Technical Memorandum

I-290

Preliminary Engineering

and Environmental (Phase 1) Study

West of Mannheim Road to East of Cicero Avenue

Existing Roadway Operations

July 2010

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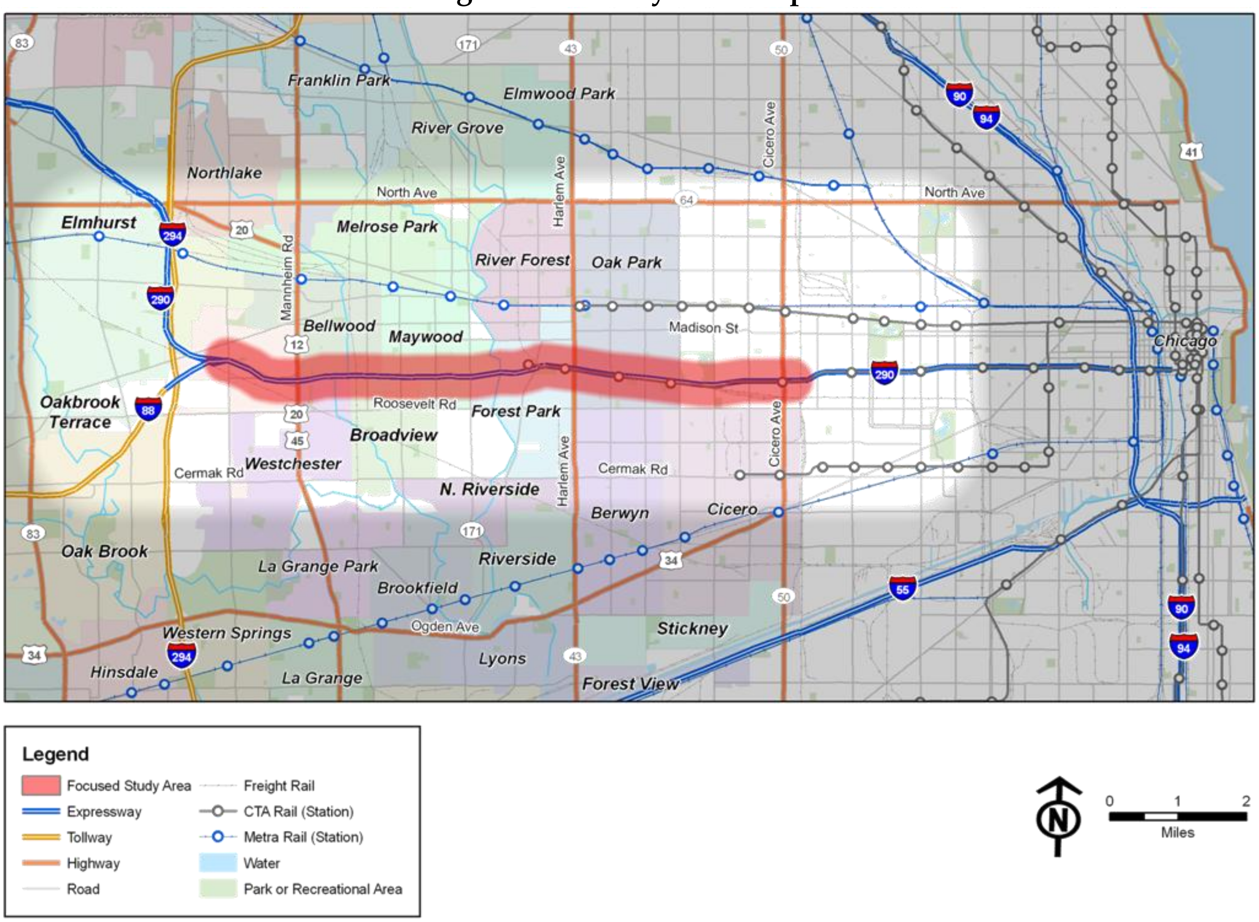
1.0 Introduction

This Technical Memorandum was prepared in support of the I-290 Preliminary Engineering and Environmental (Phase I) Study Existing Transportation System Performance Report, and documents the existing traffic operations within the Eisenhower Expressway (I-290) study area. Traffic operation analyses were performed to evaluate and document the existing traffic operations of the Eisenhower Expressway (I-290) and connecting streets from west of Mannheim Road to east of Cicero Avenue in Cook County, Illinois.

2.0 Study Area

The I-290 Phase I focused study area (Figure 2-1) is centered along I-290 in Cook County extending approximately 7.5 miles from west of US 12/20/45 (Mannheim Road) to east of IL Route 50 (Cicero Avenue). The focused study area includes adjacent transit and freight railroads, interchanges, cross streets and other parallel and crossing features that are within or in close proximity to the I-290 corridor.

Figure 2-1 - Study Area Map



2.1 Mainline

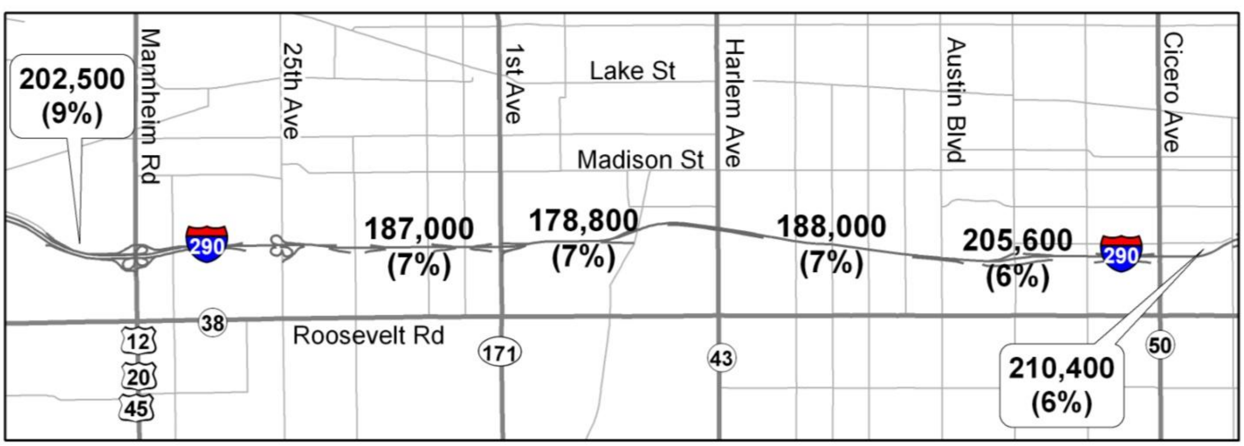
The I-290 Eisenhower Expressway has remained almost entirely unchanged since its construction over 50 years ago. Interchanges, access ramps, and lane configurations of I-290 east of the I-290 Hillside Interchange improvement project are still in their original design. The number of I-290 mainline lanes varies between different sections of its route. Starting in Hillside and traveling east along I-290, there are three mainline lanes until just east of Mannheim Road, where an auxiliary lane connects the collector-distributor (C-D) road with the off ramp for 25th Avenue. I-290 continues east with three lanes for approximately 5.5 miles, just east of Austin Avenue. Here, the eastbound I-290 on-ramp from Austin Avenue enters I-290 on the left and forms a fourth lane. I-290 continues east as four lanes for approximately 6 miles to its eastern terminus in downtown Chicago.

The westbound direction of I-290 has a similar configuration, except west of 25th Avenue, the on-ramp from Harrison Street merges with the expressway to form a short auxiliary lane connecting the Harrison Street on-ramp to the downstream Mannheim Road off-ramp. A fourth mainline lane is added by the Mannheim Road westbound on-ramp. The four mainline lanes continue west past Mannheim Road for a mile to the I-88 & I-290 split; here two lanes continue on I-290 and two lanes on I-88.

An existing lane diagram in Appendix A illustrates the existing mainline, crossroads, and ramp lane configurations in the focused study area.

Traffic volumes are heavy along I-290, ranging from 178,800 to 210,400 vehicles per day (Figure 2-2). Volumes are higher on the east and west ends where four lanes of capacity are available, lower volumes are associated with the six lane section between 25th Avenue and Austin Blvd.

Figure 2-2 - I-290 Study Area ADT (% Trucks)[1]



[1] 2007 IDOT ADT data

2.2 Cross-Roads

2.2.1 Interchanges

Within the seven mile section between Mannheim Road and Cicero Avenue, there are 11 interchanges providing access to I-290: Mannheim Road (US 112/20/45), 25th Avenue, 17th Avenue, 9th Avenue, 1st Avenue (IL 171), Des Plaines Avenue, Harlem Avenue (IL 43), Austin Boulevard, Central Avenue, Laramie Avenue, and Cicero Avenue (IL 50). This represents an interchange every two thirds of a mile on average. All interchanges, with the exception of Mannheim Road, maintain their original design from the 1950's. Drawings that illustrate existing cross road lane configurations are provided in Appendix B.

U.S. Route 12/45 (Mannheim Road) (full access partial cloverleaf interchange)

Mannheim Road is a full interchange in Hillside which provides full access between I-290 and this north-south U.S. marked route. It was completely reconstructed in 2001 as part of the Hillside Interchange Project and was designed to accommodate a future capacity expansion of I-290. The average daily traffic (ADT) on Mannheim Road north and south of I-290 is between 27,400 to 41,100 vehicles per day (vpd).

25th Avenue (full access partial cloverleaf interchange)

The 25th Avenue interchange is located within the limits of Bellwood, Broadview and Maywood. This connection is considered a partial cloverleaf interchange and has full access to I-290. Direct access ramps are provided at 25th Avenue for all movements except for a westbound on ramp, and a eastbound to southbound ramp. Both the eastbound to southbound off ramp and westbound on ramp to I-290 are located west of the Indiana Harbor Belt (IHB) railroad bridge and are connected to 25th Avenue via frontage roads. Eastbound traffic must exit west of the IHB railroad bridge and travel 1/3 of a mile along frontage roads to a signal at Lexington Street and 25th Avenue. Traffic desiring to enter westbound I-290 from 25th Avenue must take a 1/3 mile route via Congress Street and Harrison Street. The ADT on 25th Avenue north and south of I-290 is between 13,700 and 24,000 vpd.

17th Avenue (full access frontage road slip-ramp interchange)

Full access to I-290 is provided at 17th Avenue. This full interchange is located within a residential setting of Maywood and Broadview. It is a compressed diamond configuration with slip ramps connecting to 17th Avenue via the one-way streets of Harrison Street to the north and Bataan Drive to the south. The ADT on 17th Avenue is 9,500 vpd.

9th Avenue (partial access frontage road slip-ramp interchange)

Partial access to I-290 is supplied by an interchange at 9th Avenue via two slip ramps that provide access to and from the east via connections with Harrison Street and Bataan Drive. This half interchange is located in a residential setting of Maywood. The ADT on 9th Avenue is 10,800 vpd.

Illinois Route 171 (1st Avenue) (full access frontage road slip-ramp interchange)

1st Avenue provides full access to and from each direction of travel with I-290 via slip ramp connections with Harrison Street and Bataan Drive frontage roads. A dedicated northbound exit ramp provides access to eastbound I-290. It lies on the east side of Maywood and shares a border with Forest Park to the south of I-290. 1st Avenue is the eastern limit of the one-way frontage roads of Harrison Street and Bataan Drive in Maywood. The ADT on 1st Avenue north and south of I-290 is between 27,700 and 32,200 vpd.

Des Plaines Avenue (partial access 1/2 compressed diamond interchange)

Access to and from I-290 is provided only to the west at Des Plaines Avenue on dedicated ramps. CTA's Forest Park Blue Line Terminal Station and maintenance/yard facility lie adjacent to the eastbound on-ramp to I-290. Des Plaines Avenue's profile is tightly constrained: first climbing over I-290, it then quickly descends under both the CTA Blue Line and the CSX railroad, before climbing back up to connect with Jackson Boulevard. The DesPlaines Avenue interchange is located within the Village of Forest Park. The ADT on Des Plaines Avenue is 14,900 vpd.

Illinois Route 43 (Harlem Avenue) (single point inside ramp interchange)

The Harlem Avenue interchange was constructed with left-hand exiting and entering ramps. The ramps intersect Harlem Avenue similar to that of a standard four-way intersection, and it is controlled by a single traffic signal. Access to the CTA Blue Line Harlem Station is provided on the west side of Harlem, just south of the ramp intersection by a CTA bus stop and sidewalks. No bus pull out exists and buses must stop in the through traffic lane. This interchange lies on the east edge of Forest Park and the west edge of Oak Park. The ADT on Harlem Avenue north and south of I-290 is between 28,900 and 39,800 vpd.

Austin Boulevard (single point inside ramp interchange)

The Austin Boulevard interchange was constructed with left-hand exiting and entering ramps. The ramps intersect Austin Boulevard similar to that of a standard four-way intersection, and it is controlled by a single traffic signal. Access to the CTA Blue Line Austin Station is provided on the west side of Austin Boulevard, just south of the ramp intersection by a CTA bus stop and raised sidewalks. No bus pull out exists, and buses must stop in the through traffic lane. The interchange lies on the east edge of Oak Park and the western city limit of Chicago. The ADT on Austin Boulevard north and south of I-290 is between 15,000 and 21,700 vpd.

Central Avenue (full access diamond interchange)

The Central Avenue interchange is a conventional diamond interchange that provides access to the expressway in all directions within the City of Chicago. Central Avenue is the only cross road interchange in the study area that crosses under I-290. All ramps directly connect with Central Avenue except for the westbound off ramp. This ramp connects traffic to Flournoy Street, which is a one-way street that soon connects with Central Avenue. Just north of the interchange is the Harrison and Central CTA bus terminal. The ADT on Central Avenue north and south of I-290 is between 11,000 and 20,000 vpd.

Laramie Avenue (partial access frontage road slip-ramp interchange)

The interchange with Laramie Avenue lies within the City of Chicago and is considered a partial interchange because only two travel directions are served, the westbound exit to Laramie Avenue and the eastbound on ramp from Laramie Avenue. These two ramps connect to one-way frontage roads rather than to Laramie Avenue itself. The westbound off ramp connects to Flournoy Street, and the eastbound on ramp is accessed from Lexington Street. The ADT on Laramie Avenue is north and south of I-290 is between 10,000 and 16,000 vpd. This interchange lies within the City of Chicago and works in connection with Cicero Avenue in providing full access to I-290.

Illinois Route 50 (Cicero Avenue) (partial access frontage road slip-ramp interchange)

The interchange with Cicero Avenue is within the city of Chicago and is considered a partial interchange because only two travel directions are served: the eastbound exit to Cicero Avenue and the westbound on ramp from Cicero Avenue. However, it operates in connection with Laramie Avenue interchange to provide full access to I-290. Two slip-ramps connect to one-way frontage roads rather than to Cicero Avenue itself. The eastbound off ramp connects to Lexington Street, and the westbound on ramp is accessed from Flournoy Street. Access to the CTA Blue Line Cicero Station is provided on the west side of Cicero Avenue in the middle of the overpass. Pedestrian access is provided by a raised sidewalk along the west side of Cicero Avenue, as well as a bus stop in front of the station. The ADT on Cicero Avenue north and south of I-290 is between 29,500 and 33,300 vpd.

2.2.2 Non-Interchange Cross Roads

In addition to the north-south roads that provide direct access to I-290, there are nine non-interchanging north-south roads that cross I-290 within the Phase I study area. These crossings are made by Wolf Road, Frontage Road Connection, Bellwood Avenue/Westchester Boulevard, 5th Avenue, Circle Avenue, Oak Park Avenue, East Avenue, Ridgeland Avenue, and Lombard Avenue. Most of the these crossings are bridges which carry the cross street over I-290; the only exceptions to this are Wolf Road and Frontage Road Connection, where mainline bridges carry the expressway over the cross road. The cross roads provide local access to and from I-290 through full or partial interchanges with Mannheim Road, 25th Avenue, 17th Avenue, 9th Avenue, 1st Avenue, Des Plaines Avenue, Harlem Avenue, Austin Boulevard, Central Avenue, Laramie Avenue, and Cicero Avenue.

In addition to the nine road crossings, there are two overhead pedestrian bridge crossings near Home Avenue and Lavergne Avenue. The Home Avenue bridge serves to connect the residential areas between Harlem Avenue and Oak Park Avenue, and the Lavergne Avenue bridge connects the mixed use areas between Laramie Avenue and Cicero Avenue and also provides access to the CTA Blue Line station west of Cicero Avenue.

2.2.3 Frontage Roads

Frontage roads exist on both sides of the I-290 Eisenhower Expressway for most of the study area, although they are not continuous. One notable location is between 1st Avenue to Des Plaines Avenue, where the Forest Home, Waldheim, and Concordia cemeteries abut I-290 and frontage traffic must divert several blocks to other routes. There are several other locations where frontage road traffic needs to divert off the frontage road to continue in the direction of travel. The frontage roads vary from two way streets to one-way one-lane streets with parking. These routes include Congress Street, Harrison Street, Lehmer Street and Flournoy Street on the north side of I-290, and Harrison Street, Wedgwood Drive, Indian Joe Drive, Lexington Street, Bataan Drive, Garfield Street, and Railroad Avenue on the south side of I-290.

2.3 Adjacent Arterials

The primary parallel arterial roads near I-290 are Roosevelt Road to the south and Madison Street to the north. Roosevelt Road features several different configurations as it travels east and west, including one and two lanes in each direction, a variety of median types, and parking allowed or prohibited in various locations. Traffic on Roosevelt Road ranges from about 19,500 to 28,300 vehicles per day. Madison Street also features several different configurations as it travels east and west, including one and two lanes in each direction, a variety of median types, but with parking allowed at most locations. Traffic on Madison Street varies from about 11,600 to 26,100 vpd. These arterial roads are limited in their capacity to carry additional traffic by the number of through lanes and the operation of signalized intersections along their routes.

Other parallel arterial roads to the north and south of I-290 include Lake Street (approximately 1 mile to the north), North Avenue (approximately 2.4 miles to the north), and Cermak Road (approximately 1.6 miles to the south). The ADT on Lake Street varies from 10,000 to 22,500 vpd. Along North Avenue, the ADT varies between 29,400 and 52,900,000 vpd. The ADT on Cermak Road varies between 19,100 and 37,000 vpd.

The principal arterial north-south routes are US 12/20/45 (Mannheim Road), IL 171 (1st Avenue), IL 43 (Harlem Avenue), and IL 50 (Cicero Avenue). Traffic on these north-south arterial routes varies from 27,000 to 41,000 vpd in the vicinity of I-290.

Figure 2-3 - Study Area Arterial ADTs[2] (2009)

2.4 Current Mitigation Measures

To mitigate congestion, the Illinois Department of Transportation (IDOT) has had a Congestion Management System (CMS) to monitor and respond to traffic events, including a traffic monitoring control center in Oak Park. Within the I-290 corridor, the CMS strategies relative to traffic operational improvements include ramp metering and traffic surveillance. The existing ramp metering and the traffic monitoring equipment have been in service for over two decades. As part of the current plan to maintain traffic flow, IDOT's incident management system includes "Minute Man" patrols to provide prompt response to incidents. Variable message signs have been installed at various locations along I-290 and these are instrumental in providing motorists with advance warnings of incidents and maintenance–related lane reductions. Even with these management systems in place mobility and capacity remains constrained.

[2] 2007 IDOT ADT data

3.0 Performance Measures

This section defines basic performance measures – volume to capacity (v/c) ratio and level of service (LOS) – used in evaluating roadway operations within the study area. IDOT's LOS policy for urban freeways is also described in this section.

3.1 Volume/Capacity Ratio

A measure of how well a roadway segment is functioning is the volume to capacity ratio (v/c ratio). The volume or "v" is the number of vehicles driving on a roadway segment. The capacity portion of the equation "c" is the number of vehicles the subject roadway section can accommodate before a breakdown occurs. If the number of vehicles on a section of highway and the number of vehicles that the highway section can accommodate are the same, the v/c ratio is equal to one. Another way to view this situation is that 100% of the capacity of the roadway has been used. Once capacity is reached (v/c > 1), operations become very unstable and vehicles are operating with the minimum spacing between them in order to maintain uniform flow and vehicle speeds are highly variable. Minor disruptions within the traffic stream such as vehicles entering from ramps, disabled vehicles on the shoulder, crashes, and vehicles being ticketed (off-road) cannot be accommodated. Their occurrence will result in operations that rapidly deteriorate resulting in traffic jams, brief periods of movement and stoppages. The operational conditions of a traffic stream are measured by Level of Service (LOS).

3.2 Level of Service

LOS is a transportation congestion measure that represents the collective factors of speed, travel time, traffic interruption, freedom to maneuver, safety, driver comfort and convenience, and operating volume. LOS procedures from the Transportation Research Board's Highway Capacity Manual (HCM), 2000 were used to evaluate I-290 corridor traffic operations during the morning (A.M.) and evening (P.M.) peak hours. The HCM defines six levels-of-service, ranging from A to F. LOS A represents the best operating conditions and LOS F the worst. Each of these levels represents a range of operating conditions and the driver's perception of these conditions. The HCM defines the operating conditions for each level of service as follows:

LOS A indicates primarily free flow operation at average travel speeds. Vehicles are completely unimpeded in their ability to maneuver within the traffic stream.

LOS B also indicates free flow speed, although the presence of other vehicles becomes noticeable. Average travel speeds are the same as in LOS A, but drivers have less freedom to maneuver. Minor disruptions to vehicular flow will be easily absorbed

LOS C, the influence of traffic density on operations becomes marked. The ability to maneuver within the traffic stream is clearly affected by other vehicles. Travel speeds are affected. Minor disruptions can cause deterioration in service and queues will form behind any major traffic disruption.

LOS D, the ability to maneuver is severely restricted due to traffic congestion. Travel speed is reduced by the increasing traffic volume. Only minor disruptions can be absorbed without extensive queues forming and the traffic service deteriorating.

LOS E represents operations at capacity and very unstable. Vehicles are operating with the minimum spacing between them in order to maintain uniform flow. Minor disruptions cannot be dissipated and there occurrence will result in operations to deteriorate to LOS F

LOS F represents forced or breakdown flow. It occurs either when vehicles arrive at a rate greater than the rate at which they are discharged or when the forecast demand exceeds the computed capacity of a planned facility. LOS F is used to characterize both the point at which the breakdown occurs and/or the operations afterward, i.e., travel speeds are low and vehicles experience brief periods of movement and stoppages. Due to the low traffic speeds and stoppages, the measured volume during breakdown conditions will decrease.

As described above, the performance of a roadway facility is most often described in terms of LOS. It provides a common letter grade rating system, understandable to a broad range of stakeholders. However, LOS is determined based on the primary performance measure for the roadway element being evaluated. For example, the performance of a signalized intersection is measured by the amount of delay. Density is the primary performance measure for evaluating basic freeway segments and ramp junctions. The primary performance measure for evaluating freeway weaving operations is speed.

3.3 IDOT LOS Policy

Although I-290 is referred to as an "expressway", it is functionally classified as a freeway by IDOT. IDOT's LOS policy on freeways, as documented in Chapter 44 of the Bureau of Design and Environment (BDE) Manual, indicates that freeways in urban areas should provide for a LOS C at a minimum; however, a LOS D may be considered for a reconstruction project where existing cross section elements are left in place, with study and justification.[3]

For urban regional arterials such as Mannheim Road and Cicero Avenue, IDOT design policy (BDE Chapter 46) calls for providing a desired LOS D in Northeastern Illinois.[4] "3R" rehabilitation of urban arterial streets (excluding new construction and reconstruction) calls for providing a minimum LOS D at *current* traffic volumes.[5]

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[3] IDOT Bureau of Design and Environment Manual, Figure 44-5C, note 4.

[4] IDOT Bureau of Design and Environment Manual, Figure 46-2E

[5] IDOT Bureau of Design and Environment Manual 49-4.05

A lower than the desired LOS for a proposed improvement may be justified to minimize impacts to communities and other resources, as well as - reduce costs . It may be noted that these level of service criteria/policies (excluding "3R") are applicable to design forecast year traffic volumes 20 years beyond the study phase, and apply to new highway construction or reconstruction projects. Therefore, projected increases in traffic affect the ability of a new or reconstructed highway design to maintain a minimum LOS.

4.0 Analysis Methodology

The roadway elements evaluated in the I-290 corridor traffic operations analysis include basic freeway segments, freeway ramp junctions (merge and diverge areas), weaving sections, and interchange crossroad intersections (ramp termini). This section describes the roadway elements, methodology, and the measures used to analyze their performance.

4.1 Mainline Basic Freeway Segments

Basic freeway segments include the portions of the freeway where flow is not influenced by the merging, diverging, or weaving associated with ramp/freeway connections. The primary factors that affect operations on basic freeway segments include lane widths, lateral clearance, number of lanes, interchange density, heavy vehicles, grades and driver familiarity. The common methodology used for analyzing basic freeway segment operations is described in Chapter 23 of the HCM, 2000. The performance measure used to estimate the LOS for traffic capacity and operations on freeway segments is density in terms of passenger cars per lane per mile. The basic freeway segments within the I-290 study area were evaluated using Highway Capacity Software (HCS) Version 5.4, a computerized version of HCM, 2000. The analysis was performed using IDOT's April 2009 traffic volumes. These volumes were obtained from I-290 automated loop count data from IDOT's Traffic Systems Center (TSC). The methodology used to develop peak hour volumes used in the analysis of basic freeway segments is explained in Section 4.5.

4.2 Mainline Ramp Junctions

The analysis associated with operations at ramp junctions with the freeway mainline typically involves the effects of vehicles either merging onto or diverging from the mainline. The analysis evaluates the impacts of the turbulence caused by the merging and diverging operations that occurs specifically in the two lanes adjacent to the merge/diverge point. The methodology used for analyzing freeway ramp junctions operations is illustrated in Chapter 25 of the HCM, 2000. The HCM methodology defines an influence area of 1,500 feet for merging and diverging traffic (1,500 feet downstream from ramp if merging and 1,500 feet upstream from ramp if diverging). The LOS and operations at an interchange ramp junction adjacent to the freeway is dependent on the number of lanes on the freeway mainline, the number of lanes on the ramp, the volume of traffic on the mainline, specifically in the two lanes adjacent to the ramp, the volume of traffic entering or exiting at the ramp, the length of the acceleration or deceleration lanes, the side of the mainline that the ramp connects to (right or left), the free-flow speed of the mainline and ramp, and the terrain. The performance measure used to determine the LOS for ramp junctions is density. The existing ramp junctions within the I-290 study area were evaluated using HCS Version 5.4, a computerized version of HCM, 2000. The analysis was performed using April 2009 traffic volumes provided by IDOT's Traffic Systems Center. The methodology used to develop peak hour volumes for the analysis of ramp junctions is explained in Section 4.5.

4.3 Mainline Ramp Weaves

The HCM defines weaving as the crossing of two or more traffic streams travelling in the same general direction along a significant length of highway without the aid of traffic control devices, with the exception of guide signs. Weaving segments are formed when a merge area is closely followed by a diverge area within 2,500 feet, and the two are joined by an auxiliary lane. Per the HCM, segments longer than 2500 feet exhibit characteristics similar to a basic freeway segment, and were analyzed as such in this report. For segments longer than 2500 feet, ramp junction analysis is used to analyze the operations for the immediate merge and diverge influence areas of the ramps. The methodology used for analyzing freeway weaving segments is described in Chapter 24 of the HCM, 2000. The most critical aspect of operations within a weaving segment is the intense lane changing maneuvers that take place within the confined length of the weaving segment. Factors that influence the operation of the weaving segment include the weaving length, the number of lanes in the weaving segment, the number of vehicles entering and exiting the weave, the freeway traffic, and the weave configuration type. The performance measure that determines LOS within weaving sections is density (passenger cars/mile/lane).

The HCM methodology identifies three weaving configurations; Type A, B and C. The identifying characteristic of a Type A weaving segment is that all weaving vehicles must make one lane change to complete their maneuver successfully. In a Type B weave, one weaving movement can be made without making any lane changes, and the other weaving movement requires at most one lane change. In a Type C weave, one weaving movement may be made without making a lane change, and the other weaving movement requires a minimum of two lane changes for a successful completion of a weaving maneuver. The weaving segments within the I-290 study area were evaluated using HCS Version 5.4, a computerized version of HCM, 2000. The analysis was performed using April 2009 traffic volumes provided by IDOT's Traffic Systems Center. The methodology used to develop peak hour volumes for the analysis of weaving sections is explained in Section 4.5.

4.4 Interchange Ramp Terminals

Interchange ramp terminals (intersections) at crossroads are critical components of the highway network. They provide the connection between various highway facilities (i.e., freeway-arterial and arterial-arterial), and their safe and efficient operation is essential for providing adequate access to the freeway and the connecting crossroad. The most common types of ramp terminals are the two closely spaced signalized/unsignalized intersections related to the slip-ramp interchanges. The two closely spaced intersections in these interchanges do not operate in isolation – each intersection affects the other in ways that are unique to the configuration, with heavier-than-usual left-turning and right-turning movements as vehicles enter and exit the freeway or a major crossroad. The general methodology used for analyzing interchange ramp terminals is illustrated in Chapter 26 of the HCM, 2000. The ramp terminals are evaluated as signalized or unsignalized intersections. The LOS is evaluated on the basis of average control delay per vehicle (in seconds per vehicle). Table 4-1presents the criteria for LOS versus delay for ramp terminals per HCM 2000.

Table 4-1 - LOS Criteria for Signalized Intersections (HCM Exhibit 26-8)

LOS	Control Delay per Vehicle (s/veh)
A	≤ 10
B	> 10 - 20
C	> 20 - 35
D	> 35 - 55
E	> 55 - 80
F	> 80

An evaluation of existing traffic operations at all signalized and un-signalized I-290 ramp terminals was conducted using Synchro Version 7.0 and HCS Version 5.4. The analysis was performed for A.M. and P.M. peak hours using available traffic data that included I-290 ramp counts (2009) provided by IDOT's Traffic Systems Center, IDOT's 2001 intersection turning movement counts, and current published ADT (2007).

Field reviews were conducted to confirm existing intersection configurations, signal timing, and phasing information. This included confirming the number of lanes on each approach, the required or permitted usage of each lane (i.e., left only lane, dual turning lane, share lane, or right only lane), and other information pertinent to the accurate modeling of signal operations (e.g., free turn movements). Timing schedule sheets on Central Avenue, Laramie Avenue, and Cicero Avenue were provided by the Chicago Department of Transportation (CDOT). The methodology to develop the peak hour turning movements used in the analysis of ramp terminals is explained in the following paragraphs.

4.5 Peak Hour Volumes Used in Analysis

This section presents the methodology used to develop peak hour volumes used in the analysis of existing basic freeway segments, ramp junctions, weaving sections, and ramp terminals (intersections).

Hourly traffic counts for I-290 mainline and ramp locations between Mannheim Road and Chicago Loop were provided by IDOT's TSC. The mainline and ramp count data for the month of April 2009 was provided by the TSC. The April 2009 count data was summarized for three weekdays (Tuesday, Wednesday and Thursday), and average hourly volumes were calculated for each of those days to identify the morning and evening peak hours. Based on this data, the morning and evening I-290 peak hour volume in the eastbound (inbound) direction occurred on Wednesday between 7 and 8 A.M. and between 4 and 5 P.M. In the westbound direction (outbound), the peak hour volume occurred between 8 and 9 A.M., and between 4 and 5 P.M.

The eastbound C-D Road connecting I-88 and I-290 to Mannheim Road was also analyzed. Hourly traffic volumes for the month of August 2009 were provided for the connections between eastbound I-290 and eastbound I-88 to the Mannheim Road C-D road. IDOT's standard operating procedure is to close the eastbound Roosevelt Road entrance ramp to I-88 during the P.M. peak period (weekdays, between 2 P.M. and 7 P.M.) to reduce traffic volumes at the I-88/I-290 merge. The C-D road volume was derived from the Wednesday average peak hour volumes for eastbound I-290 mainline west of the C-D road exit, eastbound I-290 and I-88 connections to the C-D road, and for the Mannheim Road ramps. To convert the August C-D road peak hour volume to an annualized peak hour volume, IDOT's seasonal ADT adjustment factors were applied[6].

The peak hour volumes used in the analysis of interchange ramp and crossroad intersections (ramp terminals) were established using IDOT's 2001 intersection turning movement counts, latest available ADT counts (2007 and 2009), and year 2009 TSC ramp counts. Twelve (12) hour turning movement counts at the cross-roads were conducted by IDOT between June and October, 2001. To reflect traffic volume changes since 2001, the 2001 intersection turning counts were adjusted according to the percent change between the 2001 ADT volume and latest available (2006 or 2009) crossroad ADT volume. Because ADT is typically only available along the north south crossroad, IDOT's 2009 ramp count data was also used to adjust left and right turn volumes. The reasonableness and accuracy of the adjustments was spot verified by performing field counts at the I-290 interchange intersections of 1st Avenue and Harlem Avenue. The crossroad and ramp volume adjustments, and the field counts that were collected January 6th, 2010 are available in Appendix E-4.

4.6 Intersection Turn Lane Storage Analysis

Intersection operations can be negatively affected by turn lane traffic queues that overflow into adjacent through lanes. To understand how available intersection turn lane storage lengths may be affecting overall intersection operations, turn lane storage analysis was performed for all intersection turn lane movements.

The intersection HCS analysis output was used to determine the "back of queue" (BOQ) value for each turn lane. The BOQ number represents the maximum number of passenger vehicles that are queued while waiting for a signal. The length of the queue is then approximated by multiplying the BOQ value by 25ft, which represents the length of a typical passenger vehicle and vehicle spacing. The estimated queue length is divided by the actual, measured turn lane storage and expressed as a percent of turn lane storage used. Any percent storage used value over 100% indicates that the available storage length will be exceeded by the turn lane queue.

[6] Average daily traffic volumes in the Chicago area vary from month to month as much as 15%. To annualize the volumes, an adjustment factor is calculated by the state to correct for seasonal variances. April's factor is 1.00 which indicates that these volumes do not need adjustment; however August has a factor of 1.06 which indicates volumes are typically 6% higher than the annual average. To annualize the August data, the recorded volumes are divided by 1.06.

5.0 Operational Analysis Results

5.1 Existing Mainline Operations

Table 5-1, and the companion Corridor Level of Service exhibit in Appendix C, provide a comprehensive overview of the existing A.M. and P.M. peak hour mainline operations for all mainline elements analyzed (basic freeway segments, ramp junctions, and weaving segments) for east and westbound I-290 within the focused study area. As seen in the table, almost the entire I-290 mainline in the study area is operating at LOS E and F during the A.M. and P.M. peak hours. This means that the facility is operating at capacity or in breakdown flow, with low travel speeds and periods of stop and go flow. The existing traffic operations and LOS analysis for the individual roadway elements are described in subsequent sections.

Table 5-2 summarizes the proportion of the existing mainline operating at each LOS. On average, heavy to severe congestion, or level of service D or worse, occurs along 95% of the mainline within the focused study area. In the peak direction, eastbound AM and westbound PM, 88% and 86% of the facility operates at LOS E or F, respectively. The reverse peak direction, westbound A.M. and eastbound P.M. is nearly as bad with 83% and 82% of the facility operating at LOS E or F, respectively. All of the mainline ramp junctions in the focused study operate under congested conditions with LOS D or worse. The majority of these ramp junctions operate at LOS F.

In the case of I-290, observations and speed information indicate that I-290 experiences system wide oversaturated conditions throughout significant portions of the day, including the AM and PM peak periods. As indicated in the Highway Capacity Manual, even the methodology for localized oversaturated conditions is not sufficient to accurately evaluate a facility with system wide congestion. Given this condition, this report considers segments which, based on observations and available volume data, are operating in the congested flow regime (LOS F), contrary to the results of the HCS analysis. The HCS analysis output is included Appendix E and is annotated to indicate those segments that are oversaturated.

Table 5-1 - Overall I-290 Mainline LOS Summary

Eastbound between locations (west to east)	Analysis Type	# of Lanes	2009 Existing Conditions AM Peak	2009 Existing Conditions PM Peak
I-88 / 290 CD Merge				
	Segment	2	C	C
CD Road - Harrison St. On Ramp				
	Weave	3	F	F
CD Road - Off Ramp to Mannheim Rd				
	Segment	2	F	F
Lane Drop Near Westchester Blvd.				
	Segment	1	F	F
CD Road On Ramp (east of Mannheim)				
I-88 On Ramp (near Wolf Road)				
	Segment	3	D	C
West of Mannheim Road				
	Segment	3	F	F
CD Road On Ramp (east of Mannheim)				
	Weave		F	F
25th Ave Off Ramp (east of Addison Cr.)				
	Segment	3	F	F
25th Ave On Ramp (Loop)				
	Weave		F	F
25th Ave Off Ramp (Loop)				
	Segment	3	F	F
25th Ave On Ramp (Loop)				
	Weave		F	F
17th Ave Off Ramp				
	Segment	3	F	F
17th Ave On Ramp	Ramp Jnct.		F	F
	Segment	3	F	F
9th Ave On Ramp	Ramp Jnct.		F	F
	Segment	3	F	F
1st Ave Off Ramp	Ramp Jnct.		F	F
	Segment	3	F	F
1st Ave On Ramp	Ramp Jnct.		F	F
	Segment	3	F	F
DesPlaines Ave Off Ramp	Ramp Jnct.		F	F
	Segment	3	E	F
Harlem Ave Off Ramp	Ramp Jnct.		E	F
	Segment	3	E	E
Harlem Ave On Ramp	Ramp Jnct.		F	F
	Segment	3	F	F
Austin Ave Off Ramp	Ramp Jnct.		F	F
	Segment	3	F	F
Austin Blvd On Ramp	Ramp Jnct.		F	F
	Segment	4	E	E
Central Avenue Off Ramp	Ramp Jnct.		E	D
	Segment	4	E	D
Central Avenue On Ramp	Ramp Jnct.		D	D
	Segment	4	E	E
Laramie Ave On Ramp				
	Weave		F	E
Cicero Ave Off Ramp				
	Segment	4	E	D
Kostner Ave				

Westbound between locations (east to west)	Seg #	Analysis Type	# of Lanes	2009 Existing Conditions AM Peak	2009 Existing Conditions PM Peak
I-294/I-88 Diverge					
	37	Segment	4	E	D
Wolf Road Off Ramp					
	36	Weave		D	D
Mannheim Rd. On Ramp					
	35	Segment	4	E	D
Mannheim Rd. On Ramp (loop)					
	34	Segment	3	F	F
Mannheim Rd. Off Ramp					
	33	Weave		F	E
25th Ave On Ramp (by Addison Cr.)					
	32	Segment	3	F	F
25th Ave Off Ramp (Loop)	31	Ramp Jnct.		F	F
	30	Segment	3	F	F
25th Avenue Off Ramp					
	29	Weave		F	E
17th Ave On Ramp					
	28	Segment	3	F	F
17th Ave Off Ramp	27	Ramp Jnct.		F	F
	26	Segment	3	F	F
9th Ave Off Ramp	25	Ramp Jnct.		F	F
	24	Segment	3	F	F
1st Ave On Ramp	23	Ramp Jnct.		F	F
	22	Segment	3	F	E
1st Ave Off Ramp	21	Ramp Jnct.		F	F
	20	Segment	3	F	F
DesPlaines Ave On Ramp	19	Ramp Jnct.		F	F
	18	Segment	3	F	F
Harlem Ave On Ramp	17	Ramp Jnct.		F	F
	16	Segment	3	F	F
Harlem Ave Off Ramp	15	Ramp Jnct.		F	F
	14	Segment	3	F	F
Austin Blvd On Ramp	13	Ramp Jnct.		F	F
	12	Segment	3	F	F
Austin Blvd Off Ramp					
	11	Weave		F	F
Central Avenue On Ramp	10	Ramp Jnct.		F	F
	9	Segment	4	F	F
Central Avenue Off Ramp	8	Ramp Jnct.		F	F
	7	Segment	4	F	F
Laramie Ave Off Ramp					
	6	Weave		F	F
Cicero Ave On Ramp					
	5	Segment	4	D	D
Kostner Ave					

Table 5-2 - Proportion of I-290 Mainline by LOS (2009)

Mainline Segments								
LOS	EASTBOUND				WESTBOUND			
	AM		PM		AM		PM	
	Length	%	Length	%	Length	%	Length	%
F	32,102	60%	34,650	65%	36,859	80%	32,621	71%
E	14,693	28%	6,073	11%	4,361	9%	4,238	9%
D	3,126	6%	6,072	11%	4,868	11%	9,229	20%
C	3,298	6%	6,424	12%	0	0%	0	0%
B	0	0%	0	0%	0	0%	0	0%
A	0	0%	0	0%	0	0%	0	0%
Total	53,219	100%	53,219	100%	46,088	100%	46,088	100%

Ramp Junctions								
LOS	EASTBOUND				WESTBOUND			
	AM		PM		AM		PM	
	Count	%	Count	%	Count	%	Count	%
F	8	73%	9	82%	11	100%	11	100%
E	2	18%	0	0%	0	0%	0	0%
D	1	9%	2	18%	0	0%	0	0%
C	0	0%	0	0%	0	0%	0	0%
B	0	0%	0	0%	0	0%	0	0%
A	0	0%	0	0%	0	0%	0	0%
Total	11	100%	11	100%	11	100%	11	100%

Average peak period speeds are consistently low along I-290. Figure 5-1 and Figure 5-2 illustrate the existing speeds along I-290 as calculated by the 2010 regional travel model. For the traditional commute pattern eastbound travel speeds range between 24mph and 36mph in the AM period and between 24pmh & 39mph in the westbound direction during the PM peak. Reverse commute speeds are slightly higher with westbound average speeds ranging between 30mph and 48mph in the AM period, and eastbound average speeds ranging between 29mph and 47mph in the PM period.

Figure 5-1 - I-290 Mainline Average 2010 Travel Model Speeds – AM Peak

Figure 5-2 - I-290 Mainline Average 2010 Travel Model Speeds – PM Peak

5.2 Mainline Basic Freeway Segments

Table 5-3 summarizes the results of the I-290 mainline basic freeway segment HCS analysis for the A.M. and P.M. peak hours. The A.M. and P.M. peak hours in the focused study area are between 6 A.M to 9 A.M. and 4 P.M. to 6 P.M. respectively. The results of the basic freeway segment analysis indicate a majority of the three-lane segments, along eastbound and westbound I-290 between 25th Avenue and Austin Boulevard, are operating at LOS F during A.M. and P.M. peak hours. LOS F represents a breakdown in vehicular flow that occurs when the traffic arrival rate in a segment is greater than discharge rate. At LOS F, a density value is not provided by the capacity analysis since operations are unpredictable, i.e. motorists experience cycles of movement and stoppages. The impacts of this breakdown condition affect adjacent upstream segments leading to longer backups and severe congestion along mainline I-290 as well as at the ramp junctions. At breakdown conditions, traffic is closely spaced and experiences stop and go flow, and although the lanes are completely full, throughput volume decreases dramatically due to very slow speeds and unstable flow. This is apparent in the hourly mainline count station data where actual hourly traffic volume declines during the peak travel periods. Section 5.2.1 shows the period of congestion and breakdown conditions based on the TSC mainline volume data at two count stations within the study area.

The majority of the existing eastbound four-lane segments between Austin Boulevard and Cicero Avenue operate at LOS E during A.M. and P.M. peak hours. In the westbound direction the four lane segments east of Harlem are operates at LOS F during the A.M. and P.M. peak hours. Factors contributing to the sub-standard LOS along basic freeway segments are discussed in Section 6.2. The HCS output for this analysis is included in Appendix E-1.

Table 5-3 - I-290 Mainline Basic Freeway Segment LOS

Eastbound LOS Between Locations (west to east)	2009 Existing Conditions AM Peak	2009 Existing Conditions PM Peak
I-88 / 290 CD Merge		
	C	C
CD Road - Harrison St. On Ramp		
CD Road - Off Ramp to Mannheim Rd		
	F	F
Lane Drop Near Westchester Blvd.		
	F	F
CD Road On Ramp (east of Mannheim)		
I-88 On Ramp (near Wolf Road)		
	D	C
West of Mannheim Road		
	F	F
CD Road On Ramp (east of Mannheim)		
25th Ave Off Ramp (east of Addison Cr.)		
	F	F
25th Ave On Ramp (Loop)		
25th Ave Off Ramp (Loop)		
	F	F
25th Ave On Ramp (Loop)		
17th Ave Off Ramp		
	F	F
17th Ave On Ramp		
	F	F
9th Ave On Ramp		
	F	F
1st Ave Off Ramp		
	F	F
1st Ave On Ramp		
	F	F
DesPlaines Ave Off Ramp		
	E	F
Harlem Ave Off Ramp		
	E	E
Harlem Ave On Ramp		
	F	F
Austin Ave Off Ramp		
	F	F
Austin Blvd On Ramp		
	E	E
Central Avenue Off Ramp		
	E	D
Central Avenue On Ramp		
	E	E
Laramie Ave On Ramp		
Cicero Ave Off Ramp		
	E	D
Kostner Ave		

Westbound LOS Between Locations (east to west)	2009 Existing Conditions AM Peak	2009 Existing Conditions PM Peak
I-294/I-88 Diverge		
	E	D
Wolf Road Off Ramp		
Mannheim Rd. On Ramp		
	E	D
Mannheim Rd. On Ramp (loop)		
	F	F
Mannheim Rd. Off Ramp		
25th Ave On Ramp (by Addison Cr.)		
	F	F
25th Ave Off Ramp (Loop)		
	F	F
25th Avenue Off Ramp		
17th Ave On Ramp		
	F	F
17th Ave Off Ramp		
	F	F
9th Ave Off Ramp		
	F	F
1st Ave On Ramp		
	F	E
1st Ave Off Ramp		
	F	F
DesPlaines Ave On Ramp		
	F	F
Harlem Ave On Ramp		
	F	F
Harlem Ave Off Ramp		
	F	F
Austin Blvd On Ramp		
	F	F
Austin Blvd Off Ramp		
Central Avenue On Ramp		
	F	F
Central Avenue Off Ramp		
	F	F
Laramie Ave Off Ramp		
Cicero Ave On Ramp		
	D	D
Kostner Ave		

5.2.1 Duration of Congestion

To determine the overall periods of congestion beyond the peak hours, the available April 2009 mainline count station traffic volume data was analyzed. Two count stations are located along both the eastbound and westbound mainline lanes within the focused study area: eastbound at 9th Avenue and East Avenue, and westbound at 5th Avenue and East Avenue. The LOS for each one hour time period was calculated at each count stations. Table 5-4 summarizes the results:

Table 5-4 - I-290 Mainline Periods of Congestion (2009)

Time	Eastbound		Westbound	
	9th Ave	East Ave	5th Ave	East Ave
1:00 AM	A	A	A	A
2:00 AM	A	A	A	A
3:00 AM	A	A	A	A
4:00 AM	A	A	A	A
5:00 AM	A	A	B	B
6:00 AM *	E	F	F	F
7:00 AM *	F	F	F	F
8:00 AM *	F	F	F	F
9:00 AM *	E	F	F	F
10:00 AM	D	E	D	D
11:00 AM	D	E	D	D
12:00 PM	D	E	D	D
1:00 PM	D	E	E	E
2:00 PM	E	E	E	E
3:00 PM	E	E	E	E
4:00 PM *	E	F	F	F
5:00 PM *	F	F	F	F
6:00 PM *	F	F	F	F
7:00 PM	E	E	E	E
8:00 PM	D	E	E	E
9:00 PM	D	D	D	D
10:00 PM	D	D	D	D
11:00 PM	C	C	D	D
12:00 AM	C	B	B	C

* Peak Period

Traffic data indicates that the I-290 Eisenhower Expressway experiences congested conditions (LOS D or worse) for up to seventeen hours each weekday for both eastbound and westbound lanes.

Eastbound I-290 experiences breakdown conditions with stop-and-go traffic during both the AM and PM rush periods and in both directions. The very slow average traffic speeds, typical of breakdown conditions, result in decreased through volume, therefore during breakdown conditions, actual through volume is not representative of the actual demand.

5.3 Mainline Ramp Junctions

The I-290 freeway ramp junction analysis of the A.M. and P.M. peak hours is summarized in Table 5-5. Almost all existing ramp junctions along eastbound I-290 between 17th Avenue and Austin Boulevard operate at LOS F during both the AM and PM peak hours. In the westbound direction, all the existing ramp junctions between Central Avenue and 25th Avenue operate at LOS F during A.M. and P.M. peak hours.

Operations related to the left hand ramps at Harlem Avenue and Austin Boulevard appear to affect the mainline level of service. This configuration directs slower on and off ramp maneuvers into the left through lane, which typically is the higher speed lane. The turbulence of this lower speed weaving maneuver creates turbulence at the exit point as well as a ripple effect back into upstream mainline segments, further contributing to stop and go traffic. Factors contributing to the sub-standard LOS at ramp junctions are discussed in Section 6.2. The HCS output for this analysis is included in Appendix E-2.

Table 5-5 - I-290 Ramp Junction Analysis Summary

Ramp Junctions (west to east)	2009 Existing Eastbound		Ramp Junctions (west to east)	2009 Existing Westbound	
	AM Peak	PM Peak		AM Peak	PM Peak
17th Ave On Ramp	F	F	25th Ave Off Ramp (Loop)	F	F
9th Ave On Ramp	F	F	17th Ave Off Ramp	F	F
1st Ave Off Ramp	F	F	9th Ave Off Ramp	F	F
1st Ave On Ramp	F	F	1st Ave On Ramp	F	F
DesPlaines Ave Off Ramp	F	F	1st Ave Off Ramp	F	F
Harlem Ave Off Ramp	E	F	DesPlaines Ave On Ramp	F	F
Harlem Ave On Ramp	F	F	Harlem Ave On Ramp	F	F
Austin Ave Off Ramp	F	F	Harlem Ave Off Ramp	F	F
Austin Blvd On Ramp	F	F	Austin Blvd On Ramp	F	F
Central Avenue Off Ramp	E	D	Central Avenue ON Ramp	F	F
Central Avenue on Ramp	D	D	Central Avenue Off Ramp	F	F

5.4 Mainline Ramp Weaves

The results of the I-290 corridor weaving section analysis for the A.M. and P.M. peak hours is summarized Table 5-6. The weaving sections along I-290 are "Type A" weaves which are formed by a continuous auxiliary lane connecting single lane on-ramp to a single lane off-ramp.

Table 5-6 - Mainline Weaving Segment LOS

Weaving Sections (west to east)	2009 Existing Eastbound AM Peak	2009 Existing Eastbound PM Peak
CD Road - Harrison St. On Ramp CD Road - Off Ramp to Mannheim Rd	F	F
CD Road On Ramp (east of Mannheim) 25th Ave Off Ramp (east of Addison Cr.)	F	F
25th Ave On Ramp (Loop) 25th Ave Off Ramp (Loop)	F	F
25th Avenue On Ramp 17th Ave Off Ramp	F	F
Laramie Ave On Ramp Cicero Ave Off Ramp	F	E

Weaving Sections (west to east)	2009 Existing Westbound AM Peak	2009 Existing Westbound PM Peak
Wolf Road Off Ramp 25th Ave On Ramp	D	D
Mannheim Rd. Off Ramp 25th Ave On Ramp (by Addison Cr.)	F	E
25th Avenue Off Ramp 17th Ave On Ramp	F	E
Austin Blvd Off Ramp Central Avenue On Ramp	F	F
Laramie Ave Off Ramp Cicero Ave On Ramp	F	F

5.4.1 Eastbound I-290 Weaving Sections

There are five existing weaving sections along eastbound I-290 within the focused study area. They are described here in the direction of travel.

The first eastbound weaving section is along the Mannheim Road C-D road between Harrison Street on-ramp and Mannheim Road off-ramp. The two ramps are connected by approximately 1,500 feet of auxiliary lane. This weaving segment operates at LOS F during the A.M. and P.M. peak hours mainly due to the heavy traffic volumes exiting the at the single lane Mannheim Road off-ramp.

The second eastbound weaving section exists between the Mannheim Road C-D Road on-ramp and 25th Avenue off-ramp. This weaving section is characterized by the convergence of heavy C-D road traffic volumes (1,440 vehicles A.M. peak hour and 1,900 vehicles P.M. peak hour) onto a highly congested section of I-290. This weave section occurs within an 850 foot auxiliary lane connected to the downstream 25th Avenue exit ramp. This high volume weaving operation contributes to breakdown in traffic flow during both the morning and evening peak hours, operating at LOS F during the A.M. and P.M. peak hours, respectively.

The third eastbound weaving section is formed by the closely spaced entrance and exit loop ramps at the 25th Avenue interchange, with only 450 feet available for vehicles to maneuver on and off the expressway. This weaving section operates under breakdown conditions at LOS F for both A.M. and P.M. peak hours.

The fourth eastbound weaving section is formed by the entrance of the northbound 25th Avenue entrance ramp and the exit slip ramp to Bataan Drive and 17th Avenue. The ramps are connected by approximately 1,100 feet of auxiliary lane. This weaving section operates under breakdown conditions at LOS F during both the A.M. and P.M. peak hours.

The fifth eastbound weaving section in the focused study area is between the Laramie Avenue entrance ramp and Cicero Avenue exit ramp. The exit and entrance ramps are connected by approximately 700 feet of auxiliary lane. This weaving section operates in breakdown conditions (LOS F) during the A.M. peak hour, and at LOS E during the P.M. peak hour.

5.4.2 Westbound I-290 Weaving Sections

There are five existing weaving sections identified along westbound I-290. They are described here in the direction of travel.

The first westbound weaving section, starting at the east end of the study area, is formed by the Cicero Avenue entrance ramp and Laramie Avenue exit ramp, which are separated by approximately 530 feet of auxiliary lane. This weaving section operates at LOS F during the A.M. and P.M. peak hours.

The second weaving segment is between Central Avenue on-ramp and Austin Boulevard off-ramp. This segment was analyzed as a weaving segment because of the lane changing maneuvers made between drivers intending to exit at Austin Boulevard, and the last minute through traffic lane change from the left lane (Traffic is prohibited from entering at Central Avenue and Exiting at Austin Avenue by the use of pavement marking). This segment experiences high I-290 mainline volumes (5,740 vph in the A.M. peak hour and 6,410 vph in the P.M. peak hour), heavy Austin Boulevard exit ramp volumes (890 vph in the A.M. peak hour and 1100 vph in the P.M. peak hour), and Central Avenue on-ramp volumes (500 vph in the A.M. peak hour and 660 vph in the P.M. peak hour). This segment operates at LOS F in breakdown conditions during the A.M. and P.M. peak hours.

The third weaving section is formed by the I-290 entrance slip-ramp from Harrison Street (west of 17th Avenue) and the exit ramp to 25th Avenue, connected by approximately 730 feet of auxiliary lane. This weaving section operates under breakdown conditions (LOS F) during the A.M. peak hour and at LOS E during the P.M. peak hour.

The fourth weaving section is formed by the 25th Avenue entrance ramp and the exit ramp to Mannheim Road connected by approximately 1600 feet of auxiliary lane. This weaving section also operates under breakdown conditions (LOS F) during the A.M. peak hour and at LOS E during the P.M. peak hour.

The fifth weaving segment along westbound I-290 is between 25th Avenue on-ramp and wolf Road off-ramp connected by approximately 1200 feet of auxiliary lane. This weaving section operates at LOS D during the A.M. and P.M. peak hour.

The HCS output for this analysis is included in Appendix E-3.

5.5 Mainline Lane Drop Conditions and Spillover Congestion

This section describes the existing eastbound and westbound lane drop/capacity reduction conditions along I-290 within the focused study area and the impact on traffic operations.

In the eastbound direction, a lane drop condition exists where the Mannheim C-D road merges with the three-lane segment of I-290. Here traffic from four lanes merge into three lanes when the auxiliary lane ends at the 25th Avenue off-ramp, resulting in an immediate mainline capacity reduction. High volumes of traffic from the C-D road (1,400 vph in the A.M. peak hour and 1,900 vph in the PM hour) merging with mainline traffic (3,940 vph in the A.M. peak hour and 3,340 vph in the P.M. peak hour), within a short segment cause weaving conflicts that contribute to breakdown conditions and deteriorated levels of service (LOS F) in this segment. The breakdown congestion caused by the lane drop consistently results in traffic back-ups that extend west past Mannheim road along the mainline and CD road. Further backups are absorbed somewhat by the five combined lanes of storage on the CD and mainline, as well as the ability for CD road traffic to exit at Mannheim Road to avoid congestion.

In the westbound direction, a four to three lane capacity reduction exists at the Austin Boulevard off ramp where the left most lane terminates as the Austin Blvd. off ramp. As mentioned in Section 5.3.2, this section experiences severe breakdown conditions in both the A.M and P.M peak periods. The four lanes of demand compressing into the three available lanes results in breakdown conditions along the upstream four-lane mainline segments to the east, consistently extending beyond Kostner Avenue throughout the peak periods.

5.6 Intersections at Freeway Interchanges

The I-290 interchange intersection analysis results for the A.M. and P.M. peak hours are summarized in Table 5-7.

Intersections at the I-290 interchanges at 25th Avenue, Central Avenue (recently reconstructed), and Laramie Avenue operate at acceptable levels of service with the available capacity accommodating the demand for most or all intersection movements. Intersections at the 1st Avenue, Harlem Avenue, Austin Boulevard, and Cicero Avenue interchanges experience congested operations in both the A.M and P.M. peak periods. At these intersections, demand exceeds the capacity and operations break down and IDOT policy thresholds (volume to capacity ratios of 0.85) are exceeded, causing numerous movements to fail.

A turning lane storage analysis was completed for the peak periods at each interchange intersection. Existing available storage lengths for each turn were compared against the A.M. and P.M. peak hour turn queue lengths derived from the HCS intersection analysis output. This analysis found turn lane storage is consistently exceeded at these intersections, with turn lane queues backing up into the through lanes causing the though lane movements to fail at LOS F. Seven out of ten existing interchange intersections have through movements that fail due to spillover of traffic from adjacent left/right turn lanes. A table summarizing intersection storage and spillover calculations is included in Appendix E-4.

The intersections at 17th Avenue interchange also experience undesirable levels of service (LOS D or worse) for most movements. 17th Avenue is primarily a local street that serves as a full access slip ramp interchange, and therefore attracts more traffic than it is designed to handle. It also experiences high truck volumes as this access to I-290 is easier to navigate by truckers compared to the circuitous and tight 25th Avenue ramp configurations. The HCS output for the interchange intersection analysis is included in Appendix E-4.

Table 5-7 - Interchange Intersection LOS Summary (2009)

Direction	25th Avenue				17th Avenue				9th Avenue			
	Congress St.		Lexington St.		Harrison Street		Bataan Drive		Harrison Street		Bataan Drive	
	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
EB Left	C	C										
EB Thru			D	D			D	D			A	B
EB Right	B	B										
WB Left					D	D						
WB Thru			C	C	E	F*			A	B		
WB Right												
NB Left	B	D			A	A						
NB Thru	A	A	A	A	A	A	D	D	B	B	B	C
NB Right												
SB Left												
SB Thru	B	D	A	A	D	D	A	A	B	C	B	D
SB Right												
LOS	B	C	B	B	D	D	C	C	B	C	B	C

Direction	1st Avenue				Des Plaines Avenue				Harlem Ave		Austin Blvd.	
	Harrison Street		Bataan Drive		CTA Station		Harrison Street		I-290 Ramps		I-290 Ramps	
	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
EB Left					D	D	D	E	E	D	C	C
EB Thru			F*	F*			D	D				
EB Right			C	C	C	C	D	F*	D	D	D	E
WB Left	E	E							D	F	D	F
WB Thru	E	F					F	F				
WB Right	C	C							D	E	F	E
NB Left					B	B			C	C	F	E
NB Thru	A	A	E	E	A	A	C	C	F*	F*	F*	F*
NB Right									B	B	E	A
SB Left							D	D	F	F	E	F
SB Thru	F*	F*	A	E	B	B	B	B	C	D	F*	F*
SB Right									B	B	A	A
LOS	E	F	D	E	B	B	C	D	E	E	F	F

Direction	Central Avenue				Laramie Avenue				Cicero Avenue			
	I-290 WB Ramp		I-290 EB Ramp		Flournoy Street		Lexington Street		Flournoy Street		Lexington Street	
	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
EB Left											E	D
EB Thru			C	D			C	D			F*	E
EB Right			C	C							F	E
WB Left	C	C			C	B			C	C		
WB Thru	C	C			C	B			C	C		
WB Right	C	C			D	B						
NB Left	B	C							C	C		
NB Thru	A	A	C	C	A	B	B	B	F*	F*	B	B
NB Right												
SB Left			C	C			A	A			B	B
SB Thru	B	B	A	A	B	B	B	B	C	F*	A	B
SB Right	B	B					B	B	B	B		
LOS	B	B	B	C	B	B	B	B	F	F	E	C

* LOS is affected by turn lane storage overflow.

5.7 Parallel Arterial Operations

There are five arterials that parallel I-290 within the broad study area; listed from north to south they are: North Avenue, Lake Street, Madison Street, Roosevelt Road, and Cermak Road.

To understand the operational performance of these arterials, they were examined (from between Wolf Road and Cicero Avenue) for their level of volume/capacity (V/C) during an average afternoon peak period in 2010. V/C is defined here as the ratio of traffic demand flow rate to the link segment capacity, and is used as a tool to provide conceptual level picture of traffic congestion. For this analysis, the V/C ratios were classified into the following ranges;

less than 0.50	Uncongested traffic conditions (green)
0.50 to 0.85	Congested traffic conditions (orange)
0.85 and over	Very congested conditions (red)

Figure 5-3 shows the 2010 PM peak period analysis that based on the I-290 travel model results, and Table 5-8 provides a summary of arterial congestion levels based on length. All five parallel arterials have segments with V/C levels that reflect very congested conditions, with 91% of all study area arterial operating under congested to very congested conditions. Most have a mixed of very congested (red) and congestion (orange) levels. 100% of North Avenue operates under very congested conditions however Madison and Lake show road segments operating under uncongested conditions (green) due to the fact that these roads have somewhat less capacity and/or traffic demand than the other three arterials and thus experience less delay. Appendix D provides a summary of how the V/C values were calculated and a table listing the arterial V/C ratios by sub-segment.

Figure 5-3 - 2010 Arterial PM Peak Period Volume to Capacity Ratios

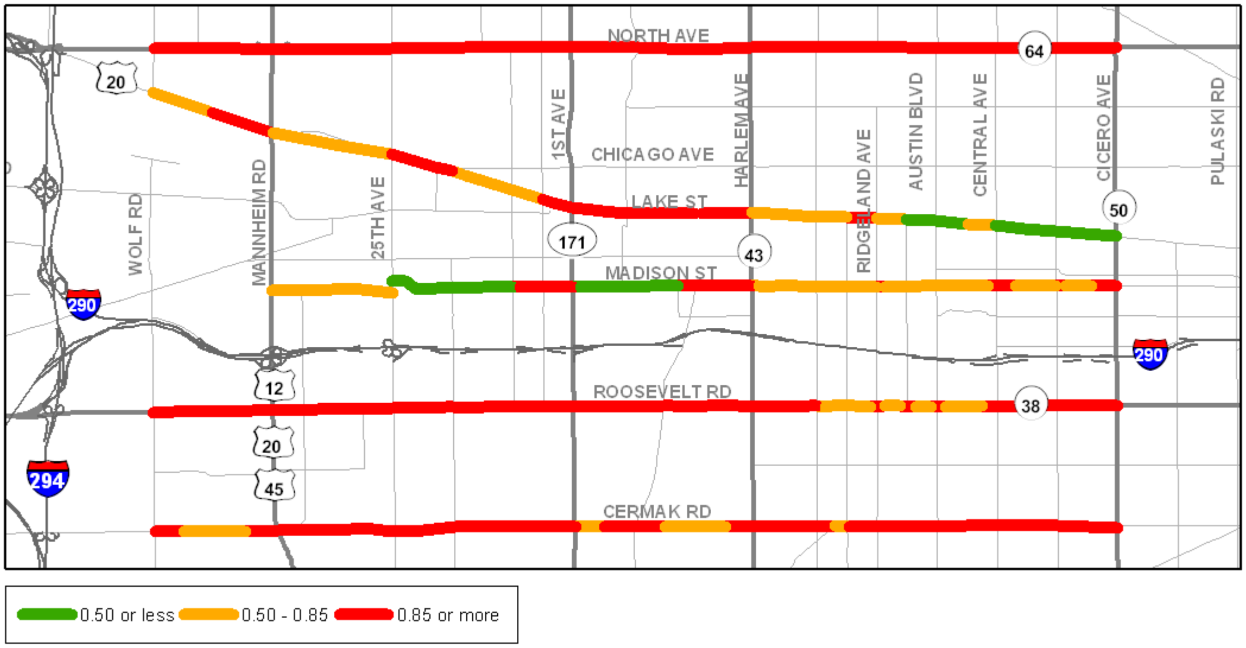


Table 5-8 - 2010 PM Peak Period Arterial Operations Summary

Arterial	Total Length Reviewed	Uncongested		Congested		Very Congested	
		length	%	length	%	Length	%
North Avenue	8.13 mi	0.00 mi	0%	0.00 mi	0%	8.13 mi	100%
Lake Street	8.26 mi	1.53 mi	19%	3.36 mi	41%	3.37 mi	41%
Madison Street	7.11 mi	1.91 mi	27%	3.40 mi	48%	1.80 mi	25%
Roosevelt Road	8.10 mi	0.00 mi	0%	1.01 mi	12%	7.09 mi	88%
Cermak Road	8.13 mi	0.00 mi	0%	1.28 mi	16%	6.85 mi	84%
Total	39.73 mi	3.44 mi	9%	9.05 mi	23%	27.24 mi	69%

To better understand what types of trips (local versus regional long distances trips) use these parallel arterials, a select link analysis was performed using the current year (2010) I-290 travel model. A select link analysis captures model trips using a specific road segment and maps locations where the trips begin and end (Figure 5-4 shows the select link model results for I-290 and the arterials). For example, a selected two-way segment in the center of I-290 just east of 1st Avenue (IL 171) is shown in Figure 5-4. The zones that are active, (i.e., from where a trip using this segment either started or ended), cover most of DuPage County, parts of Kane County, the vicinity of O'Hare Airport and many parts of Chicago, north and south. The reach of the I-290 segments covers over 35 miles from west to east with a broad reach in Chicago.

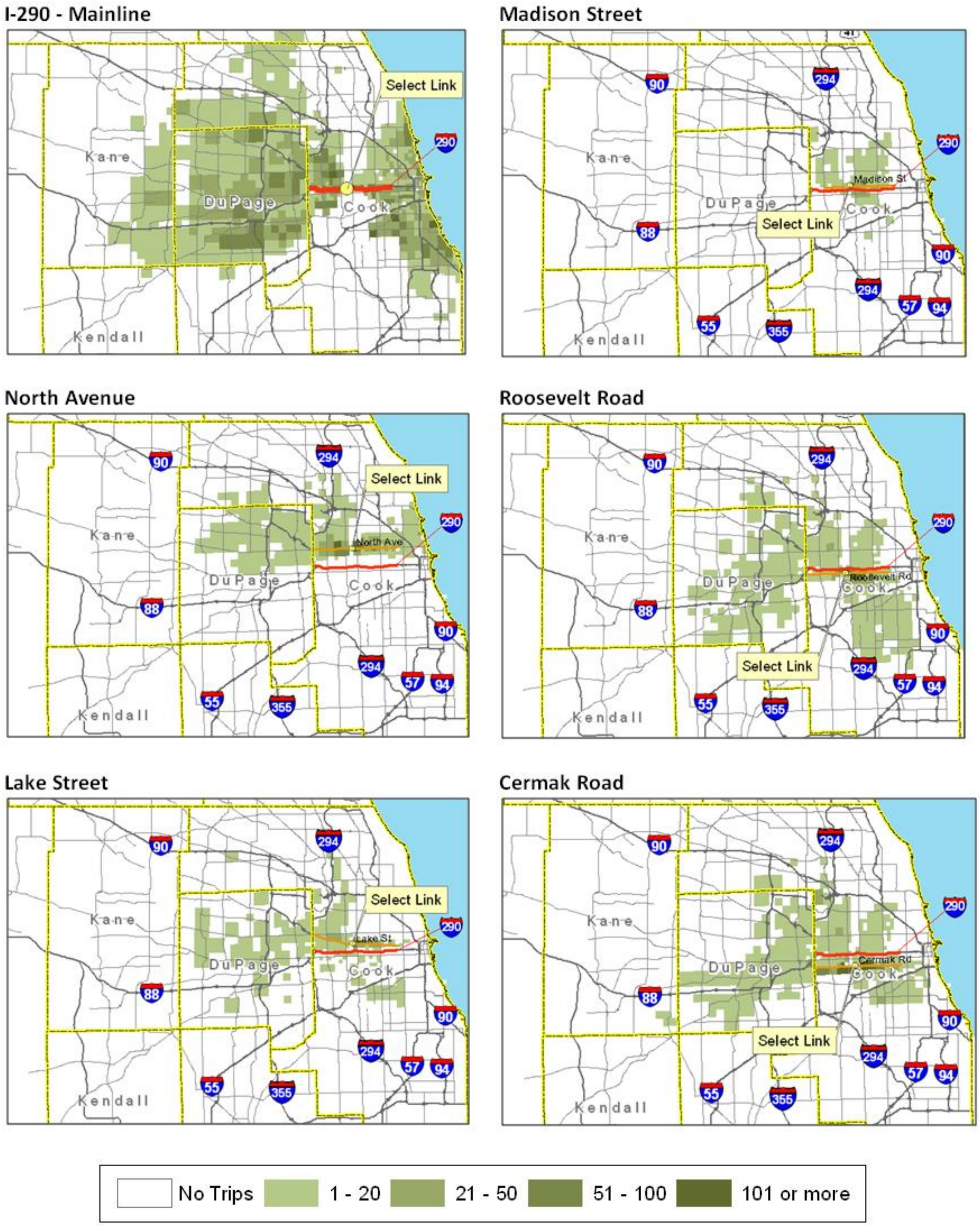
A single two-way segment was selected at an east-west location at each arterial that lies along the same north-south axis as selected for I-290. The major findings are:

- North Avenue, Roosevelt Road, Cermak Road, and to a somewhat lesser extent Lake Street, have select-link travelers that start or end in zones that are similar to travelers that use I-290. Their reach extends well into DuPage County and in parts of north and northwest Cook and Chicago. Each roadway generally maintains its location and traffic density as it extends west.

- Madison Street has a much more localized pattern of origin and destination zones with the bulk of its influence remaining in Cook County.

The select link analysis indicates that North Avenue, Roosevelt Road, Cermak Road, and to a lesser extent Lake Street, are serving trips similar in pattern to those served by I-290. These longer distance trips would normally be served by I-290, however with the heavy congestion on I-290, these parallel arterial routes are attracting longer trips.

Figure 5-4 - I-290 and Arterial Select Link Trip Analysis



6.0 Factors Affecting Operations

The results of the traffic operations analysis of existing conditions indicate that the majority of roadway elements within the I-290 corridor are operating under extremely congested conditions and deteriorated levels of service. Each of the various element analyzed have different factors that affect their performance under traffic. This section identifies the primary factors that influence the performance of the major roadway elements analyzed.

6.1 Basic Freeway Segments

A majority of the three and four lane basic freeway segments along east and westbound I-290 operate at LOS E or worse during both A.M. and P.M. peak hours. This deteriorated LOS may be attributed to the following factors:

- Inadequate capacity for travel demand
- Existing geometric design deficiencies
- Violation of the Basic Number of Lanes principle (westbound)
- Violation of the Lane Balance principle (eastbound)

Inadequate capacity for travel demand

Demand exceeding the available capacity is the primary factor causing congestion in the corridor. I-290 generally carries upward of 188,000 and 210,000 vehicles per day on six and eight lane freeway section, respectively (from Figure 2-2). Based on a maximum expected capacity of 138,000 and 187,000 vehicles per day[7], the mainline operates in excess of 36% of its expected capacity.

Geometric Design Deficiencies

The existing design deficiencies within the focused study area also affect the traffic operations. These deficiencies include non-compliance with American Association of State Highway and Transportation Official's (AASHTO) "basic number of lanes" principle, principle of lane balance, and substandard interchange configurations. These deficiencies are described in the paragraphs below. For further information on the existing geometric design deficiencies, refer to the Roadway Existing Conditions Technical Memorandum.

Basic Number of Lanes

The basic number of lanes, as defined by AASHTO, is the minimum number of through lanes designated and maintained over a significant length along a facility exclusive of ramp/auxiliary lanes. Typically the basic number of lanes along a facility should remain the same unless there is a significant volume of traffic exiting or entering the freeway where the basic number of lanes would either increase or decrease, such as at system to system interchanges or entering or exiting the fringe of a metropolitan area or population center.

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[7] From 2000 Highway Capacity Manual, Exhibit 13-6 using volume at 10% of ADT at LOS E

West of the study area, the basic number of lanes along I-290 varies at between segments along the corridor. Along eastbound I-290, the basic number of lanes is three from the I-355 system interchange to the Mannheim Road CD exit ramp, where the basic number of lanes is temporality reduced to two until eastbound entrance ramp from I-88 adds a third lane back. This basic 3-lane configuration continues to Austin Boulevard, where the entrance ramp adds a fourth lane which continues to the I-90/I-94 interchange/Circle interchange.

East of the study area, along westbound I-290, there are four basic lanes from between I-90/94 interchange to Austin Boulevard where the far left lane terminates as the exit ramp for Austin Boulevard. From this point I-290 continues with three basic lanes out to Mannheim Road, where a fourth basic lane is added by the Mannheim Road entrance ramp. The four lanes split at the junction of I-88 with two lanes continuing westbound on I-290. A third lane is added at the entrance ramp from Northbound I-294 and the configuration continues as three lanes to the I-355 interchange.

The present configuration along eastbound I-290 from I-88 to Austin Boulevard violates the "basic number of lanes "principle. In the westbound direction at Austin Boulevard, the basic number of lanes is reduced from four lanes to three lanes. However, the traffic volumes do not drop off significantly at Austin Boulevard, and because the capacity is reduced without a commensurate reduction in traffic volume, congestion results. Therefore this is not logical location for a through lane to be removed. Conversely, the location where I-88 merges or diverges from I-290 is a logical location for a change in the basic number of lanes because significant volume of traffic is entering or exiting at this system to system interchange.

Lane Balance Principle

The Lane Balance Principle is documented in the AASHTO 2004 Policy on Geometric Design, which recommends that to provide for efficient traffic operation through and beyond an interchange, there should be a balance in the number of traffic lanes before and after the merging or diverging of two traffic streams. A basic number of lanes should be maintained for a significant length of the roadway (exclusive of auxiliary lanes) and should not be changed between pairs of interchanges.

To comply with the requirements of lane balance principle at ramp entrances, AASHTO recommends that the number of lanes beyond the merging of two traffic streams should not be *less than* the sum of all traffic lanes on the merging roadways minus one. In the case of I-290 eastbound at I-88, the number of lanes east of the merge with I-88 should be not less than 4 in each direction (I-290 with 3 lanes plus I-88 with 2 lanes). However, there are only three lanes along I-290, east of its merge with I-88. This is not in compliance with AASHTO's lane balance principle.

6.2 Ramp Junctions and Weaving

The majority of the ramp junctions within the 3 lane sections of eastbound and westbound I-290, and each of the identified weaving sections operate at deteriorated LOS. This low performance can be attributed to several factors:

- High mainline and ramp volumes

- Complex maneuvers between closely spaced interchanges and ramp
- Non-uniform exit and entrance ramp patterns
- Short or non-existent ramp acceleration and deceleration lanes

Mainline operations along are affected by the type, location, and spacing of interchanges and ramps. Between Mannheim Road and Cicero Avenue, a distance of approximately seven miles, there are eleven interchanges with as many as 20 ramps in each direction. The high number of interchanges and ramps occurring in the relatively short distance, and the non-uniform ramp configuration between successive interchanges (right-hand vs. left hand ramps) within the study area contribute to drivers slowing down in higher speed lanes and making unexpected maneuvers. The I-290 Crash Analysis demonstrates the high crash rates associated with the left hand ramp operations at Harlem and Austin Avenue, as well as discernable increases in crashes associated with the closely spaced ramps between 25th Avenue and 1st Avenue.

Abrupt, substandard ramp entrance and exit angles result in short acceleration/deceleration areas for entering and exiting traffic. Short acceleration and deceleration area cause vehicles to either enter the freeway at reduced speed or slow down within a through travel lane. These maneuvers add friction within the traffic stream causing an adverse impact to operations as well as increased potential for crashes.

6.3 Interchange Intersections

Seven out of ten interchanges in the study area have failing movements that reduce overall operations at the intersections. Identified factors that impact traffic operations at interchange intersections include:

- Demand exceeding capacity
- Existing signal timing and phasing
- Intersection geometry
- Inadequate storage lengths for turning

Harlem Avenue, Austin Boulevard, 1st Avenue, and Cicero Avenue experience high traffic volumes. The I-290 interchange intersections with these arterials are inadequately sized to handle the high through traffic volumes at peak periods, and the existing turn lanes are insufficient in number and length to handle turning traffic volumes. Turn lane storage is consistently exceeded during peak periods at these intersections, with turn lane queues backing up into the through lanes causing the though lane movements to fail. Multiple movements at these intersections are experiencing breakdown conditions during the A.M. and P.M. peak hours.

The signal timing of an intersection plays an important role in its operational performance. Cycle lengths that are too short may not provide adequate green time for all phases resulting in cycle failures. Conversely, longer cycle lengths may result in increased delay and longer queues for all users. The sub-standard LOS (LOS D) at 17th Avenue intersections can be attributed to long control delays being experienced by external movements not being serviced for a long time under the current signal timing and phasing plans. The existing timing and phasing operations at this interchange are intended to prevent internal queuing (between the crossroad intersections on the bridge) and to clear the ramp traffic and prevent it from spilling back on to the freeway through lanes. This phasing requires longer cycle lengths which in turn result in longer control delays and deteriorated LOS for movements that are not being serviced. It may also be noted that the traffic operations analysis does not take into account the on-ramp traffic back-ups due to ramp metering.

At the DesPlaines Avenue interchange, the east and westbound approaches at the Harrison Street intersection were found to be operating at LOS D or worse during the A.M. and P.M. peak hours. This sub-standard LOS could also be attributed to signal timing. The traffic along Harrison Street experiences extended delays due to long cycle lengths and allocation of green time primarily to the north and southbound approaches along Des Plaines Avenue.

Many of the interchange intersections within the study area have deficient geometry that further hampers operations. Sharp, inadequate intersection turning radii at almost all of the intersections force turning vehicles slow down dramatically before entering into the turn, thus reducing the number of vehicles that can make the turn during the green light. Small radius, 90 degree turns with narrow or non-existent shoulders force trucks to make wide right turns to avoid obstacles veering towards oncoming traffic. These slow maneuvers not only causing slowdowns within that turning traffic lane, but also to opposing through traffic that may be affected by trucks appearing to encroach into the oncoming lane. The high percentage of turning and angle crashes occurring at these intersections can also be attributed in part to this geometric issue.

Another indication of the existing substandard geometric issues that can reduce operations are the cross-street bridge condition ratings. Six of the cross-road structures associated with an I-290 interchange are rated as "Functionally Obsolete," which indicates that the existing deck is not adequate to carry the number of lanes needed for the traffic volumes, as well as are problems related to the bridge approaches. These are 17th Avenue, 9th Avenue, 1st Avenue, DesPlaines Avenue, Austin Boulevard, and Laramie Avenue. (for more information, see section 1.6 of the Roadway Existing Conditions Technical Memorandum)

Inadequate turn lane storage is also a problem at 12 of the 18 intersections analyzed, where queues for traffic waiting to make a turn, consistently spillover into the through lanes during peak periods, adding to the congested conditions. Turn lane storage capacity at Austin Blvd is exceed by two to eight times what is available for 5 of the 8 movements.

6.4 Parallel Arterials

Several factors influence the operation along the parallel arterials including:

- Traffic volume: Higher traffic demand results in higher volume to capacity ratios, with congestion beginning when demand approaches the design capacity of a roadway. Breakdown conditions occur when demand exceeds capacity resulting in extremely congested conditions characterized by lower speeds, longer trip times, and longer queues.

- Number of lanes and cross-sections: Providing an adequate numbers of lanes, including appropriate number of turn lanes, increases the available capacity on an arterial, allowing it to convey more traffic at a lower V/C ratios. The lack of adequate number of through and turn lanes results in higher volume to capacity ratios and greater congestion.
- Traffic signals: Operations along arterials are impacted by signal density (the number of traffic signals per mile). Service volumes are higher on arterials that have less number of traffic signals per mile. Higher number of traffic signals per mile on an arterial will result in lower travel speeds, increase in delay, queuing at intersections, congestion, and opportunity for crashes.
- Mainline Congestion: The parallel arterials currently function as alternate east-west routes to I-290. Congested conditions along mainline I-290 may result in the "spillover" traffic getting diverted to these arterials.

7. Conclusion

The I-290 Eisenhower Expressway, its interchanges and crossroads, and adjacent arterial network all experience heavy congestion, primarily due to demand exceeding the available capacity of the various facilities. As shown in the existing conditions operations analysis, the Eisenhower Expressway experiences congested conditions (LOS D or worse) for up to seventeen hours each weekday. Almost the entire I-290 mainline in the study area is operating at LOS E and F during the A.M. and P.M. peak periods. This means that the facility is operating at capacity or in oversaturated breakdown conditions, with low travel speeds and periods of stop and go traffic.

Although congestion in the focused study area can be primarily attributed to the overwhelming traffic demand in the corridor, many other key factors contribute to the problem, including the mainline lane imbalance and capacity reductions, turbulent weaving operations between closely spaced interchange ramps, non-uniform interchange ramp configurations, and substandard geometrics.

List of References

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