	3,502	89	2.6%
Paulsboro	6,577	6,482	-95	-1.4%
Wenonah	2,331	2,639	308	13.2%
West Deptford	19,380	22,683	3,303	17.0%
Woodbury	10,904	11,315	411	3.8%
Woodbury Heights	3,392	3,642	250	7.4%
<b>Study Area Total</b>	<b>90,568</b>	<b>101,106</b>	<b>10,538</b>	<b>11.6%</b>

Source: Delaware Valley Regional Planning Commission

February 1991

**TABLE 5: Employment Growth in the Kings Highway Study Area**

Municipality	1990	2010	Change	
	DVRPC Estimate	DVRPC Forecast	Number	Percent
Deptford	11,820	14,620	2,800	23.7%
East Greenwich	1,430	1,680	250	17.5%
Greenwich	3,440	3,830	390	11.3%
Mantua	4,910	6,600	1,690	35.6%
National Park	310	420	110	35.5%
Paulsboro	4,700	5,750	1,050	22.3%
Wenonah	470	600	130	27.7%
West Deptford	6,520	8,350	1,830	28.1%
Woodbury	9,480	10,540	1,060	11.2%
Woodbury Heights	2,130	2,740	610	28.6%
<b>Study Area Total</b>	<b>45,210</b>	<b>55,130</b>	<b>9,920</b>	<b>21.9%</b>

Source: Delaware Valley Regional Planning Commission

February 1991

Several municipalities within the study area were subdivided into smaller areas called zones in order to more accurately create a well defined highway network. Since the population and employment data is presented at the municipal level, it was necessary to assign the appropriate amount of population and employment into the proper zones. West Deptford Township was subdivided into 24 smaller zones and Woodbury was subdivided into eleven zones. The appropriate levels of population and employment was assigned to each.

To project future traffic volumes on the road network, the municipal level population and employment forecasts for the Year 2010 needed to be assigned to the subdivided zones. While population and employment projections also were developed at the municipal level, local expertise was required in locating areas of expected growth within the municipality. Municipal officials in West Deptford and Woodbury were provided with the municipal level forecasts and asked to assign the appropriate growth to the proper zones. Their assistance in this task was essential in producing the future trip generation and O-D patterns used to develop the future traffic projections.

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## V. FUTURE TRAFFIC

### Future Traffic Volumes

This section will present the Year 2010 traffic projections for the highway network developed through the QRS II modelling process and projected intersection turning movements which resulted from applications of the Turnflow Program. Both of these computer models have been explained in the previous section.

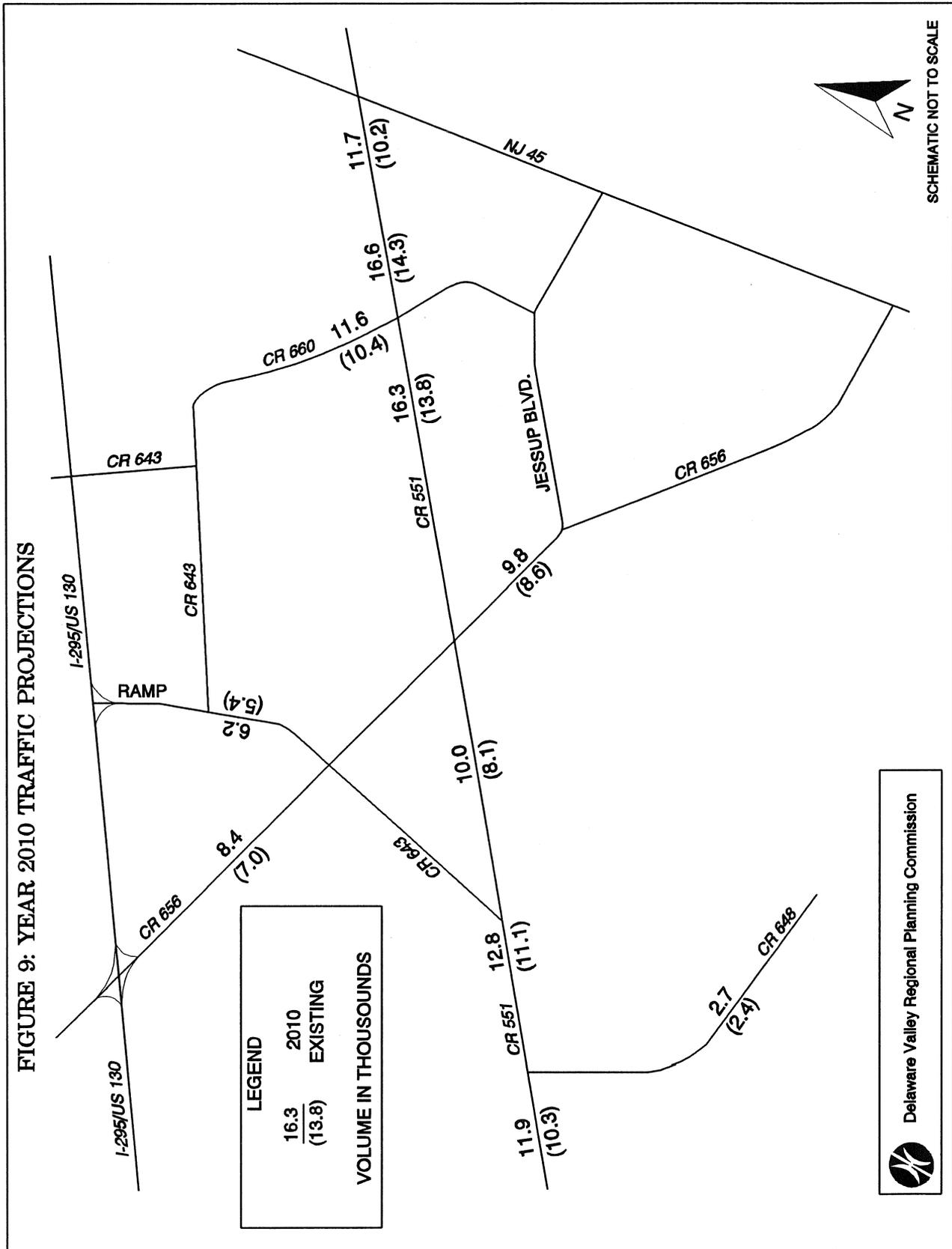
The Year 2010 daily traffic projections for the highway segments are displayed in Figure 9. The traffic volumes on CR 551 are generally expected increase in the range of approximately 14 to 18 percent with one location (between CR 656 and CR 643) projected to increase by approximately 23.4%. In absolute terms, the volumes increase in the range of 1,500 to 2,500 vehicles per day. Table 6 presents the Year 2010 traffic projections along with the absolute and percent change from the existing AADT's for this network. The location of the highest projected volume in the study area corresponds to the location of the highest existing count. The projection of 16,600 vehicles per day on CR 551 just east of CR 660 is a 16.1% increase over the existing count of 14,300. The location of the lowest projected volume in the study area corresponds to the location with the lowest existing count. The 2,400 vehicles counted on CR 648 is expected to increase by 12.5% to 2,700 vehicles per day.

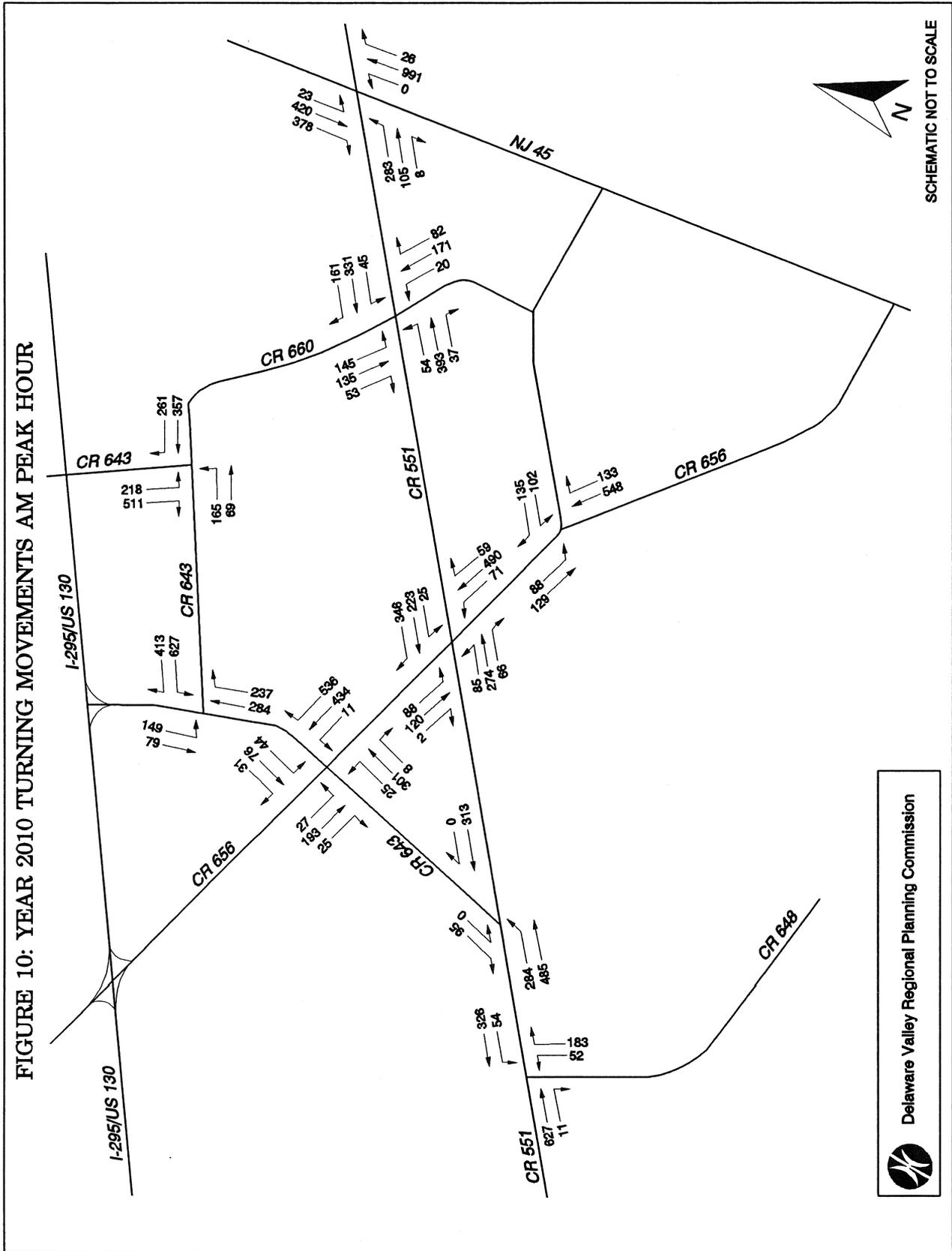
Figures 10 and 11 display the projected AM and PM peak hour intersection turning movements. These turning movements were derived by converting the daily volumes into peak hour volumes using the K factor from the corresponding existing AADT. The intersection inflows and outflows were determined by applying the D factor from the corresponding existing count to these future peak hour volumes. The inflows and outflows were input into the Turnflow Program and were balanced to develop the future AM and PM peak hour intersection turning movements.

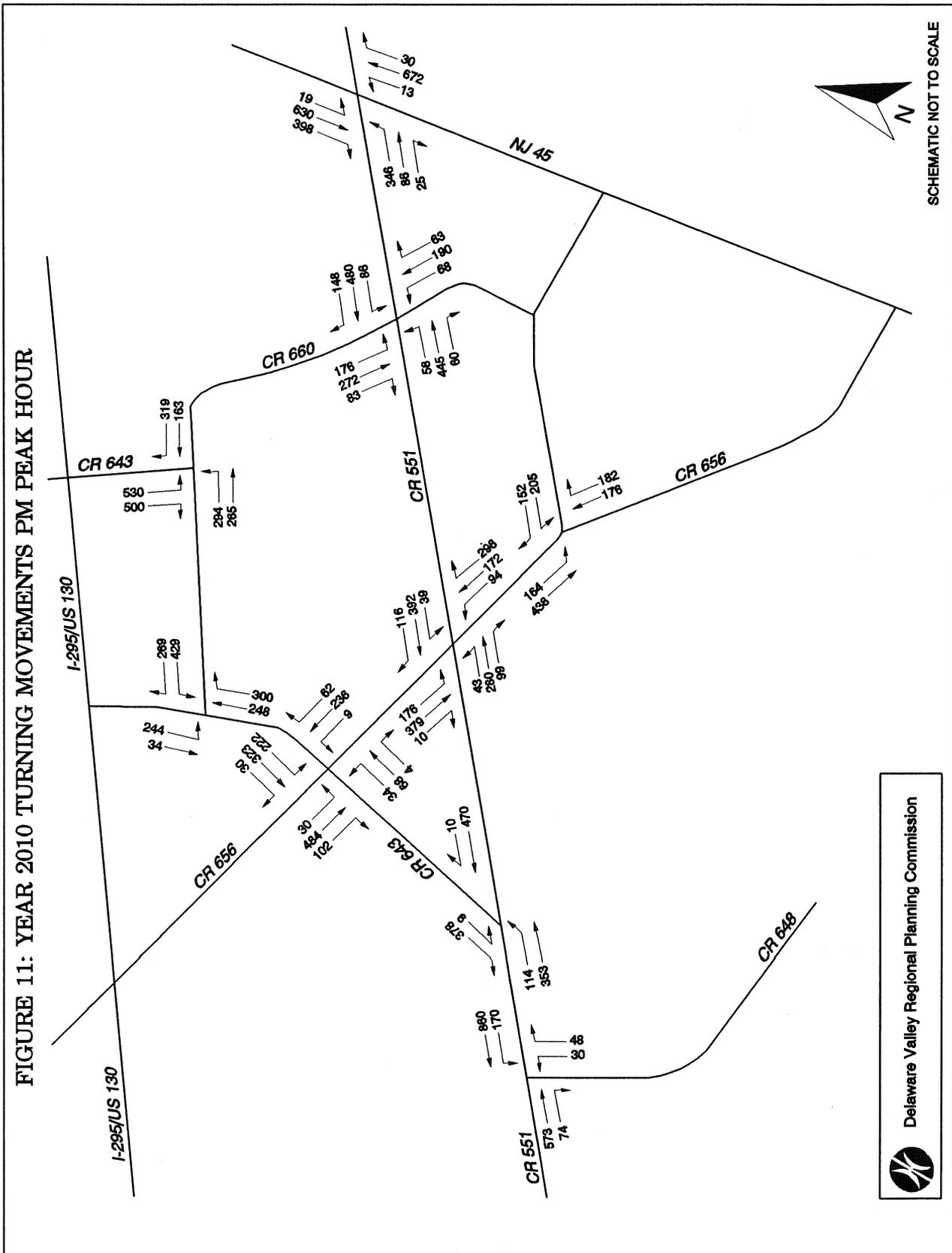
### Future Level of Service

A level of service (LOS) analysis was performed for the nine intersections and the highway segments using the Year 2010 projected volumes and the existing intersection and roadway configurations. The results of this LOS analysis are presented in Figures 12, 13 and 14.

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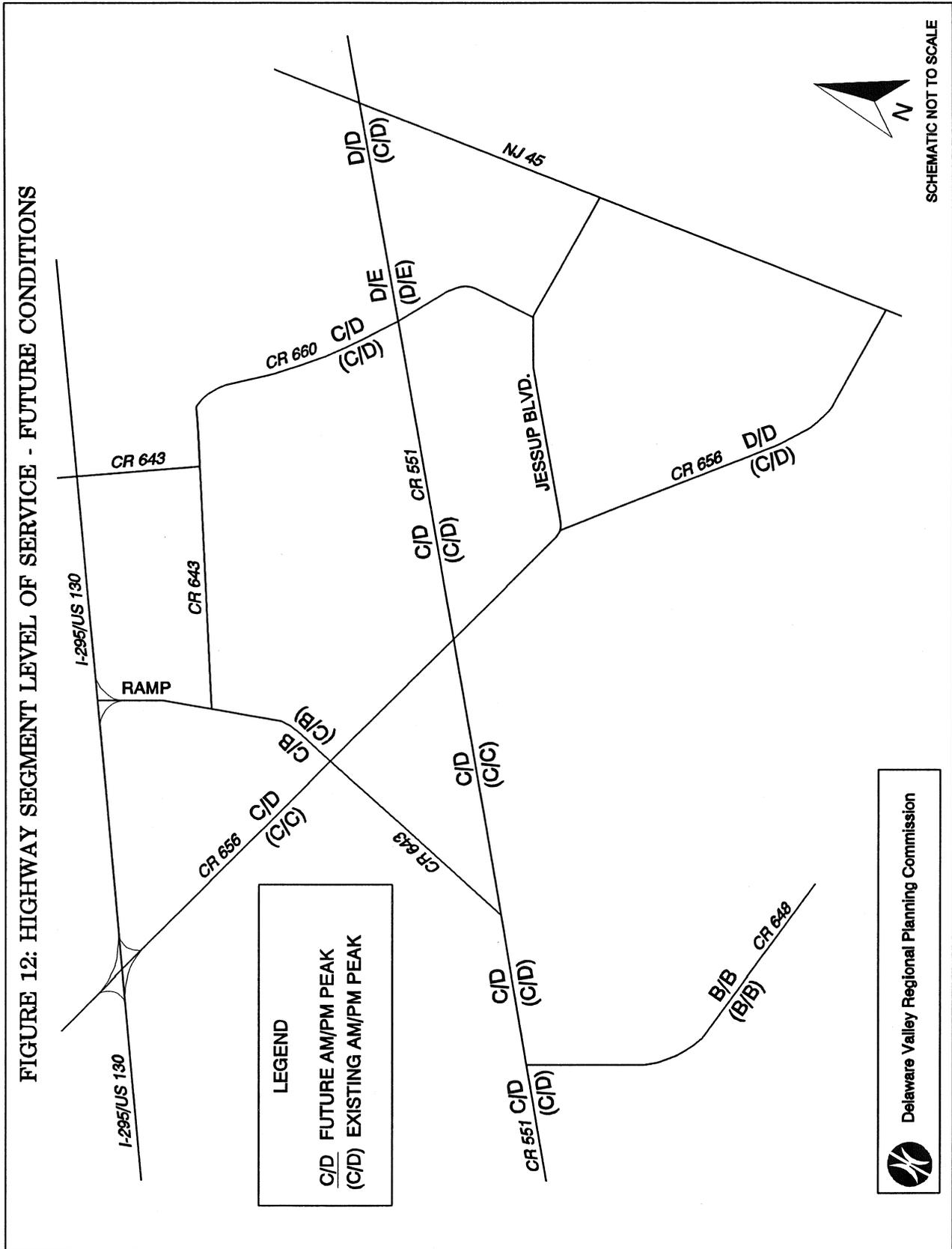
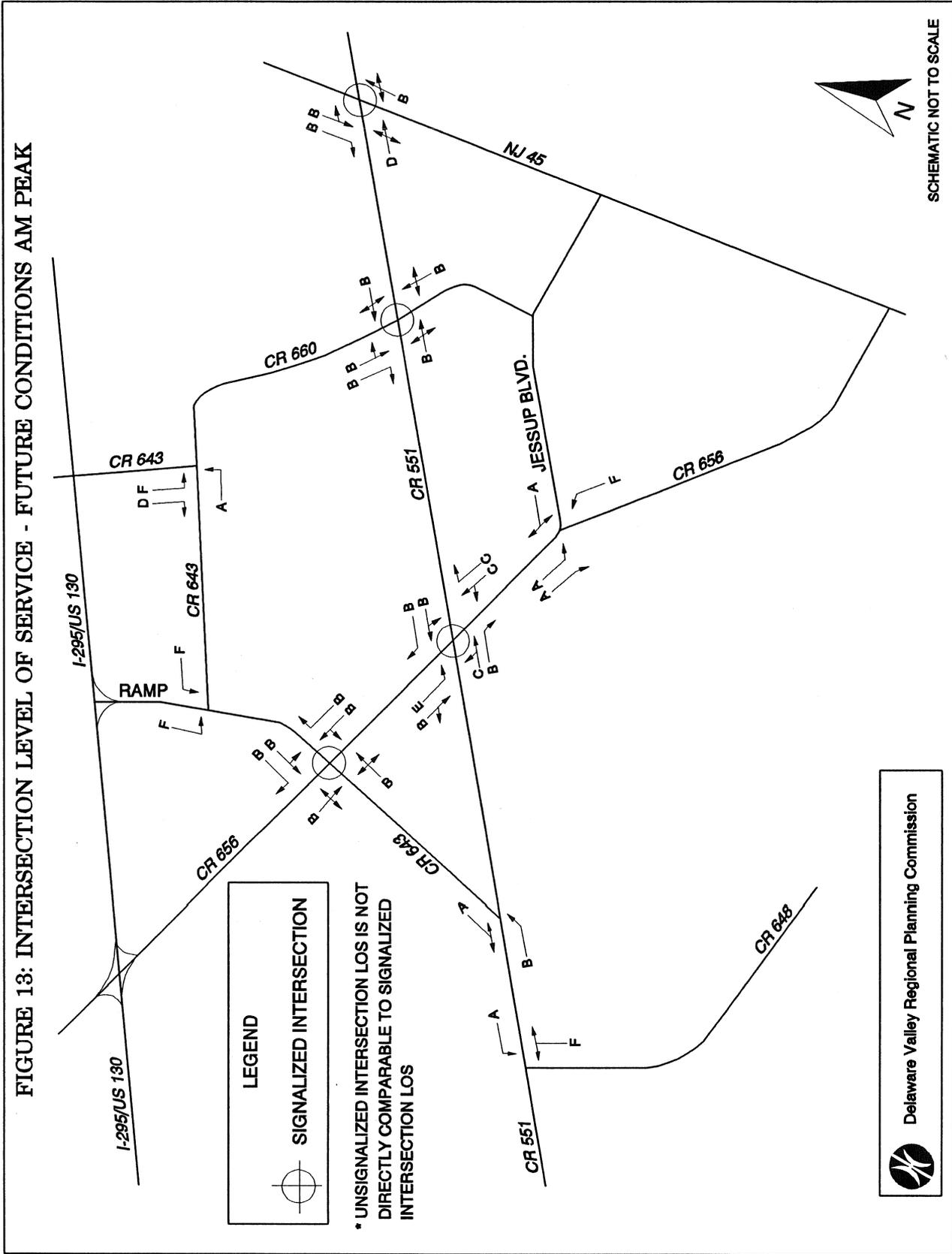
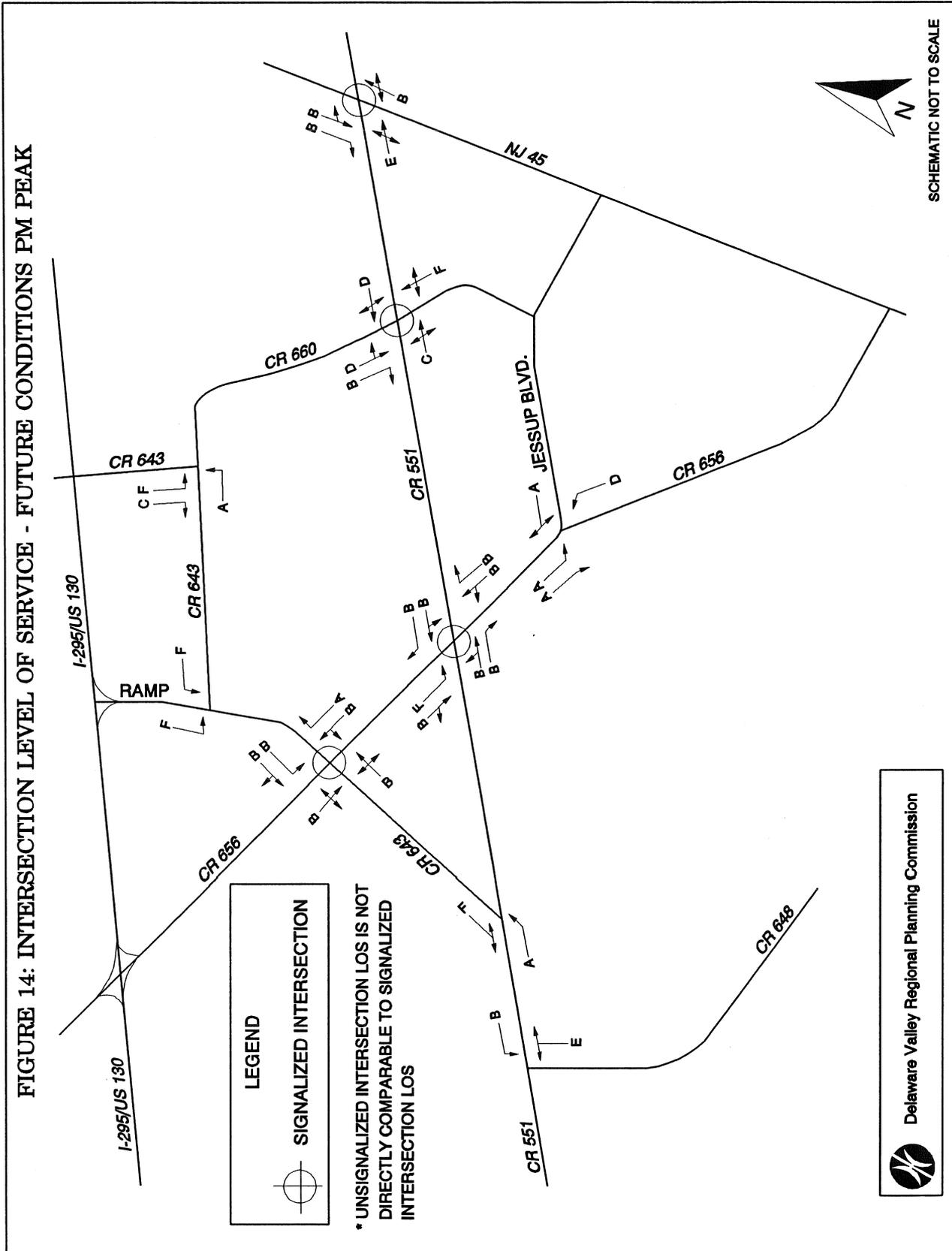


FIGURE 13: INTERSECTION LEVEL OF SERVICE - FUTURE CONDITIONS AM PEAK





**TABLE 6: Year 2010 Traffic Projections**

County Route No.	Segment Limits	1991 AADT	2010 Volume	Absolute Change	Percent Change
CR 551	NJ 45 to Penn St	10,200	11,700	1,500	14.7 %
CR 551	Princeton Ave to CR 660	14,300	16,600	2,300	16.1 %
CR 551	CR 660 to CR 656	13,800	16,300	2,500	18.1 %
CR 551	CR 656 to CR 643	8,100	10,000	1,900	23.4 %
CR 551	CR 643 to CR 648	11,100	12,800	1,700	15.3 %
CR 551	CR 648 to CR 678	10,300	11,900	1,600	15.5 %
CR 660	CR 551 to CR 643	10,400	11,600	1,200	11.5 %
CR 643	CR 551 to CR 660	5,400	6,200	800	14.8 %
CR 656	CR 551 to I-295	7,000	8,400	1,400	20.0 %
CR 656	CR 551 to NJ 45	8,600	9,800	1,200	14.0 %
CR 648	CR 551 to NJ 45	2,400	2,700	300	12.5 %

The level of service analysis for two-lane highways indicates generally acceptable operating conditions on all links. Only minor deterioration of existing conditions is expected to occur. There are no links that are expected to experience LOS F, however, as in the existing conditions, the segment of Kings Highway just east of CR 660 is expected to experience LOS D in the AM peak period and E in the PM peak period.

The level of service analyses prepared for the four signalized intersections indicated that for the most part the intersection operations are expected to be acceptable, however some intersections are expected to have deficiencies on selected approaches. The following is a summary of the findings of the level of service analysis for the future conditions for each of the signalized intersections.

CR 551 (Kings Highway) and NJ 45 (Mantua Pike) - both approaches of NJ 45 are expected to continue to operate satisfactorily in both peak periods. Conditions on the CR

551 approach are expected to deteriorate in the AM peak from existing LOS C to LOS D and in the PM peak from existing LOS D to LOS E.

CR 551 (Kings Highway) and CR 660 (Jessup Road) - this intersection is expected to experience a noticeable decrease in service levels in the PM peak. In the PM peak, the northbound Jessup Road approach goes from existing LOS D to LOS F in the future. On CR 551, the westbound approach is expected to deteriorate from LOS B to LOS D and the eastbound approach is expected to deteriorate from LOS B to LOS C. The largest increases in traffic volumes in the study area are expected to occur on the links of CR 551 adjacent to this intersection. The overall PM peak period intersection operations are expected to deteriorate from existing LOS B to LOS F in the future.

CR 551 (Kings Highway) and CR 656 (Mantua Grove Road) - generally, this intersection is expected to operate at an acceptable level of service in both the AM peak and the PM peak, however deficiencies are expected to occur on the southbound CR 656 left turn lane which is projected to operate at LOS E in the AM peak and LOS F in the PM peak. Overall intersection operations in the future are expected to be LOS C in both the AM and PM peaks.

CR 656 (Mantua Grove Road) and CR 643 (Grove Road) - all approaches of this intersection are expected to continue to operate at an acceptable service level during both peak periods.

The findings of the level of service analysis prepared for the five unsignalized intersections using projected traffic volumes and existing configurations is presented below.

CR 551 (Kings Highway) and CR 643 (Grove Road) - in the AM peak, the intersection operates extremely well. In the PM peak, the CR 643 approach experiences LOS F.

CR 551 (Kings Highway) and CR 648 (Ogden Road) - the westbound left turns from CR 551 operate at LOS A in the AM peak and LOS B in the PM peak period. However, deficiencies exist on the CR 648 approach. This approach is projected to deteriorate to LOS F in the AM peak and LOS E in the PM peak period.

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CR 643 (Grove Road) and I-295 NB Entrance/Exit Ramp - in its present configuration, this intersection is expected to experience serious deficiencies accommodating the projected traffic volumes, however the planned reconstruction of the I-295 interchanges in West Deptford, East Greenwich and Greenwich Townships is expected to address improvements to this intersection. Improvements call for relocating this intersection and adding a fourth leg by constructing an access road through the industrial park which will connect to the proposed I-295 interchange with Mid-Atlantic Parkway.

CR 643 (Grove Road) and CR 660 (Jessup Road) - this intersection is also expected to experience deficiencies if left in its present configuration. Like the previous intersection, it is also proposed to be improved by the I-295 interchange reconstruction. The planned improvements call for a realignment and relocation of the existing intersection.

CR 656 (Parkville Road) and Jessup Boulevard - in the AM peak, the westbound left turns from CR 656 are expected to experience LOS F. In the PM peak, this movement is projected to operate at LOS D. All other approaches should operate satisfactorily in both peak periods.

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## VI. RECOMMENDATIONS

This section discusses recommendations for physical improvements to the highway network to be required as a result of the projected traffic volumes. The future level of service analysis indicates that, for the most part, the highway network will continue to operate with acceptable service levels in the Year 2010. However, there are some locations where conditions are expected to deteriorate and physical improvements to the roads will be necessary. The following recommendations will address improvements to those locations.

CR 551 is expected to be able to accommodate the Year 2010 projected traffic volumes. In the AM peak, the section of CR 551 between CR 660 and the East Greenwich Township line is expected to operate at LOS C and the section between NJ 45 and CR 660 is expected to operate at LOS D. In the PM peak, the CR 551 corridor is expected to operate at LOS D throughout the study area except for the link just east of CR 660 which is projected to operate at LOS E.

The projected increases in traffic volumes on CR 551 of approximately 15 to 23 percent over a 20 year time period represent, at most, moderate growth. Neither the projected volumes nor the resulting operating conditions would warrant widening this road to four lanes. However, traffic flow could be aided by upgrading and standardizing the highway to a 50 foot cartway as specified on the official county map. This cartway should consist of one travel lane and a paved shoulder in each direction plus provisions for a left turn lane where needed at major intersections. The projected traffic increases on the remaining roads in the network are expected to be easily absorbed by the facility.

At the CR 551 and NJ 45 intersection, level of service analyses of the future traffic conditions indicate a LOS D in the AM peak and LOS F in the PM peak on the eastbound CR 551 approach. Although there are a large number of left turns from this approach in both peak periods (283 in the AM and 346 in the PM) there is no opposing flow for this movement since the opposite leg of the intersection is a one-way street carrying traffic away from the intersection. Since both the northbound and southbound approaches of NJ 45 operate at LOS B, a retiming of the signal should provide adequate green time to the CR 551 approach to allow it to operate more efficiently and keep the overall intersection operating at an acceptable level.

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At the intersection of CR 551 and CR 660, PM peak hour traffic is expected to experience congested conditions on several approaches. The level of service analysis indicated a LOS D for the westbound CR 551 approach and for the southbound CR 660 through and left turn movement. LOS F is expected on the northbound CR 660 approach. The CR 551 approaches both consist of one lane and a paved shoulder. Although a paved shoulder exists, the heavy right turns on the westbound approach force the through traffic and left turns to share one approach lane. The northbound CR 660 approach has no shoulder, forcing the through and right turn movements to wait behind vehicles queued to turn left. The southbound CR 660 approach is projected to have 176 left turns the PM peak. Construction of left turn lanes on all approaches is recommended to relieve the anticipated congestion. This improvement results in LOS B on all approaches in the PM peak.

At the intersection of CR 551 and CR 656, the southbound CR 656 left turn lane is expected to experience congestion in both the AM and PM peak periods. Since this is the only movement expected to operate below LOS C and all approaches carry two lanes, this study recommends a retiming of this signal to reflect the demands of the turning movements.

Serious deficiencies are expected to exist on CR 643 at the intersection with the I-295 entrance/exit ramp and at the intersection with CR 660. These two unsignalized intersections are planned to be realigned, relocated and reconstructed as part of the I-295 interchange reconstruction project. These improvements are necessary to alleviate the expected congested conditions and to provide new mobility and access to this area. Since these improvements, planned by the New Jersey Department of Transportation affect county roads, the county should review the proposed improvements before they are implemented. Furthermore, the county should monitor these improvements to ensure their completion and effectiveness.

At the unsignalized intersection of CR 656 and Jessup Boulevard, the northbound CR 656 approach is projected to experience LOS F in the PM peak. This approach is stop controlled. A traffic signal warrant analysis should be conducted to determine if the installation of a traffic signal will allow the intersection to operate more efficiently.

The CR 643 approach to CR 551 experiences LOS F in the PM peak. A traffic signal warrant should be conducted at this intersection also.

The CR 648 approach to CR 551 experiences deficiencies in both the AM and PM peak

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periods. Horizontal sight distance is restricted at this intersection for vehicles attempting to enter CR 551 from CR 648. Looking west on CR 551 from CR 648, sight distance is limited by a house and some vegetation. This requires larger gaps in the traffic stream on CR 551 for vehicles to safely pull out from CR 648. Installation of a traffic signal would allow safe access to CR 551. However, if a traffic signal is not installed because it does not meet warrants or because of public opposition, the county should investigate the possibility of increasing the sight distance by cutting back the vegetation.

Over the next 20 years, the Kings Highway Corridor is expected to experience moderate growth rates both in terms of development and traffic volumes predicated partially on the completion of I-476 (Blue Route) in Pennsylvania and the reconstruction of I-295 in West Deptford and East Greenwich Townships. Even with the level of anticipated growth, the resulting traffic can in most locations, be easily absorbed by the existing highway network. Most of these facilities operate so much under capacity that, for the most part, major physical improvements are not necessary. However, minor improvements such as minor widening for the construction of shoulders, addition of left turn lanes and traffic signal retiming should provide congestion relief to the level for which it is needed.

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