2

Existing Infrastructure System Inventory

This chapter describes the existing transportation infrastructure system within the study area. Sections of this chapter present the existing traffic demands and operations, safety and geometrics, and a summary of the deficiencies of the corridor. Information is provided specific to mainline freeway sections, interchange ramps, and signalized and unsignalized intersections that have the potential to affect operations on I- 95.

This chapter also presents information related to major transit services within the corridor such as Amtrak and Shore Line East rail, Southeast Area Transit buses, and Rideshare vanpools.

2.1 Existing I-95 Traffic Demand

Traffic volumes presented in this study have been developed by the study team. The I-95 mainline average daily traffic (ADT) volumes are representative of year 2000 conditions and are the most recent ADT volumes available from ConnDOT. The I-95 mainline and ramp peak hour traffic volumes are representative of 2001/2002 conditions and were developed by ConnDOT through an ongoing statewide traffic counting program. This information was supplemented by manual counts conducted by the study team at intersections considered central to corridor operations. Detailed traffic volume networks are presented in the appendix.

2.1.1 Daily Volumes

Year 2000 two-way average daily traffic (ADT) volumes for mainline sections are presented in Table 2-1. As shown in the table, traffic volumes along mainline I-95 range from 36,600 vehicles per day (vpd) between Exits 92 and 93 to 121,000 vpd between Exits 84 and 85.

Table 2-1
I-95 Average Daily Traffic Volumes

Section	2000 ADT	Section	2000 ADT	Section	2000 ADT
Exit 54 to 55	83,900	Exit 67 (Elm St) to 67 (Rte154)	64,400	Exit 82 to 82A	77,400
Exit 55 to 56	80,000	Exit 67 (Rte 154) to 68	57,600	Exit 82A to 83	68,800
Exit 56 to 57	75,700	Exit 68 to 69	66,500	Exit 83 to 84	90,100
Exit 57 to 58	74,200	Exit 69 to 70	80,600	Exit 84 to 85	121,000
Exit 58 to 59	71,300	Exit 70 to 71	69,800	Exit 85 to 86	91,500
Exit 59 to 60	68,400	Exit 71 to 72	70,100	Exit 86 to 87(Rte 1)	67,400
Exit 60 to 61	71,600	Exit 72 to 73	71,400	Exit 87(Rte 1) to 87 (Rte 349)	60,800
Exit 61 to 62	67,100	Exit 73 to 74	71,600	Exit 87(Rte 349) to 88	75,900
Exit 62 to 63	66,600	Exit 74 to 75	75,800	Exit 88 to 89	69,400
Exit 63 to 64	64,200	Exit 75 to 76	83,500	Exit 89 to 90	63,800
Exit 64 to 65	64,100	Exit 76 to 80	61,200	Exit 90 to 91	52,600
Exit 65 to 66	61,000	Exit 80 to 81	61,600	Exit 91 to 92	42,900
Exit 66 to 67 (Elm St.)	58,900	Exit 81 to 82	66,700	Exit 92 to 93	36,600

2.1.2 Peak Hour Volumes

While daily volume data provides an overview of the traffic flows along the I-95 mainline, this study evaluates how the mainline and interchange facilities accommodate the peak hour demands placed upon them. In 1999, ConnDOT completed the *Southeastern Connecticut Corridor Study* that evaluated the transportation demands and needs of the southeast corridor of the state. The study analyzed existing traffic demands on I-95 and selected locations on US Route 1. The result of that analysis, in part, was the identification of the peak traffic periods.

The 1999 study found that severe congestion on I-95 occurs Friday through Sunday in the summer months due to commuter traffic and traffic heading to and from recreational attractions in the southeastern Connecticut region and Rhode Island. The study further found that traffic is highest on Friday in the summer months most likely due to a combination of commuter and tourist traffic. Therefore, the traffic volumes presented in this feasibility study are representative of the summer peak traffic periods. These volumes identify capacity and operational needs for existing and future conditions on the I-95 mainline, its interchanges, and selected adjacent intersections along local and state roads.

The morning and evening peak hour traffic volumes representing 2001 and 2002 conditions for the mainline sections were provided by ConnDOT and are shown in Table 2-2. For the 2001 AM peak hour, the table shows that southbound (SB) is the predominant direction of flow from Exits 54 to 63 and from Exits 87 to 91. The northbound (NB) direction is the predominant flow direction for the remainder of the mainline. In the 2002 PM peak hour, the predominant direction of flow is the northbound direction with the exception of the sections from Exits 75 to 82A and from Exits 84 to 87.

The peak hour volumes shown in Table 2-2 will be the basis of the capacity and level of service analyses presented in subsequent sections of this report.

Table 2-2
I-95 Mainline Peak Hour Volumes – 2001 AM and 2002 PM Existing Conditions

Section	2001 AM Peak Hour				2002 PM Peak Hour			
	Volume (vph)	% of Daily Traffic	Directional Split (vph) NB/SB	Directional Distribution	Volume (vph)	% of Daily Traffic	Directional Split (vph) NB/SB	Directional Distribution
Exit 54 to 55	6,100	7.3	2,600 / 3,500	57% SB	7,000	8.3	3,700 / 3,300	53% NB
Exit 55 to 56	5,940	7.4	2,460 / 3,480	59% SB	6,830	8.5	3,670 / 3,160	54% NB
Exit 56 to 57	5,740	7.6	2,340 / 3,400	59% SB	6,520	8.6	3,520 / 3,000	54% NB
Exit 57 to 58	5,670	7.6	2,330 / 3,340	59% SB	6,420	8.6	3,420 / 3,000	53% NB
Exit 58 to 59	5,550	7.8	2,400 / 3,150	57% SB	6,160	8.6	3,190 / 2,970	52% NB
Exit 59 to 60	5,130	7.5	2,240 / 2,890	56% SB	5,760	8.4	3,090 / 2,670	54% NB
Exit 60 to 61	5,390	7.5	2,370 / 3,020	56% SB	6,130	8.6	3,290 / 2,840	54% NB
Exit 61 to 62	5,010	7.5	2,320 / 2,690	54% SB	5,690	8.5	3,080 / 2,610	54% NB
Exit 62 to 63	5,000	7.5	2,440 / 2,560	51% SB	5,750	8.6	3,040 / 2,710	53% NB
Exit 63 to 64	4,790	7.5	2,480 / 2,310	52% NB	5,580	8.7	2,940 / 2,640	53% NB
Exit 64 to 65	4,700	7.3	2,550 / 2,150	54% NB	5,550	8.7	2,850 / 2,700	51% NB
Exit 65 to 66	4,450	7.3	2,450 / 2,000	55% NB	5,230	8.6	2,750 / 2,480	53% NB
Exit 66 to 67 (Elm St)	4,340	7.4	2,420 / 1,920	56% NB	5,030	8.5	2,650 / 2,380	53% NB
Exit 67 (Elm St) to 67 (Rte 154)	4,300	6.7	2,260 / 2,040	53% NB	5,140	8.0	2,630 / 2,510	51% NB
Exit 67 (Rte 154) to 68	4,160	7.2	2,260 / 1,900	54% NB	4,870	8.4	2,630 / 2,240	54% NB
Exit 68 to 69	4,860	7.3	2,560 / 2,300	53% NB	6,170	9.3	3,330 / 2,840	54% NB
Exit 69 to 70	6,360	7.9	3,230 / 3,130	51% NB	7,920	9.8	4,180 / 3,740	53% NB
Exit 70 to 71	5,740	8.2	3,100 / 2,640	54% NB	6,670	9.6	3,430 / 3,240	51% NB
Exit 71 to 72	6,010	8.6	3,300 / 2,710	55% NB	7,030	10.0	3,640 / 3,390	52% NB
Exit 72 to 73	5,960	8.4	3,300 / 2,660	55% NB	6,900	9.7	3,540 / 3,360	51% NB
Exit 73 to 74	6,020	8.4	3,390 / 2,630	56% NB	6,950	9.7	3,490 / 3,460	50% NB
Exit 74 to 75	6,230	8.2	3,660 / 2,570	59% NB	7,370	9.7	3,750 / 3,620	51% NB
Exit 75 to 76	6,770	8.1	4,000 / 2,770	59% NB	8,170	9.8	3,900 / 4,270	52% SB
Exit 76 to 80	4,970	8.1	3,100 / 1,870	62% NB	6,120	10.0	2,800 / 3,320	54% SB
Exit 80 to 81	5,040	8.2	3,150 / 1,890	63% NB	6,220	10.1	2,820 / 3,400	55% SB
Exit 81 to 82	5,360	8.0	3,320 / 2,040	62% NB	6,750	10.1	3,140 / 3,610	53% SB
Exit 82 to 82A	6,290	8.1	3,800 / 2,490	60% NB	8,180	10.6	3,750 / 4,430	54% SB
Exit 82A to 83	5,670	8.2	3,680 / 1,990	65% NB	6,860	10.0	3,500 / 3,360	51% NB
Exit 83 to 84	7,230	8.0	4,690 / 2,540	65% NB	8,860	9.8	4,500 / 4,360	51% NB
Exit 84 to 85	9,110	7.5	5,320 / 3,790	58% NB	11,860	9.8	5,750 / 6,110	52% SB
Exit 85 to 86	6,910	7.6	3,620 / 3,290	52% NB	9,710	10.6	4,550 / 5,160	53% SB
Exit 86 to 87 (Rte 1)	5,440	8.1	3,000 / 2,440	55% NB	7,410	11.0	3,550 / 3,860	52% SB
Exit 87 (Rte 1) to 87 (Rte 349)	4,660	7.7	2,170 / 2,490	53% SB	6,560	10.8	3,300 / 3,260	50% NB
Exit 87 (Rte 349) to 88	6,130	8.1	2,540 / 3,590	59% SB	8,130	10.7	4,570 / 3,560	56% NB
Exit 88 to 89	5,730	8.3	2,420 / 3,310	58% SB	7,430	10.7	4,170 / 3,260	56% NB
Exit 89 to 90	5,030	7.9	2,320 / 2,710	54% SB	6,720	10.5	3,670 / 3,050	55% NB
Exit 90 to 91	4,710	9.0	2,320 / 2,390	51% SB	5,390	10.2	3,100 / 2,290	58% NB
Exit 91 to 92	3,910	9.1	2,070 / 1,840	53% NB	4,370	10.2	2,470 / 1,900	57% NB
Exit 92 to 93	3,390	9.3	1,950 / 1,440	58% NB	3,370	9.2	2,000 / 1,370	59% NB

2.1.3 Surface Street Traffic Volumes

In addition to the traffic volumes collected on the I-95 mainline, existing traffic volumes were collected at 75 intersections throughout the study area during the summer Friday evening peak hour. The volumes were collected between Memorial Day and Labor Day during 2002. The locations are summarized in the appendix of this report and were selected due to their proximity to the interstate, and/or their potential to influence future improvement alternatives. Later sections of this report address the operational characteristics at each of these locations.

2.1.4 Trucks

To quantify truck volumes on I-95, ConnDOT conducted a vehicle classification study in 2000. In this study, vehicles were classified as either cars or trucks. Cars consisted of all passenger vehicles, motorcycles, and two-axle pick-up trucks. Trucks consisted of all vehicles with six or more tires.

The percentage of trucks in the two-way traffic stream varies from 8 to 22 percent during the peak hour. The highest truck percentages occur near the Connecticut/Rhode Island border in North Stonington where the northbound and southbound truck percentages are 8 percent and 14 percent, respectively. A traffic diagram showing the truck percentages in each section along I-95 is included in the appendix.

2.1.5 Mainline Speeds

Using the floating car method, a speed study was conducted along the I-95 mainline within the study area on Friday, July 19, 2002. The purpose of this study was to determine the prevailing vehicle speeds through each section of I-95 during the summer Friday evening peak hour. For each direction, three observations of the corridor were taken during the evening peak hour. An observer recorded travel times between exits while the driver maintained the tempo of the traffic stream.

The posted speed limit on I-95 in the study area is 65 mph with the exception of the area between Exits 74 and 76 where the posted speed limit is 55 mph. Travel Time–Speed Diagrams are shown in the appendix and indicate that travel speeds are generally in the posted speed limit range. Two areas with significant speed reduction occur between Exits 54 and 57 and between Exits 70 and 71. Mean travel speeds of 25 mph to 35 mph between Exits 54 and 57 in the southbound direction are the result of traffic congestion in this area. The northbound speeds are also reduced (60 mph to 45 mph), but to a lesser degree than the southbound direction. Between Exits 70 and 71, the mean travel speed of 40 mph in the northbound direction is also the result of traffic congestion.

2.2 Geometrics

I-95 is a major north-south route that traverses through New England. However, I-95 actually runs in a west-east direction in southeastern Connecticut. The section of I-95 from Branford to Waterford was opened in 1958 and the section from Waterford to the Connecticut/Rhode Island border was opened in 1964.

The southeastern Connecticut corridor carries a significant amount of traffic during typical commuting hours that is primarily comprised of a combination of commuter and recreational traffic, especially during the summer. Since I-95 was constructed, traffic volumes on this highway have increased dramatically. As a result, interchanges that were designed in accordance with the recommended standards at the time they were constructed may not conform to current freeway standards. Additionally, capacity issues at the ramps have begun to affect the operating conditions on the mainline. The significant traffic volumes combined with the geometric deficiencies increase the potential for operational and safety problems. Each interchange located within the study area was evaluated for conformance with current design standards. These evaluations included acceleration and deceleration lane lengths, approximate design speed of interchange ramps, minimum horizontal curvature and ramp terminal separations.

2.2.1 Methodology/Review of Geometrics

The study area encompasses the I-95 corridor beginning at Exit 54 in Branford and ending east of Exit 93 at the Rhode Island state line. Thirty-eight interchanges consisting of 69 exit ramps and 69 entrance ramps are located along this section of I-95.

2.2.2 Mainline Review

The I-95 mainline geometry generally consists of a four lane freeway with two 12 foot wide lanes in each direction, 10 foot wide outside shoulders, and 4 foot wide median shoulders. Exceptions to the four lane freeway section include:

- Six lane sections on both approaches to the Baldwin Bridge (Old Saybrook to Old Lyme) widening to an eight lane section on the bridge
- Six lane sections on both approaches to the Gold Star Bridge (New London to Groton) widening to a ten lane section on the bridge

The mainline geometric features were evaluated using existing geometric mapping. I-95 is classified as an urban freeway in accordance with current design conventions; this corresponds to a design speed of 70 mph. Four geometric features along the mainline were evaluated for conformance with current design standards, including:

- Minimum lane width (12 feet)
- Minimum outside shoulder width (10 feet)
- Maximum grade (4% for rolling terrain)
- Maximum degree of horizontal curvature (2°-45')

All design values were taken from the 2001 Fourth Edition of *A Policy on Geometric Design of Highways and Streets* published by the American Association of State Highway and Transportation Officials (2001 AASHTO). Lane and shoulder widths were evaluated using year 2000 digital orthophotos. No minimum lane width deficiencies were identified within the project limits, but two areas were identified where inadequate outside shoulder widths are present. The results of the geometric analysis are summarized in Tables 2-3 to 2-5 and are illustrated on Figure 2-1.

Table 2-3
I-95 Outside Shoulder Width Deficiencies (10' Minimum)

Town	Closest Interchange	Approximate Location	Shoulder Width (ft)	Length (ft)
Northbound				
Old Lyme	Exit 70	Lieutenant River	8	2,000
Southbound				
Old Lyme	Exit 70	Lieutenant River	8	2,000

Table 2-4
I-95 Mainline Grade Deficiencies (4% Maximum)

Town	Closest Interchange	Approximate Location	Grade (%)	Length (ft)
Northbound				
Old Lyme	Exit 72	North Bride Brook Road	4.4	160
Waterford	Exit 80	Oil Mill Brook	5.0	290
Waterford	Exit 81	750' west of Stony Brook	4.4	635
Waterford	Exit 82	500' west of Route 85	5.0	1,370
Southbound				
Old Lyme	Exit 71	1500' west of Hatchetts Hill Rd	4.9	1,110

Table 2-5
I-95 Mainline Degree of Horizontal Curvature Deficiencies (2°-45' Maximum)

Town	Closest Interchange	Approximate Location	Degree of Curvature	Length (ft)
Northbound				
New London	Exit 84	Exit 84 Entrance Ramp	3°	845
Southbound				
East Lyme	Exit 76	Exit 76 Entrance Ramp	4°	1,270
Groton	Exit 86	Route 184	3°-30'	730

2.2.3 Interchange Review

Each interchange ramp was evaluated for standard acceleration and deceleration lane length and minimum horizontal curvature. According to 2001 AASHTO guidelines, the minimum desirable ramp design speed is equal to one-half the mainline design speed. Therefore the I-95 mainline design speed, which is 70 mph, translates to a minimum ramp design speed of 35 mph. Although this is the desired minimum value, it is often impractical to design ramps to meet this criterion where existing site constraints dictate a less conservative design is required. This is typical where loop or partial-loop ramps are utilized in cloverleaf-type interchanges to minimize the overall footprint of the interchange. AASHTO recommends a minimum design speed of 25 mph for these ramps.

Existing horizontal curvature determined from ConnDOT right-of-way plans and digital orthophotos was used to estimate existing ramp design speeds. These estimated speeds were then used to evaluate each ramp for conformance with the minimum desirable speed of 35 mph. For the purposes of this study, ramps with estimated speeds of less than 35 mph were considered deficient. These locations are shown in Table 2-6 and are illustrated on Figure 2-1. It should be noted, however, that numerous ramps within the study area are loop or partial-loop ramps that require a minimum speed of 25 mph in accordance with AASHTO standards. The locations of these ramps are also shown in Table 2-6.

Existing acceleration and deceleration lane lengths obtained from right-of-way plans and digital orthophotos were also used to evaluate each ramp terminal for conformance with AASHTO design standards. The acceleration and deceleration lane lengths were compared to the estimated ramp speeds to identify locations where inadequate speed-change lengths exist. Table 2-7 and Figure 2-1 provide a summary of these deficient locations.

Table 2-6
I-95 Ramp Design Speed Deficiencies ('X' indicates a deficiency)

Location	Design Speed			Radius (ft)
	25 mph and below	25 – 30 mph	30 – 35 mph	
Northbound				
Exit 55 Off[1,2]		X		180
Exit 57 On[1]		X		200
Exit 66 On[1]	X			140
Exit 69 Off[1]			X	275
Exit 71 Off[1,2]		X		180
Exit 81 On		X		230
Exit 87 Off			X	250
Southbound				
Exit 55 Off[1,2]		X		180
Exit 57 On[1]		X		180
Exit 59 Off[1,2]		X		180
Exit 61 On[1]		X		180
Exit 62 On[1]		X		180
Exit 63 Off[1,2]		X		180
Exit 66 On[1]	X			140
Exit 67 On[1]	X			140
Exit 72 Off[1]		X		180
Exit 74 Off[1]	X			130
Exit 74 On		X		160
Exit 81 Off		X		230
Exit 81 On		X		200
Exit 85 On			X	250
Exit 88 On[1]			X	260
Exit 89 On[1]			X	260
Exit 90 On[1]			X	260
Exit 91 On[1]			X	250

1 Loop or partial-loop ramp type. In accordance with 2001 AASHTO guidelines, minimum design speeds of 25 mph and minimum curve radii of 150 feet are acceptable.
2 Radius shown is for controlling (smallest radius) curve on ramp. Radius at diverge is standard for 35 mph.

Table 2-7
I-95 Ramp Acceleration/Deceleration Lane Length Deficiencies ('X' indicates a deficiency)

Interchange	Northbound		Southbound	
	Deceleration Lane	Acceleration Lane	Deceleration Lane	Acceleration Lane
Exit 54	N/A	X	X	N/A
Exit 55	X	X	X	X
Exit 56	X	X		X
Exit 57	X	X	X	X
Exit 58	X	X	X	X
Exit 59	X		X	X
Exit 60	N/A	X	X	N/A
Exit 61	X		X	X
Exit 62	X	X	X	X
Exit 63	X	X	X	X
Exit 64	X	X	X	X
Exit 65	X	X		X
Exit 66		X	X	X
Exit 67 (Elm St)	N/A	X		N/A
Exit 67 (Rte 154)	X	N/A	N/A	X
Exit 68	N/A	Lane Ahead		N/A
Exit 69	X	Lane Ahead	Exit Only Lane	X
Exit 70	Exit Only Lane	X	X	Lane Ahead
Exit 71	X	X		X
Exit 72		X	X	X
Exit 73	X	X	X	X
Exit 74	X	X	X	X
Exit 75		X	X	X
Exit 76		N/A	N/A	
Exit 80	N/A	X	X	N/A
Exit 81		X	X	X
Exit 82	X	X		
Exit 82A	X		N/A	X
Exit 83		Lane Ahead	Exit Only Lane	N/A
Exit 84	N/A	Lane Ahead	Exit Only Lane	N/A
Exit 85		N/A	N/A	Lane Ahead
Exit 86	Exit Only Lane	N/A	N/A	Lane Ahead
Exit 87				
Exit 88	X	X	X	X
Exit 89		X	X	X
Exit 90	X		X	X
Exit 91	X	X	X	X
Exit 92	X	X	X	X
Exit 93	X	X	X	X

The minimum separation distance between successive interchange ramps was also compared to 2001 AASHTO recommendations. A minimum spacing of 500 feet is recommended between exit and entrance ramps and 2,000 feet is recommended between entrance and exit ramps. The southbound ramps at Exit 74, which are separated by 425 feet, are the only ramps with deficient exit-entrance ramp separation. Locations with deficient entrance-exit ramp separation distances are shown in Table 2-8 and on Figure 2-1.

Table 2-8
I-95 Entrance to Exit Ramp Separation Deficiencies (2,000' Minimum)

Northbound			Southbound		
From	**To**	**Separation (ft)**	**From**	**To**	**Separation (ft)**
Madison Rest Area	Exit 62	1000	Exit 62	Madison Rest Area	1900
Exit 71	Exit 72	800	Exit 69	Exit 68	900
Exit 75	Exit 76	1400	Exit 72	Exit 71	400
Exit 82	Exit 82A	1500	Exit 82A	Exit 82	1200

2.3 Existing Traffic Operations

The next step in the study process was to evaluate the operations of I-95 within the study area. This analysis provides a technical assessment of the operational characteristics of the ramps, freeway, weaving sections, and intersections using the procedures documented in the *2000 Highway Capacity Manual* (HCM) and compares these characteristics with the hourly traffic demand volumes. The traffic analysis was conducted using the peak hour traffic volumes described in Section 2.1.2 and the geometric design conditions as they currently exist along the study area roadways.

Understanding the relationship between the supply and demand on a roadway is a fundamental consideration in evaluating how well a transportation facility fulfills its objective to safely and efficiently accommodate the travelling public. The traffic operations analysis procedures used to evaluate the I-95 study area roadways assigns a level of service (LOS) rating for each specific section, intersection, or area of roadway analyzed. LOS is a qualitative measurement of the operating conditions of a roadway facility or intersection taking into account a number of variables such as speed, vehicle maneuverability, driver comfort, and safety. Similar to a report card, LOS designations are letter based, ranging from A to F, with LOS A representing the best operating condition and LOS F representing the worst operating condition. LOS A represents free flow conditions and LOS E and F represent conditions where demands approach or are at the available capacity. A more detailed description of the various LOS designations is included in the appendix.

The HCM does not recommend a specific LOS for design purposes, rather it offers a description of the conditions associated with each level of service. For example, LOS C is described in the manual with key words and phrases such as "stable operations," "traffic stream is notably affected," "lane change requires additional care," and "a noticeable increase in (driver) tension." As conditions deteriorate to LOS D, the HCM describes conditions with words such as "unstable flow," "average travel speeds are noticeably reduced," "freedom to maneuver is severely limited," and "drastically reduced physical and psychological (driver) comfort."

2.3.1 Methodology/Criteria

The criteria used to evaluate the I-95 roadway capacity were based on the methodology presented in the 2000 HCM. The HCM presents various methods for evaluating traffic operations for various types of roadway facilities as defined by the Federal Highway Administration (FHWA). The criteria presented in the HCM is based on years of research in traffic operations and traffic flow and is a tool that FHWA and the traffic

engineering community utilize for analyzing traffic operations. The following HCM chapters were utilized in the evaluation of the I-95 study area transportation facilities:

- Chapter 16 – Signalized Intersections
- Chapter 17 – Unsignalized Intersections
- Chapter 23 – Basic Freeway Segments
- Chapter 24 – Freeway Weaving
- Chapter 25 – Ramps and Ramp Junctions

All of these chapters were used to define the operating conditions for the various traffic conditions and traffic volumes experienced along I-95 and the study area roadways.

The following sections provide a summary of the existing conditions for the I-95 mainline, ramps and intersection in the study area. For the purposes of this study, LOS D and better are considered acceptable conditions. LOS E and F represent operational deficiencies.

2.3.2 Mainline Operations

The procedures for analyzing the operational conditions of the I-95 mainline are based on analysis procedures presented in Chapter 23 (Basic Freeway Segments) of the HCM. The HCM procedures for analyzing freeway sections use a number of factors including traffic volumes, number of lanes, width of those lanes, percentage of trucks in the traffic stream, lateral clearance to obstructions along the side of the road, freeway speed, terrain, and driver population (primary commuters, or some mix of recreational and commuter) in the analysis section.

Levels of service (LOS) for freeway sections are defined in terms of density and are measured in passenger cars per mile per lane (pc/mi/ln). LOS A would describe a freeway section where vehicles are operating at free flow speeds, vehicle maneuverability is relatively unimpeded, and densities are less than 11 pc/mi/ln. LOS C would describe a freeway where vehicles are operating close to or at free-flow speeds, maneuverability is becoming noticeably restricted but it is possible with diligence, and densities are between 18 and 26 pc/mi/ln. At LOS E, the freeway section is operating at capacity, maneuverability is severely restricted, and densities are highly variable due to potential volatility of the congestion but are greater than 35 pc/mi/ln. At LOS F, the traffic volume on the freeway section exceeds the capacity of that section.

The results of the freeway section analysis for existing traffic conditions are summarized in Table 2-9 and illustrated on Figure 2-2. The table shows each section of I-95 within the study area that was evaluated, the number of travel lanes in that section, the general terrain type, the existing peak hour volume (the higher of the AM or the PM peak hour), and the corresponding level of service. A section is defined as the area of I-95 between successive interchanges (i.e., the area between Exit 54 and Exit 55 is a section).

Northbound Freeway Sections

The northbound direction of I-95 operates between LOS C to F. There are no northbound sections that operate at LOS A or B. Almost half of all sections operate at LOS E or F and experience operational deficiencies. Generally, the freeway can be separated into areas which operate with similar levels of service. The northbound sections that operate at LOS E or F are as follows: Exits 54 to 56, Exits 70 to 76 and Exits 82 to 84. The other northbound sections generally operate at LOS C or D. These sections include the Baldwin Bridge (Exits 69 to 70) and the Gold Star Bridge (Exits 84 to 85). There are a few northbound sections

however, within these groups that operate at LOS E or F. Those individual sections are Exits 68 to 69, Exits 85 to 86 and Exits 89 to 90.

Southbound Freeway Sections

The southbound direction of I-95 operates between LOS B and F. About one-third of the sections operate at LOS E or F and experience operational deficiencies. The section between Exit 92 and the Rhode Island state line operates at LOS B. As with the northbound direction, the southbound direction also has areas which operate at similar levels of service. The southbound sections that operate at LOS C or D are Exits 84 to 92 and Exits 56 to 70. These sections include the Baldwin Bridge (Exits 69 to 70) and the Gold Star Bridge (Exits 84 to 85). The other southbound sections, Exits 54 to 56 and Exits 70 to 84, operate at LOS E or F.

Table 2-9
Freeway Section Analysis — Summary of 2002 Existing Conditions

Section		Terrain	Number of Lanes	Peak Hour	Level of Service	2025 Volumes (vph)[1]
From	To					
Northbound						
Exit 54	**Exit 55**	**Level**	**2**	**PM**	**F**	**3,700**
Exit 55	**Exit 56**	**Level**	**2**	**PM**	**F**	**3,670**
Exit 56	Exit 57	Level	2	PM	D	3,520
Exit 57	Exit 58	Level	2	PM	D	3,420
Exit 58	Exit 59	Level	2	PM	D	3,190
Exit 59	Exit 60	Rolling	2	PM	D	3,090
Exit 60	Exit 61	Rolling	2	PM	D	3,290
Exit 61	Exit 62	Rolling	2	PM	D	3,080
Exit 62	Exit 63	Rolling	2	PM	D	3,040
Exit 63	Exit 64	Rolling	2	PM	D	2,940
Exit 64	Exit 65	Rolling	2	PM	D	2,850
Exit 65	Exit 66	Rolling	2	PM	D	2,750
Exit 66	Exit 67 (Elm St)	Rolling	2	PM	D	2,650
Exit 67 (Rte 154)	Exit 68	Rolling	2	PM	D	2,630
Exit 68	**Exit 69**	**Rolling**	**3**	**PM**	**E**	**3,330**
Exit 69	Exit 70	Rolling	4	PM	C	4,180
Exit 70	**Exit 71**	**Rolling**	**2**	**PM**	**E**	**3,430**
Exit 71	**Exit 72**	**Rolling**	**2**	**PM**	**E**	**3,640**
Exit 72	**Exit 73**	**Rolling**	**2**	**PM**	**E**	**3,540**
Exit 73	**Exit 74**	**Rolling**	**2**	**PM**	**E**	**3,490**
Exit 74	**Exit 75**	**Rolling**	**2**	**PM**	**E**	**3,750**
Exit 75	**Exit 76**	**Rolling**	**2**	**AM**	**F**	**4,000**
Exit 76	Exit 80	Rolling	2	AM	D	3,100
Exit 80	Exit 81	Rolling	2	AM	D	3,150
Exit 81	Exit 82	Rolling	2	AM	D	3,320
Exit 82	**Exit 82A**	**Rolling**	**2**	**AM**	**E**	**3,800**
Exit 82A	**Exit 83**	**Rolling**	**3**	**AM**	**F**	**3,680**
Exit 83	**Exit 84**	**Rolling**	**4**	**AM**	**F**	**4,690**
Exit 84	Exit 85	Rolling	5	PM	C	5,750
Exit 85	**Exit 86**	**Rolling**	**3**	**PM**	**F**	**4,550**
Exit 86	Exit 87	Rolling	3	PM	C	3,550
Exit 87	Exit 88	Rolling	3	PM	D	4,570
Exit 88	Exit 89	Rolling	3	PM	D	4,170
Exit 89	**Exit 90**	**Rolling**	**2**	**PM**	**E**	**3,670**

Table 2-9
Freeway Section Analysis — Summary of 2002 Existing Conditions

Section		Terrain	Number of Lanes	Peak Hour	Level of Service	2025 Volumes (vph)[1]
From	To					
Exit 90	Exit 91	Rolling	2	PM	D	3,100
Exit 91	Exit 92	Rolling	2	PM	C	2,470
Exit 92	Exit 93	Rolling	2	PM	C	2,000
Exit 93	State Line	Rolling	2	PM	C	2,050
Southbound						
Exit 54	**Exit 55**	**Level**	**2**	**AM**	**F**	**3,500**
Exit 55	**Exit 56**	**Level**	**2**	**AM**	**F**	**3,480**
Exit 56	Exit 57	Level	2	AM	D	3,400
Exit 57	Exit 58	Level	2	AM	D	3,340
Exit 58	Exit 59	Level	2	AM	D	3,150
Exit 59	Exit 60	Rolling	2	AM	D	2,890
Exit 60	Exit 61	Rolling	2	AM	D	3,020
Exit 61	Exit 62	Rolling	2	AM	D	2,690
Exit 62	Exit 63	Rolling	2	PM	D	2,710
Exit 63	Exit 64	Rolling	2	PM	D	2,640
Exit 64	Exit 65	Rolling	2	PM	D	2,700
Exit 65	Exit 66	Rolling	2	PM	D	2,480
Exit 66	Exit 67 (Elm St)	Rolling	2	PM	C	2,380
Exit 67 (Elm St)	Exit 67 (Rte 154)	Rolling	2	PM	D	2,510
Exit 67 (Rte 154)	Exit 68	Rolling	2	PM	C	2,240
Exit 68	Exit 69	Rolling	2	PM	D	2,840
Exit 69	Exit 70	Rolling	4	PM	C	3,740
Exit 70	**Exit 71**	**Rolling**	**2**	**PM**	**E**	**3,240**
Exit 71	**Exit 72**	**Rolling**	**2**	**PM**	**E**	**3,390**
Exit 72	**Exit 73**	**Rolling**	**2**	**PM**	**E**	**3,360**
Exit 73	**Exit 74**	**Rolling**	**2**	**PM**	**E**	**3,460**
Exit 74	**Exit 75**	**Rolling**	**2**	**PM**	**E**	**3,620**
Exit 75	**Exit 76**	**Rolling**	**2**	**PM**	**F**	**4,270**
Exit 76	**Exit 80**	**Rolling**	**2**	**PM**	**E**	**3,320**
Exit 80	**Exit 81**	**Rolling**	**2**	**PM**	**E**	**3,400**
Exit 81	**Exit 82**	**Rolling**	**2**	**PM**	**E**	**3,610**
Exit 82	**Exit 82A (Frontage Rd)**	**Rolling**	**2**	**PM**	**F**	**4,430**
Exit 82A (Frontage Rd)	**Exit 83**	**Rolling**	**2**	**PM**	**F**	**3,360**
Exit 83	**Exit 84**	**Rolling**	**4**	**PM**	**F**	**4,360**
Exit 84	Exit 85	Rolling	5	PM	D	6,110
Exit 85	Exit 86	Rolling	4	PM	D	5,160
Exit 86	Exit 87 (Rte 1)	Rolling	3	PM	C	3,860
Exit 87 (Rte 1)	Exit 87 (Rte 349)	Level	3	PM	C	3,260
Exit 87 (Rte 349)	Exit 88	Rolling	3	AM	C	3,590
Exit 88	Exit 89	Rolling	3	AM	C	3,310
Exit 89	Exit 90	Rolling	2	PM	D	3,050
Exit 90	Exit 91	Rolling	2	AM	C	2,390
Exit 91	Exit 92	Rolling	2	PM	C	1,900
Exit 92	Exit 93	Rolling	2	AM	B	1,440
Exit 93	State Line	Rolling	2	AM	B	1,540

Note: Boldface entries denote capacity deficiencies during the peak period.
1 vph – Vehicles per hour, including all vehicle types (e.g. passenger cars, trucks, motorcycles, etc.)

2.3.3 Ramp Operations

The HCM procedures for analyzing the operational conditions of highway ramps focus on the interaction between freeway mainline through traffic and merging and diverging traffic to and from the ramps. These analyses consider a number of factors including the length of acceleration or deceleration lanes and free-flow vehicle speeds along the freeway. In particular, the analysis for merging vehicles focuses on the areas where individual on-ramp vehicles attempt to find gaps in the adjacent mainline traffic stream. The action of this merging traffic creates turbulence along the mainline that can affect freeway operations. The converse of this is the diverge movement which forces exiting vehicles to shift in advance of the exit and occupy the right-hand lane (in the case of a right-hand exit lane) in order to exit the freeway. This action causes some turbulence to the overall traffic stream as the vehicles shift lanes and slow their speed in preparation for the off-ramp.

There are three left-hand off-ramps and two left-hand on-ramps within the corridor. Left-hand off-ramps are undesirable because they can cause driver uncertainty and require slower traffic to merge into the left lane to exit the mainline. Left-hand on-ramps are undesirable because they require the driver to merge into the higher speed, passing lane to enter the mainline. Left-hand ramps exist at the following locations:

- Exit 76 NB Off-ramp
- Exit 86 NB Off-ramp
- Exit 86 SB On-ramp
- Exit 87 SB Off-ramp
- Exit 87 SB On-ramp

Level of service for ramp operations is based on the density of the vehicles within the influence areas created by the merging or diverging vehicles. According to the HCM, the influence area for these movements is about 1,500 feet before the diverge area and 1,500 feet beyond the merge area. LOS A represents a condition where merging and diverging vehicles create no disruption to the mainline through vehicles and there is virtually no turbulence within the ramp influence area. On the other hand, LOS E/F represents conditions where the turbulence created by the merging and diverging vehicles becomes intrusive to all drivers in the influence area. Under these conditions, any minor changes to the traffic conditions could result in the creation of unacceptable queues along the ramps and for the mainline through traffic.

It is also important to note that ramp analyses do not evaluate the weaving conditions created by ramp operations along some freeway exits. For example, the ramp analysis does not take into account the factors involved where an on-ramp (such as I-95 southbound at Exit 72) is immediately followed (within 2,500 feet) downstream by an off-ramp (such as I-95 southbound Exit 71). This condition is evaluated as part of the weaving analysis presented in Section 2.3.4. The results of the I-95 ramp analyses are shown in Table 2-10 and also on Figure 2-2.

Northbound Ramps

Slightly more than one-third of the on and off-ramps along the northbound direction of I-95 operate at LOS E or F. The remaining ramps operate at LOS C or D. As with the freeway analysis, there is a general operational trend that shows groups of ramps operating under similar levels of service. The ramp groups that generally operate at LOS E or F are in the area of Exits 54 to 58, Exits 69 to 76, and Exits 82 to 90. The ramp groups that operate at LOS C or D are in the area of Exits 58 to 68, Exits 80 to 81 and Exits 90 to 93.

Southbound Ramps

Approximately one-third of the on and off-ramps along the southbound direction of I-95 operate at LOS E or F. There are three ramps (Exit 92 Off and Exit 93 On/Off) that operate at LOS B. The remaining ramps operate at LOS C or D. The ramp groups that generally operate at LOS E or F are in the area of Exits 70 to 89. The ramp groups that generally operate at LOS C or D are in the area of Exits 54 to 69 and Exits 90 to 92.

Table 2-10
Ramp Merge/Diverge Analysis – Summary of 2002 Existing Conditions

Ramp	Ramp Volume	Terrain	Peak Hour	Level of Service	Density (pc/mi/ln)
Northbound					
Exit 54 On	**540**	**Level**	**PM**	**E**	**36**
Exit 55 Off	**400**	**Level**	**PM**	**E**	**39**
Exit 55 On	**370**	**Level**	**PM**	**E**	**36**
Exit 56 Off	**500**	**Level**	**PM**	**E**	**39**
Exit 56 On	350	Level	PM	D	35
Exit 57 Off	**370**	**Rolling**	**PM**	**E**	**38**
Exit 57 On	270	Rolling	PM	D	35
Exit 58 Off	**450**	**Rolling**	**PM**	**E**	**37**
Exit 58 On	220	Rolling	PM	D	33
Exit 59 Off	550	Rolling	PM	D	35
Exit 59 On	450	Rolling	PM	D	31
Exit 60 On	200	Rolling	PM	D	35
Exit 61 Off	**450**	**Rolling**	**PM**	**E**	**36**
Exit 61 On	240	Rolling	PM	D	30
Exit 62 Off	350	Rolling	PM	D	34
Exit 62 On	310	Rolling	PM	D	31
Exit 63 Off	550	Rolling	PM	D	35
Exit 63 On	450	Rolling	PM	D	30
Exit 64 Off	340	Rolling	PM	D	32
Exit 64 On	250	Rolling	PM	D	29
Exit 65 Off	410	Rolling	PM	D	31
Exit 65 On	310	Rolling	PM	D	28
Exit 66 Off	300	Rolling	PM	D	30
Exit 66 On	200	Rolling	PM	D	30
Exit 67 (Elm St) On	310	Rolling	PM	D	33
Exit 67 (Rte 154) Off	330	Rolling	PM	D	32
Exit 68 On	700	Rolling	PM	D	33
Exit 69 Off	**200**	**Rolling**	**PM**	**E**	**36**
Exit 69 On	**1050**	**Rolling**	**PM**	**F**	**40**
Exit 70 Off	**1000**	**Rolling**	**PM**	**F**	**44**
Exit 70 On	**250**	**Rolling**	**PM**	**E**	**37**
Exit 71 Off	**90**	**Rolling**	**PM**	**E**	**36**
Exit 71 On	**300**	**Rolling**	**PM**	**E**	**38**
Exit 72 Off	**350**	**Rolling**	**PM**	**E**	**38**
Exit 72 On	**250**	**Rolling**	**PM**	**E**	**37**

Table 2-10
Ramp Merge/Diverge Analysis – Summary of 2002 Existing Conditions

Ramp	Ramp Volume	Terrain	Peak Hour	Level of Service	Density (pc/mi/ln)
Exit 73 Off	**100**	**Rolling**	**PM**	**E**	**39**
Exit 73 On	**50**	**Rolling**	**PM**	**E**	**36**
Exit 74 Off	**300**	**Rolling**	**PM**	**E**	**38**
Exit 74 On	**560**	**Rolling**	**PM**	**E**	**39**
Exit 75 Off	**250**	**Rolling**	**PM**	**F**	**41**
Exit 75 On	**400**	**Rolling**	**PM**	**F**	**40**
Exit 76 Off	**1100**	**Rolling**	**PM**	**F**	**43**
Exit 80 On	20	Rolling	PM	D	31
Exit 81 (Cross Rd) Off	220	Rolling	PM	D	31
Exit 81 (Parkway South) On	540	Rolling	PM	D	32
Exit 82 Off	**330**	**Rolling**	**PM**	**E**	**35**
Exit 82 On	**940**	**Rolling**	**PM**	**E**	**39**
Exit 82A Off	**400**	**Rolling**	**PM**	**F**	**41**
Exit 82A On	**150**	**Rolling**	**PM**	**E**	**36**
Exit 83 Off	**250**	**Rolling**	**PM**	**E**	**39**
Exit 83 On	1250	Rolling	PM	D	28
Exit 84 On	**1250**	**Rolling**	**PM**	**F**	**35**
Exit 85 Off	**1200**	**Rolling**	**PM**	**F**	**34**
Exit 86 Off	**1000**	**Rolling**	**PM**	**F**	**41**
Exit 87 Off	250	Rolling	PM	D	34
Exit 87 On	1270	Rolling	PM	D	29
Exit 88 Off	**750**	**Rolling**	**PM**	**F**	**47**
Exit 88 On	**350**	**Rolling**	**PM**	**F**	**40**
Exit 89 Off	**750**	**Rolling**	**PM**	**F**	**44**
Exit 89 On	**250**	**Rolling**	**PM**	**E**	**36**
Exit 90 Off	**900**	**Rolling**	**PM**	**F**	**41**
Exit 90 On	330	Rolling	PM	D	29
Exit 91 Off	700	Rolling	PM	D	33
Exit 91 On	70	Rolling	PM	C	25
Exit 92 Off	870	Rolling	PM	C	28
Exit 92 On	400	Rolling	PM	C	22
Exit 93 Off	200	Rolling	PM	C	24
Exit 93 On	250	Rolling	PM	C	21
Southbound					
Exit 54 Off	650	Level	PM	D	35
Exit 55 Off	360	Level	PM	D	34
Exit 55 On	500	Level	PM	D	33
Exit 56 (Industrial Rd) Off	320	Level	PM	D	35
Exit 56 (Leetes Island Rd) On	480	Level	PM	D	34
Exit 57 Off	250	Rolling	PM	D	35
Exit 57 On	250	Rolling	PM	D	33
Exit 58 Off	300	Rolling	PM	D	33

Table 2-10
Ramp Merge/Diverge Analysis – Summary of 2002 Existing Conditions

Ramp	Ramp Volume	Terrain	Peak Hour	Level of Service	Density (pc/mi/ln)
Exit 58 On	330	Rolling	PM	D	32
Exit 59 Off	250	Rolling	PM	D	31
Exit 59 On	550	Rolling	PM	D	31
Exit 60 Off	170	Rolling	PM	D	33
Exit 61 Off	200	Rolling	PM	D	31
Exit 61 On	430	Rolling	PM	D	30
Exit 62 Off	380	Rolling	PM	D	31
Exit 62 On	280	Rolling	PM	D	30
Exit 63 Off	430	Rolling	PM	D	31
Exit 63 On	500	Rolling	PM	D	29
Exit 64 Off	310	Rolling	PM	D	31
Exit 64 On	250	Rolling	PM	D	29
Exit 65 Off	230	Rolling	PM	D	30
Exit 65 On	450	Rolling	PM	D	29
Exit 66 Off	200	Rolling	PM	D	30
Exit 66 On	300	Rolling	PM	D	28
Exit 67 (Elm St) Off	310	Rolling	PM	D	32
Exit 67 (Rte 154 – SB) On	180	Rolling	PM	D	31
Exit 67 (Rte 154 – NB) On	270	Rolling	PM	D	28
Exit 68 Off	600	Rolling	PM	D	33
Exit 69 Off	**1200**	**Rolling**	**PM**	**F**	**43**
Exit 69 On	300	Rolling	PM	D	31
Exit 70 Off	**200**	**Rolling**	**PM**	**E**	**39**
Exit 70 On	**700**	**Rolling**	**PM**	**F**	**41**
Exit 71 Off	**270**	**Rolling**	**PM**	**E**	**40**
Exit 71 On	**120**	**Rolling**	**PM**	**E**	**36**
Exit 72 Off	**220**	**Rolling**	**PM**	**E**	**40**
Exit 72 On	**250**	**Rolling**	**PM**	**E**	**38**
Exit 73 Off	**180**	**Rolling**	**PM**	**E**	**38**
Exit 73 On	**80**	**Rolling**	**PM**	**E**	**37**
Exit 74 Off	**460**	**Rolling**	**PM**	**F**	**43**
Exit 74 On	**300**	**Rolling**	**PM**	**E**	**37**
Exit 75 Off	**800**	**Rolling**	**PM**	**F**	**48**
Exit 75 On	**150**	**Rolling**	**PM**	**E**	**40**
Exit 76 On	**950**	**Rolling**	**PM**	**F**	**45**
Exit 80 Off	**80**	**Rolling**	**PM**	**E**	**39**
Exit 81 (Cross Road) On	**270**	**Rolling**	**PM**	**E**	**36**
Exit 81 (Parkway North) Off	**480**	**Rolling**	**PM**	**E**	**41**
Exit 82 Off	**1220**	**Rolling**	**PM**	**F**	**50**
Exit 82 On	**400**	**Rolling**	**PM**	**E**	**39**
Exit 82A (Frontage Rd) On	**1070**	**Rolling**	**PM**	**F**	**44**
Exit 83 Off	1000	Rolling	PM	D	33

Table 2-10
Ramp Merge/Diverge Analysis – Summary of 2002 Existing Conditions

Ramp	Ramp Volume	Terrain	Peak Hour	Level of Service	Density (pc/mi/ln)
Exit 84 Off	**1750**	**Rolling**	**PM**	**F**	**36**
Exit 85 On	**950**	**Rolling**	**PM**	**F**	**40**
Exit 86 On	**1300**	**Rolling**	**PM**	**E**	**37**
Exit 87 (Rte 349) Off	300	Rolling	PM	D	33
Exit 87 (US Rte 1) Off	**250**	**Rolling**	**PM**	**F**	**33**
Exit 87 On	**850**	**Rolling**	**PM**	**F**	**29**
Exit 88 Off	250	Rolling	PM	D	35
Exit 88 On	**550**	**Rolling**	**PM**	**E**	**38**
Exit 89 Off	**250**	**Rolling**	**PM**	**E**	**35**
Exit 89 On	**460**	**Rolling**	**PM**	**E**	**36**
Exit 90 Off	290	Rolling	PM	C	28
Exit 90 On	1050	Rolling	PM	D	30
Exit 91 Off	70	Rolling	PM	C	22
Exit 91 On	460	Rolling	PM	C	26
Exit 92 Off	250	Rolling	PM	B	15
Exit 92 On	780	Rolling	PM	C	22
Exit 93 Off	300	Rolling	PM	B	18
Exit 93 On	150	Rolling	PM	B	18

Note: Boldface entries denote capacity deficiencies during the peak hour.

2.3.4 Weaves

HCM analysis procedures define a weaving movement as the interaction between the crossings of two or more traffic streams travelling in the same direction without the aid of traffic control devices. There are a number of weaving areas along I-95 which require a significant amount of driver awareness as vehicles are simultaneously accelerating onto the mainline freeway from the on-ramp and decelerating from the mainline freeway to the off-ramp.

The HCM procedures for analyzing freeway weaving areas uses the interaction between conflicting traffic streams to estimate vehicle speeds within a weaving section. More formally defined, weaving areas occur when the merge area of an on-ramp is closely followed (within 2,500 feet) by the diverge area of an off-ramp. Thus, traffic within a weaving area is subject to turbulence above that which is normally present on basic freeway sections. This turbulence is in the form of forced lane changes within a restricted distance.

Critical inputs used to arrive at the LOS of the weaving section are traffic volumes in the weaving section (weaving and non-weaving), the length and configuration of the section, and free-flow vehicle speeds. LOS is determined separately for weaving and non-weaving vehicles, and is based on the average speeds of these vehicles in the weaving section. The results of the weaving analysis under existing traffic volume conditions are summarized in Table 2-11 and illustrated on Figure 2-2.

Northbound Weaving Sections

There are four weaving sections in the northbound direction. The weaves between Exit 68 and Exit 69 and Exit 71 and Exit 72 operate at LOS C and LOS D, respectively. The weave between Exit 75 and Exit 76 operates at LOS F. The weave between Exit 82A and Exit 83 operates at LOS B.

Southbound Weaving Sections

There are four weaving sections in the southbound direction. The weaves between Exit 69 and Exit 68 and Exit 72 and Exit 71 operate at LOS C and LOS D, respectively. The weaves between Exit 76 and Exit 75 and Exit 82A and Exit 82 operate at LOS E and LOS F, respectively.

Table 2-11
Weaving Sections Analysis – Summary of 2002 Existing Conditions

Section Description	Weave Length (ft)	Peak Hour	Level of Service	Density (pc/mi/ln)
Northbound				
Exit 68 to Exit 69	1320	PM	C	24
Exit 71 to Exit 72	800	PM	D	30
Exit 75 to Exit 76	**1250**	**PM**	**F**	**71**
Exit 82A to Exit 83	2300	PM	B	17
Southbound				
Exit 69 to Exit 68	1000	PM	C	22
Exit 72 to Exit 71	500	PM	D	31
Exit 76 to Exit 75	**1000**	**PM**	**E**	**42**
Exit 82A (Frontage Rd) to Exit 82	**1000**	**PM**	**F**	**47**

2.3.5 Intersections

The level of service (LOS) for signalized intersections is defined in terms of delay, which is a measure of driver discomfort, frustration, and lost travel time. Specifically, LOS criteria are stated in terms of the control delay per vehicle for a 15-minute analysis period. Control delay includes initial deceleration delay, queue move-up time, stopped delay and final acceleration delay.

The LOS for unsignalized intersections assumes that traffic on the local arterial is not affected by traffic on the side streets. That is, the through and right-turning movements on the mainline are unimpeded by side street traffic. The level of service is determined for left-turns from the main street onto the side street and for all side street movements. The level of service for each movement is calculated by determining the number of gaps that are available in the conflicting traffic stream. Based on the number of gaps, the capacity of the movement can be calculated. The demand of the movement is then compared to the capacity and utilized to determine average delay for a particular movement.

Capacity analyses were conducted at all intersections of ramp termini with local streets within the study area. In addition, capacity analyses were conducted at several predefined intersections within the study area that are adjacent to the I-95 mainline.

The results of the intersection analysis, utilizing summer 2001 Thursday and Friday evening traffic counts are summarized in Table 2-12 for signalized intersections and Table 2-13 for unsignalized intersections. Figure 2-3 presents graphical representations of the analyses. The following is a summary of locations operating at saturated levels (LOS E or LOS F):

Signalized Intersections

- Intersection of US Route 1 (Main Street) and SR 740 (Cedar Street) operates at LOS F
- At Exit 55, intersection of US Rte 1 (E. Main Street) and southbound ramps operates at LOS F
- At Exit 63, intersections of Route 81 (Killingworth Turnpike) with northbound on-ramp and southbound ramps operate at LOS F
- At Exit 70, intersections of the southbound on-ramp and Route 156 (Neck Road), and the southbound off-ramp and US Route 1 (Boston Post Road) operate at LOS F
- At Exit 82, intersection of Route 85 (Broad Street) and northbound ramps operates at LOS E
- At Exit 82, intersection of Route 85 (Broad Street) and southbound ramps, and intersection of Route 85 (Broad Street) and US Route 1 (Coleman Street) operate at LOS F
- At Exit 90, intersection of Route 27 (White Hall Avenue) and northbound ramps operates at LOS F
- Intersection of Route 27 (White Hall Avenue) and Coogan Boulevard operates at LOS F
- At Exit 91, intersection of Route 234 (Pequot Trail) and northbound ramps operates at LOS E
- At Exit 92, intersection of Route 2 (Liberty Street) and southbound on-ramp operates at LOS F

Unsignalized Intersections

- Eastbound approach of Cedar Knolls Drive to intersection with SR 740 (Cedar Street) operates at LOS F
- At Exit 59, southbound off-ramp at SR 718 (Goose Lane) operates at LOS E
- At Exit 61, northbound off-ramp at Route 79 (Durham Road) operates at LOS F
- At Exit 64, northbound off-ramp at Route 145 (Horse Hill Road) operates at LOS E
- At Exit 64, southbound off-ramp at Route 145 (Horse Hill Road) operates at LOS F
- At Exit 67, northbound off-ramp at Route 154 (Middlesex Turnpike) operates at LOS E and F
- At Exit 89, northbound and southbound off-ramps at SR 614 (Allyn Street) operate at LOS F

Table 2-12
Signalized Intersection Analysis – Summary of 2002 Existing Conditions

Signalized Intersections	Peak Hour	Level of Service	V/C[1]	Delay[2]
Exit 54 NB Ramps at SR 740 (Cedar St)	PM	C	0.63	24
Exit 54 SB Ramps at SR 740 (Cedar St)	PM	D	0.63	51
US Rte 1 (Main St) at SR 740 (Cedar St)	**PM**	**F**	**0.94**	**99**
Exit 55 NB Ramps at US Rte 1 (East Main St)	PM	C	0.55	34
Exit 55 SB Ramps at US Rte 1 (East Main St)	**PM**	**F**	**0.88**	**85**
Exit 57 NB Ramps at US Rte 1 (Boston Post Rd)	PM	D	0.65	49
Exit 58 NB Ramps at Rte 77 (Church St)	PM	C	0.76	25
US Rte 1 at SR 718 (Goose Lane)	PM	C	0.67	34
Exit 61 SB Ramps at Rte 79 (Durham Rd)	PM	C	0.40	23
Route 79 (Durham Rd) at Old Rte 79/Woodland Rd	PM	B	0.42	14
Exit 62 NB Ramps at Hammonasset Connector	PM	B	0.3	17
Exit 63 NB Off-Ramp at North High St	PM	C	0.37	29
Exit 63 NB On-Ramp at Rte 81 (Killingworth Tpke)	**PM**	**F**	**0.93**	**172**

Table 2-12
Signalized Intersection Analysis – Summary of 2002 Existing Conditions

Signalized Intersections	Peak Hour	Level of Service	V/C[1]	Delay[2]
Exit 63 SB Ramps at Rte 81 (Killingworth Tpke)	**PM**	**F**	**0.62**	**149**
Rte 81 (Killingworth Tpke) at Glenwood Rd	PM	B	0.51	20
Rte 145 at Old Clinton Rd	PM	C	0.42	21
Exit 65 NB Ramps at Rte 153 (Essex Rd)	PM	A	0.40	9
Exit 65 SB Ramps at Rte 153 (Essex Rd)	PM	B	0.42	15
Rte 153 at Westbrook Mall Entrance	PM	B	0.39	19
Exit 70 NB Off-Ramp at Rte 156 (Neck Rd)	PM	C	0.30	26
Exit 70 SB On-Ramp at Rte 156	**PM**	**F**	**0.96**	**196**
US Rte 1 (Halls Rd) at Rte 156	PM	D	0.44	52
Exit 70 SB Off-Ramp at US Rte 1 (Boston Post Rd)	**PM**	**F**	**0.84**	**119**
SR 449 (Rocky Neck Connector) at Rte 156	PM	C	0.33	25
Exit 82 NB Ramps at Rte 85 (Broad St)	**PM**	**E**	**0.65**	**78**
Exit 82 SB Ramps at Rte 85 (Hartford Tpke)	**PM**	**F**	**0.87**	**116**
US Rte 1 (Coleman St) at Rte 85 (Broad St)	**PM**	**F**	**0.71**	**102**
Vauxhall St at US Rte 1 (Coleman St)	PM	C	0.51	34
US Rte 1 at Bridge St	PM	B	0.37	18
Exit 88 NB Ramps at Rte 117 (North Rd)	PM	C	0.49	31
Exit 88 SB Ramps at Rte 117 (North Rd)	PM	B	0.40	14
Exit 90 NB Ramps at Rte 27 (White Hall Ave)	**PM**	**F**	**0.83**	**157**
Rte 27 (White Hall Ave) at Coogan Blvd	**PM**	**F**	**0.65**	**68**
Exit 91 NB Ramps at Rte 234 (Pequot Trail)	**PM**	**E**	**0.54**	**68**
Exit 92 NB Off-Ramp at Rte 2 (Liberty St)	PM	D	0.73	51
Exit 92 SB On-Ramp at Rte 2 (Liberty St)	**PM**	**F**	**0.50**	**101**
Exit 92 SB Off-Ramp at Rte 49 (Pendleton Hill Rd)	PM	D	0.43	46

Note: Boldface entries denote operational deficiencies during the peak hour.
1 V/C - Volume to Capacity ratio
2 Delay - Average stopped delay to all vehicles entering the intersection in seconds per vehicle

Table 2-13
Unsignalized Intersection Analysis – Summary of 2002 Existing Conditions

Unsignalized Intersections	Movement	Demand[1]	Delay[2]	Level of Service
SR 740 (Cedar St) at Cedar Knolls Drive	Northbound Left	100	11	B
	Eastbound	**100**	**>100**	**F**
Exit 57 SB Ramps at US Rte 1 (Boston Post Rd)	Westbound	250	18	C
	Southbound	20	8	A
Rte 77 at Commuter Lot Drive	Northbound Left	10	9	A
Exit 58 SB Ramps at Rte 77 (Church St)	Northbound Left	200	10	A
Exit 58 NB Off-Ramp at North River St	Southbound	60	13	B
	Northbound	80	12	B
Exit 59 NB Ramps at SR 718 (Goose Lane)	Southbound Left	100	11	B
Exit 59 SB Ramps at SR 718 (Goose Lane)	Northbound Left	450	10	A
	Eastbound	**250**	**41**	**E**

Table 2-13
Unsignalized Intersection Analysis – Summary of 2002 Existing Conditions

Unsignalized Intersections	Movement	Demand[1]	Delay[2]	Level of Service
SR 718 (Goose Lane) at Clapboard Hill Rd	Southbound Left	10	9	A
	Westbound	120	21	C
Exit 60 SB Off-Ramp at Mungertown Rd	Northbound Left	40	8	A
	Westbound	170	12	B
	Eastbound	60	9	A
Exit 60 NB On-Ramp at Fort Path Rd	Northbound	50	10	A
Mungertown Rd at Fort Path Rd	Westbound	30	8	A
	Southbound Left	70	9	A
Exit 61 NB Ramps at Rte 79 (Durham Rd)	Southbound Left	80	10	B
	Eastbound Left	**190**	**>100**	**F**
	Eastbound Right	260	16	C
	Eastbound		**>100**	**F**
Rte 79 (Durham Road) at Commuter Lot Drive	Southbound Left	10	10	A
	Westbound	30	23	C
Exit 62 SB Ramps at Hammonasett Connector	Southbound Left	90	9	A
	Westbound	380	24	C
Exit 64 NB Ramps at Rte 145 (Horse Hill Rd)	Southbound Left	70	9	A
	Eastbound	**340**	**39**	**E**
Exit 64 SB Ramps at Rte 145 (Horse Hill Rd)	Northbound Left	150	9	A
	Westbound	**310**	**78**	**F**
Exit 66 NB Ramps at Rte 166 (Spencer Plains Rd)	Northbound Left	130	9	A
	Eastbound	300	17	C
Exit 66 SB Ramps at Rte 166 (Spencer Plains Rd)	Southbound Left	40	8	A
	Westbound	200	17	C
Exit 67 SB Off-Ramp at Elm St	Westbound	310	12	B
Exit 67 NB On-Ramp at Elm St	Northbound Left	70	8	A
	Southbound Left	20	8	A
	Eastbound	140	20	C
Exit 67 NB Off-Ramp at Rte 154 (Middlesex Tpke)	Eastbound Right	230	19	C
	Eastbound Left	**100**	**90**	**F**
	Eastbound		**41**	**E**
Exit 68 SB Off-Ramp at Rte 628	Westbound	600	18	C
Exit 69 SB Off-Ramp at Essex Rd	Northbound	60	10	A
Exit 71 NB Ramps at Four Mile River Rd	Southbound Left	160	8	A
	Westbound	90	14	B
Exit 71 SB Ramps at Four Mile River Rd	Northbound Left	90	8	A
	Westbound	270	15	C
Four Mile River Rd at Hatchetts Hill Rd	Northbound Left	20	8	A
	Westbound	160	13	B
Exit 73 SB Ramps at West Society Rd	Northbound		9	A
	Northbound Left	0	10	B
	Northbound Right	180	9	A
	Westbound	80	8	A

Table 2-13
Unsignalized Intersection Analysis – Summary of 2002 Existing Conditions

Unsignalized Intersections	Movement	Demand[1]	Delay[2]	Level of Service
Exit 73 NB Ramps at Society Rd	Southbound	100	10	B
	Eastbound Left	20	8	A
Parkway North at Vauxhall St Extension	Northbound	480	12	B
Parkway South at Vauxhall St Extension	Southbound	220	10	A
Exit 89 NB Ramps at Rte 614 (Allyn St)	Southbound Left	80	8	A
	Eastbound Left	**360**	**>100**	**F**
	Eastbound Right	390	14	B
	Eastbound		**93**	**F**
Exit 89 SB Ramps at SR 614 (Allyn St)	Southbound Left	180	9	A
	Westbound	**250**	**69**	**F**
Exit 90 SB Ramps at Rte 27 (White Hall Ave)	Northbound Left	70	8	A
Exit 90 NB Ramps at Clara Dr (Aquarium)	Northbound		11	B
	Northbound Right	140	11	B
Exit 91 SB Ramps at Taugwonk Rd	Southbound Left	40	8	A
	Westbound		11	B
	Westbound Left	60	11	B
	Westbound Right	10	9	A
Exit 93 NB Ramps at Rte 216 (Clark Falls Rd)	Southbound Left	210	8	A
	Eastbound	200	15	C
Exit 93 SB Ramps at Rte 216 (Clark Falls Rd)	Northbound Left	60	8	A
	Westbound	300	13	B
Rte 216 (Clark Falls Rd) at Rte 184	Northbound	410	16	C
	Southbound	80	9	A
	Eastbound	280	11	B
	Westbound	70	10	A
	Intersection		13	B

Note: Boldface entries denote operational deficiencies during the peak hour.
1 Demand is expressed in vehicles per hour, including all vehicle types (e.g. passenger cars, trucks, motorcycles, etc.)
2 Delay - Average stopped delay in seconds per vehicle

2.3.6 Other Geometric Issues

The presence of slow vehicle lanes affects mainline operations. There are slow vehicle lanes located on the northbound lanes east of Exit 63, Exit 90, Exit 91and Exit 92 and west of Exit 93; on the southbound lanes east of Exit 90; on the southbound lanes east of Exit 91; on the southbound lanes east and west of Exit 92; and on the southbound lanes in the vicinity of Exit 93. Due to the inadequate capacity of the mainline, when the slow vehicle lanes end and trucks attempt to merge back into the mainline traffic stream, additional turbulence is created within the mainline traffic stream and traffic operations and safety issues result. This situation was identified in the 1999 *Southeastern Connecticut Corridor Study* completed by ConnDOT.

As part of the 1999 study, a recommendation was made to evaluate all slow vehicle lanes within the corridor and determine if each is warranted. As a result of this assessment, the Division of Traffic Engineering has recently directed the removal of slow vehicle lanes on the northbound lanes in Stonington east of Exit 90 between Deans Mills Road and Route 234 (Pequot Trail Road); on the northbound lanes in Stonington east of Exit 91 between North Anguilla Road and Route 2; on the northbound lanes in North Stonington east of Exit

92 between Route 2 and the northbound on-ramp from Route 49; and on the southbound lanes in Stonington east of Exit 90 between Route 234 (Pequot Trail Road) and Jerry Browne Road. All other slow vehicle lanes were found to be warranted. Slow vehicle lane locations are shown on Figure 2-2.

2.4 Safety Analysis

A safety analysis was conducted for the I-95 freeway system within the study area to determine if the year 2000 traffic demands combined with the geometric conditions of the roadways or ramps result in potentially unsafe operating conditions.

2.4.1 Methodology

The safety analysis was based on an examination of accident rates on the roadway and a comparison to statewide averages for similar type facilities. The source of the accident data is the ConnDOT *Traffic Accident Surveillance Report*. The Traffic Accident Surveillance Report compiles statewide accident data on a three-year basis. The report calculates actual accident rates for every roadway link and intersection on state numbered roadways. Also calculated is a critical accident rate for each location based on the type of roadway or intersection, the traffic volume, and the vehicle miles of travel on the roadway. The ratio of the actual accident rate to the critical accident rate is then calculated. If this ratio is higher than one, then the rate of accident occurrence at that location is said to be "higher than expected." When a location has 15 or more accidents, and a "higher than expected" accident rate, the location meets the criteria of a high accident location. The objective in developing the report and identifying high accident locations is to define those locations which have the greatest promise for accident reduction and thus to give a broad measure of overall needs of highway safety improvements. High accident locations are given priority for funding of future safety improvement projects.

2.4.2 Qualitative Description

Traffic accident data for I-95 was supplied by ConnDOT for the period from January 1997 to December 1999, which represents the most recent three-year period available. These data included all reported accidents on State roadways with property damage greater than $1,000 or personal injury. A review of these data indicates that nine locations along I-95 within the project limits exhibit a "higher than expected" ratio of actual accident rate to the critical accident rate and are identified as high accident locations. These locations are shown on Figure 2-1.

2.4.3 Quantitative Accident Data

For each of the high accident locations, a more detailed analysis was undertaken to determine if the traffic demands placed on the roadway or the geometric conditions of the roadway including ramps or weaves are the cause of unsafe operating conditions. The sections of I-95 identified as high accident locations within the study area are discussed below with a summary of the accident data presented in Table 2-14.

Exit 54 to North Ivy Street (Branford)

On the section of I-95 between Exit 54 and the overpass at North Ivy Street, a total of 66 accidents occurred during the three-year study period. Forty-three accidents (65%) occurred in the southbound direction with 32 on the mainline and 11 occurring on the Exit 54 southbound off-ramp. The remaining 23 accidents (35%) occurred in the northbound direction, 19 on the mainline and 4 accidents occurring on the Exit 54 northbound on ramp. The predominant collision type on this section was 44 rear-end collisions (67%). This area includes deficient northbound acceleration and southbound deceleration ramps, and LOS F conditions.

Twenty-seven of the 44 (61%) rear-end collisions occurred on the southbound mainline. The predominant reasons listed for cause of accidents were following too close and driving too fast for conditions. Congestion was listed as a major factor contributing to some of these accidents. Excessive speed and slippery road surfaces were major factors in other accidents.

Exit 61 to Exit 62 (Madison)

A total of 68 accidents occurred on this section of I-95 during the three-year period. Thirty-nine (57%) of the accidents were located within the northbound and southbound rest areas and they were primarily associated with maneuvers in and out of parking spaces. There were two accidents between vehicles and pedestrians within the rest areas. There are no LOS or geometric deficiencies in this area.

On the northbound and southbound mainline there were 27 accidents, 13 northbound and 14 southbound. Seventeen of these accidents (63%) were collisions with fixed objects. The collisions were primarily with guiderails, concrete barriers, and light poles. These were attributed mostly to driving too fast for conditions/slippery road surfaces.

Exit 69 to Exit 70 (Old Saybrook/Old Lyme)

From Exit 69 to Exit 70 there were a total of 28 accidents over the three-year period. Twenty-five accidents (89%) occurred on the mainline, 15 accidents northbound and 10 accidents southbound. The remaining three accidents occurred on Exit 70 ramps. The predominant collision types on the mainline included 11 fixed object collisions (39%) and 7 rear-end collisions (25%). There are no LOS deficiencies in this area. The Exit 70 northbound off-ramp is listed as deficient.

The fixed object collisions were primarily with guiderails and concrete barriers. Causes of these accidents were driving too fast for conditions with slippery road conditions a major contributing factor. Rear-end collisions were most numerous on the northbound mainline, making up six (67%) of the total 9 rear-end collisions. Rear-end collisions listed following too close as the primary cause of accident. Congestion was a major factor contributing to some of these accidents. Excessive speed was another major factor in other accidents.

Exit 70 to Exit 71 (Old Lyme)

A total of 159 accidents occurred on this section of I-95 during the three-year period. All 159 accidents occurred on the mainline with 77 accidents (48%) northbound and 82 accidents (52%) southbound. Sixty-five accidents (41%) involved collisions with fixed objects. The other predominant collision types were rear-end collisions with 54 accidents (34%), and sideswipes with 28 accidents (18%). This area operates at congested LOS E conditions. There are no geometric deficiencies in this area.

The fixed object collisions were primarily with guiderails and concrete barriers. Causes of these accidents were driving too fast for conditions with slippery road conditions a major contributing factor.

Rear-end collisions were distributed almost evenly between the northbound and southbound mainline. Rear-end collisions listed following too close as the primary cause of accident. Congestion was a major factor contributing to some of these accidents. Excessive speed was another major factor in other accidents. The sideswipes were attributed to either improper lane change or slippery conditions.

Exit 71 to Exit 72 (Old Lyme/East Lyme)

A total of 95 accidents occurred on this section of I-95 during the three-year period. Seventy-one accidents (75%) occurred on the mainline and 24 accidents (25%) occurred on the ramps. Of the mainline accidents, 37 (52%) occurred northbound and 34 (48%) occurred southbound. The predominant accident types were 46 rear-end collisions (48%) and 37 fixed object collisions (39%). This area contains a nonstandard interchange terminal spacing with deficient acceleration and deceleration lanes. It also operates under congested LOS E conditions. There are no geometric deficiencies in this area.

Rear-end collisions were more abundant on the mainline, making up 55% of the total mainline accidents. Northbound mainline had the majority of rear-end collisions, 24 accidents versus 15 accidents on the southbound mainline. Typical reasons listed for cause of these accidents were following too close and driving too fast for conditions. Congestion was listed as a major factor contributing to some of these accidents. Excessive speed and slippery road surfaces were major factors in other accidents. Fixed object collisions had a distribution of 11 accidents to 15 accidents between northbound and southbound mainline. The predominant object involved in these collisions was guiderails. Typical reason listed for cause of these accidents was driving too fast for conditions, with slippery road surfaces being the largest contributing factor. The majority of accidents (75%) that occurred at the ramps were rear-end and fixed object collisions. The major reason listed for cause of rear-end accidents was following too close, the result of congestion at the ramps. Fixed object collisions were mostly involved with guiderails and highway signs near the gore areas.

Exit 84 to Exit 85 (Waterford/Groton)

Of the 94 accidents on this section of I-95, 72 (77%) were on the Gold Star Bridge. The other 22 accidents were on the mainline off of the bridge. Predominant accident types include 39 fixed object collisions (41%), 26 sideswipes (28%), and 19 rear-end collisions (22%). There are no LOS deficiencies in this area. Geometric deficiencies in this area include the Exit 85 northbound deceleration lane and the Exit 85 southbound acceleration lane.

For the 72 accidents on the Gold Star Bridge, 33 (46%) were fixed object collisions, 27 (38%) were sideswipes, and 12 (17%) were rear-end collisions. Fixed objects hit were mainly bridge rail and concrete barriers. The primary reasons listed for cause of these accidents were driving too fast for conditions and driver lost control of vehicle. Almost all of these accidents occurred during icy conditions. The sideswipes were attributed to either improper lane change or slippery conditions. Rear-end collisions were the result of following too close and driving too fast for conditions.

For the other 22 mainline accidents, nine (41%) were rear-end collisions, six (27%) were sideswipes, and six (27%) were fixed object collisions. Similar accident causes for the bridge also apply to the non-bridge mainline.

Exit 92 Interchanges (Stonington/North Stonington)

This section of I-95 lies between the two Exit 92 interchanges: the western interchange with Route 2 and the eastern interchange with Route 49. A total of 42 accidents occurred along this section of I-95 during the three-year period. Seventeen accidents (40%) occurred on the mainline, while 25 accidents (60%) occurred on the ramps. Eleven accidents (65%) occurred on the northbound mainline and 6 accidents (35%) occurred on the southbound mainline. Twenty-one accidents (84%) occurred at the Exit 92/Route 2 northbound off ramp. The remaining 4 accidents were at the Exit 92/Route 2 southbound on-ramp. The predominant accident types included 24 fixed object collisions (57%) and 11 rear-end collisions (26%). There are no LOS or geometric deficiencies in this area.

Twenty fixed object collisions (46%) were on the mainline northbound and at the Exit 92/ Route 2 northbound off-ramp. Guiderails was the fixed object involved with most of the accidents that occurred on the mainline. The majority of the fixed object collisions at the off ramp involved sliding off/into an embankment. The major reason listed for cause of accidents was driving too fast for conditions. Slippery road surface was considered to be a major contributing factor. Nine of the 11 rear-end collision accidents (82%) occurred at the Exit 92/Route 2 northbound off-ramp. The primary reason listed as the cause of these accidents was following too close. Excessive speed and driver inattention were predominant contributing factors.

Exit 92 Interchanges (North Stonington)

A total of 25 accidents occurred along this section of I-95 during the three-year period. Twenty-two accidents (88%) occurred on the mainline, while 3 accidents (12%) occurred in the southbound rest area. Seventeen accidents (77%) occurred on the northbound mainline and 5 accidents (23%) occurred on the southbound mainline. The predominant accident type included 19 (76%) fixed object collisions. There are no LOS or geometric deficiencies in this area.

Fifteen of the 19 fixed object collisions were on the northbound mainline. The predominant object involved in these collisions was guiderails. Typical reason listed for the cause of these accidents was driving too fast for conditions, with slippery road surfaces being the largest contributing factor.

Exit 92 to Exit 93 (North Stonington)

All of the 66 accidents on this section of I-95 occurred on the mainline, split evenly between northbound and southbound. The predominant collision type was fixed object collision, with 53 (80%) of the 66 total accidents. There are no LOS or geometric deficiencies in this area.

Fixed object collisions were distributed evenly between northbound and southbound directions. Primary reasons listed for the cause of accidents were driver lost control of vehicle and driver falling asleep. The primary object hit in these collisions was guiderail, with a few vehicles driving into/off an embankment. Most of these accidents were attributable to slippery road surfaces. The six sideswipes that occurred were generally caused by improper lane changes. The four rear-end collisions had various reasons listed for cause of accident, with excessive speed and slippery road surfaces being contributing factors.

Table 2-14
High Accident Locations Summary – January 1, 1997 to December 31, 1999

Location	Collision Type					
	Rear End	Side	Fixed	Moving	Turning	Other
Mile 53.21 to 53.54, Branford						
Exit 54 to N. Ivy Street						
Mainline Northbound	8	3	6	2		
Mainline Southbound	27	4	1			
Exit 54 NB On Ramp	2	1	1			
Exit 54 SB Off Ramp	7	1	1		1	1
Mile 65.17 to 66.08, Madison						
Exit 61 to Exit 62						
Mainline Northbound	1	2	9	1		
Mainline Southbound	3	2	8	1		
Rest Areas						
Northbound		3	4		2	8
Southbound	1	5	1		1	14
NB Rest Area Exit Ramp			2			
Mile 78.59 to 78.75, Old Saybrook/Old Lyme						
Exit 69 to Exit 70						
Mainline Northbound	6	1	6	1		1
Mainline Southbound	1	2	5	2		
Ramps						
Exit 70 NB On Ramp	1		1			
Exit 70 SB Off Ramp	1					
Mile 80.21 to 83.19, Old Lyme						
Exit 70 to Exit 71						
Mainline Northbound	26	10	37	4		
Mainline Southbound	28	18	28	7		1
Mile 83.20 to 83.70, Old Lyme/East Lyme						
Exit 71/72						
Mainline Northbound	24	1	11			1
Mainline Southbound	15	3	15	1		
Ramps						
Off Ramp Northbound	2		4			
On Ramp Southbound	1	2	3			
Off Ramp Southbound	4	1	4	1	2	
Mile 93.90 to 94.47, Waterford/Groton						
Exit 84 to Exit 85						
Mainline Northbound	5	2	2			
Mainline Southbound	4	4	4	1		
Gold Star Bridge						
Northbound	4	12	15	4		
Southbound	8	8	18	3		
Mile 107.42 to 107.80, Stonington/North Stonington						
Exit 92 at Route 2 to Exit 92 at Route 49						
Mainline Northbound	1		9			1
Mainline Southbound		1	3	2		
Ramps (Route 2)						
Exit 92 NB Off Ramp	9		11			1
Exit 92 SB On Ramp	1	2	1			

Table 2-14
High Accident Locations Summary – January 1, 1997 to December 31, 1999

Location	Collision Type					
	Rear End	Side	Fixed	Moving	Turning	Other
Mile 107.81 to 108.64, North Stonington						
Exit 92 at Route 2 to Exit 92 at Route 49						
Mainline Northbound		1	15	1		
Mile 107.81 to 108.64, North Stonington (Continued)						
Mainline Southbound	2	1	2			
Rest Area						
Southbound			2			1
Mile 109.03 to 111.01, North Stonington						
Exit 92 to Exit 93						
Mainline Northbound	4	3	26			
Mainline Southbound		3	27	1		2

2.5 Deficiencies Summary

The evaluation of existing traffic operations has provided an overview of the operational characteristics for the I-95 freeway mainline, ramps, and weaving movements along the mainline. Additionally, the analysis has provided an overview of a number of signalized and unsignalized intersections that are affected by traffic entering or exiting I-95. The analysis has shown that there are specific locations where traffic operations do not meet current operational guidelines exclusive of any future traffic volume growth throughout the study area. The following findings were presented:

Traffic Demands

- In 2000, average daily traffic demand on I-95 varied from 36,600 vehicles per day (vpd) between Exits 92 and 93 (the eastern end of the study area) to 121,000 vpd between Exits 84 to 85.
- For the weekday morning peak hour, I-95 southbound is the predominant direction of flow from Exits 91 to 87 and from Exits 63 to 54. The northbound direction is the predominant flow direction for the remainder of the mainline. In the weekday evening peak hour, the predominant direction of flow on I-95 is the northbound direction except between Exits 75 and 82A and Exits 84 and 87.
- Heavy vehicles comprise 8 to 22 percent of the two-way traffic stream during the peak hour.

Geometry

In the study area, there are 38 interchanges consisting of 68 exit ramps and 68 entrance ramps. Each of these ramps has been evaluated for geometric deficiencies based on the 2001 AASHTO design standards. Within the study area, 10 exit ramps and 15 entrance ramps were identified as not meeting current design standards for minimum ramp design speeds.

Traffic Operations

This study analyzed traffic operations on I-95 mainline sections, interchange ramps, weaving sections, and key intersections in the study area. Level of service (LOS) is used as the qualitative measurement denoting the different operating conditions that occur under various traffic volume loadings. LOS designations are letter based, ranging from A to F, with LOS A representing the best operating condition under relatively free flowing

traffic conditions and LOS F representing the worst operating condition, or locations that are at or approaching capacity. LOS E or F on a mainline section is an indication of volumes approaching or exceeding the roadway capacity. LOS E or F at a ramp is an indication where the turbulence created by merging or diverging vehicles is intrusive to all drivers. LOS E or F in a weaving area is an indication of the high volume of vehicles creating turbulence within a limited maneuver area. LOS E or F at an intersection is an indication of volumes approaching or exceeding the capacity of the intersection, or in the case of a signalized intersection, it may also be an indication of poor signal timings.

- **Mainline** - There are 38 northbound sections and 40 southbound sections between Exit 54 and the Rhode Island state line. The analysis indicates that 14 northbound and 14 southbound sections operate at LOS E or F. A section is defined for this study as the area of I-95 between successive interchanges.
- **Ramps** - A total of 138 ramps were analyzed – 68 in each direction. The ramp analysis showed that 35 northbound ramps operate at LOS E or F and 28 southbound ramps also operate at LOS E or F.

Weaves

Eight weaving sections were analyzed including four in the northbound direction and four in the southbound direction. Three of the eight sections operate at LOS E or F. These weave areas are located northbound and southbound between Exit 75 and Exit 76 and southbound between Exit 82A and Exit 82.

Intersections

A total of 75 intersections were evaluated. These locations were at ramp termini, or on key roadways in the vicinity of the I-95 corridor. Of these intersections, 37 were signalized and 38 were unsignalized. For the signalized locations, 13 operate at LOS E or F during the summer, Friday evening peak hour. Ten of these locations occur where I-95 ramps intersect the local street system. For the unsignalized locations, eight operate at LOS E or F during the summer, Friday evening peak hour. Seven of those locations are intersections of the local street system with I-95 ramps.

Safety

Traffic accident data for I-95 for the most recent period available indicates that there are nine locations along I-95 within the project limits which are exhibiting a “higher than expected” accident rate. These include two ramp interchanges and seven mainline sections.

The two interchange sections are at Exit 92 (Mile 107.42 to 107.80) and Exit 92 (Mile 107.81 to 108.64). The first Exit 92 section has predominant accident types which include rear-end and fixed object collisions. The second Exit 92 section has fixed object collisions as the major accident type. The primary reasons listed for these accidents types were following too close and driving too fast for conditions.

The mainline section from Exit 54 to North Ivy Street (Mile 53.21 to 53.54) had rear-end collisions as the most frequent type of accident. Forty-four rear-end collisions (67%) occurred in this area. The predominant reasons listed for the cause of these accidents were following too close and driving too fast for conditions. Congestion, excessive speed and slippery road surfaces were major factors contributing to these accidents.

The two mainline sections from Exit 61 to Exit 62 (Mile 65.17 to 66.08) and Exit 92 to Exit 93 (Mile 109.03 to 111.01) had fixed object collisions as their most common re-occurring accident type. These collisions were

primarily with guiderails, concrete barriers, and light poles. These were attributed mostly to driving too fast for conditions and slippery road surfaces.

The two mainline sections from Exit 69 to Exit 70 (Mile 78.59 to 78.75) and Exit 70 to Exit 71 (Mile 83.20 to 83.70) had predominant accident types that included rear-end accidents and fixed object collisions. The primary reasons listed were following too close and driving too fast for conditions.

The remaining two mainline sections from Exit 70 to Exit 71 (Mile 80.21 to 83.19) and Exit 84 to Exit 85 (Mile 93.90 to 94.47) had several predominant accident types. Those types were rear-end, fixed object, and sideswipes. The sideswipes were attributed to either improper lane change or slippery conditions. The other reasons listed were following too close and driving too fast for conditions.

2.6 Multi-Modal Transportation Services

Several transit modes exist within the corridor which provide options to vehicular travel on I-95. The types of services and available riderships of other modes of transportation are presented in this section. Actual schedules for some of the services are included in the appendix.

Rail Service

- **Shore Line East (SLE)** – The southeastern Connecticut corridor is served by the Shore Line East rail line (SLE), which operates between New London and Stamford. The SLE mainly serves commuters, since it operates only weekdays, in the morning and evening peak hours. Morning service starts at 5:33 a.m. and runs until 10:00 a.m., while afternoon service operates between 2:10 p.m. and 10:06 p.m. In December 2001 the SLE started Express service through to Stamford with one morning train and one evening train to and from Stamford with a stop in Bridgeport. In June 2002 a second train was added providing additional morning and evening express service. Easy connections to MetroNorth trains are available in New Haven with a simple crossing of the platform. The SLE provides service between New London and Stamford with stations along the corridor in New London, Old Saybrook, Westbrook, Clinton, Madison, Guilford, Branford, New Haven, Bridgeport and Stamford. The New Haven stops include the new State Street station which is within walking distance to the Downtown New Haven Green area and provides access to Commuter Connection bus service. The Commuter Connection service is a special Connecticut Department of Transportation commuter shuttle bus service picking up passengers at New Haven's State Street Station in the morning and taking them to New Haven's central business district & the Sargent Drive/Long Wharf area. Currently, eastbound (toward New London) daily service consists of 12 trains, three in the AM and nine in the PM. Westbound (toward New Haven) daily service consists of 13 trains, seven in the AM and six in the PM. The SLE average daily bi-directional ridership between New London and New Haven in 2002 was approximately 2700 riders/day.
- **Amtrak/ACELA (Amtrak) –** The corridor is served by Amtrak rail service which provides interstate rail service between Boston and Washington, D.C. There are six stops within Connecticut along the corridor: Mystic, New London, Old Saybrook, New Haven, Bridgeport, and Stamford. The ACELA Express does not stop in Mystic or Bridgeport. Table 2-16 shows the number of trains departing from each station for Amtrak and Acela Express services separately. Additional schedule information is included in the appendix.

Table 2-15
Amtrak/ACELA Express Daily Stops

Amtrak – Number of Daily Stops							
Station	**Mon.**	**Tues.**	**Wed.**	**Thurs.**	**Fri.**	**Sat.**	**Sun.**
Northbound							
Stamford	8	8	8	8	9	9	9
Bridgeport	5	5	5	5	6	5	5
New Haven	9	9	9	9	10	9	9
Old Saybrook	6	6	6	6	6	8	8
New London	8	8	8	8	9	9	8
Mystic	4	4	4	4	4	6	6
Southbound							
Mystic	4	4	4	4	4	4	5
New London	9	9	9	9	9	8	9
Old Saybrook	7	7	7	7	7	5	6
New Haven	9	9	9	9	9	9	10
Bridgeport	6	6	6	6	6	7	8
Stamford	9	9	9	9	9	9	10
ACELA Express – Number of Daily Stops							
Station	**Mon.**	**Tues.**	**Wed.**	**Thurs.**	**Fri.**	**Sat.**	**Sun.**
Northbound							
Stamford	8	8	8	8	8	4	5
Bridgeport	0	0	0	0	0	0	0
New Haven	8	8	8	8	8	4	5
Old Saybrook	0	0	0	0	0	0	0
New London	1	1	1	1	1	1	1
Mystic	0	0	0	0	0	0	0
Southbound							
Mystic	0	0	0	0	0	0	0
New London	2	2	2	2	2	0	1
Old Saybrook	0	0	0	0	0	0	0
New Haven	9	9	9	9	9	3	6
Bridgeport	0	0	0	0	0	0	0
Stamford	7	7	7	7	7	1	4

Amtrak has completed a major upgrading of service for the northeast. The four primary components of the upgrade were:

- Upgrading the infrastructure to a high-speed rail line with improvements to reduce congestion between Amtrak and other commuter trains
- Electrification of the rail line between Boston and New Haven. This eliminates the need to change locomotives from electric to diesel in New Haven and permits the usage of high-speed electric trains with significantly greater acceleration.
- Acquisition of new high-speed trains
- Introducing new high-speed rail service

Bus Service

- **Southeast Area Transit (SEAT)** – The Southeast Area Transit District (SEAT) provides regional bus service in the corridor with multi-modal coordination with Rail, ferry, and long haul bus services in New London. The transit district serves nine towns: New London, Groton, Norwich, Griswold, Montville, East Lyme Waterford, Ledyard, and Stonington. SEAT operates thirteen Bus runs in the region. There are four corridor service runs (Run #1, Run #2, Run #3, and Run #9) connecting major cities and towns starting at 6:00 am and ending at 6:55 pm. Run #1 makes six, two hour round trips per day between Norwich and New London primarily along Route 32. Run #2 makes six, two hour round trips per day between Norwich, Groton, and New London primarily along Route 12. Run #3 makes five, two hour round trips per day between Groton, New London, and Niantic along several routes including I-95, Route 12, Route 156, Route 1, and Route 161. Run #9 makes three morning and three evening one-hour round trips between Norwich and Jewett City primarily along Route 12. In addition to the corridor runs, there are three local runs serving Norwich starting at 6:00 am and ending at 6:55 pm; there are three local runs serving New London starting at 7:00 am and ending at 6:55 pm; and there is one local run serving Groton starting at 6:40 am and ending at 6:45 pm. There are also two runs that serve the Mohegan Sun (Run #101) and Foxwoods (Run #108) Resort casinos. Run # 101 makes four AM stops and six PM stops at the Mohegan Sun at approximately one hour intervals on Monday through Saturday. Run #101 has no Sunday service. Run #101 stops at New London, Route 32/163, Norwich Transportation Center, and Westgate Plaza. Run #108 makes eight stops at Foxwoods at approximately 2 hour intervals starting at 6:55 am and ending at 8:00 pm Monday through Saturday. On Sunday, Run 108 makes six stops at Foxwoods at approximately two hour intervals starting at 9:50 am and ending at 6:00 pm. Run #108 stops at New London, and Mistick Village. Both of the casino routes accommodate the Amtrak schedule at the New London station. The service provides connections to five northbound and four southbound Amtrak trains.

  Most of the routes operate Monday through Saturday with no Sunday service. Only the Foxwoods Resort Casino run operates from 9:10 am to 6:00 pm on Sunday.

  The SEAT 2002 average daily ridership was approximately 2,300 riders per day.

- **CT Transit, New Haven Metro Area** – CT Transit New Haven Metro Area operates three bus routes in the corridor. These routes include the S-Route, the F-Route, and Route-26. The S-Route is operated by Dattco Inc. and provides weekday service from New Haven to Madison along Route 1. The last bus in the evening is extended east to Old Saybrook. There are twelve round trips daily with 30 minute departures, making a stop in Madison, and Guilford, and two stops in Branford and New Haven with additional stops at Shore Line East train stations upon request. The S-Route 2002 average daily ridership was 300 riders per day. There is no Saturday or Sunday service.

  In the corridor, the F-Route provides service from Branford to New Haven along local roads. There are three morning and eight afternoon and evening 30 minute round trips per week day and one morning round trip on Saturday. The route includes several local stops. There is no service to Branford on Sunday.

  Route-26 provides weekday express service from Old Saybrook to New Haven along I-95. There is one am and one pm trip in each direction making various stops. There is no Saturday or Sunday service.

- **Estuary Transit District (ET)** – ET operates the Shoreline Shuttle providing weekday service from Madison to Old Saybrook similar to the S-Route. There are 12 round trips daily with varying Headway intervals along US Route 1, making a stop in Madison and Guilford, and two stops in Branford and New Haven with additional stops at Shore Line East train stations upon request. The last bus in the evening is extended east to Old Saybrook. The ET Shoreline Shuttle average daily ridership was 74 riders per day.
- **Madison-New Haven Commuter Express Bus** – The Madison-New Haven Commuter Express Bus, operated by Dattco Inc., runs from Madison to New Haven along Route I-95. There is one morning and one evening trip that makes a stop at the commuter parking lots at exit 61 in Madison and exit 65 in Clinton, and terminates in downtown New Haven. The average daily ridership is 9 riders/day.

Commuter Ferry Service

- **Cross Sound Ferry** – The Cross Sound Ferry operates between New London and Orient Point, Long Island. The company operates six boats that can carry vehicles and one high speed boat for passengers only. The fleet makes 26 round trips daily in the summer and eight round trips daily in the winter. In 1999 the fleet carried approximately 1.2 million passengers, 360,000 cars, and 12,000 trucks.
- **Montauk Ferry** – The Montauk Ferry operates between New London and Montauk, New York. The company makes one round trip on Friday night and one round trip on Saturday night between Mother's Day and Labor Day. The boat carries between 80 and 120 passengers per trip.

Rideshare Service

- ***EasyStreet* Vanpool –** A total of 113 vans encompass the *EasyStreet* Vanpool system operating on I-95 between Branford and the Rhode Island state line. These vans carry an approximate total of 2000 commuters on a typical workday. In addition, *Rideworks* provides a matching service that helps commuters locate vanpool and carpool availability in their area.
- **Park and Ride Facilities –** There are 19 Park and Ride lots located at various interchanges within the study area which accommodate parking for approximately 1,360 commuter vehicles.

Bicycle Facilities

- **Recommended Routes –** There are numerous recommended bicycle routes located within the study corridor. These routes, which are identified on the *Connecticut 2002 Bicycle Map* published by ConnDOT, include Route 77 in Guilford, Route 79 in Madison, Route 81 in Clinton, Route 154 in Old Saybrook, Route 156 in Old Lyme, Route 161in East Lyme and Route 27 in Stonington. US Route 1 is also a recommended bicycle route along much of the I-95 corridor between Branford and Rhode Island. Figure 2-4, which was developed from ConnDOT's *2002 Bicycle Map*, shows the existing bicycle routes located within the I-95 study area.