Technical Memorandum

I-290

Preliminary Engineering and Environmental (Phase I) Study

West of Mannheim Road to East of Cicero Avenue

Appendix E

Existing Roadway Operations

July 2010

Appendix A-D - (under separate cover)

Appendix E - HCS Analysis Output:

E-1 Basic Freeway Segment Analysis

E-2 Ramp Junction Analysis

E-3 Ramp Weaving Analysis

E-4 Interchange Intersection Analysis

- **Existing Intersection Signal Phasing**
- **Intersection Traffic Counts – 2010-Jan-06**
- **Crossroad ADT Volume Adjustment Percentages**
- **Ramp Volume Adjustment Percentages**
- **Intersection Volume Adjustments**
- **Intersection Turn-Lane Storage Analysis**
- **Intersection HCS Analysis Output**

HCS LOS Methodology for Supersaturated Conditions:

The Highway Capacity Software (HCS) was developed by McTrans as a faithful implementation of the Highway Capacity Manual (HCM) procedures. The HCS uses the information and methodologies from the HCM to determine various degrees of congestion based on roadway and freeway characteristics, such as volume, length of roadways, lane width, and free flow speed. The characteristics are then used to determine levels of service, or degrees of congestion, based on studies that have published and accepted.

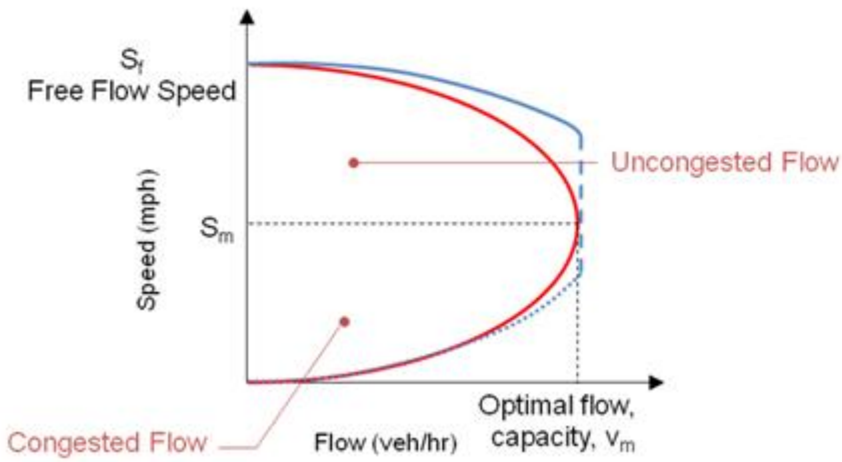
The HCM 2000 acknowledges limitations in the ability of the methodology to address oversaturated traffic flow conditions. Oversaturated refers to conditions in which traffic demands exceed the capacity of the facility:

> *"The freeway facility methodology is limited to the extent that it can accommodate demand in excess of capacity. The procedures address only local oversaturated flow situations, not systemwide oversaturated flow conditions."*[1]

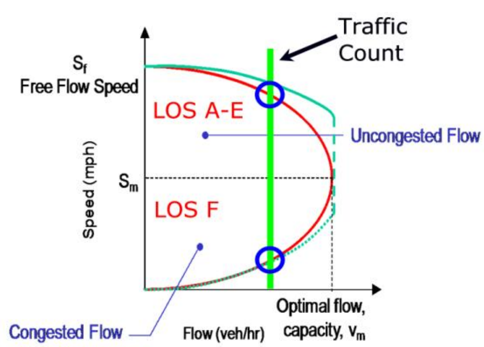
The methodology for determining the level of service for a basic freeway segment is based on the results of an NCHRP study entitled "Speed-Flow Relationships for Basic Freeway Sections". Traffic counts at each entrance to and exit from the freeway serve as input to the methodology. Whereas entrance counts are considered to represent the current entrance demands for the freeway facility (provided there is NOT a queue), the exit counts may not represent the current exit demands for the freeway due to congestion. Oftentimes, counts taken in congested areas take into account only the demand that is served, not the entire demand. The picture below summarizes the difference between served and unserved demand. The unserved demand usually results in a queue along the freeway. The served demand in oversaturated conditions is when volume equals capacity of the roadway and is considered a LOS E. At any point when volume is over capacity, that is considered a LOS F, or breakdown conditions. Typically, when there is unserved demand, this is considered a LOS F.

[1] 2000 Highway Capacity Manual, Transportation Research Board, Section 22.1.

The graphic below illustrates the relationship between traffic demand and travel speed. At low flow levels, free flow speeds can generally be maintained. As demand flows near capacity and flow becomes more unstable, speeds begin to drop. The speed at which the facility is at capacity (or at LOS E) is considered Sm. As shown in the figure, once the facility reaches optimum capacity, as demand continues to increase and flow becomes more and more unstable, the actual flow (or "served demand") will begin to decrease, with the remainder ("unserved demand") forming as a queue. The speed-flow relationship is used as the basis for determining level of service for basic freeway segments.



As shown in the illustration below, a traffic count (representing flow rate) that is taken along a freeway will intersect the flow/speed curve twice, unless the traffic count taken is actually the capacity. Without the context of observed flow conditions or speed data, a count taken in oversaturated conditions could be misinterpreted as operating the uncongested flow regime (the top portion of the curve), when the flow is actually representative of breakdown conditions indicative of LOS F. However, without analysis of a broader timeframe and manipulation of the data to represent the full demand conditions, not only the served demand, as outlined in the HCM methodology, HCS analysis, by default, will be based on the upper (uncongested) intersection on the flow/speed curve.



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 annotated to indicate those segments that are oversaturated.

Technical Memorandum

Appendix E-1

Basic Freeway Segment Analysis

I-290 Eastbound

HCS+: Basic Freeway Segments Release 5.4

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	12/4/2009
Analysis Time Period:	AM
Freeway/Direction:	I-290 EB
From/To:	I-294 On to C-D Road Off
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	1820	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	479	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	1006	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	4.5	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1006	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	55.0	mi/h
Number of lanes, N	2	
Density, D	18.3	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.4

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	12/4/2009
Analysis Time Period:	PM
Freeway/Direction:	I-290 EB
From/To:	I-294 On to C-D Road Off
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	3514	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	925	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	1295	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1295	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	55.0	mi/h
Number of lanes, N	3	
Density, D	23.5	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.4

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	12/4/2009
Analysis Time Period:	AM Peak
Freeway/Direction:	I-290 EB
From/To:	C-D Road before Lane Drop
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	1400	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	368	v
Trucks and buses	15	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.930	
Driver population factor, fp	1.00	
Flow rate, vp	792	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	4.5	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	792	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	55.0	mi/h
Number of lanes, N	2	
Density, D	14.4	pc/mi/ln
Level of service, LOS	B	

Overall results are not computed when free-flow speed is less than 55 mph.

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

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E-mail:

Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	12/4/2009
Analysis Time Period:	PM Peak
Freeway/Direction:	I-290 EB
From/To:	C-D Road before Lane Drop
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	1900	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	500	v
Trucks and buses	15	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.930	
Driver population factor, fp	1.00	
Flow rate, vp	1075	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	4.5	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1075	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	55.0	mi/h
Number of lanes, N	2	
Density, D	19.5	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

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Phone: Fax:
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Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	12/4/2009
Analysis Time Period:	AM Peak
Freeway/Direction:	I-290 EB
From/To:	C-D Road before Merge (1 lane)
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	2800	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	737	v
Trucks and buses	15	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.930	
Driver population factor, fp	1.00	
Flow rate, vp	1584	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	4.5	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1584	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	55.0	mi/h
Number of lanes, N	2	
Density, D	28.8	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

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Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	12/4/2009
Analysis Time Period:	PM Peak
Freeway/Direction:	I-290 EB
From/To:	C-D Road before Merge (1 lane)
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	3800	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1000	v
Trucks and buses	15	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.930	
Driver population factor, fp	1.00	
Flow rate, vp	2150	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	4.5	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2150	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	52.2	mi/h
Number of lanes, N	2	
Density, D	41.2	pc/mi/ln
Level of service, LOS	E	

Overall results are not computed when free-flow speed is less than 55 mph.

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

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Phone: Fax:
E-mail:

Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	12/4/2009
Analysis Time Period:	AM
Freeway/Direction:	I-290 EB
From/To:	C-D Road Off to I-88 On
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	2104	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	554	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	1163	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	4.5	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1163	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	55.0	mi/h
Number of lanes, N	2	
Density, D	21.1	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

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Phone: Fax:
E-mail:

Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	12/4/2009
Analysis Time Period:	PM
Freeway/Direction:	I-290 EB
From/To:	C-D Road Off to I-88 On
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	1869	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	492	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	1033	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	4.5	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1033	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	55.0	mi/h
Number of lanes, N	2	
Density, D	18.8	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.4

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	12/4/2009
Analysis Time Period:	AM
Freeway/Direction:	I-290 EB
From/To:	I-88 On to C-D Road On
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	3940	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1037	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	1452	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1452	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	55.0	mi/h
Number of lanes, N	3	
Density, D	26.4	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.4

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	12/4/2009
Analysis Time Period:	PM
Freeway/Direction:	I-290 EB
From/To:	I-88 On to C-D Road On
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	3340	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	879	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	1231	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1231	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	55.0	mi/h
Number of lanes, N	3	
Density, D	22.4	pc/mi/ln
Level of service, LOS	C	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.4

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/18/2009
Analysis Time Period:	AM
Freeway/Direction:	I-290 EB
From/To:	25th Off to 25th SB On-ramp
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	5030	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1324	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	1853	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1853	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	54.9	mi/h
Number of lanes, N	3	
Density, D	33.7	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

HCS+: Basic Freeway Segments Release 5.4

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/18/2009
Analysis Time Period:	PM
Freeway/Direction:	I-290 EB
From/To:	25th Off to 25th SB On-ramp
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	4810	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1266	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	1764	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1764	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	55.0	mi/h
Number of lanes, N	3	
Density, D	32.1	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

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Phone: Fax:
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Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/18/2009
Analysis Time Period:	AM
Freeway/Direction:	I-290 EB
From/To:	25th Off to 25th NB On-ramp
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	5200	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1368	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	1916	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1916	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	54.7	mi/h
Number of lanes, N	3	
Density, D	35.0+	pc/mi/ln
Level of service, LOS	E	

Overall results are not computed when free-flow speed is less than 55 mph.

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

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Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/18/2009
Analysis Time Period:	PM
Freeway/Direction:	I-290 EB
From/To:	25th Off to 25th NB On-ramp
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	5060	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1332	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	1855	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1855	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	54.9	mi/h
Number of lanes, N	3	
Density, D	33.8	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

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Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/18/2009
Analysis Time Period:	AM Peak
Freeway/Direction:	I-290 EB
From/To:	17th Ave off to 17th Ave On
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	5250	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1382	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	1934	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1934	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	54.6	mi/h
Number of lanes, N	3	
Density, D	35.4	pc/mi/ln
Level of service, LOS	E	

Overall results are not computed when free-flow speed is less than 55 mph.

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

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Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/18/2009
Analysis Time Period:	PM
Freeway/Direction:	I-290 EB
From/To:	17th Ave Off to 17th Ave On
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	5070	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1334	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	1859	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1859	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	54.9	mi/h
Number of lanes, N	3	
Density, D	33.9	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

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Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/18/2009
Analysis Time Period:	AM
Freeway/Direction:	I-290 EB
From/To:	17th to 9th
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	5450	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1434	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	2008	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2008	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	54.1	mi/h
Number of lanes, N	3	
Density, D	37.1	pc/mi/ln
Level of service, LOS	E	

Overall results are not computed when free-flow speed is less than 55 mph.

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

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Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/18/2009
Analysis Time Period:	PM
Freeway/Direction:	I-290 EB
From/To:	17th to 9th
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	5370	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1413	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	1969	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1969	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	54.4	mi/h
Number of lanes, N	3	
Density, D	36.2	pc/mi/ln
Level of service, LOS	E	

Overall results are not computed when free-flow speed is less than 55 mph.

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

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Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/18/2009
Analysis Time Period:	AM
Freeway/Direction:	I-290 EB
From/To:	9th to 1st
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	5840	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1537	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	2152	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2152	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	52.2	mi/h
Number of lanes, N	3	
Density, D	41.3	pc/mi/ln
Level of service, LOS	E	

Overall results are not computed when free-flow speed is less than 55 mph.

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

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Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/18/2009
Analysis Time Period:	PM
Freeway/Direction:	I-290 EB
From/To:	9th to 1st
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	5850	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1539	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	2145	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2145	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	52.3	mi/h
Number of lanes, N	3	
Density, D	41.0	pc/mi/ln
Level of service, LOS	E	

Overall results are not computed when free-flow speed is less than 55 mph.

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

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Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/18/2009
Analysis Time Period:	AM
Freeway/Direction:	I-290 EB
From/To:	1st Off-ramp to 1st On-ramp
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	5620	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1479	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	2071	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2071	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	53.4	mi/h
Number of lanes, N	3	
Density, D	38.8	pc/mi/ln
Level of service, LOS	E	

Overall results are not computed when free-flow speed is less than 55 mph.

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

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Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/18/2009
Analysis Time Period:	PM
Freeway/Direction:	I-290 EB
From/To:	1st Off-ramp to 1st On-ramp
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	5630	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1482	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	2064	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2064	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	53.5	mi/h
Number of lanes, N	3	
Density, D	38.6	pc/mi/ln
Level of service, LOS	E	

Overall results are not computed when free-flow speed is less than 55 mph.

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

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Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/18/2009
Analysis Time Period:	AM
Freeway/Direction:	I-290 EB
From/To:	1st to Des Plaines
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	6240	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1642	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	2299	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2299	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S		mi/h
Number of lanes, N	3	
Density, D		pc/mi/ln
Level of service, LOS	F	

Overall results are not computed when free-flow speed is less than 55 mph.

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Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/18/2009
Analysis Time Period:	PM
Freeway/Direction:	I-290 EB
From/To:	1st to Des Plaines
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	6510	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1713	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	2387	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2387	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S		mi/h
Number of lanes, N	3	
Density, D		pc/mi/ln
Level of service, LOS	F	

Overall results are not computed when free-flow speed is less than 55 mph.

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Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/4/2009
Analysis Time Period:	AM
Freeway/Direction:	I-290 EB
From/To:	Des Plaines to Harlem
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	6100	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1605	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	2247	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2247	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	50.1	mi/h
Number of lanes, N	3	
Density, D	44.9	pc/mi/ln
Level of service, LOS	E	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.4

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/18/2009
Analysis Time Period:	PM
Freeway/Direction:	I-290 EB
From/To:	Des Plaines to Harlem
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	6240	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1642	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	2288	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2288	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S		mi/h
Number of lanes, N	3	
Density, D		pc/mi/ln
Level of service, LOS	F	

Overall results are not computed when free-flow speed is less than 55 mph.

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Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/4/2009
Analysis Time Period:	AM
Freeway/Direction:	I-290 EB
From/To:	Harlem Off-ramp to Harlem On
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	5850	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1539	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	2155	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2155	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	52.1	mi/h
Number of lanes, N	3	
Density, D	41.4	pc/mi/ln
Level of service, LOS	E	

Overall results are not computed when free-flow speed is less than 55 mph.

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Phone: Fax:
E-mail:

Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/18/2009
Analysis Time Period:	PM
Freeway/Direction:	I-290 EB
From/To:	Harlem Off-ramp to Harlem On
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	5780	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1521	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	2119	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2119	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	52.7	mi/h
Number of lanes, N	3	
Density, D	40.2	pc/mi/ln
Level of service, LOS	E	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.4

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/18/2009
Analysis Time Period:	AM
Freeway/Direction:	I-290 EB
From/To:	Harlem to Austin
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	6670	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1755	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	2457	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2457	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S		mi/h
Number of lanes, N	3	
Density, D		pc/mi/ln
Level of service, LOS	F	

Overall results are not computed when free-flow speed is less than 55 mph.

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Phone: Fax:
E-mail:

Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/18/2009
Analysis Time Period:	PM
Freeway/Direction:	I-290 EB
From/To:	Harlem to Austin
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	6610	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1739	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	2424	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2424	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S		mi/h
Number of lanes, N	3	
Density, D		pc/mi/ln
Level of service, LOS	F	

Overall results are not computed when free-flow speed is less than 55 mph.

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Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/18/2009
Analysis Time Period:	AM
Freeway/Direction:	I-290 EB
From/To:	Austin Off to Austin On
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	6490	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1708	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	2391	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2391	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S		mi/h
Number of lanes, N	3	
Density, D		pc/mi/ln
Level of service, LOS	F	

Overall results are not computed when free-flow speed is less than 55 mph.

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Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/18/2009
Analysis Time Period:	PM
Freeway/Direction:	I-290 EB
From/To:	Austin Off to Austin On
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	6150	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1618	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	2255	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2255	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S		mi/h
Number of lanes, N	3	
Density, D		pc/mi/ln
Level of service, LOS	F	

Overall results are not computed when free-flow speed is less than 55 mph.

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Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/18/2009
Analysis Time Period:	AM
Freeway/Direction:	I-290 EB
From/To:	Austin to Central
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	7670	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	2018	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	2119	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2119	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	52.7	mi/h
Number of lanes, N	4	
Density, D	40.2	pc/mi/ln
Level of service, LOS	E	

Overall results are not computed when free-flow speed is less than 55 mph.

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Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/18/2009
Analysis Time Period:	PM
Freeway/Direction:	I-290 EB
From/To:	Austin to Central
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	7110	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1871	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	1955	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1955	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	54.5	mi/h
Number of lanes, N	4	
Density, D	35.9	pc/mi/ln
Level of service, LOS	E	

Overall results are not computed when free-flow speed is less than 55 mph.

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Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/18/2009
Analysis Time Period:	AM
Freeway/Direction:	I-290 EB
From/To:	Central Off-ramp to Central On
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	7360	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1937	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	2034	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2034	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	53.9	mi/h
Number of lanes, N	4	
Density, D	37.8	pc/mi/ln
Level of service, LOS	E	

Overall results are not computed when free-flow speed is less than 55 mph.

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Phone: Fax:
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Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/18/2009
Analysis Time Period:	PM
Freeway/Direction:	I-290 EB
From/To:	Central Off-ramp to Central On
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	6530	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1718	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	1796	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1796	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	55.0	mi/h
Number of lanes, N	4	
Density, D	32.7	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

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Phone: Fax:
E-mail:

Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/18/2009
Analysis Time Period:	AM
Freeway/Direction:	I-290 EB
From/To:	Central to Laramie
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	7980	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	2100	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	2205	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2205	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	51.1	mi/h
Number of lanes, N	4	
Density, D	43.2	pc/mi/ln
Level of service, LOS	E	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.4

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/18/2009
Analysis Time Period:	PM
Freeway/Direction:	I-290 EB
From/To:	Central to Laramie
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	7130	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1876	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	1961	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1961	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	54.5	mi/h
Number of lanes, N	4	
Density, D	36.0	pc/mi/ln
Level of service, LOS	E	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.4

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/18/2009
Analysis Time Period:	AM
Freeway/Direction:	I-290 EB
From/To:	Cicero to Kostner
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	7350	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1934	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	2031	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2031	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	53.9	mi/h
Number of lanes, N	4	
Density, D	37.7	pc/mi/ln
Level of service, LOS	E	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.4

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/18/2009
Analysis Time Period:	PM
Freeway/Direction:	I-290 EB
From/To:	Cicero to Kostner
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	6860	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1805	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	1887	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1887	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	54.8	mi/h
Number of lanes, N	4	
Density, D	34.4	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

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Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/18/2009
Analysis Time Period:	AM
Freeway/Direction:	I-290 EB
From/To:	Kostner to Independence
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	7990	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	2103	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	2208	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2208	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	51.0	mi/h
Number of lanes, N	4	
Density, D	43.3	pc/mi/ln
Level of service, LOS	E	

Overall results are not computed when free-flow speed is less than 55 mph.

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E-mail:

Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/18/2009
Analysis Time Period:	PM
Freeway/Direction:	I-290 EB
From/To:	Kostner to Independence
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	7590	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1997	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	2087	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2087	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	53.2	mi/h
Number of lanes, N	4	
Density, D	39.2	pc/mi/ln
Level of service, LOS	E	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.4

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/18/2009
Analysis Time Period:	AM
Freeway/Direction:	I-290 EB
From/To:	Independence to Homan
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	8020	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	2111	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	2216	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2216	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	50.8	mi/h
Number of lanes, N	4	
Density, D	43.6	pc/mi/ln
Level of service, LOS	E	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.4

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Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/18/2009
Analysis Time Period:	PM
Freeway/Direction:	I-290 EB
From/To:	Independence to Homan
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	7370	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1939	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	2027	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2027	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	53.9	mi/h
Number of lanes, N	4	
Density, D	37.6	pc/mi/ln
Level of service, LOS	E	

Overall results are not computed when free-flow speed is less than 55 mph.

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Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/18/2009
Analysis Time Period:	AM
Freeway/Direction:	I-290 EB
From/To:	Sacramento to Western
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	7750	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	2039	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	2141	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2141	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	52.4	mi/h
Number of lanes, N	4	
Density, D	40.9	pc/mi/ln
Level of service, LOS	E	

Overall results are not computed when free-flow speed is less than 55 mph.

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Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/18/2009
Analysis Time Period:	PM
Freeway/Direction:	I-290 EB
From/To:	Sacramento to Western
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	7220	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1900	v
Trucks and buses	9	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.957	
Driver population factor, fp	1.00	
Flow rate, vp	1986	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1986	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	54.3	mi/h
Number of lanes, N	4	
Density, D	36.6	pc/mi/ln
Level of service, LOS	E	

Overall results are not computed when free-flow speed is less than 55 mph.

I-290 Westbound

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E-mail:

Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	12/4/2009
Analysis Time Period:	AM
Freeway/Direction:	I-290 WB
From/To:	I-88 Off to I-294 Off-ramp
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	3430	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	903	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	1896	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	4.5	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1896	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	54.8	mi/h
Number of lanes, N	2	
Density, D	34.6	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

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Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	12/4/2009
Analysis Time Period:	PM
Freeway/Direction:	I-290 WB
From/To:	I-88 Off to I-294 Off-ramp
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	3524	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	927	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	1947	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	4.5	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1947	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	54.6	mi/h
Number of lanes, N	2	
Density, D	35.7	pc/mi/ln
Level of service, LOS	E	

Overall results are not computed when free-flow speed is less than 55 mph.

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Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	12/4/2009
Analysis Time Period:	
Freeway/Direction:	I-290 WB
From/To:	Wolf Road Off-ramp to I-88 Off
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	7100	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1868	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	1962	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1962	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	54.5	mi/h
Number of lanes, N	4	
Density, D	36.0	pc/mi/ln

Level of service, LOS	E

Overall results are not computed when free-flow speed is less than 55 mph.

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Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	12/4/2009
Analysis Time Period:	PM
Freeway/Direction:	I-290 WB
From/To:	Wolf Road Off-ramp to I-88 Off
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	6930	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1824	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	1915	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1915	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	54.7	mi/h
Number of lanes, N	4	
Density, D	35.0-	pc/mi/ln

Level of service, LOS	D

Overall results are not computed when free-flow speed is less than 55 mph.

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Phone: Fax:
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Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/4/2009
Analysis Time Period:	AM
Freeway/Direction:	I-290 WB
From/To:	Mannheim NB On to Mann. SB On
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Mainline Operations Analysis

Flow Inputs and Adjustments

Volume, V	7020	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1847	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	1940	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1940	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	54.6	mi/h
Number of lanes, N	4	
Density, D	35.5	pc/mi/ln
Level of service, LOS	E	

Overall results are not computed when free-flow speed is less than 55 mph.

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Phone: Fax:
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Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/4/2009
Analysis Time Period:	PM Peak
Freeway/Direction:	I-290 WB
From/To:	Mannheim NB On to Mann. SB On
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Mainline Operations Analysis

Flow Inputs and Adjustments

Volume, V	6740	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1774	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	1862	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1862	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	54.9	mi/h
Number of lanes, N	4	
Density, D	33.9	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.4

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/4/2009
Analysis Time Period:	AM
Freeway/Direction:	I-290 WB
From/To:	Mannheim Off to Mannheim NB On
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Mainline Operations Analysis

Flow Inputs and Adjustments

Volume, V	6380	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1679	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	2351	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2351	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S		mi/h
Number of lanes, N	3	
Density, D		pc/mi/ln
Level of service, LOS	F	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.4

Phone: Fax:
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Operational Analysis

Analyst:	Rct
Agency or Company:	IDOT/PB
Date Performed:	8/4/2009
Analysis Time Period:	PM
Freeway/Direction:	I-290 WB
From/To:	Mannheim Off to Mannheim NB On
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Mainline Operations Analysis

Flow Inputs and Adjustments

Volume, V	6210	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1634	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	2288	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2288	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S		mi/h
Number of lanes, N	3	
Density, D		pc/mi/ln
Level of service, LOS	F	

Overall results are not computed when free-flow speed is less than 55 mph.

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Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/4/2009
Analysis Time Period:	AM
Freeway/Direction:	I-290 WB
From/To:	25th SB Off to 25th On
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	6530	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1718	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	2406	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2406	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S		mi/h
Number of lanes, N	3	
Density, D		pc/mi/ln
Level of service, LOS	F	

Overall results are not computed when free-flow speed is less than 55 mph.

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Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/4/2009
Analysis Time Period:	PM
Freeway/Direction:	I-290 WB
From/To:	25th SB Off to 25th On
Jurisdiction:	
Analysis Year:	Existing 2009

Description: I-290 Mainline Operations Analysis

Flow Inputs and Adjustments

Volume, V	6300	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1658	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	2321	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2321	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S		mi/h
Number of lanes, N	3	
Density, D		pc/mi/ln
Level of service, LOS	F	

Overall results are not computed when free-flow speed is less than 55 mph.

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E-mail:

Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/4/2009
Analysis Time Period:	AM
Freeway/Direction:	I-290 WB
From/To:	25th Off to 25th SB Off
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	6830	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1797	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	2516	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2516	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S		mi/h
Number of lanes, N	3	
Density, D		pc/mi/ln
Level of service, LOS	F	

Overall results are not computed when free-flow speed is less than 55 mph.

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Operational Analysis

Analyst: RCT
Agency or Company: IDOT/PB
Date Performed: 8/4/2009
Analysis Time Period: PM
Freeway/Direction: I-290 WB
From/To: 25th Off to 25th SB Off
Jurisdiction:
Analysis Year: Existing 2009
Description: I-290 Mainline Operations Analysis

Flow Inputs and Adjustments

Volume, V	6550	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1724	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	2413	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2413	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S		mi/h
Number of lanes, N	3	
Density, D		pc/mi/ln
Level of service, LOS	F	

Overall results are not computed when free-flow speed is less than 55 mph.

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Operational Analysis

Analyst:	RJP
Agency or Company:	IDOT/PB
Date Performed:	8/4/2009
Analysis Time Period:	AM
Freeway/Direction:	I-290 WB
From/To:	25th to Mannheim
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Mainline Operations Analysis

Flow Inputs and Adjustments

Volume, V	7300	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1921	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	2017	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2017	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	54.0	mi/h
Number of lanes, N	4	
Density, D	37.3	pc/mi/ln
Level of service, LOS	E	

Overall results are not computed when free-flow speed is less than 55 mph.

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Operational Analysis

Analyst:	RJP
Agency or Company:	IDOT/PB
Date Performed:	8/4/2009
Analysis Time Period:	PM
Freeway/Direction:	I-290 WB
From/To:	25th to Mannheim
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Mainline Operations Analysis

Flow Inputs and Adjustments

Volume, V	6790	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1787	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	1876	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1876	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	54.9	mi/h
Number of lanes, N	4	
Density, D	34.2	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

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Operational Analysis

Analyst:	RJP
Agency or Company:	IDOT/PB
Date Performed:	8/4/2009
Analysis Time Period:	AM
Freeway/Direction:	I-290 WB
From/To:	17th to 25th
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	6980	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1837	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	1929	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	0.50	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	0.0	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1929	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	54.7	mi/h
Number of lanes, N	4	
Density, D	35.3	pc/mi/ln
Level of service, LOS	E	

Overall results are not computed when free-flow speed is less than 55 mph.

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Operational Analysis

Analyst:	RJP
Agency or Company:	IDOT/PB
Date Performed:	8/4/2009
Analysis Time Period:	PM
Freeway/Direction:	I-290 WB
From/To:	17th to 25th
Jurisdiction:	
Analysis Year:	Existing 2009

Description: I-290 Mainline Operations Analysis

Flow Inputs and Adjustments

Volume, V	6700	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1763	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	1851	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1851	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	54.9	mi/h
Number of lanes, N	4	
Density, D	33.7	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

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Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/4/2009
Analysis Time Period:	AM
Freeway/Direction:	I-290 WB
From/To:	17th Off-ramp to 17th n-ramp
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	6390	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1682	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	2354	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2354	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S		mi/h
Number of lanes, N	3	
Density, D		pc/mi/ln
Level of service, LOS	F	

Overall results are not computed when free-flow speed is less than 55 mph.

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Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/4/2009
Analysis Time Period:	PM
Freeway/Direction:	I-290 WB
From/To:	17th Off-ramp to 17th On-ramp
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	6220	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1637	v
Trucks and buses	3	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.985	
Driver population factor, fp	1.00	
Flow rate, vp	2215	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2215	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	50.9	mi/h
Number of lanes, N	3	
Density, D	43.6	pc/mi/ln
Level of service, LOS	E	

Overall results are not computed when free-flow speed is less than 55 mph.

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

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Operational Analysis

Analyst:	RJP
Agency or Company:	IDOT/PB
Date Performed:	8/4/2009
Analysis Time Period:	AM
Freeway/Direction:	I-290 WB
From/To:	9th to 17th
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	6470	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1703	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	2384	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2384	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S		mi/h
Number of lanes, N	3	
Density, D		pc/mi/ln
Level of service, LOS	F	

Overall results are not computed when free-flow speed is less than 55 mph.

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Phone: Fax:
E-mail:

Operational Analysis

Analyst:	RJP
Agency or Company:	IDOT/PB
Date Performed:	8/4/2009
Analysis Time Period:	PM
Freeway/Direction:	I-290 WB
From/To:	9th to 17th
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	6370	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1676	v
Trucks and buses	3	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.985	
Driver population factor, fp	1.00	
Flow rate, vp	2269	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2269	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S		mi/h
Number of lanes, N	3	
Density, D		pc/mi/ln
Level of service, LOS	F	

Overall results are not computed when free-flow speed is less than 55 mph.

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Operational Analysis

Analyst:	RJP
Agency or Company:	IDOT/PB
Date Performed:	8/4/2009
Analysis Time Period:	AM
Freeway/Direction:	I-290 WB
From/To:	1st to 9th
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	6570	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1729	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	2421	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2421	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S		mi/h
Number of lanes, N	3	
Density, D		pc/mi/ln
Level of service, LOS	F	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.4

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	RJP
Agency or Company:	IDOT/PB
Date Performed:	8/4/2009
Analysis Time Period:	PM
Freeway/Direction:	I-290 WB
From/To:	1st to 9th
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	6560	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1726	v
Trucks and buses	3	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.985	
Driver population factor, fp	1.00	
Flow rate, vp	2336	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2336	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S		mi/h
Number of lanes, N	3	
Density, D		pc/mi/ln
Level of service, LOS	F	

Overall results are not computed when free-flow speed is less than 55 mph.

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Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/4/2009
Analysis Time Period:	AM
Freeway/Direction:	I-290 WB
From/To:	1st Off-ramp to 1st On-ramp
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	6500	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1711	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	2395	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2395	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S		mi/h
Number of lanes, N	3	
Density, D		pc/mi/ln
Level of service, LOS	F	

Overall results are not computed when free-flow speed is less than 55 mph.

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

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Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/4/2009
Analysis Time Period:	PM
Freeway/Direction:	I-290 WB
From/To:	1st Off-ramp to 1st On-ramp
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	5990	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1576	v
Trucks and buses	3	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.985	
Driver population factor, fp	1.00	
Flow rate, vp	2133	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2133	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	52.5	mi/h
Number of lanes, N	3	
Density, D	40.6	pc/mi/ln
Level of service, LOS	E	

Overall results are not computed when free-flow speed is less than 55 mph.

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Operational Analysis

Analyst:	RJP
Agency or Company:	IDOT/PB
Date Performed:	8/4/2009
Analysis Time Period:	AM
Freeway/Direction:	I-290 WB
From/To:	Des Plaines to 1st
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	6500	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1711	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	2395	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2395	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S		mi/h
Number of lanes, N	3	
Density, D		pc/mi/ln
Level of service, LOS	F	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.4

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Operational Analysis

Analyst:	RJP
Agency or Company:	IDOT/PB
Date Performed:	8/4/2009
Analysis Time Period:	PM
Freeway/Direction:	I-290 WB
From/To:	Des Plaines to 1st
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	6480	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1705	v
Trucks and buses	3	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.985	
Driver population factor, fp	1.00	
Flow rate, vp	2308	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2308	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S		mi/h
Number of lanes, N	3	
Density, D		pc/mi/ln
Level of service, LOS	F	

Overall results are not computed when free-flow speed is less than 55 mph.

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Operational Analysis

Analyst:	RJP
Agency or Company:	IDOT/PB
Date Performed:	8/4/2009
Analysis Time Period:	AM
Freeway/Direction:	I-290 WB
From/To:	Harlem to Des Plaines
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	5800	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1526	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	2137	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2137	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	52.4	mi/h
Number of lanes, N	3	
Density, D	40.8	pc/mi/ln
Level of service, LOS	E	

Overall results are not computed when free-flow speed is less than 55 mph.

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

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Operational Analysis

Analyst:	RJP
Agency or Company:	IDOT/PB
Date Performed:	8/4/2009
Analysis Time Period:	PM
Freeway/Direction:	I-290 WB
From/To:	Harlem to Des Plaines
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	5890	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1550	v
Trucks and buses	3	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.985	
Driver population factor, fp	1.00	
Flow rate, vp	2098	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2098	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	53.1	mi/h
Number of lanes, N	3	
Density, D	39.5	pc/mi/ln
Level of service, LOS	E	

Overall results are not computed when free-flow speed is less than 55 mph.

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

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Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/4/2009
Analysis Time Period:	AM
Freeway/Direction:	I-290 WB
From/To:	Harlem Off to Harlem On
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	5120	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1347	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	1886	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1886	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	54.8	mi/h
Number of lanes, N	3	
Density, D	34.4	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

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Phone:                                        Fax:
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_________________________Operational Analysis__________________________________

Analyst:                RCT
Agency or Company:      IDOT/PB
Date Performed:         8/4/2009
Analysis Time Period:   PM
Freeway/Direction:      I-290 WB
From/To:                Harlem Off to Harlem On
Jurisdiction:
Analysis Year:          2009
Description:  I-290 Basic Freeway Segments Operation Analysis

_________________________Flow Inputs and Adjustments___________________________

Volume, V                                     5200           veh/h
Peak-hour factor, PHF                         0.95
Peak 15-min volume, v15                       1368           v
Trucks and buses                              3              %
Recreational vehicles                         0              %
Terrain type:                                 Level
    Grade                                     0.00           %
    Segment length                            0.00           mi
Trucks and buses PCE, ET                      1.5
Recreational vehicle PCE, ER                  1.2
Heavy vehicle adjustment, fHV                 0.985
Driver population factor, fp                  1.00
Flow rate, vp                                 1852           pc/h/ln

_________________________Speed Inputs and Adjustments__________________________

Lane width                                    12.0           ft
Right-shoulder lateral clearance              6.0            ft
Interchange density                           2.00           interchange/mi
Number of lanes, N                            3
Free-flow speed:                              Measured
     FFS or BFFS                              55.0           mi/h
Lane width adjustment, fLW                    0.0            mi/h
Lateral clearance adjustment, fLC             0.0            mi/h
Interchange density adjustment, fID           7.5            mi/h
Number of lanes adjustment, fN                3.0            mi/h
Free-flow speed, FFS                          55.0           mi/h
                                              Urban Freeway

_________________________LOS and Performance Measures__________________________

Flow rate, vp                                 1852           pc/h/ln
Free-flow speed, FFS                          55.0           mi/h
Average passenger-car speed, S                54.9           mi/h
Number of lanes, N                            3
Density, D                                    33.7           pc/mi/ln
Level of service, LOS                         D

  Overall results are not computed when free-flow speed is less than 55 mph.
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Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

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Operational Analysis

Analyst:	RJP
Agency or Company:	IDOT/PB
Date Performed:	8/4/2009
Analysis Time Period:	AM
Freeway/Direction:	I-290 WB
From/To:	Austin to Harlem
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	5380	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1416	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	1982	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1982	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	54.3	mi/h
Number of lanes, N	3	
Density, D	36.5	pc/mi/ln
Level of service, LOS	E	

Overall results are not computed when free-flow speed is less than 55 mph.

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

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Operational Analysis

Analyst:	RJP
Agency or Company:	IDOT/PB
Date Performed:	8/4/2009
Analysis Time Period:	PM
Freeway/Direction:	I-290 WB
From/To:	Austin to Harlem
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	5780	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1521	v
Trucks and buses	3	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.985	
Driver population factor, fp	1.00	
Flow rate, vp	2058	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	2058	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	53.6	mi/h
Number of lanes, N	3	
Density, D	38.4	pc/mi/ln
Level of service, LOS	E	

Overall results are not computed when free-flow speed is less than 55 mph.

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

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Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/4/2009
Analysis Time Period:	AM
Freeway/Direction:	I-290 WB
From/To:	Austin Off to Austin On
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	4850	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1276	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	1787	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1787	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	55.0	mi/h
Number of lanes, N	3	
Density, D	32.5	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

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Operational Analysis

Analyst:	RCT
Agency or Company:	IDOT/PB
Date Performed:	8/4/2009
Analysis Time Period:	PM
Freeway/Direction:	I-290 WB
From/To:	Austin Off to Austin On
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	5310	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1397	v
Trucks and buses	3	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.985	
Driver population factor, fp	1.00	
Flow rate, vp	1891	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	3.0	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1891	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	54.8	mi/h
Number of lanes, N	3	
Density, D	34.5	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

HCS+: Basic Freeway Segments Release 5.4

Phone: Fax:
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Operational Analysis

Analyst:	RJP
Agency or Company:	IDOT/PB
Date Performed:	8/4/2009
Analysis Time Period:	AM
Freeway/Direction:	I-290 WB
From/To:	Central to Austin
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	5740	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1511	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	1586	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1586	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	55.0	mi/h
Number of lanes, N	4	
Density, D	28.8	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

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Operational Analysis

Analyst:	RJP
Agency or Company:	IDOT/PB
Date Performed:	8/4/2009
Analysis Time Period:	PM
Freeway/Direction:	I-290 WB
From/To:	Central to Austin
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	6410	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1687	v
Trucks and buses	3	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.985	
Driver population factor, fp	1.00	
Flow rate, vp	1712	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1712	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	55.0	mi/h
Number of lanes, N	4	
Density, D	31.1	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

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Operational Analysis

Analyst:	RJP
Agency or Company:	IDOT/PB
Date Performed:	8/4/2009
Analysis Time Period:	AM
Freeway/Direction:	I-290 WB
From/To:	Central Off to Central On
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	5240	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1379	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	1448	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1448	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	55.0	mi/h
Number of lanes, N	4	
Density, D	26.3	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

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Operational Analysis

Analyst:	RJP
Agency or Company:	IDOT/PB
Date Performed:	8/4/2009
Analysis Time Period:	PM
Freeway/Direction:	I-290 WB
From/To:	Central Off to Central On
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	5750	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1513	v
Trucks and buses	3	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.985	
Driver population factor, fp	1.00	
Flow rate, vp	1536	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1536	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	55.0	mi/h
Number of lanes, N	4	
Density, D	27.9	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

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Operational Analysis

Analyst:	RJP
Agency or Company:	IDOT/PB
Date Performed:	8/4/2009
Analysis Time Period:	AM
Freeway/Direction:	I-290 WB
From/To:	Laramie to Central
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	5550	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1461	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	1534	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1534	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	55.0	mi/h
Number of lanes, N	4	
Density, D	27.9	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

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Operational Analysis

Analyst:	RJP
Agency or Company:	IDOT/PB
Date Performed:	8/4/2009
Analysis Time Period:	PM
Freeway/Direction:	I-290 WB
From/To:	Laramie to Central
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	6040	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1589	v
Trucks and buses	3	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.985	
Driver population factor, fp	1.00	
Flow rate, vp	1613	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1613	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	55.0	mi/h
Number of lanes, N	4	
Density, D	29.3	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

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Operational Analysis

Analyst:	RT
Agency or Company:	IDOT/PB
Date Performed:	9/24/2009
Analysis Time Period:	AM
Freeway/Direction:	I-290 WB
From/To:	Cicero to Laramie
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	6100	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1605	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	1686	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1686	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	55.0	mi/h
Number of lanes, N	4	
Density, D	30.7	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

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Operational Analysis

Analyst:	RT
Agency or Company:	IDOT/PB
Date Performed:	12/2/2009
Analysis Time Period:	AM
Freeway/Direction:	I-290 WB
From/To:	Kostner to Cicero
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	5470	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1439	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	1511	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1511	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	55.0	mi/h
Number of lanes, N	4	
Density, D	27.5	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

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Operational Analysis

Analyst:	RT
Agency or Company:	IDOT/PB
Date Performed:	12/2/2009
Analysis Time Period:	PM
Freeway/Direction:	I-290 WB
From/To:	Kostner to Cicero
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	6100	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1605	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	1686	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1686	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	55.0	mi/h
Number of lanes, N	4	
Density, D	30.7	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

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Operational Analysis

Analyst:	RT
Agency or Company:	IDOT/PB
Date Performed:	12/2/2009
Analysis Time Period:	AM
Freeway/Direction:	I-290 WB
From/To:	Independence to Kostner
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	6110	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1608	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	1688	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1688	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	55.0	mi/h
Number of lanes, N	4	
Density, D	30.7	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

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Operational Analysis

Analyst:	RT
Agency or Company:	IDOT/PB
Date Performed:	12/2/2009
Analysis Time Period:	PM
Freeway/Direction:	I-290 WB
From/To:	Independence to Kostner
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	6700	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1763	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	1851	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1851	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	54.9	mi/h
Number of lanes, N	4	
Density, D	33.7	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

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Operational Analysis

Analyst:	RT
Agency or Company:	IDOT/PB
Date Performed:	12/2/2009
Analysis Time Period:	AM
Freeway/Direction:	I-290 WB
From/To:	Homan to Independence
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	6110	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1608	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	1688	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1688	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	55.0	mi/h
Number of lanes, N	4	
Density, D	30.7	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

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Operational Analysis

Analyst:	RT
Agency or Company:	IDOT/PB
Date Performed:	12/2/2009
Analysis Time Period:	PM
Freeway/Direction:	I-290 WB
From/To:	Homan to Independence
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	6630	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1745	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	1832	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1832	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	55.0	mi/h
Number of lanes, N	4	
Density, D	33.3	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

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Operational Analysis

Analyst:	RT
Agency or Company:	IDOT/PB
Date Performed:	12/2/2009
Analysis Time Period:	AM
Freeway/Direction:	I-290 WB
From/To:	Western to Sacramento
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	5930	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1561	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	1639	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1639	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	55.0	mi/h
Number of lanes, N	4	
Density, D	29.8	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

HCS+: Basic Freeway Segments Release 5.4

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	RT
Agency or Company:	IDOT/PB
Date Performed:	12/2/2009
Analysis Time Period:	PM
Freeway/Direction:	I-290 WB
From/To:	Western to Sacramento
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Basic Freeway Segments Operation Analysis

Flow Inputs and Adjustments

Volume, V	6570	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1729	v
Trucks and buses	10	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	0.00	%
Segment length	0.00	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.952	
Driver population factor, fp	1.00	
Flow rate, vp	1815	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-shoulder lateral clearance	6.0	ft
Interchange density	2.00	interchange/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	55.0	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	7.5	mi/h
Number of lanes adjustment, fN	1.5	mi/h
Free-flow speed, FFS	55.0	mi/h
	Urban Freeway	

LOS and Performance Measures

Flow rate, vp	1815	pc/h/ln
Free-flow speed, FFS	55.0	mi/h
Average passenger-car speed, S	55.0	mi/h
Number of lanes, N	4	
Density, D	33.0	pc/mi/ln
Level of service, LOS	D	

Overall results are not computed when free-flow speed is less than 55 mph.

Technical Memorandum

Appendix E-2

Ramp Junction Analysis

HCS+: Ramps and Ramp Junctions Release 5.4

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Merge Analysis

Analyst: RCT
Agency/Co.: IDOT/PB
Date performed: 8/18/2009
Analysis time period: AM Peak
Freeway/Dir of Travel: I-290 EB
Junction: 17th Ave. Entrance Ramp
Jurisdiction: IDOT
Analysis Year: 2009
Description: I-290 Phase 1 Study

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	55.0	mph
Volume on freeway	5250	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	200	vph
Length of first accel/decel lane	793	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	180	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	On	
Distance to adjacent Ramp	2681	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	5250		200		180	vph
Peak-hour factor, PHF	0.95		0.95		0.95	
Peak 15-min volume, v15	1382		53		47	v
Trucks and buses	10		10		10	%
Recreational vehicles	0		0		0	%
Terrain type:	Level		Level		Level	
Grade		%		%		%
Length		mi		mi		mi
Trucks and buses PCE, ET	1.5		1.5		1.5	
Recreational vehicle PCE, ER	1.2		1.2		1.2	
Heavy vehicle adjustment, fHV	0.952		0.952		0.952	
Driver population factor, fP	1.00		1.00		1.00	
Flow rate, vp	5803		221		199	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 0.600 Using Equation 1

$v_{12} = v_F (P_{FM}) = 3480$ pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	6024	6750	No
v_3 or v_{av34}	2323 pc/h	(Equation 25-4 or 25-5)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} = 3480		(Equation 25-8)	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	3480	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 29.3 pc/mi/ln

Level of service for ramp-freeway junction areas of influence D

Speed Estimation

Intermediate speed variable, M_S = 0.423

Space mean speed in ramp influence area, S_R = 49.5 mph

Space mean speed in outer lanes, S_0 = 48.3 mph

Space mean speed for all vehicles, S = 49.0 mph

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

HCS+: Ramps and Ramp Junctions Release 5.4

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Merge Analysis

Analyst:	RCT
Agency/Co.:	IDOT/PB
Date performed:	8/18/2009
Analysis time period:	PM Peak
Freeway/Dir of Travel:	I-290 EB
Junction:	17th Ave. Entrance Ramp
Jurisdiction:	IDOT
Analysis Year:	2009

Description: I-290 Phase 1 Study

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	55.0	mph
Volume on freeway	5070	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	300	vph
Length of first accel/decel lane	793	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	260	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	On	
Distance to adjacent Ramp	2681	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	5070	300	260	vph
Peak-hour factor, PHF	0.95	0.95	0.95	
Peak 15-min volume, v15	1334	79	68	v
Trucks and buses	9	5	3	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	0.957	0.976	0.985	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	5577	324	278	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P = 0.600 Using Equation 1

```
                    FM
                   v   = v  (P   ) =  3345    pc/h
                    12    F   FM

________________________________Capacity Checks________________________________

                            Actual        Maximum         LOS F?
     v                      5901          6750            No
      FO
     v     v                2232 pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?            No
      3 or  av34
Is   v     v      > 1.5 v  /2             No
      3 or  av34        12
If yes, v    = 3345                       (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                       Actual        Max Desirable          Violation?
     v                 3345          4600                   No
      R12
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v   + 0.0078 v    - 0.00627 L   =   29.0    pc/mi/ln
          R                   R            12              A
Level of service for ramp-freeway junction areas of influence  D

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.418
                                              S
Space mean speed in ramp influence area,     S  = 49.6    mph
                                              R
Space mean speed in outer lanes,             S  = 48.8    mph
                                              0
Space mean speed for all vehicles,           S  = 49.3    mph
_______________________________________________________________________________
```

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

HCS+: Ramps and Ramp Junctions Release 5.4

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Merge Analysis

Analyst: RCT
Agency/Co.: IDOT/PB
Date performed: 8/18/2009
Analysis time period: AM Peak
Freeway/Dir of Travel: I-290 EB
Junction: 9th Ave. Entrance Ramp
Jurisdiction: IDOT
Analysis Year: 2009
Description: I-290 Phase 1 Study

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	55.0	mph
Volume on freeway	5450	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	390	vph
Length of first accel/decel lane	325	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	220	vph
Position of adjacent Ramp	Downstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	650	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	5450	390	220	vph
Peak-hour factor, PHF	0.95	0.95	0.95	
Peak 15-min volume, v15	1434	103	58	v
Trucks and buses	10	10	10	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	0.952	0.952	0.952	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	6024	431	243	pcph

Estimation of V12 Merge Areas

L_{EQ} = 1683.12 (Equation 25-2 or 25-3)

P = 0.647 Using Equation 3

```
                    FM
                   v   = v  (P   ) =  3897   pc/h
                    12   F    FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     6455          6750            No
      FO
     v     v               2127 pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    = 3897                      (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                3897          4600                   No
      R12
_________________Level of Service Determination (if not F)______________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   37.0    pc/mi/ln
                              R             12            A
Level of service for ramp-freeway junction areas of influence  E

_____________________________Speed Estimation___________________________________

Intermediate speed variable,                 M  = 0.594
                                              S
Space mean speed in ramp influence area,     S  = 47.3    mph
                                              R
Space mean speed in outer lanes,             S  = 49.1    mph
                                              0
Space mean speed for all vehicles,           S  = 47.9    mph
________________________________________________________________________________
```

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

HCS+: Ramps and Ramp Junctions Release 5.4

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Merge Analysis

Analyst: RCT
Agency/Co.: IDOT/PB
Date performed: 8/18/2009
Analysis time period: PM Peak
Freeway/Dir of Travel: I-290 EB
Junction: 9th Ave. Entrance Ramp
Jurisdiction: IDOT
Analysis Year: 2009
Description: I-290 Phase 1 Study

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	55.0	mph
Volume on freeway	5370	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	480	vph
Length of first accel/decel lane	325	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	220	vph
Position of adjacent Ramp	Downstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	650	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	5370	480	220	vph
Peak-hour factor, PHF	0.95	0.95	0.95	
Peak 15-min volume, v15	1413	126	58	v
Trucks and buses	9	3	9	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	0.957	0.985	0.957	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	5907	513	242	pcph

Estimation of V12 Merge Areas

L_{EQ} = 1676.19 (Equation 25-2 or 25-3)

P = 0.647 Using Equation 3

$v_{12} = v_F (P_{FM}) =$ 3819 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	6420	6750	No
v_{3} or v_{av34}	2088 pc/h	(Equation 25-4 or 25-5)	
Is v_{3} or v_{av34} > 2700 pc/h?		No	
Is v_{3} or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} = 3819		(Equation 25-8)	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	3819	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ = 37.0 pc/mi/ln

Level of service for ramp-freeway junction areas of influence E

Speed Estimation

Intermediate speed variable,	M_S = 0.595	
Space mean speed in ramp influence area,	S_R = 47.3	mph
Space mean speed in outer lanes,	S_0 = 49.3	mph
Space mean speed for all vehicles,	S = 47.9	mph

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

HCS+: Ramps and Ramp Junctions Release 5.4

Robert Tan
PBQD

Phone: Fax:
E-mail:

Diverge Analysis

Analyst: RCT
Agency/Co.: IDOT/PBQD
Date performed: 8/18/2009
Analysis time period: AM Peak
Freeway/Dir of Travel: I-290 EB
Junction: 1st Ave. Exit. Ramp
Jurisdiction: IDOT
Analysis Year: 2009
Description: I-290 Phase 1 Study

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	55.0	mph
Volume on freeway	5840	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	220	vph
Length of first accel/decel lane	155	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	390	vph
Position of adjacent ramp	Upstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	650	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	5840		220		390	vph
Peak-hour factor, PHF	0.95		0.95		0.95	
Peak 15-min volume, v15	1537		58		103	v
Trucks and buses	10		10		10	%
Recreational vehicles	0		0		0	%
Terrain type:	Level		Level		Level	
Grade	0.00	%	0.00	%	0.00	%
Length	0.00	mi	0.00	mi	0.00	mi
Trucks and buses PCE, ET	1.5		1.5		1.5	
Recreational vehicle PCE, ER	1.2		1.2		1.2	
Heavy vehicle adjustment, fHV	0.952		0.952		0.952	
Driver population factor, fP	1.00		1.00		1.00	
Flow rate, vp	6455		243		431	pcph

Estimation of V12 Diverge Areas

L_{EQ} = 2144.31 (Equation 25-8 or 25-9)

P = 0.866 Using Equation 6

$v_{12} = v_R + (v_F - v_R) P_{FD} = 5621$ pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	6455	6750	No
$v_{FO} = v_F - v_R$	6212	6750	No
v_R	243	2000	No
v_{3} or v_{av34}	834 pc/h	(Equation 25-15 or 25-16)	
Is v_{3} or v_{av34} > 2700 pc/h?		No	
Is v_{3} or v_{av34} > 1.5 v_{12} /2		No	
If yes, v_{12A} = 5621		(Equation 25-18)	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	5621	4400	Yes

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ = 51.2 pc/mi/ln

Level of service for ramp-freeway junction areas of influence E

Speed Estimation

Intermediate speed variable, D_S = 0.450

Space mean speed in ramp influence area, S_R = 49.2 mph

Space mean speed in outer lanes, S_0 = 60.3 mph

Space mean speed for all vehicles, S = 50.4 mph

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

HCS+: Ramps and Ramp Junctions Release 5.4

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PBQD

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	RCT
Agency/Co.:	IDOT/PBQD
Date performed:	8/18/2009
Analysis time period:	PM Peak
Freeway/Dir of Travel:	I-290 EB
Junction:	1st Ave. Exit. Ramp
Jurisdiction:	IDOT
Analysis Year:	2009

Description: I-290 Phase 1 Study

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	55.0	mph
Volume on freeway	5850	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	220	vph
Length of first accel/decel lane	155	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	480	vph
Position of adjacent ramp	Upstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	650	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	5850		220		480	vph
Peak-hour factor, PHF	0.95		0.95		0.95	
Peak 15-min volume, v15	1539		58		126	v
Trucks and buses	9		9		3	%
Recreational vehicles	0		0		0	%
Terrain type:	Level		Level		Level	
Grade	0.00	%	0.00	%	0.00	%
Length	0.00	mi	0.00	mi	0.00	mi
Trucks and buses PCE, ET	1.5		1.5		1.5	
Recreational vehicle PCE, ER	1.2		1.2		1.2	
Heavy vehicle adjustment, fHV	0.957		0.957		0.985	
Driver population factor, fP	1.00		1.00		1.00	
Flow rate, vp	6435		242		513	pcph

Estimation of V12 Diverge Areas

L_{EQ} = 2557.16 (Equation 25-8 or 25-9)

P = 0.943 Using Equation 6

```
                    FD
                   v   = v  + (v - v ) P  =  6080   pc/h
                    12   R     F   R   FD
_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                6435          6750            No
      Fi   F
     v  = v - v            6193          6750            No
      FO   F   R
     v                     242           2000            No
      R
     v     v               355  pc/h     (Equation 25-15 or 25-16)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            No
      3 or  av34         12
If yes, v    = 6080                      (Equation 25-18)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable          Violation?
     v                6080          4400                   Yes
      12
_________________Level of Service Determination (if not F)_____________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   55.1    pc/mi/ln
                        R                   12         D
Level of service for ramp-freeway junction areas of influence E

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.450
                                              S
Space mean speed in ramp influence area,     S  = 49.2    mph
                                              R
Space mean speed in outer lanes,             S  = 60.3    mph
                                              0
Space mean speed for all vehicles,           S  = 49.7    mph
_______________________________________________________________________________
```

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

HCS+: Ramps and Ramp Junctions Release 5.4

Robert Tan
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Phone: Fax:
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Merge Analysis

Analyst:	RCT
Agency/Co.:	IDOT/PBQD
Date performed:	8/18/2009
Analysis time period:	AM Peak
Freeway/Dir of Travel:	I-290 EB
Junction:	1st Ave. Entrance Ramp
Jurisdiction:	IDOT
Analysis Year:	2009

Description: I-290 Phase 1 STUDY

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	55.0	mph
Volume on freeway	5620	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	620	vph
Length of first accel/decel lane	290	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	140	vph
Position of adjacent Ramp	Downstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	3062	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	5620		620		140	vph
Peak-hour factor, PHF	0.95		0.95		0.95	
Peak 15-min volume, v15	1479		163		37	v
Trucks and buses	10		12		10	%
Recreational vehicles	0		0		0	%
Terrain type:	Level		Level		Level	
Grade		%		%		%
Length		mi		mi		mi
Trucks and buses PCE, ET	1.5		1.5		1.5	
Recreational vehicle PCE, ER	1.2		1.2		1.2	
Heavy vehicle adjustment, fHV	0.952		0.943		0.952	
Driver population factor, fP	1.00		1.00		1.00	
Flow rate, vp	6212		692		155	pcph

Estimation of V12 Merge Areas

L_{EQ} = 1102.18 (Equation 25-2 or 25-3)

P = 0.586 Using Equation 1

$v_{12} = v_F (P_{FM}) = 3638$ pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	6904	6750	Yes
v_3 or v_{av34}	2574 pc/h	(Equation 25-4 or 25-5)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12} /2		No	
If yes, v_{12A} = 3638		(Equation 25-8)	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	3638	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A = 37.1$ pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable,	$M_S = 0.597$	
Space mean speed in ramp influence area,	$S_R = 47.2$	mph
Space mean speed in outer lanes,	$S_0 = 46.8$	mph
Space mean speed for all vehicles,	$S = 47.1$	mph

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PBQD

Phone: Fax:
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Merge Analysis

Analyst:	RCT
Agency/Co.:	IDOT/PBQD
Date performed:	8/18/2009
Analysis time period:	PM Peak
Freeway/Dir of Travel:	I-290 EB
Junction:	1st Ave. Entrance Ramp
Jurisdiction:	IDOT
Analysis Year:	2009

Description: I-290 Phase 1 STUDY

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	55.0	mph
Volume on freeway	5630	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	880	vph
Length of first accel/decel lane	290	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	270	vph
Position of adjacent Ramp	Downstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	3062	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	5630		880		270	vph
Peak-hour factor, PHF	0.95		0.95		0.95	
Peak 15-min volume, v15	1482		232		71	v
Trucks and buses	9		2		2	%
Recreational vehicles	0		0		0	%
Terrain type:	Level		Level		Level	
Grade		%		%		%
Length		mi		mi		mi
Trucks and buses PCE, ET	1.5		1.5		1.5	
Recreational vehicle PCE, ER	1.2		1.2		1.2	
Heavy vehicle adjustment, fHV	0.957		0.990		0.990	
Driver population factor, fP	1.00		1.00		1.00	
Flow rate, vp	6193		936		287	pcph

Estimation of V12 Merge Areas

L_{EQ} = 2040.82 (Equation 25-2 or 25-3)

P = 0.586 Using Equation 1

$v_{12} = v_F (P_{FM}) = 3627$ pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	7129	6750	Yes
v_{3} or v_{av34}	2566 pc/h	(Equation 25-4 or 25-5)	
Is v_{3} or v_{av34} > 2700 pc/h?		No	
Is v_{3} or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} = 3627		(Equation 25-8)	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	3627	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A = 38.8$ pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable, $M_S = 0.675$

Space mean speed in ramp influence area, $S_R = 46.2$ mph

Space mean speed in outer lanes, $S_0 = 46.9$ mph

Space mean speed for all vehicles, $S = 46.5$ mph

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Diverge Analysis

Analyst:	RCT
Agency/Co.:	IDOT/PBQD
Date performed:	8/18/2009
Analysis time period:	AM Peak
Freeway/Dir of Travel:	I-290 EB
Junction:	Des Plaines Ave. Exit Ramp
Jurisdiction:	IDOT
Analysis Year:	2009

Description: I-290 Phase 1 Study

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	55.0	mph
Volume on freeway	6240	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	140	vph
Length of first accel/decel lane	167	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	620	vph
Position of adjacent ramp	Upstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	3062	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	6240		140		620	vph
Peak-hour factor, PHF	0.95		0.95		0.95	
Peak 15-min volume, v15	1642		37		163	v
Trucks and buses	10		10		12	%
Recreational vehicles	0		0		0	%
Terrain type:	Level		Level		Level	
Grade	0.00	%	0.00	%	0.00	%
Length	0.00	mi	0.00	mi	0.00	mi
Trucks and buses PCE, ET	1.5		1.5		1.5	
Recreational vehicle PCE, ER	1.2		1.2		1.2	
Heavy vehicle adjustment, fHV	0.952		0.952		0.943	
Driver population factor, fP	1.00		1.00		1.00	
Flow rate, vp	6897		155		692	pcph

Estimation of V12 Diverge Areas

L_{EQ} = 3176.48 (Equation 25-8 or 25-9)

P = 0.585 Using Equation 6

$v_{12} = v_R + (v_F - v_R) P_{FD} = 4096$ pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	6897	6750	Yes
$v_{FO} = v_F - v_R$	6742	6750	No
v_R	155	2000	No
v_3 or v_{av34}	2801 pc/h	(Equation 25-15 or 25-16)	
Is v_3 or v_{av34} > 2700 pc/h?		Yes	
Is v_3 or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} = 4197		(Equation 25-18)	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	4197	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ = 38.8 pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable,	D_S = 0.442	
Space mean speed in ramp influence area,	S_R = 49.3	mph
Space mean speed in outer lanes,	S_0 = 53.7	mph
Space mean speed for all vehicles,	S = 50.9	mph

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Diverge Analysis

Analyst:	RCT
Agency/Co.:	IDOT/PBQD
Date performed:	8/18/2009
Analysis time period:	PM Peak
Freeway/Dir of Travel:	I-290 EB
Junction:	Des Plaines Ave. Exit Ramp
Jurisdiction:	IDOT
Analysis Year:	2009

Description: I-290 Phase 1 Study

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	55.0	mph
Volume on freeway	6510	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	270	vph
Length of first accel/decel lane	167	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	880	vph
Position of adjacent ramp	Upstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	3062	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	6510		270		880	vph
Peak-hour factor, PHF	0.95		0.95		0.95	
Peak 15-min volume, v15	1713		71		232	v
Trucks and buses	9		2		2	%
Recreational vehicles	0		0		0	%
Terrain type:	Level		Level		Level	
Grade	0.00	%	0.00	%	0.00	%
Length	0.00	mi	0.00	mi	0.00	mi
Trucks and buses PCE, ET	1.5		1.5		1.5	
Recreational vehicle PCE, ER	1.2		1.2		1.2	
Heavy vehicle adjustment, fHV	0.957		0.990		0.990	
Driver population factor, fP	1.00		1.00		1.00	
Flow rate, vp	7161		287		936	pcph

Estimation of V12 Diverge Areas

L_{EQ} = 4376.06 (Equation 25-8 or 25-9)

P = 0.622 Using Equation 6

$$v_{12} = v_R + (v_F - v_R) P_{FD} = 4565 \quad pc/h$$

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	7161	6750	Yes
$v_{FO} = v_F - v_R$	6874	6750	Yes
v_R	287	2000	No
v_3 or v_{av34}	2596 pc/h	(Equation 25-15 or 25-16)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} = 4565		(Equation 25-18)	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	4565	4400	Yes

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 42.0 pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable, D_S = 0.454

Space mean speed in ramp influence area, S_R = 49.1 mph

Space mean speed in outer lanes, S_0 = 54.1 mph

Space mean speed for all vehicles, S = 50.8 mph

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Diverge Analysis

Analyst:	RCT
Agency/Co.:	IDOT/PBQD
Date performed:	8/18/2009
Analysis time period:	AM Peak
Freeway/Dir of Travel:	I-290 EB
Junction:	Harlem Ave. Exit Ramp
Jurisdiction:	IDOT
Analysis Year:	2009

Description: I-290 Phase 1 Study

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	55.0	mph
Volume on freeway	6100	vph

Off Ramp Data

Side of freeway	Left	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	250	vph
Length of first accel/decel lane	260	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	820	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	2010	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	6100		250		820	vph
Peak-hour factor, PHF	0.95		0.95		0.95	
Peak 15-min volume, v15	1605		66		216	v
Trucks and buses	10		10		10	%
Recreational vehicles	0		0		0	%
Terrain type:	Level		Level		Level	
Grade	0.00	%	0.00	%	0.00	%
Length	0.00	mi	0.00	mi	0.00	mi
Trucks and buses PCE, ET	1.5		1.5		1.5	
Recreational vehicle PCE, ER	1.2		1.2		1.2	
Heavy vehicle adjustment, fHV	0.952		0.952		0.952	
Driver population factor, fP	1.00		1.00		1.00	
Flow rate, vp	6742		276		906	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P = 0.579 Using Equation 5

$$v_{12} = v_R + (v_F - v_R) P_{FD} = 4018 \text{ pc/h}$$

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	6742	6750	No
$v_{FO} = v_F - v_R$	6466	6750	No
v_R	276	2000	No
v_3 or v_{av34}	2724 pc/h	(Equation 25-15 or 25-16)	

Is v_3 or v_{av34} > 2700 pc/h? Yes

Is v_3 or v_{av34} > 1.5 v_{12}/2 No

If yes, v_{12A} = 4042 (Equation 25-18)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	4042	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D = 38.4$ pc/mi/ln

Level of service for ramp-freeway junction areas of influence E

Speed Estimation

Intermediate speed variable, D_S = 0.453

Space mean speed in ramp influence area, S_R = 49.1 mph

Space mean speed in outer lanes, S_0 = 54.5 mph

Space mean speed for all vehicles, S = 51.0 mph

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Diverge Analysis

Analyst:	RCT
Agency/Co.:	IDOT/PBQD
Date performed:	8/18/2009
Analysis time period:	PM Peak
Freeway/Dir of Travel:	I-290 EB
Junction:	Harlem Ave. Exit Ramp
Jurisdiction:	IDOT
Analysis Year:	2009

Description: I-290 Phase 1 Study

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	55.0	mph
Volume on freeway	6240	vph

Off Ramp Data

Side of freeway	Left	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	460	vph
Length of first accel/decel lane	260	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	830	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	2010	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	6240		460		830	vph
Peak-hour factor, PHF	0.95		0.95		0.95	
Peak 15-min volume, v15	1642		121		218	v
Trucks and buses	9		9		2	%
Recreational vehicles	0		0		0	%
Terrain type:	Level		Level		Level	
Grade	0.00	%	0.00	%	0.00	%
Length	0.00	mi	0.00	mi	0.00	mi
Trucks and buses PCE, ET	1.5		1.5		1.5	
Recreational vehicle PCE, ER	1.2		1.2		1.2	
Heavy vehicle adjustment, fHV	0.957		0.957		0.990	
Driver population factor, fP	1.00		1.00		1.00	
Flow rate, vp	6864		506		882	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 0.565 Using Equation 5

$$v_{12} = v_R + (v_F - v_R) P_{FD} = 4099 \text{ pc/h}$$

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	6864	6750	Yes
$v_{FO} = v_F - v_R$	6358	6750	No
v_R	506	2000	No
v_3 or v_{av34}	2765 pc/h	(Equation 25-15 or 25-16)	
Is v_3 or v_{av34} > 2700 pc/h?		Yes	
Is v_3 or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} = 4164		(Equation 25-18)	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	4164	4400	No

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086\, v_{12} - 0.009\, L_D = 39.5$ pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable, $D_S = 0.474$

Space mean speed in ramp influence area, $S_R = 48.8$ mph

Space mean speed in outer lanes, $S_0 = 54.5$ mph

Space mean speed for all vehicles, $S = 50.8$ mph

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Merge Analysis

Analyst:	RCT
Agency/Co.:	IDOT/PBQD
Date performed:	8/18/2009
Analysis time period:	AM Peak
Freeway/Dir of Travel:	I-290 EB
Junction:	Harlem Ave. Entrance Ramp
Jurisdiction:	IDOT
Analysis Year:	2009

Description: I-290 Phase 1 Study

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	55.0	mph
Volume on freeway	5850	vph

On Ramp Data

Side of freeway	Left	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	820	vph
Length of first accel/decel lane	900	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	250	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	2010	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	5850	820	250	vph
Peak-hour factor, PHF	0.95	0.95	0.95	
Peak 15-min volume, v15	1539	216	66	v
Trucks and buses	10	3	10	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	0.952	0.985	0.952	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	6466	876	276	pcph

Estimation of V12 Merge Areas

L_{EQ} = 1398.99 (Equation 25-2 or 25-3)

P = 0.603 Using Equation 1

$v_{12} = v_F (P_{FM}) = 3897$ pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	7342	6750	Yes
v_3 or v_{av34}	2569 pc/h	(Equation 25-4 or 25-5)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} = 3897		(Equation 25-8)	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	3897	4600	Yes

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A = 40.3$ pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable, $M_S = 0.994$

Space mean speed in ramp influence area, $S_R = 42.1$ mph

Space mean speed in outer lanes, $S_0 = 49.2$ mph

Space mean speed for all vehicles, $S = 43.9$ mph

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PBQD

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Merge Analysis

Analyst: RCT
Agency/Co.: IDOT/PBQD
Date performed: 8/18/2009
Analysis time period: PM Peak
Freeway/Dir of Travel: I-290 EB
Junction: Harlem Ave. Entrance Ramp
Jurisdiction: IDOT
Analysis Year: 2009
Description: I-290 Phase 1 Study

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	55.0	mph
Volume on freeway	5780	vph

On Ramp Data

Side of freeway	Left	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	830	vph
Length of first accel/decel lane	900	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	460	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	2010	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	5780		830		460	vph
Peak-hour factor, PHF	0.95		0.95		0.95	
Peak 15-min volume, v15	1521		218		121	v
Trucks and buses	9		2		9	%
Recreational vehicles	0		0		0	%
Terrain type:	Level		Level		Level	
Grade		%		%		%
Length		mi		mi		mi
Trucks and buses PCE, ET	1.5		1.5		1.5	
Recreational vehicle PCE, ER	1.2		1.2		1.2	
Heavy vehicle adjustment, fHV	0.957		0.990		0.957	
Driver population factor, fP	1.00		1.00		1.00	
Flow rate, vp	6358		882		506	pcph

Estimation of V12 Merge Areas

L_{EQ} = 1377.16 (Equation 25-2 or 25-3)

P = 0.603 Using Equation 1

$v_{12} = v_F (P_{FM}) = 3832$ pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	7240	6750	Yes
v_3 or v_{av34}	2526 pc/h	(Equation 25-4 or 25-5)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} = 3832		(Equation 25-8)	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	3832	4600	Yes

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 39.8 pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable, $M_S = 0.946$

Space mean speed in ramp influence area, $S_R = 42.7$ mph

Space mean speed in outer lanes, $S_0 = 49.4$ mph

Space mean speed for all vehicles, $S = 44.4$ mph

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Diverge Analysis

Analyst:	RCT
Agency/Co.:	IDOT/PBQD
Date performed:	8/18/2009
Analysis time period:	AM Peak
Freeway/Dir of Travel:	I-290 EB
Junction:	Austin Ave. Exit Ramp
Jurisdiction:	IDOT
Analysis Year:	2009

Description: I-290 Phase 1 Study

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	55.0	mph
Volume on freeway	6670	vph

Off Ramp Data

Side of freeway	Left	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	180	vph
Length of first accel/decel lane	301	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	6670		180			vph
Peak-hour factor, PHF	0.95		0.95			
Peak 15-min volume, v15	1755		47			v
Trucks and buses	10		10			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	0.952		0.952			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	7372		199			pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P = 0.567 Using Equation 5

$v_{12} = v_R + (v_F - v_R) P_{FD} = 4263$ pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	7372	6750	Yes
$v_{FO} = v_F - v_R$	7173	6750	Yes
v_R	199	2000	No
v_3 or v_{av34}	3109 pc/h	(Equation 25-15 or 25-16)	
Is v_3 or v_{av34} > 2700 pc/h?		Yes	
Is v_3 or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} = 4672		(Equation 25-18)	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	4672	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D = 43.7$ pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable, $D_S = 0.446$

Space mean speed in ramp influence area, $S_R = 49.2$ mph

Space mean speed in outer lanes, $S_0 = 54.6$ mph

Space mean speed for all vehicles, $S = 50.9$ mph

HCS+: Ramps and Ramp Junctions Release 5.4

Robert Tan
PBQD

Phone: Fax:
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Diverge Analysis

Analyst: RCT
Agency/Co.: IDOT/PBQD
Date performed: 8/18/2009
Analysis time period: PM Peak
Freeway/Dir of Travel: I-290 EB
Junction: Austin Ave. Exit Ramp
Jurisdiction: IDOT
Analysis Year: 2009
Description: I-290 Phase 1 Study

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	55.0	mph
Volume on freeway	6610	vph

Off Ramp Data

Side of freeway	Left	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	460	vph
Length of first accel/decel lane	301	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	6610		460			vph
Peak-hour factor, PHF	0.95		0.95			
Peak 15-min volume, v15	1739		121			v
Trucks and buses	9		9			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	0.957		0.957			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	7271		506			pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)
P_{FD} = 0.555 Using Equation 5

$$v_{12} = v_R + (v_F - v_R) P_{FD} = 4260 \text{ pc/h}$$

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	7271	6750	Yes
$v_{FO} = v_F - v_R$	6765	6750	Yes
v_R	506	2000	No
v_3 or v_{av34}	3011 pc/h	(Equation 25-15 or 25-16)	
Is v_3 or v_{av34} > 2700 pc/h?		Yes	
Is v_3 or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} = 4571		(Equation 25-18)	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	4571	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$ = 42.8 pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable, D_S = 0.474

Space mean speed in ramp influence area, S_R = 48.8 mph

Space mean speed in outer lanes, S_0 = 54.6 mph

Space mean speed for all vehicles, S = 50.7 mph

HCS+: Ramps and Ramp Junctions Release 5.4

Robert Tan
PBQD

Phone: Fax:
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Merge Analysis

Analyst:	RCT
Agency/Co.:	IDOT/PBQD
Date performed:	8/18/2009
Analysis time period:	AM Peak
Freeway/Dir of Travel:	I-290 EB
Junction:	Austin Ave. Entrance Ramp
Jurisdiction:	IDOT
Analysis Year:	2009

Description: I-290 Phase 1 Study

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	55.0	mph
Volume on freeway	6490	vph

On Ramp Data

Side of freeway	Left	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	1180	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	6490		1180			vph
Peak-hour factor, PHF	0.95		0.95			
Peak 15-min volume, v15	1708		311			v
Trucks and buses	10		0			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade		%		%	%	
Length		mi		mi	mi	
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	0.952		1.000			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	7173		1242			pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P = 0.619 Using Equation 1

$v_{12}^{FM} = v_F\ (P_{FM}) = 4444$ pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	8415	6750	Yes
v_3 or v_{av34}	2729 pc/h	(Equation 25-4 or 25-5)	
Is v_3 or v_{av34} > 2700 pc/h?		Yes	
Is v_3 or v_{av34} > 1.5 v_{12} /2		No	
If yes, v_{12A} = 4473		(Equation 25-8)	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	4473	4600	Yes

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A = 44.3$ pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable,	M_S = 2.238	
Space mean speed in ramp influence area,	S_R = 25.9	mph
Space mean speed in outer lanes,	S_0 = 49.0	mph
Space mean speed for all vehicles,	S = 29.5	mph

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

HCS+: Ramps and Ramp Junctions Release 5.4

Robert Tan
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Phone: Fax:
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Merge Analysis

Analyst: RCT
Agency/Co.: IDOT/PBQD
Date performed: 8/18/2009
Analysis time period: PM Peak
Freeway/Dir of Travel: I-290 EB
Junction: Austin Ave. Entrance Ramp
Jurisdiction: IDOT
Analysis Year: 2009
Description: I-290 Phase 1 Study

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	55.0	mph
Volume on freeway	6150	vph

On Ramp Data

Side of freeway	Left	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	960	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	6150		960			vph
Peak-hour factor, PHF	0.95		0.95			
Peak 15-min volume, v15	1618		253			v
Trucks and buses	9		0			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade		%		%		%
Length		mi		mi		mi
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	0.957		1.000			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	6765		1011			pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P = 0.619 Using Equation 1

$v_{12} = v_F (P_{FM}) = 4191$ pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	7776	6750	Yes
v_3 or v_{av34}	2574 pc/h	(Equation 25-4 or 25-5)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} = 4191		(Equation 25-8)	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	4191	4600	Yes

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A = 40.1$ pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable,	M_S = 1.386	
Space mean speed in ramp influence area,	S_R = 37.0	mph
Space mean speed in outer lanes,	S_0 = 49.3	mph
Space mean speed for all vehicles,	S = 39.6	mph

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

HCS+: Ramps and Ramp Junctions Release 5.4

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Diverge Analysis

Analyst:	RCT
Agency/Co.:	IDOT/PBQD
Date performed:	8/18/2009
Analysis time period:	AM Peak
Freeway/Dir of Travel:	I-290 EB
Junction:	Central Ave. Exit. Ramp
Jurisdiction:	IDOT
Analysis Year:	2009

Description: I-290 Phase 1 Study

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	4	
Free-flow speed on freeway	55.0	mph
Volume on freeway	7670	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	310	vph
Length of first accel/decel lane	270	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	620	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	2270	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	7670		310		620	vph
Peak-hour factor, PHF	0.95		0.95		0.95	
Peak 15-min volume, v15	2018		82		163	v
Trucks and buses	10		10		2	%
Recreational vehicles	0		0		0	%
Terrain type:	Level		Level		Level	
Grade	0.00	%	0.00	%	0.00	%
Length	0.00	mi	0.00	mi	0.00	mi
Trucks and buses PCE, ET	1.5		1.5		1.5	
Recreational vehicle PCE, ER	1.2		1.2		1.2	
Heavy vehicle adjustment, fHV	0.952		0.952		0.990	
Driver population factor, fP	1.00		1.00		1.00	
Flow rate, vp	8477		343		659	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P = 0.436 Using Equation 8

$$v_{12} = v_R + (v_F - v_R) P_{FD} = 3889 \quad pc/h$$

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	8477	9000	No
$v_{FO} = v_F - v_R$	8134	9000	No
v_R	343	2000	No
v_{3} or v_{av34}	2294 pc/h	(Equation 25-15 or 25-16)	
Is v_{3} or v_{av34} > 2700 pc/h?		No	
Is v_{3} or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} = 3889		(Equation 25-18)	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	3889	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D = 35.3$ pc/mi/ln

Level of service for ramp-freeway junction areas of influence E

Speed Estimation

Intermediate speed variable,	$D_S = 0.459$	
Space mean speed in ramp influence area,	$S_R = 49.0$	mph
Space mean speed in outer lanes,	$S_0 = 55.3$	mph
Space mean speed for all vehicles,	$S = 52.2$	mph

HCS+: Ramps and Ramp Junctions Release 5.4

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Diverge Analysis

Analyst:	RCT
Agency/Co.:	IDOT/PBQD
Date performed:	8/18/2009
Analysis time period:	PM Peak
Freeway/Dir of Travel:	I-290 EB
Junction:	Central Ave. Exit. Ramp
Jurisdiction:	IDOT
Analysis Year:	2009

Description: I-290 Phase 1 Study

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	4	
Free-flow speed on freeway	55.0	mph
Volume on freeway	7110	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	580	vph
Length of first accel/decel lane	270	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	600	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	2270	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	7110		580		600	vph
Peak-hour factor, PHF	0.95		0.95		0.95	
Peak 15-min volume, v15	1871		153		158	v
Trucks and buses	9		9		3	%
Recreational vehicles	0		0		0	%
Terrain type:	Level		Level		Level	
Grade	0.00	%	0.00	%	0.00	%
Length	0.00	mi	0.00	mi	0.00	mi
Trucks and buses PCE, ET	1.5		1.5		1.5	
Recreational vehicle PCE, ER	1.2		1.2		1.2	
Heavy vehicle adjustment, fHV	0.957		0.957		0.985	
Driver population factor, fP	1.00		1.00		1.00	
Flow rate, vp	7821		638		641	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P = 0.436 Using Equation 8

FD

$v_{12} = v_R + (v_F - v_R) P_{FD} = 3770$ pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	7821	9000	No
$v_{FO} = v_F - v_R$	7183	9000	No
v_R	638	2000	No
v_3 or v_{av34}	2025 pc/h	(Equation 25-15 or 25-16)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} = 3770		(Equation 25-18)	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	3770	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D = 34.2$ pc/mi/ln

Level of service for ramp-freeway junction areas of influence D

Speed Estimation

Intermediate speed variable, $D_S = 0.485$

Space mean speed in ramp influence area, $S_R = 48.7$ mph

Space mean speed in outer lanes, $S_0 = 56.3$ mph

Space mean speed for all vehicles, $S = 52.4$ mph

HCS+: Ramps and Ramp Junctions Release 5.4

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Merge Analysis

Analyst:	RCT
Agency/Co.:	IDOT/PBQD
Date performed:	8/18/2009
Analysis time period:	AM Peak
Freeway/Dir of Travel:	I-290 EB
Junction:	Central Ave. Entrance Ramp
Jurisdiction:	IDOT
Analysis Year:	2009

Description: I-290 Phase 1 Study

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	4	
Free-flow speed on freeway	55.0	mph
Volume on freeway	7360	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	620	vph
Length of first accel/decel lane	552	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	310	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	2270	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	7360	620	310	vph
Peak-hour factor, PHF	0.95	0.95	0.95	
Peak 15-min volume, v15	1937	163	82	v
Trucks and buses	10	2	10	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	0.952	0.990	0.952	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	8135	659	343	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 0.135 Using Equation 4

$v_{12} = v_F (P_{FM}) = 1102$ pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	8794	9000	No
v_3 or v_{av34}	3516 pc/h	(Equation 25-4 or 25-5)	
Is v_3 or v_{av34} > 2700 pc/h?		Yes	
Is v_3 or v_{av34} > 1.5 v_{12}/2		Yes	
If yes, v_{12A} = 3254		(Equation 25-8)	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	3254	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A = 32.2$ pc/mi/ln

Level of service for ramp-freeway junction areas of influence D

Speed Estimation

Intermediate speed variable, $M_S = 0.478$

Space mean speed in ramp influence area, $S_R = 48.8$ mph

Space mean speed in outer lanes, $S_0 = 47.6$ mph

Space mean speed for all vehicles, $S = 48.1$ mph

HCS+: Ramps and Ramp Junctions Release 5.4

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Merge Analysis

Analyst:	RCT
Agency/Co.:	IDOT/PBQD
Date performed:	8/18/2009
Analysis time period:	PM Peak
Freeway/Dir of Travel:	I-290 EB
Junction:	Central Ave. Entrance Ramp
Jurisdiction:	IDOT
Analysis Year:	2009

Description: I-290 Phase 1 Study

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	4	
Free-flow speed on freeway	55.0	mph
Volume on freeway	6530	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	600	vph
Length of first accel/decel lane	552	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	580	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	2270	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	6530		600		580	vph
Peak-hour factor, PHF	0.95		0.95		0.95	
Peak 15-min volume, v15	1718		158		153	v
Trucks and buses	9		3		9	%
Recreational vehicles	0		0		0	%
Terrain type:	Level		Level		Level	
Grade		%		%		%
Length		mi		mi		mi
Trucks and buses PCE, ET	1.5		1.5		1.5	
Recreational vehicle PCE, ER	1.2		1.2		1.2	
Heavy vehicle adjustment, fHV	0.957		0.985		0.957	
Driver population factor, fP	1.00		1.00		1.00	
Flow rate, vp	7183		641		638	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P = 0.138 Using Equation 4

$v_{12} = v_F (P_{FM}) =$ 989 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	7824	9000	No
v_3 or v_{av34}	3097 pc/h	(Equation 25-4 or 25-5)	
Is v_3 or v_{av34} > 2700 pc/h?		Yes	
Is v_3 or v_{av34} > 1.5 v_{12}/2		Yes	
If yes, v_{12A} = 2873		(Equation 25-8)	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	2873	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$ = 29.1 pc/mi/ln

Level of service for ramp-freeway junction areas of influence D

Speed Estimation

Intermediate speed variable, M_S = 0.413

Space mean speed in ramp influence area, S_R = 49.6 mph

Space mean speed in outer lanes, S_0 = 49.0 mph

Space mean speed for all vehicles, S = 49.3 mph

HCS+: Ramps and Ramp Junctions Release 5.4

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Diverge Analysis

Analyst:	
Agency/Co.:	IDOT/PB
Date performed:	4/1/2009
Analysis time period:	AM Peak
Freeway/Dir of Travel:	I-290 WB
Junction:	25th Ave. Exit to SB
Jurisdiction:	IDOT
Analysis Year:	2009

Description: I-290 Ramp Junction Analysis

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	55.0	mph
Volume on freeway	6830	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	20.0	mph
Volume on ramp	300	vph
Length of first accel/decel lane	125	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	6830		300			vph
Peak-hour factor, PHF	0.95		0.95			
Peak 15-min volume, v15	1797		79			v
Trucks and buses	10		10			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade	0.00	%	0.00	%	%	
Length	0.00	mi	0.00	mi	mi	
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	0.952		0.952			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	7549		332			pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P = 0.556 Using Equation 5

$v_{12} = v_R + (v_F - v_R) P_{FD} = 4345$ pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	7549	6750	Yes
$v_{FO} = v_F - v_R$	7217	6750	Yes
v_R	332	1900	No
v_3 or v_{av34}	3204 pc/h	(Equation 25-15 or 25-16)	
Is v_3 or v_{av34} > 2700 pc/h?		Yes	
Is v_3 or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} = 4849		(Equation 25-18)	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	4849	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 44.8 pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable, D_S = 0.653

Space mean speed in ramp influence area, S_R = 46.5 mph

Space mean speed in outer lanes, S_0 = 53.7 mph

Space mean speed for all vehicles, S = 48.9 mph

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Diverge Analysis

Analyst:
Agency/Co.: IDOT/PB
Date performed: 4/1/2009
Analysis time period: PM Peak
Freeway/Dir of Travel: I-290 WB
Junction: 25th Ave. Exit to SB
Jurisdiction: IDOT
Analysis Year: 2009
Description: I-290 Ramp Junction Analysis

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	55.0	mph
Volume on freeway	6550	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	20.0	mph
Volume on ramp	250	vph
Length of first accel/decel lane	125	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent ramp		vph
Position of adjacent ramp		
Type of adjacent ramp		
Distance to adjacent ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	6550		250			vph
Peak-hour factor, PHF	0.95		0.95			
Peak 15-min volume, v15	1724		66			v
Trucks and buses	3		3			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade	0.00	%	0.00	%		%
Length	0.00	mi	0.00	mi		mi
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	0.985		0.985			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	6998		267			pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 0.573 Using Equation 5

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 4122 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	6998	6750	Yes
$v_{FO} = v_F - v_R$	6731	6750	No
v_R	267	1900	No
v_3 or v_{av34}	2876 pc/h	(Equation 25-15 or 25-16)	
Is v_3 or v_{av34} > 2700 pc/h?		Yes	
Is v_3 or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} = 4298		(Equation 25-18)	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	4298	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 40.1 pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable,	D_S = 0.647	
Space mean speed in ramp influence area,	S_R = 46.6	mph
Space mean speed in outer lanes,	S_0 = 53.7	mph
Space mean speed for all vehicles,	S = 49.1	mph

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Diverge Analysis

Analyst:	
Agency/Co.:	IDOT/PB
Date performed:	4/1/2009
Analysis time period:	AM Peak
Freeway/Dir of Travel:	I-290 WB
Junction:	17th Ave. Exit
Jurisdiction:	IDOT
Analysis Year:	2009

Description: I-290 Ramp Junction Analysis

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	55.0	mph
Volume on freeway	6470	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	80	vph
Length of first accel/decel lane	311	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	100	vph
Position of adjacent ramp	Upstream	
Type of adjacent ramp	Off	
Distance to adjacent ramp	2474	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	6470		80		100	vph
Peak-hour factor, PHF	0.95		0.95		0.95	
Peak 15-min volume, v15	1703		21		26	v
Trucks and buses	10		10		10	%
Recreational vehicles	0		0		0	%
Terrain type:	Level		Level		Level	
Grade	0.00	%	0.00	%	0.00	%
Length	0.00	mi	0.00	mi	0.00	mi
Trucks and buses PCE, ET	1.5		1.5		1.5	
Recreational vehicle PCE, ER	1.2		1.2		1.2	
Heavy vehicle adjustment, fHV	0.952		0.952		0.952	
Driver population factor, fP	1.00		1.00		1.00	
Flow rate, vp	7151		88		111	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 0.577 Using Equation 5

$v_{12} = v_R + (v_F - v_R) P_{FD} = 4165$ pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	7151	6750	Yes
$v_{FO} = v_F - v_R$	7063	6750	Yes
v_R	88	2000	No
v_3 or v_{av34}	2986 pc/h	(Equation 25-15 or 25-16)	
Is v_3 or v_{av34} > 2700 pc/h?		Yes	
Is v_3 or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} = 4451		(Equation 25-18)	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	4451	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D = 39.7$ pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable, $D_S = 0.436$

Space mean speed in ramp influence area, $S_R = 49.3$ mph

Space mean speed in outer lanes, $S_0 = 53.7$ mph

Space mean speed for all vehicles, $S = 50.9$ mph

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Diverge Analysis

Analyst:
Agency/Co.: IDOT/PB
Date performed: 4/1/2009
Analysis time period: PM Peak
Freeway/Dir of Travel: I-290 WB
Junction: 17th Ave. Exit
Jurisdiction: IDOT
Analysis Year: 2009
Description: I-290 Ramp Junction Analysis

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	55.0	mph
Volume on freeway	6370	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	150	vph
Length of first accel/decel lane	311	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	190	vph
Position of adjacent ramp	Upstream	
Type of adjacent ramp	Off	
Distance to adjacent ramp	2474	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	6370		150		190	vph
Peak-hour factor, PHF	0.95		0.95		0.95	
Peak 15-min volume, v15	1676		39		50	v
Trucks and buses	3		3		3	%
Recreational vehicles	0		0		0	%
Terrain type:	Level		Level		Level	
Grade	0.00	%	0.00	%	0.00	%
Length	0.00	mi	0.00	mi	0.00	mi
Trucks and buses PCE, ET	1.5		1.5		1.5	
Recreational vehicle PCE, ER	1.2		1.2		1.2	
Heavy vehicle adjustment, fHV	0.985		0.985		0.985	
Driver population factor, fP	1.00		1.00		1.00	
Flow rate, vp	6806		160		203	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 0.582 Using Equation 5

$v_{12} = v_R + (v_F - v_R) P_{FD} = 4031$ pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	6806	6750	Yes
$v_{FO} = v_F - v_R$	6646	6750	No
v_R	160	2000	No
v_3 or v_{av34}	2775 pc/h	(Equation 25-15 or 25-16)	
Is v_3 or v_{av34} > 2700 pc/h?		Yes	
Is v_3 or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} = 4106		(Equation 25-18)	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	4106	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D = 36.8$ pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable,	$D_S = 0.442$	
Space mean speed in ramp influence area,	$S_R = 49.2$	mph
Space mean speed in outer lanes,	$S_0 = 53.7$	mph
Space mean speed for all vehicles,	$S = 50.9$	mph

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Diverge Analysis

Analyst:
Agency/Co.: IDOT/PB
Date performed: 4/1/2009
Analysis time period: AM Peak
Freeway/Dir of Travel: I-290 WB
Junction: 9th Ave. Exit
Jurisdiction: IDOT
Analysis Year: 2009
Description: I-290 Ramp Junction Analysis

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	55.0	mph
Volume on freeway	6570	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	100	vph
Length of first accel/decel lane	184	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	550	vph
Position of adjacent ramp	Upstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	800	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	6570		100		550	vph
Peak-hour factor, PHF	0.95		0.95		0.95	
Peak 15-min volume, v15	1729		26		145	v
Trucks and buses	10		10		16	%
Recreational vehicles	0		0		0	%
Terrain type:	Level		Level		Level	
Grade	0.00	%	0.00	%	0.00	%
Length	0.00	mi	0.00	mi	0.00	mi
Trucks and buses PCE, ET	1.5		1.5		1.5	
Recreational vehicle PCE, ER	1.2		1.2		1.2	
Heavy vehicle adjustment, fHV	0.952		0.952		0.926	
Driver population factor, fP	1.00		1.00		1.00	
Flow rate, vp	7262		111		625	pcph

Estimation of V12 Diverge Areas

L_{EQ} = 2722.24 (Equation 25-8 or 25-9)
P = 0.906 Using Equation 6

$$v_{12} = v_R + (v_F - v_R) P_{FD} = 6587 \quad pc/h$$

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	7262	6750	Yes
$v_{FO} = v_F - v_R$	7151	6750	Yes
v_R	111	2000	No
v_3 or v_{av34}	675 pc/h	(Equation 25-15 or 25-16)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} = 6587		(Equation 25-18)	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	6587	4400	Yes

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086\, v_{12} - 0.009\, L_D = 59.2$ pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable, $D_S = 0.438$

Space mean speed in ramp influence area, $S_R = 49.3$ mph

Space mean speed in outer lanes, $S_0 = 60.3$ mph

Space mean speed for all vehicles, $S = 50.2$ mph

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Diverge Analysis

Analyst:
Agency/Co.: IDOT/PB
Date performed: 4/1/2009
Analysis time period: PM Peak
Freeway/Dir of Travel: I-290 WB
Junction: 9th Ave. Exit
Jurisdiction: IDOT
Analysis Year: 2009
Description: I-290 Ramp Junction Analysis

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	55.0	mph
Volume on freeway	6560	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	190	vph
Length of first accel/decel lane	184	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	570	vph
Position of adjacent ramp	Upstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	800	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	6560		190		570	vph
Peak-hour factor, PHF	0.95		0.95		0.95	
Peak 15-min volume, v15	1726		50		150	v
Trucks and buses	3		3		7	%
Recreational vehicles	0		0		0	%
Terrain type:	Level		Level		Level	
Grade	0.00	%	0.00	%	0.00	%
Length	0.00	mi	0.00	mi	0.00	mi
Trucks and buses PCE, ET	1.5		1.5		1.5	
Recreational vehicle PCE, ER	1.2		1.2		1.2	
Heavy vehicle adjustment, fHV	0.985		0.985		0.966	
Driver population factor, fP	1.00		1.00		1.00	
Flow rate, vp	7009		203		621	pcph

Estimation of V12 Diverge Areas

L_{EQ} = 2864.67 (Equation 25-8 or 25-9)

P = 0.913 Using Equation 6

$$v_{12} = v_R + (v_F - v_R) P_{FD} = 6414 \quad pc/h$$

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	7009	6750	Yes
$v_{FO} = v_F - v_R$	6806	6750	Yes
v_R	203	2000	No
v_{3} or v_{av34}	595 pc/h	(Equation 25-15 or 25-16)	
Is v_{3} or v_{av34} > 2700 pc/h?		No	
Is v_{3} or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} = 6414		(Equation 25-18)	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	6414	4400	Yes

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D = 57.8$ pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable,	$D_S = 0.446$	
Space mean speed in ramp influence area,	$S_R = 49.2$	mph
Space mean speed in outer lanes,	$S_0 = 60.3$	mph
Space mean speed for all vehicles,	$S = 50.0$	mph

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Merge Analysis

Analyst:
Agency/Co.: IDOT/PB
Date performed: 4/1/2009
Analysis time period: AM Peak
Freeway/Dir of Travel: I-290 WB
Junction: 1st Ave. Entrance Ramp
Jurisdiction: IDOT
Analysis Year: 2009
Description: I-290 Ramp Junction Analysis

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	55.0	mph
Volume on freeway	6020	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	550	vph
Length of first accel/decel lane	197	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	100	vph
Position of adjacent Ramp	Downstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	800	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	6020		550		100	vph
Peak-hour factor, PHF	0.95		0.95		0.95	
Peak 15-min volume, v15	1584		145		26	v
Trucks and buses	10		16		10	%
Recreational vehicles	0		0		0	%
Terrain type:	Level		Level		Level	
Grade		%		%		%
Length		mi		mi		mi
Trucks and buses PCE, ET	1.5		1.5		1.5	
Recreational vehicle PCE, ER	1.2		1.2		1.2	
Heavy vehicle adjustment, fHV	0.952		0.926		0.952	
Driver population factor, fP	1.00		1.00		1.00	
Flow rate, vp	6654		625		111	pcph

Estimation of V12 Merge Areas

L_{EQ} = 849.41 (Equation 25-2 or 25-3)

P = 0.585 Using Equation 3

$v_{12}^{FM} = v_F \, (P_{FM}) = 3894$ pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	7279	6750	Yes
v_3 or v_{av34}	2760 pc/h	(Equation 25-4 or 25-5)	
Is v_3 or v_{av34} > 2700 pc/h?		Yes	
Is v_3 or v_{av34} > 1.5 v_{12} /2		No	
If yes, v_{12A} = 3954		(Equation 25-8)	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	3954	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734 \, v_R + 0.0078 \, v_{12} - 0.00627 \, L_A$ = 39.7 pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable,	M_S = 0.687	
Space mean speed in ramp influence area,	S_R = 46.1	mph
Space mean speed in outer lanes,	S_0 = 46.1	mph
Space mean speed for all vehicles,	S = 46.1	mph

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Merge Analysis

Analyst:
Agency/Co.: IDOT/PB
Date performed: 4/1/2009
Analysis time period: PM Peak
Freeway/Dir of Travel: I-290 WB
Junction: 1st Ave. Entrance Ramp
Jurisdiction: IDOT
Analysis Year: 2009
Description: I-290 Ramp Junction Analysis

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	55.0	mph
Volume on freeway	5990	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	570	vph
Length of first accel/decel lane	197	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	190	vph
Position of adjacent Ramp	Downstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	800	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	5990		570		190	vph
Peak-hour factor, PHF	0.95		0.95		0.95	
Peak 15-min volume, v15	1576		150		50	v
Trucks and buses	3		7		3	%
Recreational vehicles	0		0		0	%
Terrain type:	Level		Level		Level	
Grade		%		%		%
Length		mi		mi		mi
Trucks and buses PCE, ET	1.5		1.5		1.5	
Recreational vehicle PCE, ER	1.2		1.2		1.2	
Heavy vehicle adjustment, fHV	0.985		0.966		0.985	
Driver population factor, fP	1.00		1.00		1.00	
Flow rate, vp	6400		621		203	pcph

Estimation of V12 Merge Areas

L_{EQ} = 1553.42 (Equation 25-2 or 25-3)

P = 0.615 Using Equation 3

$v_{12} = v_F (P_{FM}) = 3938$ pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	7021	6750	Yes
v_{3} or v_{av34}	2462 pc/h	(Equation 25-4 or 25-5)	
Is v_{3} or v_{av34} > 2700 pc/h?		No	
Is v_{3} or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} = 3938		(Equation 25-8)	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	3938	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A = 39.5$ pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable, $M_S = 0.680$

Space mean speed in ramp influence area, $S_R = 46.2$ mph

Space mean speed in outer lanes, $S_0 = 47.5$ mph

Space mean speed for all vehicles, $S = 46.6$ mph

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Diverge Analysis

Analyst:
Agency/Co.: IDOT/PB
Date performed: 4/1/2009
Analysis time period: AM Peak
Freeway/Dir of Travel: I-290 WB
Junction: 1st Ave. Exit Ramp
Jurisdiction: IDOT
Analysis Year: 2009
Description: I-290 Ramp Junction Analysis

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	55.0	mph
Volume on freeway	6500	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	480	vph
Length of first accel/decel lane	204	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	550	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1900	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	6500		480		550	vph
Peak-hour factor, PHF	0.95		0.95		0.95	
Peak 15-min volume, v15	1711		126		145	v
Trucks and buses	10		10		16	%
Recreational vehicles	0		0		0	%
Terrain type:	Level		Level		Level	
Grade	0.00	%	0.00	%	0.00	%
Length	0.00	mi	0.00	mi	0.00	mi
Trucks and buses PCE, ET	1.5		1.5		1.5	
Recreational vehicle PCE, ER	1.2		1.2		1.2	
Heavy vehicle adjustment, fHV	0.952		0.952		0.926	
Driver population factor, fP	1.00		1.00		1.00	
Flow rate, vp	7184		531		625	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 0.556 Using Equation 5

$$v_{12} = v_R + (v_F - v_R) P_{FD} = 4230 \quad pc/h$$

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	7184	6750	Yes
$v_{FO} = v_F - v_R$	6653	6750	No
v_R	531	2000	No
v_3 or v_{av34}	2954 pc/h	(Equation 25-15 or 25-16)	
Is v_3 or v_{av34} > 2700 pc/h?		Yes	
Is v_3 or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} = 4484		(Equation 25-18)	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	4484	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D = 41.0$ pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable, $D_S = 0.476$

Space mean speed in ramp influence area, $S_R = 48.8$ mph

Space mean speed in outer lanes, $S_0 = 53.7$ mph

Space mean speed for all vehicles, $S = 50.5$ mph

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Diverge Analysis

Analyst:	
Agency/Co.:	IDOT/PB
Date performed:	4/1/2009
Analysis time period:	PM Peak
Freeway/Dir of Travel:	I-290 WB
Junction:	1st Ave. Exit Ramp
Jurisdiction:	IDOT
Analysis Year:	2009

Description: I-290 Ramp Junction Analysis

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	55.0	mph
Volume on freeway	6480	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	490	vph
Length of first accel/decel lane	204	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	570	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1900	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	6480		490		570	vph
Peak-hour factor, PHF	0.95		0.95		0.95	
Peak 15-min volume, v15	1705		129		150	v
Trucks and buses	3		3		7	%
Recreational vehicles	0		0		0	%
Terrain type:	Level		Level		Level	
Grade	0.00	%	0.00	%	0.00	%
Length	0.00	mi	0.00	mi	0.00	mi
Trucks and buses PCE, ET	1.5		1.5		1.5	
Recreational vehicle PCE, ER	1.2		1.2		1.2	
Heavy vehicle adjustment, fHV	0.985		0.985		0.966	
Driver population factor, fP	1.00		1.00		1.00	
Flow rate, vp	6923		524		621	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P = 0.563 Using Equation 5

$v_{12} = v_R + (v_F - v_R) P_{FD} = 4125$ pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	6923	6750	Yes
$v_{FO} = v_F - v_R$	6399	6750	No
v_R	524	2000	No
v_3 or v_{av34}	2798 pc/h	(Equation 25-15 or 25-16)	
Is v_3 or v_{av34} > 2700 pc/h?		Yes	
Is v_3 or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} = 4223		(Equation 25-18)	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	4223	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D = 38.7$ pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable,	D_S = 0.475	
Space mean speed in ramp influence area,	S_R = 48.8	mph
Space mean speed in outer lanes,	S_0 = 53.7	mph
Space mean speed for all vehicles,	S = 50.6	mph

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Merge Analysis

Analyst:
Agency/Co.:   IDOT/PB
Date performed: 4/1/2009
Analysis time period: AM Peak
Freeway/Dir of Travel: I-290 WB
Junction: Des Plaines Ave. Entrance Ramp
Jurisdiction: IDOT
Analysis Year: 2009
Description: I-290 Ramp Junction Analysis

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	55.0	mph
Volume on freeway	5800	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	700	vph
Length of first accel/decel lane	548	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	5800	700		vph
Peak-hour factor, PHF	0.95	0.95		
Peak 15-min volume, v15	1526	184		v
Trucks and buses	10	6		%
Recreational vehicles	0	0		%
Terrain type:	Level	Level		
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5		
Recreational vehicle PCE, ER	1.2	1.2		
Heavy vehicle adjustment, fHV	0.952	0.971		
Driver population factor, fP	1.00	1.00		
Flow rate, vp	6411	759		pcph

Estimation of V12 Merge Areas

L_{EQ} =   (Equation 25-2 or 25-3)

P =   0.593   Using Equation 1

$v_{12} = v_F (P_{FM}) = 3801$ pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	7170	6750	Yes
v_3 or v_{av34}	2610 pc/h	(Equation 25-4 or 25-5)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} = 3801		(Equation 25-8)	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	3801	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A = 37.3$ pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable, $M_S = 0.655$

Space mean speed in ramp influence area, $S_R = 46.5$ mph

Space mean speed in outer lanes, $S_0 = 46.6$ mph

Space mean speed for all vehicles, $S = 46.5$ mph

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Merge Analysis

Analyst:	
Agency/Co.:	IDOT/PB
Date performed:	4/1/2009
Analysis time period:	PM Peak
Freeway/Dir of Travel:	I-290 WB
Junction:	Des Plaines Ave. Entrance Ramp
Jurisdiction:	IDOT
Analysis Year:	2009

Description: I-290 Ramp Junction Analysis

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	55.0	mph
Volume on freeway	5890	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	590	vph
Length of first accel/decel lane	548	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	5890	590		vph
Peak-hour factor, PHF	0.95	0.95		
Peak 15-min volume, v15	1550	155		v
Trucks and buses	3	5		%
Recreational vehicles	0	0		%
Terrain type:	Level	Level		
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5		
Recreational vehicle PCE, ER	1.2	1.2		
Heavy vehicle adjustment, fHV	0.985	0.976		
Driver population factor, fP	1.00	1.00		
Flow rate, vp	6293	637		pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P = 0.593 Using Equation 1

$v_{12} = v_F (P_{FM}) =$ 3731 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	6930	6750	Yes
v_{3} or v_{av34}	2562 pc/h	(Equation 25-4 or 25-5)	
Is v_{3} or v_{av34} > 2700 pc/h?		No	
Is v_{3} or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} = 3731		(Equation 25-8)	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	3731	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 35.8 pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable,	M_S = 0.590	
Space mean speed in ramp influence area,	S_R = 47.3	mph
Space mean speed in outer lanes,	S_0 = 46.9	mph
Space mean speed for all vehicles,	S = 47.2	mph

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Merge Analysis

Analyst:	
Agency/Co.:	IDOT/PB
Date performed:	4/1/2009
Analysis time period:	AM Peak
Freeway/Dir of Travel:	I-290 WB
Junction:	Harlem Ave. Entrance Ramp
Jurisdiction:	IDOT
Analysis Year:	2009

Description: I-290 Ramp Junction Analysis

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	55.0	mph
Volume on freeway	5120	vph

On Ramp Data

Side of freeway	Left	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	680	vph
Length of first accel/decel lane	487	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	260	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	2320	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	5120		680		260	vph
Peak-hour factor, PHF	0.95		0.95		0.95	
Peak 15-min volume, v15	1347		179		68	v
Trucks and buses	10		3		10	%
Recreational vehicles	0		0		0	%
Terrain type:	Level		Level		Level	
Grade		%		%		%
Length		mi		mi		mi
Trucks and buses PCE, ET	1.5		1.5		1.5	
Recreational vehicle PCE, ER	1.2		1.2		1.2	
Heavy vehicle adjustment, fHV	0.952		0.985		0.952	
Driver population factor, fP	1.00		1.00		1.00	
Flow rate, vp	5659		727		287	pcph

Estimation of V12 Merge Areas

L_{EQ} = 1011.03 (Equation 25-2 or 25-3)

P = 0.591 Using Equation 1

$v_{12} = v_F (P_{FM}) = 3345$ pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	6386	6750	No
v_3 or v_{av34}	2314 pc/h	(Equation 25-4 or 25-5)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} = 3345		(Equation 25-8)	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	3345	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A = 37.0$ pc/mi/ln

Level of service for ramp-freeway junction areas of influence E

Speed Estimation

Intermediate speed variable, $M_S = 0.629$

Space mean speed in ramp influence area, $S_R = 46.8$ mph

Space mean speed in outer lanes, $S_0 = 49.9$ mph

Space mean speed for all vehicles, $S = 47.7$ mph

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

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Merge Analysis

Analyst:
Agency/Co.: IDOT/PB
Date performed: 4/1/2009
Analysis time period: PM Peak
Freeway/Dir of Travel: I-290 WB
Junction: Harlem Ave. Entrance Ramp
Jurisdiction: IDOT
Analysis Year: 2009
Description: I-290 Ramp Junction Analysis

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	55.0	mph
Volume on freeway	5200	vph

On Ramp Data

Side of freeway	Left	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	690	vph
Length of first accel/decel lane	487	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	580	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	2320	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	5200		690		580	vph
Peak-hour factor, PHF	0.95		0.95		0.95	
Peak 15-min volume, v15	1368		182		153	v
Trucks and buses	3		3		3	%
Recreational vehicles	0		0		0	%
Terrain type:	Level		Level		Level	
Grade		%		%		%
Length		mi		mi		mi
Trucks and buses PCE, ET	1.5		1.5		1.5	
Recreational vehicle PCE, ER	1.2		1.2		1.2	
Heavy vehicle adjustment, fHV	0.985		0.985		0.985	
Driver population factor, fP	1.00		1.00		1.00	
Flow rate, vp	5556		737		620	pcph

Estimation of V12 Merge Areas

L_{EQ} = 991.13 (Equation 25-2 or 25-3)

P = 0.591 Using Equation 1

$v_{12} = v_F \, (P_{FM}) =$ 3284 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	6293	6750	No
v_3 or v_{av34}	2272 pc/h	(Equation 25-4 or 25-5)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12} /2		No	
If yes, v_{12A} = 3284		(Equation 25-8)	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	3284	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A =$ 36.5 pc/mi/ln

Level of service for ramp-freeway junction areas of influence E

Speed Estimation

Intermediate speed variable,	M_S = 0.609	
Space mean speed in ramp influence area,	S_R = 47.1	mph
Space mean speed in outer lanes,	S_0 = 50.0	mph
Space mean speed for all vehicles,	S = 47.9	mph

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

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Diverge Analysis

Analyst:
Agency/Co.: IDOT/PB
Date performed: 4/1/2009
Analysis time period: AM Peak
Freeway/Dir of Travel: I-290 WB
Junction: Harlem Ave. Exit Ramp
Jurisdiction: IDOT
Analysis Year: 2009
Description: I-290 Ramp Junction Analysis

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	55.0	mph
Volume on freeway	5380	vph

Off Ramp Data

Side of freeway	Left	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	260	vph
Length of first accel/decel lane	343	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	680	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	2320	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	5380		260		680	vph
Peak-hour factor, PHF	0.95		0.95		0.95	
Peak 15-min volume, v15	1416		68		179	v
Trucks and buses	10		10		3	%
Recreational vehicles	0		0		0	%
Terrain type:	Level		Level		Level	
Grade	0.00	%	0.00	%	0.00	%
Length	0.00	mi	0.00	mi	0.00	mi
Trucks and buses PCE, ET	1.5		1.5		1.5	
Recreational vehicle PCE, ER	1.2		1.2		1.2	
Heavy vehicle adjustment, fHV	0.952		0.952		0.985	
Driver population factor, fP	1.00		1.00		1.00	
Flow rate, vp	5946		287		727	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 0.598 Using Equation 5

$v_{12} = v_R + (v_F - v_R) P_{FD} = 3672$ pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	5946	6750	No
$v_{FO} = v_F - v_R$	5659	6750	No
v_R	287	2000	No
v_3 or v_{av34}	2274 pc/h	(Equation 25-15 or 25-16)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} = 3672		(Equation 25-18)	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	3672	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D = 34.3$ pc/mi/ln

Level of service for ramp-freeway junction areas of influence D

Speed Estimation

Intermediate speed variable, $D_S = 0.454$

Space mean speed in ramp influence area, $S_R = 49.1$ mph

Space mean speed in outer lanes, $S_0 = 56.1$ mph

Space mean speed for all vehicles, $S = 51.3$ mph

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

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Diverge Analysis

Analyst:	
Agency/Co.:	IDOT/PB
Date performed:	4/1/2009
Analysis time period:	PM Peak
Freeway/Dir of Travel:	I-290 WB
Junction:	Harlem Ave. Exit Ramp
Jurisdiction:	IDOT
Analysis Year:	2009

Description: I-290 Ramp Junction Analysis

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	55.0	mph
Volume on freeway	5780	vph

Off Ramp Data

Side of freeway	Left	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	580	vph
Length of first accel/decel lane	343	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	690	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	2320	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	5780		580		690	vph
Peak-hour factor, PHF	0.95		0.95		0.95	
Peak 15-min volume, v15	1521		153		182	v
Trucks and buses	3		3		3	%
Recreational vehicles	0		0		0	%
Terrain type:	Level		Level		Level	
Grade	0.00	%	0.00	%	0.00	%
Length	0.00	mi	0.00	mi	0.00	mi
Trucks and buses PCE, ET	1.5		1.5		1.5	
Recreational vehicle PCE, ER	1.2		1.2		1.2	
Heavy vehicle adjustment, fHV	0.985		0.985		0.985	
Driver population factor, fP	1.00		1.00		1.00	
Flow rate, vp	6175		620		737	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P = 0.577 Using Equation 5

$v_{12} = v_R + (v_F - v_R) P_{FD} = 3826$ pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	6175	6750	No
$v_{FO} = v_F - v_R$	5555	6750	No
v_R	620	2000	No
v_3 or v_{av34}	2349 pc/h	(Equation 25-15 or 25-16)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} = 3826		(Equation 25-18)	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	3826	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D = 35.7$ pc/mi/ln

Level of service for ramp-freeway junction areas of influence E

Speed Estimation

Intermediate speed variable, $D_S = 0.484$

Space mean speed in ramp influence area, $S_R = 48.7$ mph

Space mean speed in outer lanes, $S_0 = 55.8$ mph

Space mean speed for all vehicles, $S = 51.0$ mph

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

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E-mail:

Merge Analysis

Analyst:
Agency/Co.: IDOT/PB
Date performed: 4/1/2009
Analysis time period: AM Peak
Freeway/Dir of Travel: I-290 WB
Junction: Austin Blvd. Entrance Ramp
Jurisdiction: IDOT
Analysis Year: 2009
Description: I-290 Ramp Junction Analysis

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	55.0	mph
Volume on freeway	4850	vph

On Ramp Data

Side of freeway	Left	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	530	vph
Length of first accel/decel lane	774	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4850	530		vph
Peak-hour factor, PHF	0.95	0.95		
Peak 15-min volume, v15	1276	139		v
Trucks and buses	10	2		%
Recreational vehicles	0	0		%
Terrain type:	Level	Level		
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5		
Recreational vehicle PCE, ER	1.2	1.2		
Heavy vehicle adjustment, fHV	0.952	0.990		
Driver population factor, fP	1.00	1.00		
Flow rate, vp	5361	563		pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P = 0.599 Using Equation 1

```
                  FM
                 v   = v  (P   ) =  3212   pc/h
                  12    F    FM

______________________________Capacity Checks_______________________________

                           Actual        Maximum         LOS F?
     v                     5924          6750            No
      FO
     v     v               2149 pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v       > 2700 pc/h?          No
      3 or  av34
Is   v     v       > 1.5 v  /2           No
      3 or  av34          12
If yes, v     = 3212                     (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area__________________
                      Actual        Max Desirable          Violation?
     v                3212          4600                   No
      R12
_________________Level of Service Determination (if not F)__________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   32.8    pc/mi/ln
          R                   R            12             A
Level of service for ramp-freeway junction areas of influence  D

_____________________________Speed Estimation_______________________________

Intermediate speed variable,                  M  = 0.517
                                               S
Space mean speed in ramp influence area,      S  = 48.3    mph
                                               R
Space mean speed in outer lanes,              S  = 50.4    mph
                                               0
Space mean speed for all vehicles,            S  = 48.9    mph
____________________________________________________________________________
```

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

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Merge Analysis

Analyst:	RT
Agency/Co.:	IDOT/PB
Date performed:	4/8/2010
Analysis time period:	PM Peak
Freeway/Dir of Travel:	I-290 WB
Junction:	Austin Blvd. Entrance Ramp
Jurisdiction:	IDOT
Analysis Year:	2009

Description: I-290 Ramp Junction Analysis

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	55.0	mph
Volume on freeway	7300	vph

On Ramp Data

Side of freeway	Left	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	470	vph
Length of first accel/decel lane	774	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	7300		470			vph
Peak-hour factor, PHF	0.95		0.95			
Peak 15-min volume, v15	1921		124			v
Trucks and buses	3		1			%
Recreational vehicles	0		0			%
Terrain type:	Level		Level			
Grade		%		%		%
Length		mi		mi		mi
Trucks and buses PCE, ET	1.5		1.5			
Recreational vehicle PCE, ER	1.2		1.2			
Heavy vehicle adjustment, fHV	0.985		0.995			
Driver population factor, fP	1.00		1.00			
Flow rate, vp	7799		497			pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P = 0.599 Using Equation 1

$$v_{12} = v_F (P_{FM}) = 4673 \text{ pc/h}$$

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	8296	6750	Yes
v_3 or v_{av34}	3126 pc/h	(Equation 25-4 or 25-5)	
Is v_3 or v_{av34} > 2700 pc/h?		Yes	
Is v_3 or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} = 5099		(Equation 25-8)	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	5099	4600	Yes

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 48.8 pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable, M_S = 2.202

Space mean speed in ramp influence area, S_R = 26.4 mph

Space mean speed in outer lanes, S_0 = 49.3 mph

Space mean speed for all vehicles, S = 29.9 mph

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E-mail:

Merge Analysis

Analyst:
Agency/Co.: IDOT/PB
Date performed: 4/1/2009
Analysis time period: AM Peak
Freeway/Dir of Travel: I-290 WB
Junction: Central Ave. Entrance Ramp
Jurisdiction: IDOT
Analysis Year: 2009
Description: I-290 Ramp Junction Analysis

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	4	
Free-flow speed on freeway	55.0	mph
Volume on freeway	5240	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	500	vph
Length of first accel/decel lane	606	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	310	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	2110	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	5240	500	310	vph
Peak-hour factor, PHF	0.95	0.95	0.95	
Peak 15-min volume, v15	1379	132	82	v
Trucks and buses	10	2	10	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	0.952	0.990	0.952	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	5792	532	343	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P = 0.151 Using Equation 4

```
                           FM
                         v   = v  (P   ) =  876    pc/h
                          12    F   FM

_______________________________Capacity Checks_______________________________

                           Actual        Maximum         LOS F?
     v                     6324          9000            No
      FO
     v     v               2458 pc/h     (Equation 25-4 or 25-5)
      3 or  av34
Is   v     v      > 2700 pc/h?           No
      3 or  av34
Is   v     v      > 1.5 v  /2            Yes
      3 or  av34         12
If yes, v    = 2316                      (Equation 25-8)
         12A

________________________Flow Entering Merge Influence Area______________________
                      Actual        Max Desirable          Violation?
     v                2316          4600                   No
      12A
_________________Level of Service Determination (if not F)______________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   23.6    pc/mi/ln
          R                   R            12             A
Level of service for ramp-freeway junction areas of influence  C

_____________________________Speed Estimation________________________________

Intermediate speed variable,                    M  = 0.346
                                                 S
Space mean speed in ramp influence area,        S  = 50.5    mph
                                                 R
Space mean speed in outer lanes,                S  = 50.5    mph
                                                 0
Space mean speed for all vehicles,              S  = 50.5    mph
_______________________________________________________________________________
```

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

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Merge Analysis

Analyst:
Agency/Co.: IDOT/PB
Date performed: 4/1/2009
Analysis time period: PM Peak
Freeway/Dir of Travel: I-290 WB
Junction: Central Ave. Entrance Ramp
Jurisdiction: IDOT
Analysis Year: 2009
Description: I-290 Ramp Junction Analysis

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	4	
Free-flow speed on freeway	55.0	mph
Volume on freeway	5750	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	660	vph
Length of first accel/decel lane	606	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	290	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	2110	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	5750	660	290	vph
Peak-hour factor, PHF	0.95	0.95	0.95	
Peak 15-min volume, v15	1513	174	76	v
Trucks and buses	3	3	3	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	0.985	0.985	0.985	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	6143	705	310	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM} = 0.130 Using Equation 4

$v_{12}^{FM} = v_F (P_{FM}) =$ 797 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	6848	9000	No
v_3 or v_{av34}	2673 pc/h	(Equation 25-4 or 25-5)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12}/2		Yes	
If yes, v_{12A} = 2457		(Equation 25-8)	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	2457	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A =$ 26.0 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable,	M_S = 0.371	
Space mean speed in ramp influence area,	S_R = 50.2	mph
Space mean speed in outer lanes,	S_0 = 50.2	mph
Space mean speed for all vehicles,	S = 50.2	mph

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

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Diverge Analysis

Analyst:
Agency/Co.: IDOT/PB
Date performed: 4/1/2009
Analysis time period: AM Peak
Freeway/Dir of Travel: I-290 WB
Junction: Central Ave. Exit Ramp
Jurisdiction: IDOT
Analysis Year: 2009
Description: I-290 Ramp Junctions Analysis

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	4	
Free-flow speed on freeway	55.0	mph
Volume on freeway	5550	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	310	vph
Length of first accel/decel lane	346	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	500	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	2110	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	5550		310		500	vph
Peak-hour factor, PHF	0.95		0.95		0.95	
Peak 15-min volume, v15	1461		82		132	v
Trucks and buses	10		10		2	%
Recreational vehicles	0		0		0	%
Terrain type:	Level		Level		Level	
Grade	0.00	%	0.00	%	0.00	%
Length	0.00	mi	0.00	mi	0.00	mi
Trucks and buses PCE, ET	1.5		1.5		1.5	
Recreational vehicle PCE, ER	1.2		1.2		1.2	
Heavy vehicle adjustment, fHV	0.952		0.952		0.990	
Driver population factor, fP	1.00		1.00		1.00	
Flow rate, vp	6134		343		532	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P = 0.436 Using Equation 8

$v_{12} = v_R + (v_F - v_R) P_{FD} = 2868$ pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	6134	9000	No
$v_{FO} = v_F - v_R$	5791	9000	No
v_R	343	2000	No
v_3 or v_{av34}	1633 pc/h	(Equation 25-15 or 25-16)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} = 2868		(Equation 25-18)	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	2868	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D = 25.8$ pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable, $D_S = 0.459$

Space mean speed in ramp influence area, $S_R = 49.0$ mph

Space mean speed in outer lanes, $S_0 = 57.9$ mph

Space mean speed for all vehicles, $S = 53.4$ mph

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

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Diverge Analysis

Analyst:	
Agency/Co.:	IDOT/PB
Date performed:	4/1/2009
Analysis time period:	PM Peak
Freeway/Dir of Travel:	I-290 WB
Junction:	Central Ave. Exit Ramp
Jurisdiction:	IDOT
Analysis Year:	2009

Description: I-290 Ramp Junctions Analysis

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	4	
Free-flow speed on freeway	55.0	mph
Volume on freeway	6040	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	290	vph
Length of first accel/decel lane	346	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	660	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	2110	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	6040		290		660	vph
Peak-hour factor, PHF	0.95		0.95		0.95	
Peak 15-min volume, v15	1589		76		174	v
Trucks and buses	3		3		3	%
Recreational vehicles	0		0		0	%
Terrain type:	Level		Level		Level	
Grade	0.00	%	0.00	%	0.00	%
Length	0.00	mi	0.00	mi	0.00	mi
Trucks and buses PCE, ET	1.5		1.5		1.5	
Recreational vehicle PCE, ER	1.2		1.2		1.2	
Heavy vehicle adjustment, fHV	0.985		0.985		0.985	
Driver population factor, fP	1.00		1.00		1.00	
Flow rate, vp	6453		310		705	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = 0.436 Using Equation 8

$v_{12} = v_R + (v_F - v_R) P_{FD} = 2988$ pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	6453	9000	No
$v_{FO} = v_F - v_R$	6143	9000	No
v_R	310	2000	No
v_3 or v_{av34}	1732 pc/h	(Equation 25-15 or 25-16)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12}/2		No	
If yes, v_{12A} = 2988		(Equation 25-18)	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	2988	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D = 26.8$ pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable, $D_S = 0.456$

Space mean speed in ramp influence area, $S_R = 49.1$ mph

Space mean speed in outer lanes, $S_0 = 57.5$ mph

Space mean speed for all vehicles, $S = 53.3$ mph

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

Technical Memorandum

Appendix E-3

Weaving Section Analysis

HCS+: Freeway Weaving Release 5.4

Robert Tan
PBQD

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	RCT
Agency/Co.:	IDOT/PB
Date Performed:	4/8/2010
Analysis Time Period:	AM Peak
Freeway/Dir of Travel:	I-290 EB C-D Rd.
Weaving Location:	Harrison Ent. to Mannheim Ex.
Jurisdiction:	IDOT
Analysis Year:	2009

Description: I-290 Phase 1 Study

Inputs

Freeway free-flow speed, SFF	45	mph
Weaving number of lanes, N	3	
Weaving segment length, L	1500	ft
Terrain type	Level	
Grade		%
Length		mi
Weaving type	A	
Volume ratio, VR	0.39	
Weaving ratio, R	0.20	

Conversion to pc/h Under Base Conditions

	Non-Weaving		Weaving		
	V o1	V o2	V w1	V w2	
Volume, V	1450	0	750	200	veh/h
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	
Peak 15-min volume, v15	382	0	197	53	v
Trucks and buses	20	10	20	10	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	0.909	0.952	0.909	0.952	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	1678	0	868	221	pc/h

Weaving and Non-Weaving Speeds

	Weaving	Non-Weaving
a (Exhibit 24-6)	0.35	0.0020
b (Exhibit 24-6)	2.20	4.00
c (Exhibit 24-6)	0.97	1.30
d (Exhibit 24-6)	0.80	0.75
Weaving intensity factor, Wi	1.57	0.22
Weaving and non-weaving speeds, Si	28.61	43.60
Number of lanes required for unconstrained operation, Nw (Exhibit 24-7)		1.50
Maximum number of lanes, Nw (max) (Exhibit 24-7)		1.40
Type of operation is		Constrained

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	36.15	mph
Weaving segment density, D	25.52	pc/mi/ln
Level of service, LOS	C	

Capacity of base condition, cb	4703	pc/h
Capacity as a 15-minute flow rate, c	4275	pc/h
Capacity as a full-hour volume, ch	4061	pc/h

Limitations on Weaving Segments

	Analyzed	If Max Exceeded See Note Maximum	Note
Weaving flow rate, Vw	1089	2800	a
Average flow rate (pcphpl)	922		b
Volume ratio, VR	0.39	0.45	c
Weaving ratio, R	0.20	N/A	d
Weaving length (ft)	1500	2500	e

Notes:

a. Weaving segments longer than 2500 ft. are treated as isolated merge and diverge areas using the procedures of Chapter 25, "Ramps and Ramp Junctions".

b. Capacity constrained by basic freeway capacity.

c. Capacity occurs under constrained operating conditions.

d. Three-lane Type A segments do not operate well at volume ratios greater than 0.45. Poor operations and some local queuing are expected in such cases.

e. Four-lane Type A segments do not operate well at volume ratios greater than 0.35. Poor operations and some local queuing are expected in such cases.

f. Capacity constrained by maximum allowable weaving flow rate: 2,800 pc/h (Type A), 4,000 (Type B), 3,500 (Type C).

g. Five-lane Type A segments do not operate well at volume ratios greater than 0.20. Poor operations and some local queuing are expected in such cases.

h. Type B weaving segments do not operate well at volume ratios greater than 0.80. Poor operations and some local queuing are expected in such cases.

i. Type C weaving segments do not operate well at volume ratios greater than 0.50. Poor operations and some local queuing are expected in such cases.

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

HCS+: Freeway Weaving Release 5.4

Robert Tan
PBQD

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	RCT
Agency/Co.:	IDOT/PB
Date Performed:	4/8/2010
Analysis Time Period:	PM Peak
Freeway/Dir of Travel:	I-290 EB C-D Rd.
Weaving Location:	Harrision Ent. to Mannheim Ex.
Jurisdiction:	IDOT
Analysis Year:	2009

Description: I-290 Phase 1 Study

Inputs

Freeway free-flow speed, SFF	45	mph
Weaving number of lanes, N	3	
Weaving segment length, L	1500	ft
Terrain type	Level	
Grade		%
Length		mi
Weaving type	A	
Volume ratio, VR	0.33	
Weaving ratio, R	0.46	

Conversion to pc/h Under Base Conditions

	Non-Weaving		Weaving		
	V_{o1}	V_{o2}	V_{w1}	V_{w2}	
Volume, V	1850	0	500	450	veh/h
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	
Peak 15-min volume, v15	487	0	132	118	v
Trucks and buses	20	10	20	10	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	0.909	0.952	0.909	0.952	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	2142	0	578	497	pc/h

Weaving and Non-Weaving Speeds

	Weaving	Non-Weaving
a (Exhibit 24-6)	0.15	0.0035
b (Exhibit 24-6)	2.20	4.00
c (Exhibit 24-6)	0.97	1.30
d (Exhibit 24-6)	0.80	0.75
Weaving intensity factor, Wi	0.71	0.40
Weaving and non-weaving speeds, Si	35.49	40.00
Number of lanes required for unconstrained operation, Nw (Exhibit 24-7)		1.38
Maximum number of lanes, Nw (max) (Exhibit 24-7)		1.40
Type of operation is		Unconstrained

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	38.37	mph
Weaving segment density, D	27.95	pc/mi/ln
Level of service, LOS	C	

Capacity of base condition, cb	5012	pc/h
Capacity as a 15-minute flow rate, c	4556	pc/h
Capacity as a full-hour volume, ch	4328	pc/h

Limitations on Weaving Segments

	Analyzed	If Max Exceeded See Note Maximum	Note
Weaving flow rate, Vw	1075	2800	a
Average flow rate (pcphpl)	1072		b
Volume ratio, VR	0.33	0.45	c
Weaving ratio, R	0.46	N/A	d
Weaving length (ft)	1500	2500	e

Notes:

a. Weaving segments longer than 2500 ft. are treated as isolated merge and diverge areas using the procedures of Chapter 25, "Ramps and Ramp Junctions".

b. Capacity constrained by basic freeway capacity.

c. Capacity occurs under constrained operating conditions.

d. Three-lane Type A segments do not operate well at volume ratios greater than 0.45. Poor operations and some local queuing are expected in such cases.

e. Four-lane Type A segments do not operate well at volume ratios greater than 0.35. Poor operations and some local queuing are expected in such cases.

f. Capacity constrained by maximum allowable weaving flow rate: 2,800 pc/h (Type A), 4,000 (Type B), 3,500 (Type C).

g. Five-lane Type A segments do not operate well at volume ratios greater than 0.20. Poor operations and some local queuing are expected in such cases.

h. Type B weaving segments do not operate well at volume ratios greater than 0.80. Poor operations and some local queuing are expected in such cases.

i. Type C weaving segments do not operate well at volume ratios greater than 0.50. Poor operations and some local queuing are expected in such cases.

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

HCS+: Freeway Weaving Release 5.4

Robert Tan
PBQD

Phone: Fax:
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Operational Analysis

Analyst:	RCT
Agency/Co.:	IDOT/PB
Date Performed:	8/18/2009
Analysis Time Period:	AM Peak
Freeway/Dir of Travel:	I-290 EB
Weaving Location:	Mannheim C-D Ent. to 25th Ex.
Jurisdiction:	IDOT
Analysis Year:	2009

Description: I-290 Phase 1 Study

Inputs

Freeway free-flow speed, SFF	55	mph
Weaving number of lanes, N	4	
Weaving segment length, L	1155	ft
Terrain type	Level	
Grade		%
Length		mi
Weaving type	A	
Volume ratio, VR	0.32	
Weaving ratio, R	0.18	

Conversion to pc/h Under Base Conditions

	Non-Weaving		Weaving		
	V o1	V o2	V w1	V w2	
Volume, V	3630	0	1400	310	veh/h
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	
Peak 15-min volume, v15	955	0	368	82	v
Trucks and buses	10	10	10	10	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	0.952	0.952	0.952	0.952	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	4012	0	1547	342	pc/h

Weaving and Non-Weaving Speeds

	Weaving	Non-Weaving
a (Exhibit 24-6)	0.35	0.0020
b (Exhibit 24-6)	2.20	4.00
c (Exhibit 24-6)	0.97	1.30
d (Exhibit 24-6)	0.80	0.75
Weaving intensity factor, Wi	2.71	0.40
Weaving and non-weaving speeds, Si	27.13	47.06
Number of lanes required for unconstrained operation, Nw (Exhibit 24-7)		1.68
Maximum number of lanes, Nw (max) (Exhibit 24-7)		1.40
Type of operation is		Constrained

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	38.10	mph
Weaving segment density, D	38.72	pc/mi/ln
Level of service, LOS	E	

Capacity of base condition, cb	6387	pc/h
Capacity as a 15-minute flow rate, c	6083	pc/h
Capacity as a full-hour volume, ch	5779	pc/h

Limitations on Weaving Segments

	Analyzed	If Max Exceeded See Note Maximum	Note
Weaving flow rate, Vw	1889	2800	a
Average flow rate (pcphpl)	1475	2250	b
Volume ratio, VR	0.32	0.35	c
Weaving ratio, R	0.18	N/A	d
Weaving length (ft)	1155	2500	e

Notes:

a. Weaving segments longer than 2500 ft. are treated as isolated merge and diverge areas using the procedures of Chapter 25, "Ramps and Ramp Junctions".

b. Capacity constrained by basic freeway capacity.

c. Capacity occurs under constrained operating conditions.

d. Three-lane Type A segments do not operate well at volume ratios greater than 0.45. Poor operations and some local queuing are expected in such cases.

e. Four-lane Type A segments do not operate well at volume ratios greater than 0.35. Poor operations and some local queuing are expected in such cases.

f. Capacity constrained by maximum allowable weaving flow rate: 2,800 pc/h (Type A), 4,000 (Type B), 3,500 (Type C).

g. Five-lane Type A segments do not operate well at volume ratios greater than 0.20. Poor operations and some local queuing are expected in such cases.

h. Type B weaving segments do not operate well at volume ratios greater than 0.80. Poor operations and some local queuing are expected in such cases.

i. Type C weaving segments do not operate well at volume ratios greater than 0.50. Poor operations and some local queuing are expected in such cases.

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

HCS+: Freeway Weaving Release 5.4

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Operational Analysis

Analyst:	RCT
Agency/Co.:	IDOT/PB
Date Performed:	8/18/2009
Analysis Time Period:	PM Peak
Freeway/Dir of Travel:	I-290 EB
Weaving Location:	Mannheim C-D Ent. to 25th Ex.
Jurisdiction:	IDOT
Analysis Year:	2009

Description: I-290 Phase 1 Study

Inputs

Freeway free-flow speed, SFF	55	mph
Weaving number of lanes, N	4	
Weaving segment length, L	1155	ft
Terrain type	Level	
Grade		%
Length		mi
Weaving type	A	
Volume ratio, VR	0.44	
Weaving ratio, R	0.19	

Conversion to pc/h Under Base Conditions

	Non-Weaving		Weaving		
	V o1	V o2	V w1	V w2	
Volume, V	2910	0	1900	430	veh/h
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	
Peak 15-min volume, v15	766	0	500	113	v
Trucks and buses	9	10	8	9	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	0.957	0.952	0.962	0.957	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	3201	0	2080	473	pc/h

Weaving and Non-Weaving Speeds

	Weaving	Non-Weaving
a (Exhibit 24-6)	0.35	0.0020
b (Exhibit 24-6)	2.20	4.00
c (Exhibit 24-6)	0.97	1.30
d (Exhibit 24-6)	0.80	0.75
Weaving intensity factor, Wi	3.22	0.56
Weaving and non-weaving speeds, Si	25.66	43.87
Number of lanes required for unconstrained operation, Nw (Exhibit 24-7)		2.07
Maximum number of lanes, Nw (max) (Exhibit 24-7)		1.40
Type of operation is		Constrained

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	33.36	mph
Weaving segment density, D	43.12	pc/mi/ln
Level of service, LOS	F	

Capacity of base condition, cb	6214	pc/h
Capacity as a 15-minute flow rate, c	5946	pc/h
Capacity as a full-hour volume, ch	5649	pc/h

Limitations on Weaving Segments

	Analyzed	If Max Exceeded See Note Maximum	Note
Weaving flow rate, Vw	2553	2800	a
Average flow rate (pcphpl)	1438	2250	b
Volume ratio, VR	0.44	0.35	c
Weaving ratio, R	0.19	N/A	d
Weaving length (ft)	1155	2500	e

Notes:

a. Weaving segments longer than 2500 ft. are treated as isolated merge and diverge areas using the procedures of Chapter 25, "Ramps and Ramp Junctions".

b. Capacity constrained by basic freeway capacity.

c. Capacity occurs under constrained operating conditions.

d. Three-lane Type A segments do not operate well at volume ratios greater than 0.45. Poor operations and some local queuing are expected in such cases.

e. Four-lane Type A segments do not operate well at volume ratios greater than 0.35. Poor operations and some local queuing are expected in such cases.

f. Capacity constrained by maximum allowable weaving flow rate: 2,800 pc/h (Type A), 4,000 (Type B), 3,500 (Type C).

g. Five-lane Type A segments do not operate well at volume ratios greater than 0.20. Poor operations and some local queuing are expected in such cases.

h. Type B weaving segments do not operate well at volume ratios greater than 0.80. Poor operations and some local queuing are expected in such cases.

i. Type C weaving segments do not operate well at volume ratios greater than 0.50. Poor operations and some local queuing are expected in such cases.

HCS+: Freeway Weaving Release 5.4

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Operational Analysis

Analyst:	RCT
Agency/Co.:	IDOT/PB
Date Performed:	8/18/2009
Analysis Time Period:	AM Peak
Freeway/Dir of Travel:	I-290 EB
Weaving Location:	25th Ent. to 25th Ex.
Jurisdiction:	IDOT
Analysis Year:	2009

Description: I-290 Phase 1 Study

Inputs

Freeway free-flow speed, SFF	55	mph
Weaving number of lanes, N	4	
Weaving segment length, L	500	ft
Terrain type	Level	
Grade		%
Length		mi
Weaving type	A	
Volume ratio, VR	0.06	
Weaving ratio, R	0.20	

Conversion to pc/h Under Base Conditions

	Non-Weaving V o1	V o2	Weaving V w1	V w2	
Volume, V	4970	0	230	60	veh/h
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	
Peak 15-min volume, v15	1308	0	61	16	v
Trucks and buses	10	10	13	10	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	0.952	0.952	0.939	0.952	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	5493	0	257	66	pc/h

Weaving and Non-Weaving Speeds

	Weaving	Non-Weaving
a (Exhibit 24-6)	0.15	0.0035
b (Exhibit 24-6)	2.20	4.00
c (Exhibit 24-6)	0.97	1.30
d (Exhibit 24-6)	0.80	0.75
Weaving intensity factor, Wi	1.37	0.53
Weaving and non-weaving speeds, Si	34.00	44.39
Number of lanes required for unconstrained operation, Nw (Exhibit 24-7)		0.52
Maximum number of lanes, Nw (max) (Exhibit 24-7)		1.40
Type of operation is		Unconstrained

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	43.65	mph
Weaving segment density, D	33.31	pc/mi/ln
Level of service, LOS	D	

Capacity of base condition, cb	6780	pc/h
Capacity as a 15-minute flow rate, c	6457	pc/h
Capacity as a full-hour volume, ch	6134	pc/h

Limitations on Weaving Segments

	Analyzed	If Max Exceeded See Note Maximum	Note
Weaving flow rate, Vw	323	2800	a
Average flow rate (pcphpl)	1454	2250	b
Volume ratio, VR	0.06	0.35	c
Weaving ratio, R	0.20	N/A	d
Weaving length (ft)	500	2500	e

Notes:

a. Weaving segments longer than 2500 ft. are treated as isolated merge and diverge areas using the procedures of Chapter 25, "Ramps and Ramp Junctions".
b. Capacity constrained by basic freeway capacity.
c. Capacity occurs under constrained operating conditions.
d. Three-lane Type A segments do not operate well at volume ratios greater than 0.45. Poor operations and some local queuing are expected in such cases.
e. Four-lane Type A segments do not operate well at volume ratios greater than 0.35. Poor operations and some local queuing are expected in such cases.
f. Capacity constrained by maximum allowable weaving flow rate: 2,800 pc/h (Type A), 4,000 (Type B), 3,500 (Type C).
g. Five-lane Type A segments do not operate well at volume ratios greater than 0.20. Poor operations and some local queuing are expected in such cases.
h. Type B weaving segments do not operate well at volume ratios greater than 0.80. Poor operations and some local queuing are expected in such cases.
i. Type C weaving segments do not operate well at volume ratios greater than 0.50. Poor operations and some local queuing are expected in such cases.

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

HCS+: Freeway Weaving Release 5.4

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Operational Analysis

Analyst:	RCT
Agency/Co.:	IDOT/PB
Date Performed:	8/18/2009
Analysis Time Period:	PM Peak
Freeway/Dir of Travel:	I-290 EB
Weaving Location:	25th Ent. to 25th Ex.
Jurisdiction:	IDOT
Analysis Year:	2009

Description: I-290 Phase 1 Study

Inputs

Freeway free-flow speed, SFF	55	mph
Weaving number of lanes, N	4	
Weaving segment length, L	500	ft
Terrain type	Level	
Grade		%
Length		mi
Weaving type	A	
Volume ratio, VR	0.09	
Weaving ratio, R	0.22	

Conversion to pc/h Under Base Conditions

	Non-Weaving		Weaving		
	V o1	V o2	V w1	V w2	
Volume, V	4710	0	350	100	veh/h
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	
Peak 15-min volume, v15	1239	0	92	26	v
Trucks and buses	9	10	10	9	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	0.957	0.952	0.952	0.957	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	5181	0	386	110	pc/h

Weaving and Non-Weaving Speeds

	Weaving	Non-Weaving
a (Exhibit 24-6)	0.15	0.0035
b (Exhibit 24-6)	2.20	4.00
c (Exhibit 24-6)	0.97	1.30
d (Exhibit 24-6)	0.80	0.75
Weaving intensity factor, Wi	1.43	0.58
Weaving and non-weaving speeds, Si	33.54	43.49
Number of lanes required for unconstrained operation, Nw (Exhibit 24-7)		0.68
Maximum number of lanes, Nw (max) (Exhibit 24-7)		1.40
Type of operation is		Unconstrained

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	42.39	mph
Weaving segment density, D	33.48	pc/mi/ln
Level of service, LOS	D	

Capacity of base condition, cb	6780	pc/h
Capacity as a 15-minute flow rate, c	6488	pc/h
Capacity as a full-hour volume, ch	6164	pc/h

Limitations on Weaving Segments

	Analyzed	Maximum	If Max Exceeded See Note Note
Weaving flow rate, Vw	496	2800	a
Average flow rate (pcphpl)	1419	2250	b
Volume ratio, VR	0.09	0.35	c
Weaving ratio, R	0.22	N/A	d
Weaving length (ft)	500	2500	e

Notes:

a. Weaving segments longer than 2500 ft. are treated as isolated merge and diverge areas using the procedures of Chapter 25, "Ramps and Ramp Junctions".

b. Capacity constrained by basic freeway capacity.

c. Capacity occurs under constrained operating conditions.

d. Three-lane Type A segments do not operate well at volume ratios greater than 0.45. Poor operations and some local queuing are expected in such cases.

e. Four-lane Type A segments do not operate well at volume ratios greater than 0.35. Poor operations and some local queuing are expected in such cases.

f. Capacity constrained by maximum allowable weaving flow rate: 2,800 pc/h (Type A), 4,000 (Type B), 3,500 (Type C).

g. Five-lane Type A segments do not operate well at volume ratios greater than 0.20. Poor operations and some local queuing are expected in such cases.

h. Type B weaving segments do not operate well at volume ratios greater than 0.80. Poor operations and some local queuing are expected in such cases.

i. Type C weaving segments do not operate well at volume ratios greater than 0.50. Poor operations and some local queuing are expected in such cases.

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

HCS+: Freeway Weaving Release 5.4

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Operational Analysis

Analyst:	RCT
Agency/Co.:	IDOT/PB
Date Performed:	8/18/2009
Analysis Time Period:	AM Peak
Freeway/Dir of Travel:	I-290 EB
Weaving Location:	25th Ent. to 17th Ex.
Jurisdiction:	
Analysis Year:	2009

Description: I-290 Phase 1 Study

Inputs

Freeway free-flow speed, SFF	55	mph
Weaving number of lanes, N	4	
Weaving segment length, L	1215	ft
Terrain type	Level	
Grade		%
Length		mi
Weaving type	A	
Volume ratio, VR	0.07	
Weaving ratio, R	0.44	

Conversion to pc/h Under Base Conditions

	Non-Weaving		Weaving		
	V o1	V o2	V w1	V w2	
Volume, V	5020	0	230	180	veh/h
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	
Peak 15-min volume, v15	1321	0	61	47	v
Trucks and buses	10	10	7	10	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	0.952	0.952	0.966	0.952	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	5548	0	250	198	pc/h

Weaving and Non-Weaving Speeds

	Weaving	Non-Weaving
a (Exhibit 24-6)	0.15	0.0035
b (Exhibit 24-6)	2.20	4.00
c (Exhibit 24-6)	0.97	1.30
d (Exhibit 24-6)	0.80	0.75
Weaving intensity factor, Wi	0.72	0.31
Weaving and non-weaving speeds, Si	41.15	49.48
Number of lanes required for unconstrained operation, Nw (Exhibit 24-7)		0.70
Maximum number of lanes, Nw (max) (Exhibit 24-7)		1.40
Type of operation is		Unconstrained

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	48.74	mph
Weaving segment density, D	30.75	pc/mi/ln
Level of service, LOS	D	

Capacity of base condition, cb	7681	pc/h
Capacity as a 15-minute flow rate, c	7315	pc/h
Capacity as a full-hour volume, ch	6949	pc/h

Limitations on Weaving Segments

	Analyzed	If Max Exceeded See Note Maximum	Note
Weaving flow rate, Vw	448	2800	a
Average flow rate (pcphpl)	1499	2250	b
Volume ratio, VR	0.07	0.35	c
Weaving ratio, R	0.44	N/A	d
Weaving length (ft)	1215	2500	e

Notes:

a. Weaving segments longer than 2500 ft. are treated as isolated merge and diverge areas using the procedures of Chapter 25, "Ramps and Ramp Junctions".

b. Capacity constrained by basic freeway capacity.

c. Capacity occurs under constrained operating conditions.

d. Three-lane Type A segments do not operate well at volume ratios greater than 0.45. Poor operations and some local queuing are expected in such cases.

e. Four-lane Type A segments do not operate well at volume ratios greater than 0.35. Poor operations and some local queuing are expected in such cases.

f. Capacity constrained by maximum allowable weaving flow rate: 2,800 pc/h (Type A), 4,000 (Type B), 3,500 (Type C).

g. Five-lane Type A segments do not operate well at volume ratios greater than 0.20. Poor operations and some local queuing are expected in such cases.

h. Type B weaving segments do not operate well at volume ratios greater than 0.80. Poor operations and some local queuing are expected in such cases.

i. Type C weaving segments do not operate well at volume ratios greater than 0.50. Poor operations and some local queuing are expected in such cases.

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

HCS+: Freeway Weaving Release 5.4

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Operational Analysis

Analyst:	RCT
Agency/Co.:	IDOT/PB
Date Performed:	8/18/2009
Analysis Time Period:	PM Peak
Freeway/Dir of Travel:	I-290 EB
Weaving Location:	25th Ent. to 17th Ex.
Jurisdiction:	IDOT
Analysis Year:	2009

Description: I-290 Phase 1 Study

Inputs

Freeway free-flow speed, SFF	55	mph
Weaving number of lanes, N	4	
Weaving segment length, L	1215	ft
Terrain type	Level	
Grade		%
Length		mi
Weaving type	A	
Volume ratio, VR	0.10	
Weaving ratio, R	0.50	

Conversion to pc/h Under Base Conditions

	Non-Weaving		Weaving		
	V o1	V o2	V w1	V w2	
Volume, V	4800	0	270	260	veh/h
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	
Peak 15-min volume, v15	1263	0	71	68	v
Trucks and buses	9	10	5	9	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	0.957	0.952	0.976	0.957	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	5280	0	291	286	pc/h

Weaving and Non-Weaving Speeds

	Weaving	Non-Weaving
a (Exhibit 24-6)	0.15	0.0035
b (Exhibit 24-6)	2.20	4.00
c (Exhibit 24-6)	0.97	1.30
d (Exhibit 24-6)	0.80	0.75
Weaving intensity factor, Wi	0.74	0.32
Weaving and non-weaving speeds, Si	40.87	49.01
Number of lanes required for unconstrained operation, Nw (Exhibit 24-7)		0.82
Maximum number of lanes, Nw (max) (Exhibit 24-7)		1.40
Type of operation is		Unconstrained

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	48.07	mph
Weaving segment density, D	30.46	pc/mi/ln
Level of service, LOS	D	

```
Capacity of base condition, cb          7681   pc/h
Capacity as a 15-minute flow rate, c    7350   pc/h
Capacity as a full-hour volume, ch      6982   pc/h
```

Limitations on Weaving Segments

	Analyzed	If Max Exceeded See Note Maximum	Note
Weaving flow rate, Vw	577	2800	a
Average flow rate (pcphpl)	1464	2250	b
Volume ratio, VR	0.10	0.35	c
Weaving ratio, R	0.50	N/A	d
Weaving length (ft)	1215	2500	e

Notes:

a. Weaving segments longer than 2500 ft. are treated as isolated merge and diverge areas using the procedures of Chapter 25, "Ramps and Ramp Junctions".

b. Capacity constrained by basic freeway capacity.

c. Capacity occurs under constrained operating conditions.

d. Three-lane Type A segments do not operate well at volume ratios greater than 0.45. Poor operations and some local queuing are expected in such cases.

e. Four-lane Type A segments do not operate well at volume ratios greater than 0.35. Poor operations and some local queuing are expected in such cases.

f. Capacity constrained by maximum allowable weaving flow rate: 2,800 pc/h (Type A), 4,000 (Type B), 3,500 (Type C).

g. Five-lane Type A segments do not operate well at volume ratios greater than 0.20. Poor operations and some local queuing are expected in such cases.

h. Type B weaving segments do not operate well at volume ratios greater than 0.80. Poor operations and some local queuing are expected in such cases.

i. Type C weaving segments do not operate well at volume ratios greater than 0.50. Poor operations and some local queuing are expected in such cases.

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

HCS+: Freeway Weaving Release 5.4

Robert Tan
PBQD

Phone: Fax:
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Operational Analysis

Analyst:	RCT
Agency/Co.:	IDOT/PB
Date Performed:	8/18/2009
Analysis Time Period:	AM Peak
Freeway/Dir of Travel:	I-290 EB
Weaving Location:	Laramie Ent. to Cicero Ex.
Jurisdiction:	IDOT
Analysis Year:	2009

Description: I-290 Phase 1 Study

Inputs

Freeway free-flow speed, SFF	55	mph
Weaving number of lanes, N	5	
Weaving segment length, L	882	ft
Terrain type	Level	
Grade		%
Length		mi
Weaving type	A	
Volume ratio, VR	0.18	
Weaving ratio, R	0.29	

Conversion to pc/h Under Base Conditions

	Non-Weaving		Weaving		
	V o1	V o2	V w1	V w2	
Volume, V	6900	0	1080	450	veh/h
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	
Peak 15-min volume, v15	1816	0	284	118	v
Trucks and buses	10	10	10	5	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	0.952	0.952	0.952	0.976	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	7626	0	1193	485	pc/h

Weaving and Non-Weaving Speeds

	Weaving	Non-Weaving
a (Exhibit 24-6)	0.35	0.0020
b (Exhibit 24-6)	2.20	4.00
c (Exhibit 24-6)	0.97	1.30
d (Exhibit 24-6)	0.80	0.75
Weaving intensity factor, Wi	3.29	0.43
Weaving and non-weaving speeds, Si	25.48	46.53
Number of lanes required for unconstrained operation, Nw (Exhibit 24-7)		1.46
Maximum number of lanes, Nw (max) (Exhibit 24-7)		1.40
Type of operation is		Constrained

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	40.50	mph
Weaving segment density, D	45.95	pc/mi/ln
Level of service, LOS	F	

Capacity of base condition, cb	8713	pc/h
Capacity as a 15-minute flow rate, c	8298	pc/h
Capacity as a full-hour volume, ch	7883	pc/h

Limitations on Weaving Segments

	Analyzed	If Max Exceeded See Note Maximum	Note
Weaving flow rate, Vw	1678	2800	a
Average flow rate (pcphpl)	1860	2250	b
Volume ratio, VR	0.18	0.20	c
Weaving ratio, R	0.29	N/A	d
Weaving length (ft)	882	2500	e

Notes:

a. Weaving segments longer than 2500 ft. are treated as isolated merge and diverge areas using the procedures of Chapter 25, "Ramps and Ramp Junctions".

b. Capacity constrained by basic freeway capacity.

c. Capacity occurs under constrained operating conditions.

d. Three-lane Type A segments do not operate well at volume ratios greater than 0.45. Poor operations and some local queuing are expected in such cases.

e. Four-lane Type A segments do not operate well at volume ratios greater than 0.35. Poor operations and some local queuing are expected in such cases.

f. Capacity constrained by maximum allowable weaving flow rate: 2,800 pc/h (Type A), 4,000 (Type B), 3,500 (Type C).

g. Five-lane Type A segments do not operate well at volume ratios greater than 0.20. Poor operations and some local queuing are expected in such cases.

h. Type B weaving segments do not operate well at volume ratios greater than 0.80. Poor operations and some local queuing are expected in such cases.

i. Type C weaving segments do not operate well at volume ratios greater than 0.50. Poor operations and some local queuing are expected in such cases.

HCS+: Freeway Weaving Release 5.4

Robert Tan
PBQD

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	RCT
Agency/Co.:	IDOT/PB
Date Performed:	8/18/2009
Analysis Time Period:	PM Peak
Freeway/Dir of Travel:	I-290 EB
Weaving Location:	Laramie Ent. to Cicero Ex.
Jurisdiction:	IDOT
Analysis Year:	2009

Description: I-290 Phase 1 Study

Inputs

Freeway free-flow speed, SFF	55	mph
Weaving number of lanes, N	5	
Weaving segment length, L	882	ft
Terrain type	Level	
Grade		%
Length		mi
Weaving type	A	
Volume ratio, VR	0.17	
Weaving ratio, R	0.40	

Conversion to pc/h Under Base Conditions

	Non-Weaving		Weaving		
	V_{o1}	V_{o2}	V_{w1}	V_{w2}	
Volume, V	6320	0	810	540	veh/h
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	
Peak 15-min volume, v15	1663	0	213	142	v
Trucks and buses	9	10	9	5	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	0.957	0.952	0.957	0.976	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	6952	0	891	582	pc/h

Weaving and Non-Weaving Speeds

	Weaving	Non-Weaving
a (Exhibit 24-6)	0.35	0.0020
b (Exhibit 24-6)	2.20	4.00
c (Exhibit 24-6)	0.97	1.30
d (Exhibit 24-6)	0.80	0.75
Weaving intensity factor, Wi	2.96	0.37
Weaving and non-weaving speeds, Si	26.36	47.88
Number of lanes required for unconstrained operation, Nw (Exhibit 24-7)		1.41
Maximum number of lanes, Nw (max) (Exhibit 24-7)		1.40
Type of operation is		Constrained

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	41.90	mph
Weaving segment density, D	40.21	pc/mi/ln
Level of service, LOS	E	

Capacity of base condition, cb	8744	pc/h
Capacity as a 15-minute flow rate, c	8367	pc/h
Capacity as a full-hour volume, ch	7949	pc/h

Limitations on Weaving Segments

		If Max Exceeded See Note	
	Analyzed	Maximum	Note
Weaving flow rate, Vw	1473	2800	a
Average flow rate (pcphpl)	1685	2250	b
Volume ratio, VR	0.17	0.20	c
Weaving ratio, R	0.40	N/A	d
Weaving length (ft)	882	2500	e

Notes:

a. Weaving segments longer than 2500 ft. are treated as isolated merge and diverge areas using the procedures of Chapter 25, "Ramps and Ramp Junctions".

b. Capacity constrained by basic freeway capacity.

c. Capacity occurs under constrained operating conditions.

d. Three-lane Type A segments do not operate well at volume ratios greater than 0.45. Poor operations and some local queuing are expected in such cases.

e. Four-lane Type A segments do not operate well at volume ratios greater than 0.35. Poor operations and some local queuing are expected in such cases.

f. Capacity constrained by maximum allowable weaving flow rate: 2,800 pc/h (Type A), 4,000 (Type B), 3,500 (Type C).

g. Five-lane Type A segments do not operate well at volume ratios greater than 0.20. Poor operations and some local queuing are expected in such cases.

h. Type B weaving segments do not operate well at volume ratios greater than 0.80. Poor operations and some local queuing are expected in such cases.

i. Type C weaving segments do not operate well at volume ratios greater than 0.50. Poor operations and some local queuing are expected in such cases.

HCS+: Freeway Weaving Release 5.4

Phone: Fax:
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Operational Analysis

Analyst: RCT
Agency/Co.: IDOT/PB
Date Performed: 4/8/2010
Analysis Time Period: AM Peak
Freeway/Dir of Travel: Westbound
Weaving Location: Mannheim Ent. to Wolf Exit
Jurisdiction: IDOT
Analysis Year: 2009
Description: I-290 Weaving Analysis

Inputs

Freeway free-flow speed, SFF	55	mph
Weaving number of lanes, N	5	
Weaving segment length, L	1230	ft
Terrain type	Level	
Grade		%
Length		mi
Weaving type	A	Multilane or C-D
Volume ratio, VR	0.10	
Weaving ratio, R	0.44	

Conversion to pc/h Under Base Conditions

	Non-Weaving		Weaving		
	V_{o1}	V_{o2}	V_{w1}	V_{w2}	
Volume, V	6700	0	400	320	veh/h
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	
Peak 15-min volume, v15	1763	0	105	84	v
Trucks and buses	10	10	10	10	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	0.952	0.952	0.952	0.952	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	7405	0	442	353	pc/h

Weaving and Non-Weaving Speeds

	Weaving	Non-Weaving
a (Exhibit 24-6)	0.15	0.0035
b (Exhibit 24-6)	2.20	4.00
c (Exhibit 24-6)	0.97	1.30
d (Exhibit 24-6)	0.80	0.75
Weaving intensity factor, Wi	0.81	0.37
Weaving and non-weaving speeds, Si	39.80	47.88

Number of lanes required for

unconstrained operation, Nw (Exhibit 24-7)	1.03
Maximum number of lanes, Nw (max) (Exhibit 24-7)	1.40
Type of operation is	Unconstrained

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	46.95	mph
Weaving segment density, D	34.93	pc/mi/ln
Level of service, LOS	D	
Capacity of base condition, cb	9619	pc/h
Capacity as a 15-minute flow rate, c	9161	pc/h
Capacity as a full-hour volume, ch	8703	pc/h

Limitations on Weaving Segments

	Analyzed	If Max Exceeded See Note Maximum	Note
Weaving flow rate, Vw	795	2800	a
Average flow rate (pcphpl)	1640	2250	b
Volume ratio, VR	0.10	0.20	c
Weaving ratio, R	0.44	N/A	d
Weaving length (ft)	1230	2500	e

Notes:

a. Weaving segments longer than 2500 ft. are treated as isolated merge and diverge areas using the procedures of Chapter 25, "Ramps and Ramp Junctions".

b. Capacity constrained by basic freeway capacity.

c. Capacity occurs under constrained operating conditions.

d. Three-lane Type A segments do not operate well at volume ratios greater than 0.45. Poor operations and some local queuing are expected in such cases.

e. Four-lane Type A segments do not operate well at volume ratios greater than 0.35. Poor operations and some local queuing are expected in such cases.

f. Capacity constrained by maximum allowable weaving flow rate: 2,800 pc/h (Type A), 4,000 (Type B), 3,500 (Type C).

g. Five-lane Type A segments do not operate well at volume ratios greater than 0.20. Poor operations and some local queuing are expected in such cases.

h. Type B weaving segments do not operate well at volume ratios greater than 0.80. Poor operations and some local queuing are expected in such cases.

i. Type C weaving segments do not operate well at volume ratios greater than 0.50. Poor operations and some local queuing are expected in such cases.

HCS+: Freeway Weaving Release 5.4

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	RCT
Agency/Co.:	IDOT/PB
Date Performed:	4/8/2010
Analysis Time Period:	PM Peak
Freeway/Dir of Travel:	Westbound
Weaving Location:	Mannheim Ent. to Wolf Exit
Jurisdiction:	IDOT
Analysis Year:	2009

Description: I-290 Weaving Analysis

Inputs

Freeway free-flow speed, SFF	55	mph
Weaving number of lanes, N	5	
Weaving segment length, L	1230	ft
Terrain type	Level	
Grade		%
Length		mi
Weaving type	A	Multilane or C-D
Volume ratio, VR	0.13	
Weaving ratio, R	0.39	

Conversion to pc/h Under Base Conditions

	Non-Weaving		Weaving		
	V_{o1}	V_{o2}	V_{w1}	V_{w2}	
Volume, V	6370	0	560	370	veh/h
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	
Peak 15-min volume, v15	1676	0	147	97	v
Trucks and buses	3	10	7	3	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	0.985	0.952	0.966	0.985	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	6805	0	610	395	pc/h

Weaving and Non-Weaving Speeds

	Weaving	Non-Weaving
a (Exhibit 24-6)	0.15	0.0035
b (Exhibit 24-6)	2.20	4.00
c (Exhibit 24-6)	0.97	1.30
d (Exhibit 24-6)	0.80	0.75
Weaving intensity factor, Wi	0.83	0.39
Weaving and non-weaving speeds, Si	39.63	47.42
Number of lanes required for		

unconstrained operation, Nw (Exhibit 24-7)	1.21
Maximum number of lanes, Nw (max) (Exhibit 24-7)	1.40
Type of operation is	Unconstrained

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	46.25	mph
Weaving segment density, D	33.77	pc/mi/ln
Level of service, LOS	D	
Capacity of base condition, cb	9453	pc/h
Capacity as a 15-minute flow rate, c	9313	pc/h
Capacity as a full-hour volume, ch	8847	pc/h

Limitations on Weaving Segments

		If Max Exceeded See Note	
	Analyzed	Maximum	Note
Weaving flow rate, Vw	1005	2800	a
Average flow rate (pcphpl)	1562	2250	b
Volume ratio, VR	0.13	0.20	c
Weaving ratio, R	0.39	N/A	d
Weaving length (ft)	1230	2500	e

Notes:

a. Weaving segments longer than 2500 ft. are treated as isolated merge and diverge areas using the procedures of Chapter 25, "Ramps and Ramp Junctions".

b. Capacity constrained by basic freeway capacity.

c. Capacity occurs under constrained operating conditions.

d. Three-lane Type A segments do not operate well at volume ratios greater than 0.45. Poor operations and some local queuing are expected in such cases.

e. Four-lane Type A segments do not operate well at volume ratios greater than 0.35. Poor operations and some local queuing are expected in such cases.

f. Capacity constrained by maximum allowable weaving flow rate: 2,800 pc/h (Type A), 4,000 (Type B), 3,500 (Type C).

g. Five-lane Type A segments do not operate well at volume ratios greater than 0.20. Poor operations and some local queuing are expected in such cases.

h. Type B weaving segments do not operate well at volume ratios greater than 0.80. Poor operations and some local queuing are expected in such cases.

i. Type C weaving segments do not operate well at volume ratios greater than 0.50. Poor operations and some local queuing are expected in such cases.

HCS+: Freeway Weaving Release 5.4

Phone: Fax:
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Operational Analysis

Analyst:	RCT
Agency/Co.:	IDOT/PB
Date Performed:	7/6/2009
Analysis Time Period:	AM Peak
Freeway/Dir of Travel:	Westbound
Weaving Location:	25th Ent. to Mannheim Exi.
Jurisdiction:	IDOT
Analysis Year:	2009

Description: I-290 Weaving Analysis

Inputs

Freeway free-flow speed, SFF	55	mph
Weaving number of lanes, N	4	
Weaving segment length, L	2025	ft
Terrain type	Level	
Grade		%
Length		mi
Weaving type	A	Multilane or C-D
Volume ratio, VR	0.19	
Weaving ratio, R	0.44	

Conversion to pc/h Under Base Conditions

	Non-Weaving		Weaving		
	V o1	V o2	V w1	V w2	
Volume, V	5780	0	750	600	veh/h
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	
Peak 15-min volume, v15	1521	0	197	158	v
Trucks and buses	10	10	10	10	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	0.952	0.952	0.952	0.952	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	6388	0	828	663	pc/h

Weaving and Non-Weaving Speeds

	Weaving	Non-Weaving
a (Exhibit 24-6)	0.15	0.0035
b (Exhibit 24-6)	2.20	4.00
c (Exhibit 24-6)	0.97	1.30
d (Exhibit 24-6)	0.80	0.75
Weaving intensity factor, Wi	0.78	0.44
Weaving and non-weaving speeds, Si	40.28	46.15
Number of lanes required for unconstrained operation, Nw (Exhibit 24-7)		1.35
Maximum number of lanes, Nw (max) (Exhibit 24-7)		1.40
Type of operation is		Unconstrained

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	44.91	mph
Weaving segment density, D	43.86	pc/mi/ln
Level of service, LOS	F	

Capacity of base condition, cb	7756	pc/h
Capacity as a 15-minute flow rate, c	7387	pc/h
Capacity as a full-hour volume, ch	7018	pc/h

Limitations on Weaving Segments

	Analyzed	Maximum	If Max Exceeded See Note Note
Weaving flow rate, Vw	1491	2800	a
Average flow rate (pcphpl)	1969	2250	b
Volume ratio, VR	0.19	0.35	c
Weaving ratio, R	0.44	N/A	d
Weaving length (ft)	2025	2500	e

Notes:

a. Weaving segments longer than 2500 ft. are treated as isolated merge and diverge areas using the procedures of Chapter 25, "Ramps and Ramp Junctions".

b. Capacity constrained by basic freeway capacity.

c. Capacity occurs under constrained operating conditions.

d. Three-lane Type A segments do not operate well at volume ratios greater than 0.45. Poor operations and some local queuing are expected in such cases.

e. Four-lane Type A segments do not operate well at volume ratios greater than 0.35. Poor operations and some local queuing are expected in such cases.

f. Capacity constrained by maximum allowable weaving flow rate: 2,800 pc/h (Type A), 4,000 (Type B), 3,500 (Type C).

g. Five-lane Type A segments do not operate well at volume ratios greater than 0.20. Poor operations and some local queuing are expected in such cases.

h. Type B weaving segments do not operate well at volume ratios greater than 0.80. Poor operations and some local queuing are expected in such cases.

i. Type C weaving segments do not operate well at volume ratios greater than 0.50. Poor operations and some local queuing are expected in such cases.

HCS+: Freeway Weaving Release 5.4

Phone: Fax:
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Operational Analysis

Analyst:	RCT
Agency/Co.:	IDOT/PB
Date Performed:	7/6/2009
Analysis Time Period:	PM Peak
Freeway/Dir of Travel:	Westbound
Weaving Location:	25th Entrance to Mannheim Exit
Jurisdiction:	IDOT
Analysis Year:	2009

Description: I-290 Weaving Analysis

Inputs

Freeway free-flow speed, SFF	55	mph
Weaving number of lanes, N	4	
Weaving segment length, L	2025	ft
Terrain type	Level	
Grade		%
Length		mi
Weaving type	A	Multilane or C-D
Volume ratio, VR	0.16	
Weaving ratio, R	0.46	

Conversion to pc/h Under Base Conditions

	Non-Weaving		Weaving		
	V_{o1}	V_{o2}	V_{w1}	V_{w2}	
Volume, V	5720	0	580	490	veh/h
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	
Peak 15-min volume, v15	1505	0	153	129	v
Trucks and buses	3	10	3	7	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	0.985	0.952	0.985	0.966	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	6111	0	619	533	pc/h

Weaving and Non-Weaving Speeds

	Weaving	Non-Weaving
a (Exhibit 24-6)	0.15	0.0035
b (Exhibit 24-6)	2.20	4.00
c (Exhibit 24-6)	0.97	1.30
d (Exhibit 24-6)	0.80	0.75
Weaving intensity factor, Wi	0.68	0.36
Weaving and non-weaving speeds, Si	41.78	48.08
Number of lanes required for unconstrained operation, Nw (Exhibit 24-7)		1.20
Maximum number of lanes, Nw (max) (Exhibit 24-7)		1.40
Type of operation is		Unconstrained

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	46.96	mph
Weaving segment density, D	38.67	pc/mi/ln
Level of service, LOS	E	

Capacity of base condition, cb	7909	pc/h
Capacity as a 15-minute flow rate, c	7792	pc/h
Capacity as a full-hour volume, ch	7402	pc/h

Limitations on Weaving Segments

	Analyzed	If Max Exceeded See Note Maximum	Note
Weaving flow rate, Vw	1152	2800	a
Average flow rate (pcphpl)	1815	2250	b
Volume ratio, VR	0.16	0.35	c
Weaving ratio, R	0.46	N/A	d
Weaving length (ft)	2025	2500	e

Notes:

a. Weaving segments longer than 2500 ft. are treated as isolated merge and diverge areas using the procedures of Chapter 25, "Ramps and Ramp Junctions".

b. Capacity constrained by basic freeway capacity.

c. Capacity occurs under constrained operating conditions.

d. Three-lane Type A segments do not operate well at volume ratios greater than 0.45. Poor operations and some local queuing are expected in such cases.

e. Four-lane Type A segments do not operate well at volume ratios greater than 0.35. Poor operations and some local queuing are expected in such cases.

f. Capacity constrained by maximum allowable weaving flow rate: 2,800 pc/h (Type A), 4,000 (Type B), 3,500 (Type C).

g. Five-lane Type A segments do not operate well at volume ratios greater than 0.20. Poor operations and some local queuing are expected in such cases.

h. Type B weaving segments do not operate well at volume ratios greater than 0.80. Poor operations and some local queuing are expected in such cases.

i. Type C weaving segments do not operate well at volume ratios greater than 0.50. Poor operations and some local queuing are expected in such cases.

HCS+: Freeway Weaving Release 5.4

Wiedelman
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Operational Analysis

Analyst:	RCT
Agency/Co.:	IDOT/PB
Date Performed:	7/6/2009
Analysis Time Period:	AM Peak
Freeway/Dir of Travel:	I-290 WB
Weaving Location:	17th Ave. Ent. to 25th Ave. Ex
Jurisdiction:	IDOT
Analysis Year:	2009

Description: I-290 Phase 1 Study

Inputs

Freeway free-flow speed, SFF	55	mph
Weaving number of lanes, N	4	
Weaving segment length, L	887	ft
Terrain type	Level	
Grade		%
Length		mi
Weaving type	A	
Volume ratio, VR	0.11	
Weaving ratio, R	0.20	

Conversion to pc/h Under Base Conditions

	Non-Weaving V o1	V o2	Weaving V w1	V w2	
Volume, V	6240	0	590	150	veh/h
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	
Peak 15-min volume, v15	1642	0	155	39	v
Trucks and buses	10	10	10	10	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	0.952	0.952	0.952	0.952	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	6896	0	652	165	pc/h

Weaving and Non-Weaving Speeds

	Weaving	Non-Weaving
a (Exhibit 24-6)	0.15	0.0035
b (Exhibit 24-6)	2.20	4.00
c (Exhibit 24-6)	0.97	1.30
d (Exhibit 24-6)	0.80	0.75
Weaving intensity factor, Wi	1.26	0.60
Weaving and non-weaving speeds, Si	34.91	43.11
Number of lanes required for unconstrained operation, Nw (Exhibit 24-7)		0.85
Maximum number of lanes, Nw (max) (Exhibit 24-7)		1.40
Type of operation is		Unconstrained

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	42.06	mph
Weaving segment density, D	45.84	pc/mi/ln
Level of service, LOS	F	

Capacity of base condition, cb	7304	pc/h
Capacity as a 15-minute flow rate, c	6956	pc/h
Capacity as a full-hour volume, ch	6608	pc/h

Limitations on Weaving Segments

	Analyzed	If Max Exceeded See Note Maximum	Note
Weaving flow rate, Vw	817	2800	a
Average flow rate (pcphpl)	1928	2250	b
Volume ratio, VR	0.11	0.35	c
Weaving ratio, R	0.20	N/A	d
Weaving length (ft)	887	2500	e

Notes:

a. Weaving segments longer than 2500 ft. are treated as isolated merge and diverge areas using the procedures of Chapter 25, "Ramps and Ramp Junctions".

b. Capacity constrained by basic freeway capacity.

c. Capacity occurs under constrained operating conditions.

d. Three-lane Type A segments do not operate well at volume ratios greater than 0.45. Poor operations and some local queuing are expected in such cases.

e. Four-lane Type A segments do not operate well at volume ratios greater than 0.35. Poor operations and some local queuing are expected in such cases.

f. Capacity constrained by maximum allowable weaving flow rate: 2,800 pc/h (Type A), 4,000 (Type B), 3,500 (Type C).

g. Five-lane Type A segments do not operate well at volume ratios greater than 0.20. Poor operations and some local queuing are expected in such cases.

h. Type B weaving segments do not operate well at volume ratios greater than 0.80. Poor operations and some local queuing are expected in such cases.

i. Type C weaving segments do not operate well at volume ratios greater than 0.50. Poor operations and some local queuing are expected in such cases.

HCS+: Freeway Weaving Release 5.4

Wiedelman
Parsons Brinckerhoff

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	RCT
Agency/Co.:	IDOT/PB
Date Performed:	7/6/2009
Analysis Time Period:	PM Peak
Freeway/Dir of Travel:	I-290 WB
Weaving Location:	17th Ave. Ent. to 25th Ave. Ex
Jurisdiction:	IDOT
Analysis Year:	2009

Description: I-290 Phase 1 Study

Inputs

Freeway free-flow speed, SFF	55	mph
Weaving number of lanes, N	4	
Weaving segment length, L	887	ft
Terrain type	Level	
Grade		%
Length		mi
Weaving type	A	
Volume ratio, VR	0.10	
Weaving ratio, R	0.23	

Conversion to pc/h Under Base Conditions

	Non-Weaving V_{o1}	V_{o2}	Weaving V_{w1}	V_{w2}	
Volume, V	6070	0	480	150	veh/h
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	
Peak 15-min volume, v15	1597	0	126	39	v
Trucks and buses	3	10	7	3	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	0.985	0.952	0.966	0.985	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	6485	0	522	160	pc/h

Weaving and Non-Weaving Speeds

	Weaving	Non-Weaving
a (Exhibit 24-6)	0.15	0.0035
b (Exhibit 24-6)	2.20	4.00
c (Exhibit 24-6)	0.97	1.30
d (Exhibit 24-6)	0.80	0.75
Weaving intensity factor, Wi	1.15	0.53
Weaving and non-weaving speeds, Si	35.94	44.51
Number of lanes required for unconstrained operation, Nw (Exhibit 24-7)		0.79
Maximum number of lanes, Nw (max) (Exhibit 24-7)		1.40
Type of operation is		Unconstrained

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	43.52	mph
Weaving segment density, D	41.17	pc/mi/ln
Level of service, LOS	E	

Capacity of base condition, cb	7337	pc/h
Capacity as a 15-minute flow rate, c	7229	pc/h
Capacity as a full-hour volume, ch	6868	pc/h

Limitations on Weaving Segments

	Analyzed	If Max Exceeded See Note Maximum	Note
Weaving flow rate, Vw	682	2800	a
Average flow rate (pcphpl)	1791	2250	b
Volume ratio, VR	0.10	0.35	c
Weaving ratio, R	0.23	N/A	d
Weaving length (ft)	887	2500	e

Notes:

a. Weaving segments longer than 2500 ft. are treated as isolated merge and diverge areas using the procedures of Chapter 25, "Ramps and Ramp Junctions".
b. Capacity constrained by basic freeway capacity.
c. Capacity occurs under constrained operating conditions.
d. Three-lane Type A segments do not operate well at volume ratios greater than 0.45. Poor operations and some local queuing are expected in such cases.
e. Four-lane Type A segments do not operate well at volume ratios greater than 0.35. Poor operations and some local queuing are expected in such cases.
f. Capacity constrained by maximum allowable weaving flow rate: 2,800 pc/h (Type A), 4,000 (Type B), 3,500 (Type C).
g. Five-lane Type A segments do not operate well at volume ratios greater than 0.20. Poor operations and some local queuing are expected in such cases.
h. Type B weaving segments do not operate well at volume ratios greater than 0.80. Poor operations and some local queuing are expected in such cases.
i. Type C weaving segments do not operate well at volume ratios greater than 0.50. Poor operations and some local queuing are expected in such cases.

2009AM Austin Central Off Ramp.txt

HCS+: Freeway Weaving Release 5.4

Wiedelman
Parsons Brinckerhoff

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	RCT
Agency/Co.:	IDOT/PB
Date Performed:	3/25/2010
Analysis Time Period:	AM Peak
Freeway/Dir of Travel:	I-290 WB
Weaving Location:	Austin 0ff-Ramp
Jurisdiction:	IDOT
Analysis Year:	2009

Description: I-290 Phase 1 Study

Inputs

Freeway free-flow speed, SFF	55	mph
Weaving number of lanes, N	4	
Weaving segment length, L	2200	ft
Terrain type	Level	
Grade		%
Length		mi
Weaving type	A	
Volume ratio, VR	0.05	
Weaving ratio, R	0.27	

Conversion to pc/h Under Base Conditions

	Non-Weaving		Weaving		
	V_{o1}	V_{o2}	V_{w1}	V_{w2}	
Volume, V	4630	810	220	80	veh/h
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	
Peak 15-min volume, v15	1218	213	58	21	v
Trucks and buses	10	10	10	10	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	0.952	0.952	0.952	0.952	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	5117	895	243	88	pc/h

Weaving and Non-Weaving Speeds

	Weaving	Non-Weaving
a (Exhibit 24-6)	0.15	0.0035
b (Exhibit 24-6)	2.20	4.00
c (Exhibit 24-6)	0.97	1.30
d (Exhibit 24-6)	0.80	0.75
Weaving intensity factor, Wi	0.45	0.19
Weaving and non-weaving speeds, Si	46.00	52.71
Number of lanes required for unconstrained operation, Nw (Exhibit 24-7)		0.62
Maximum number of lanes, Nw (max) (Exhibit 24-7)		1.40
Type of operation is		Unconstrained

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	52.32	mph
Weaving segment density, D	30.31	pc/mi/ln
Level of service, LOS	D	

Capacity of base condition, cb	8274	pc/h
Capacity as a 15-minute flow rate, c	7880	pc/h
Capacity as a full-hour volume, ch	7486	pc/h

Limitations on Weaving Segments

	Analyzed	If Max Exceeded See Note Maximum	Note
Weaving flow rate, Vw	331	2800	a
Average flow rate (pcphpl)	1585	2250	b
Volume ratio, VR	0.05	0.35	c
Weaving ratio, R	0.27	N/A	d
Weaving length (ft)	2200	2500	e

Notes:

a. Weaving segments longer than 2500 ft. are treated as isolated merge and diverge areas using the procedures of Chapter 25, "Ramps and Ramp Junctions".

b. Capacity constrained by basic freeway capacity.

c. Capacity occurs under constrained operating conditions.

d. Three-lane Type A segments do not operate well at volume ratios greater than 0.45. Poor operations and some local queuing are expected in such cases.

e. Four-lane Type A segments do not operate well at volume ratios greater than 0.35. Poor operations and some local queuing are expected in such cases.

f. Capacity constrained by maximum allowable weaving flow rate: 2,800 pc/h (Type A), 4,000 (Type B), 3,500 (Type C).

g. Five-lane Type A segments do not operate well at volume ratios greater than 0.20. Poor operations and some local queuing are expected in such cases.

h. Type B weaving segments do not operate well at volume ratios greater than 0.80. Poor operations and some local queuing are expected in such cases.

i. Type C weaving segments do not operate well at volume ratios greater than 0.50. Poor operations and some local queuing are expected in such cases.

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

HCS+: Freeway Weaving Release 5.4

Wiedelman
Parsons Brinckerhoff

Phone: Fax:
E-mail:

Operational Analysis

Analyst: RCT
Agency/Co.: IDOT/PB
Date Performed: 3/25/2010
Analysis Time Period: PM Peak
Freeway/Dir of Travel: I-290 WB
Weaving Location: Austin 0ff-Ramp
Jurisdiction: IDOT
Analysis Year: 2009
Description: I-290 Phase 1 Study

Inputs

Freeway free-flow speed, SFF	55	mph
Weaving number of lanes, N	4	
Weaving segment length, L	2200	ft
Terrain type	Level	
Grade		%
Length		mi
Weaving type	A	
Volume ratio, VR	0.06	
Weaving ratio, R	0.27	

Conversion to pc/h Under Base Conditions

	Non-Weaving V o1	Non-Weaving V o2	Weaving V w1	Weaving V w2	
Volume, V	5035	1000	275	100	veh/h
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	
Peak 15-min volume, v15	1325	263	72	26	v
Trucks and buses	3	3	3	3	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	0.985	0.985	0.985	0.985	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	5379	1068	293	106	pc/h

Weaving and Non-Weaving Speeds

	Weaving	Non-Weaving
a (Exhibit 24-6)	0.15	0.0035
b (Exhibit 24-6)	2.20	4.00
c (Exhibit 24-6)	0.97	1.30
d (Exhibit 24-6)	0.80	0.75
Weaving intensity factor, Wi	0.49	0.22
Weaving and non-weaving speeds, Si	45.15	51.94
Number of lanes required for unconstrained operation, Nw (Exhibit 24-7)		0.67
Maximum number of lanes, Nw (max) (Exhibit 24-7)		1.40
Type of operation is		Unconstrained

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	51.49	mph
Weaving segment density, D	33.24	pc/mi/ln
Level of service, LOS	D	

Capacity of base condition, cb	8274	pc/h
Capacity as a 15-minute flow rate, c	8152	pc/h
Capacity as a full-hour volume, ch	7744	pc/h

Limitations on Weaving Segments

	Analyzed	If Max Exceeded See Note Maximum	Note
Weaving flow rate, Vw	399	2800	a
Average flow rate (pcphpl)	1711	2250	b
Volume ratio, VR	0.06	0.35	c
Weaving ratio, R	0.27	N/A	d
Weaving length (ft)	2200	2500	e

Notes:

a. Weaving segments longer than 2500 ft. are treated as isolated merge and diverge areas using the procedures of Chapter 25, "Ramps and Ramp Junctions".

b. Capacity constrained by basic freeway capacity.

c. Capacity occurs under constrained operating conditions.

d. Three-lane Type A segments do not operate well at volume ratios greater than 0.45. Poor operations and some local queuing are expected in such cases.

e. Four-lane Type A segments do not operate well at volume ratios greater than 0.35. Poor operations and some local queuing are expected in such cases.

f. Capacity constrained by maximum allowable weaving flow rate: 2,800 pc/h (Type A), 4,000 (Type B), 3,500 (Type C).

g. Five-lane Type A segments do not operate well at volume ratios greater than 0.20. Poor operations and some local queuing are expected in such cases.

h. Type B weaving segments do not operate well at volume ratios greater than 0.80. Poor operations and some local queuing are expected in such cases.

i. Type C weaving segments do not operate well at volume ratios greater than 0.50. Poor operations and some local queuing are expected in such cases.

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

HCS+: Freeway Weaving Release 5.4

Wiedelman
Parsons Brinckerhoff

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	RCT
Agency/Co.:	IDOT/PB
Date Performed:	7/6/2009
Analysis Time Period:	AM Peak
Freeway/Dir of Travel:	I-290 WB
Weaving Location:	Cicero Ent. to Laramie Ex.
Jurisdiction:	IDOT
Analysis Year:	2009

Description: I-290 Phase 1 Study

Inputs

Freeway free-flow speed, SFF	55	mph
Weaving number of lanes, N	5	
Weaving segment length, L	718	ft
Terrain type	Level	
Grade		%
Length		mi
Weaving type	A	
Volume ratio, VR	0.19	
Weaving ratio, R	0.47	

Conversion to pc/h Under Base Conditions

	Non-Weaving		Weaving		
	V o1	V o2	V w1	V w2	
Volume, V	4920	0	630	550	veh/h
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	
Peak 15-min volume, v15	1295	0	166	145	v
Trucks and buses	10	10	10	10	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	0.952	0.952	0.952	0.952	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	5437	0	696	607	pc/h

Weaving and Non-Weaving Speeds

	Weaving	Non-Weaving
a (Exhibit 24-6)	0.35	0.0020
b (Exhibit 24-6)	2.20	4.00
c (Exhibit 24-6)	0.97	1.30
d (Exhibit 24-6)	0.80	0.75
Weaving intensity factor, Wi	2.91	0.34
Weaving and non-weaving speeds, Si	26.51	48.52
Number of lanes required for unconstrained operation, Nw (Exhibit 24-7)		1.42
Maximum number of lanes, Nw (max) (Exhibit 24-7)		1.40
Type of operation is		Constrained

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	41.81	mph
Weaving segment density, D	32.24	pc/mi/ln
Level of service, LOS	D	

Capacity of base condition, cb	8363	pc/h
Capacity as a 15-minute flow rate, c	7965	pc/h
Capacity as a full-hour volume, ch	7567	pc/h

Limitations on Weaving Segments

	Analyzed	If Max Exceeded See Note Maximum	Note
Weaving flow rate, Vw	1303	2800	a
Average flow rate (pcphpl)	1348	2250	b
Volume ratio, VR	0.19	0.20	c
Weaving ratio, R	0.47	N/A	d
Weaving length (ft)	718	2500	e

Notes:

a. Weaving segments longer than 2500 ft. are treated as isolated merge and diverge areas using the procedures of Chapter 25, "Ramps and Ramp Junctions".

b. Capacity constrained by basic freeway capacity.

c. Capacity occurs under constrained operating conditions.

d. Three-lane Type A segments do not operate well at volume ratios greater than 0.45. Poor operations and some local queuing are expected in such cases.

e. Four-lane Type A segments do not operate well at volume ratios greater than 0.35. Poor operations and some local queuing are expected in such cases.

f. Capacity constrained by maximum allowable weaving flow rate: 2,800 pc/h (Type A), 4,000 (Type B), 3,500 (Type C).

g. Five-lane Type A segments do not operate well at volume ratios greater than 0.20. Poor operations and some local queuing are expected in such cases.

h. Type B weaving segments do not operate well at volume ratios greater than 0.80. Poor operations and some local queuing are expected in such cases.

i. Type C weaving segments do not operate well at volume ratios greater than 0.50. Poor operations and some local queuing are expected in such cases.

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

HCS+: Freeway Weaving Release 5.4

Wiedelman
Parsons Brinckerhoff

Phone: Fax:
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Operational Analysis

Analyst: RCT
Agency/Co.: IDOT/PB
Date Performed: 7/6/2009
Analysis Time Period: PM Peak
Freeway/Dir of Travel: I-290 WB
Weaving Location: Cicero Ent. to Laramie Ex.
Jurisdiction: IDOT
Analysis Year: 2009
Description: I-290 Phase 1 Study

Inputs

Freeway free-flow speed, SFF	55	mph
Weaving number of lanes, N	5	
Weaving segment length, L	718	ft
Terrain type	Level	
Grade		%
Length		mi
Weaving type	A	
Volume ratio, VR	0.17	
Weaving ratio, R	0.48	

Conversion to pc/h Under Base Conditions

	Non-Weaving		Weaving		
	V_{o1}	V_{o2}	V_{w1}	V_{w2}	
Volume, V	5490	0	610	550	veh/h
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	
Peak 15-min volume, v15	1445	0	161	145	v
Trucks and buses	3	10	3	5	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	0.985	0.952	0.985	0.976	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	5865	0	651	593	pc/h

Weaving and Non-Weaving Speeds

	Weaving	Non-Weaving
a (Exhibit 24-6)	0.15	0.0035
b (Exhibit 24-6)	2.20	4.00
c (Exhibit 24-6)	0.97	1.30
d (Exhibit 24-6)	0.80	0.75
Weaving intensity factor, Wi	1.27	0.60
Weaving and non-weaving speeds, Si	34.83	43.06
Number of lanes required for unconstrained operation, Nw (Exhibit 24-7)		1.35
Maximum number of lanes, Nw (max) (Exhibit 24-7)		1.40
Type of operation is		Unconstrained

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	41.35	mph
Weaving segment density, D	34.38	pc/mi/ln
Level of service, LOS	D	

Capacity of base condition, cb	8463	pc/h
Capacity as a 15-minute flow rate, c	8338	pc/h
Capacity as a full-hour volume, ch	7921	pc/h

Limitations on Weaving Segments

	Analyzed	If Max Exceeded See Note Maximum	Note
Weaving flow rate, Vw	1244	2800	a
Average flow rate (pcphpl)	1421	2250	b
Volume ratio, VR	0.17	0.20	c
Weaving ratio, R	0.48	N/A	d
Weaving length (ft)	718	2500	e

Notes:

a. Weaving segments longer than 2500 ft. are treated as isolated merge and diverge areas using the procedures of Chapter 25, "Ramps and Ramp Junctions".

b. Capacity constrained by basic freeway capacity.

c. Capacity occurs under constrained operating conditions.

d. Three-lane Type A segments do not operate well at volume ratios greater than 0.45. Poor operations and some local queuing are expected in such cases.

e. Four-lane Type A segments do not operate well at volume ratios greater than 0.35. Poor operations and some local queuing are expected in such cases.

f. Capacity constrained by maximum allowable weaving flow rate: 2,800 pc/h (Type A), 4,000 (Type B), 3,500 (Type C).

g. Five-lane Type A segments do not operate well at volume ratios greater than 0.20. Poor operations and some local queuing are expected in such cases.

h. Type B weaving segments do not operate well at volume ratios greater than 0.80. Poor operations and some local queuing are expected in such cases.

i. Type C weaving segments do not operate well at volume ratios greater than 0.50. Poor operations and some local queuing are expected in such cases.

Speed and volume conditions occurring in the field indicate over-saturated conditions indicative of LOS F, which are not adequately evaluated by the Highway Capacity Manual method.

Technical Memorandum

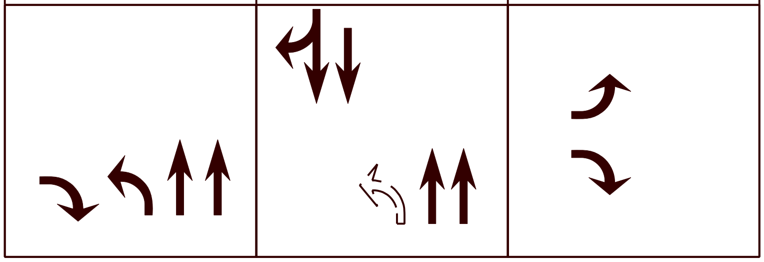
Appendix E-4

Interchange Intersection Analysis

- **Existing Intersection Signal Phasing**
- **Intersection Traffic Counts – 2010-Jan-06**
- **Crossroad ADT Volume Adjustment Percentages**
- **Ramp Volume Adjustment Percentages**
- **Intersection Volume Adjustments**
- **Intersection Turn-Lane Storage Analysis**
- **Intersection HCS Analysis Output**

25th Ave. & Congress St.

	PHASE 1	PHASE 2	PHASE 3

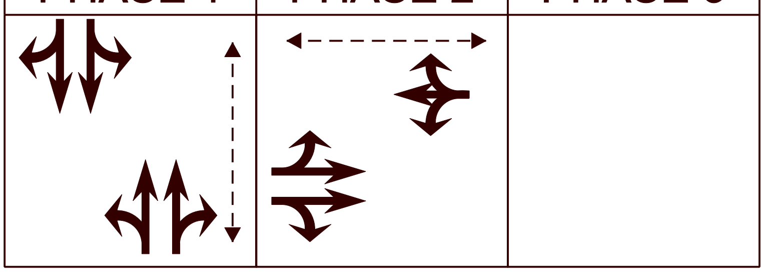


AM	G	13	34	8
	Y	4	4	4
	AR	1	1	1

PM	G	10	43	7
	Y	4	4	4
	AR	1	1	1

25th Ave. & Lexington St.

	PHASE 1	PHASE 2	PHASE 3

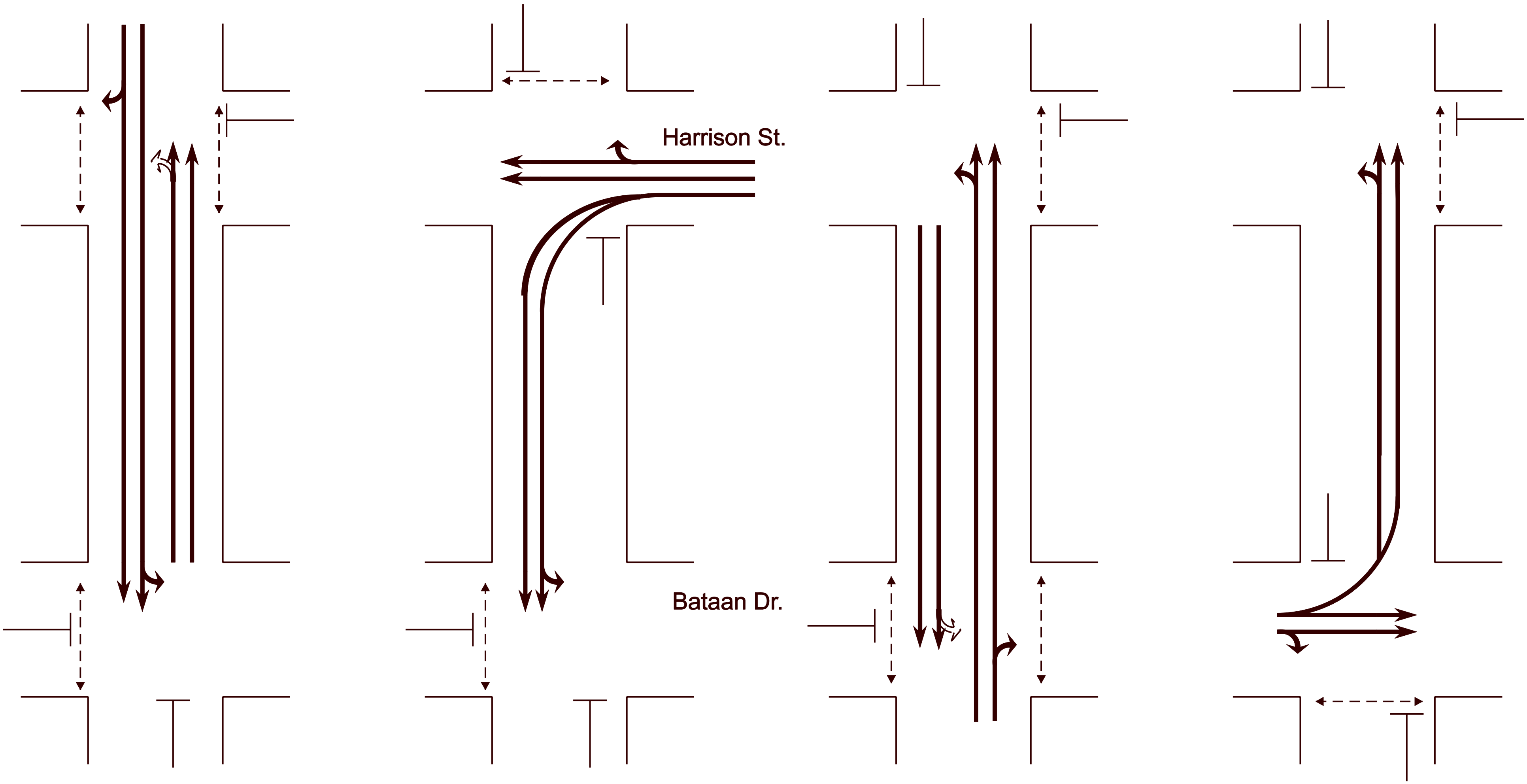


AM	G	60	20	
	Y	4	4	
	AR	1	1	

PM	G	63	17	
	Y	4	4	
	AR	1	1	

17th Ave. & Harrison St. & Bataan Dr.

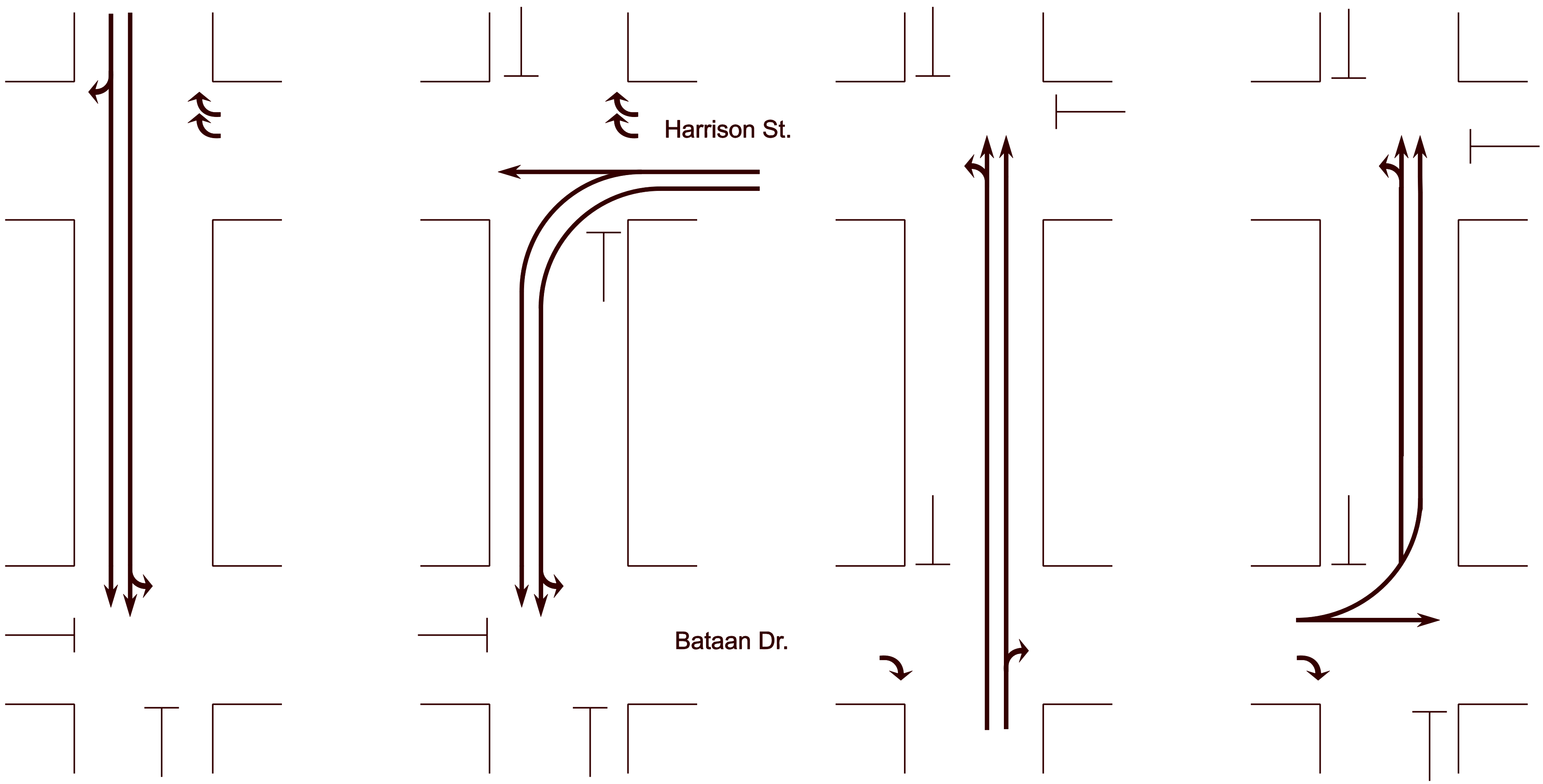
AM & PM



		PHASE 1	PHASE 2	PHASE 3	PHASE 4
AM	G	35	25	35	25
&	Y	4	4	4	4
PM	AR	1	1	1	1

ots\Lane Diagrams\Signal Phasing\Signal Timings.dgn
6/29/2010

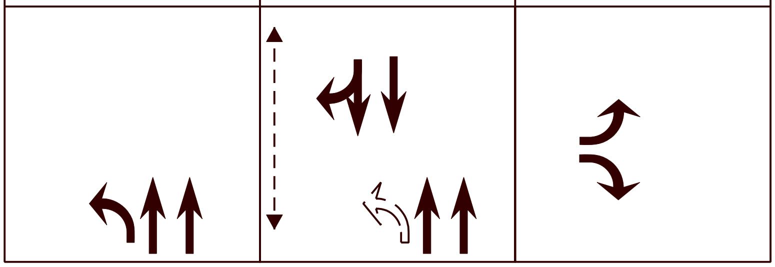
1st Ave. & Harrison St. & Bataan Dr.



		PHASE 1	PHASE 2	PHASE 3	PHASE 4
AM	G	65	30	65	30
&	Y	4	4	4	4
PM	AR	1	1	1	1

Des Plaines Ave. & CTA Station

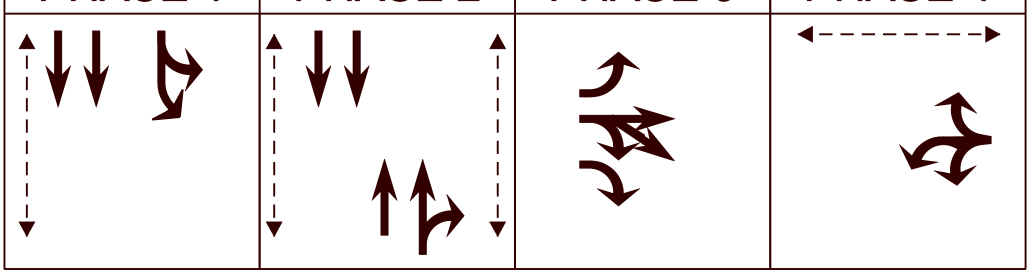
PHASE 1	PHASE 2	PHASE 3



		PHASE 1	PHASE 2	PHASE 3
AM & PM	G	11	65	25
	Y	3	4	4
	AR	1	1	1

Des Plaines Ave. & Harrison St.

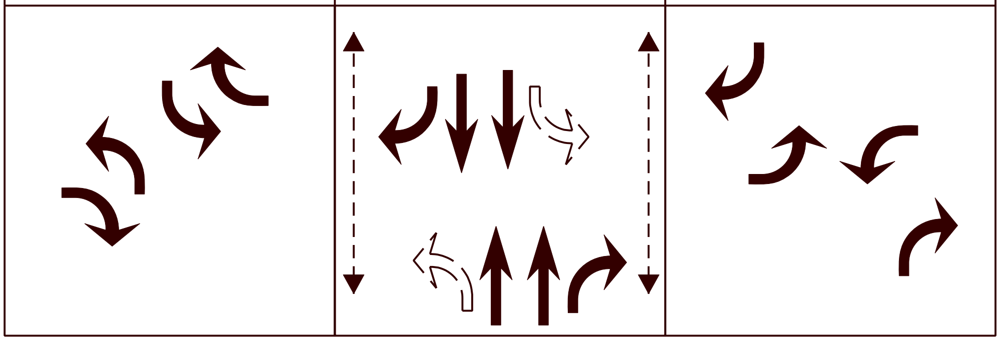
PHASE 1	PHASE 2	PHASE 3	PHASE 4



		PHASE 1	PHASE 2	PHASE 3	PHASE 4
AM	G	6	55	15	16
	Y	3	4	4	4
	AR	0	1	1	1

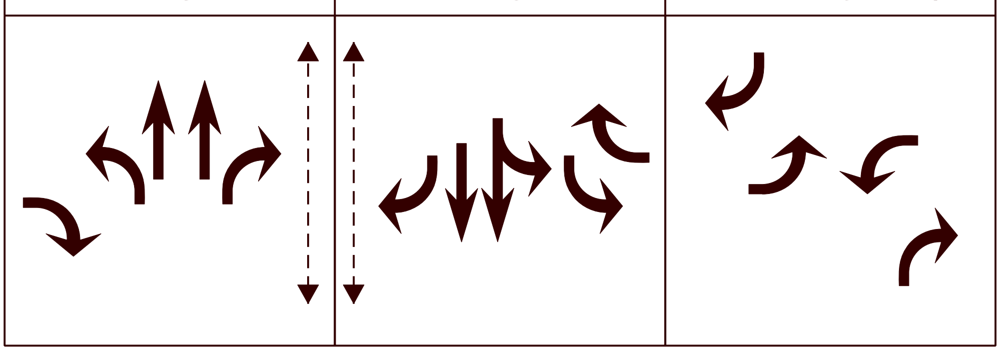
		PHASE 1	PHASE 2	PHASE 3	PHASE 4
PM	G	10	51	20	16
	Y	3	4	4	4
	AR	0	1	1	1

Harlem Ave. & I-290 Ramps



		PHASE 1	PHASE 2	PHASE 3
AM	G	30	50	30
&	Y	4	4	4
PM	AR	1	1	1

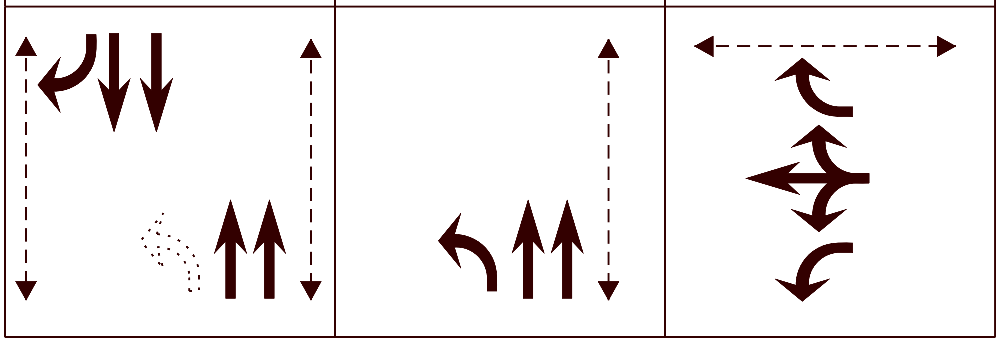
Austin Blvd. & I-290 Ramps



		PHASE 1	PHASE 2	PHASE 3
AM	G	30	30	50
&	Y	4	4	4
PM	AR	1	1	1

Central Ave. & Flournoy St.

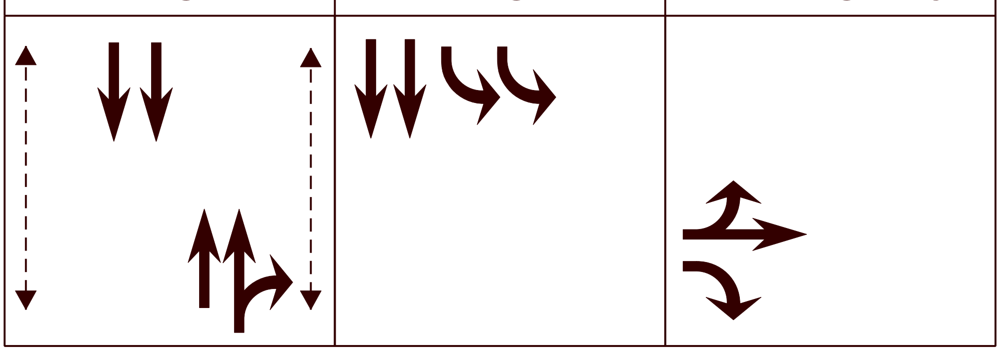
PHASE 1	PHASE 2	PHASE 3



		PHASE 1	PHASE 2	PHASE 3
AM	G	40	16	23
&	Y	3	3	3
PM	AR	0	1	1

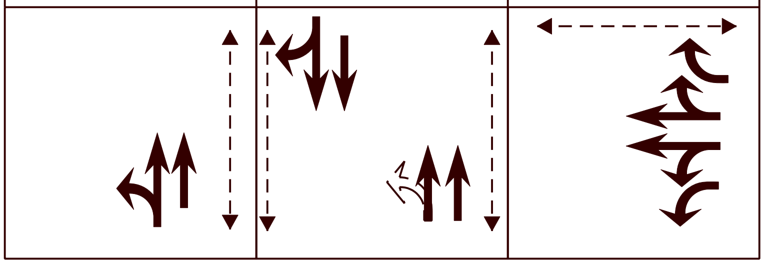
Central Ave. & EB Ramps

PHASE 1	PHASE 2	PHASE 3



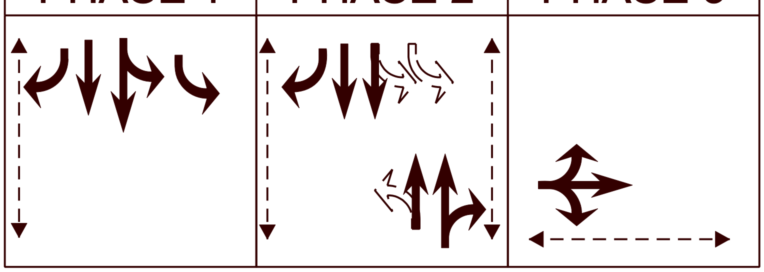
		PHASE 1	PHASE 2	PHASE 3
AM	G	35	20	23
&	Y	3	3	3
PM	AR	1	1	1

Laramie Ave. & Flournoy St.



		PHASE 1	PHASE 2	PHASE 3
AM	G	10	47	20
	Y	0	3	3
	AR	0	1	1
PM	G	7	36	34
	Y	0	3	3
	AR	0	1	1

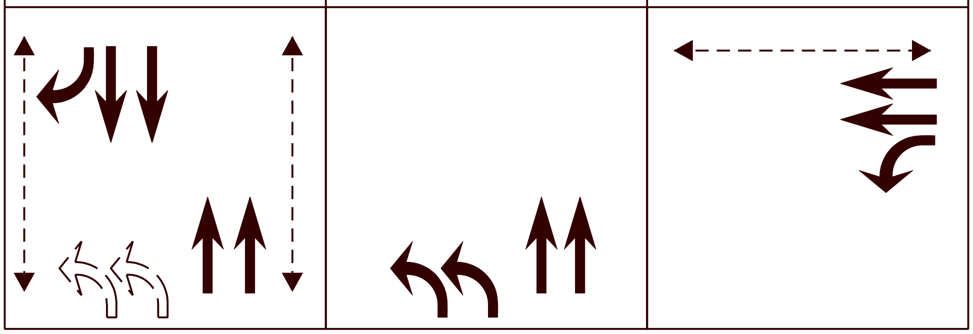
Laramie Ave. & Lexington St.



		PHASE 1	PHASE 2	PHASE 3
AM	G	20	34	20
	Y	3	3	3
	AR	0	1	1
PM	G	7	43	24
	Y	3	3	3
	AR	0	1	1

Cicero Ave. & Flournoy St.

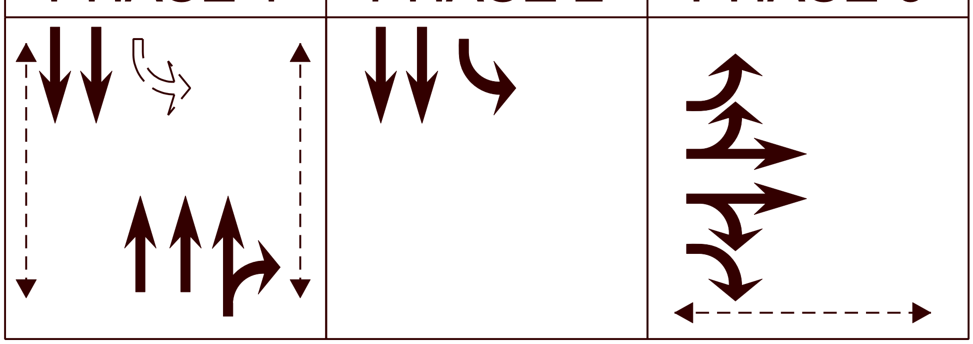
PHASE 1	PHASE 2	PHASE 3



		PHASE 1	PHASE 2	PHASE 3
AM & PM	G	43	8	23
	Y	3	3	3
	AR	0	1	1

Cicero Ave. & Lexington St.

PHASE 1	PHASE 2	PHASE 3



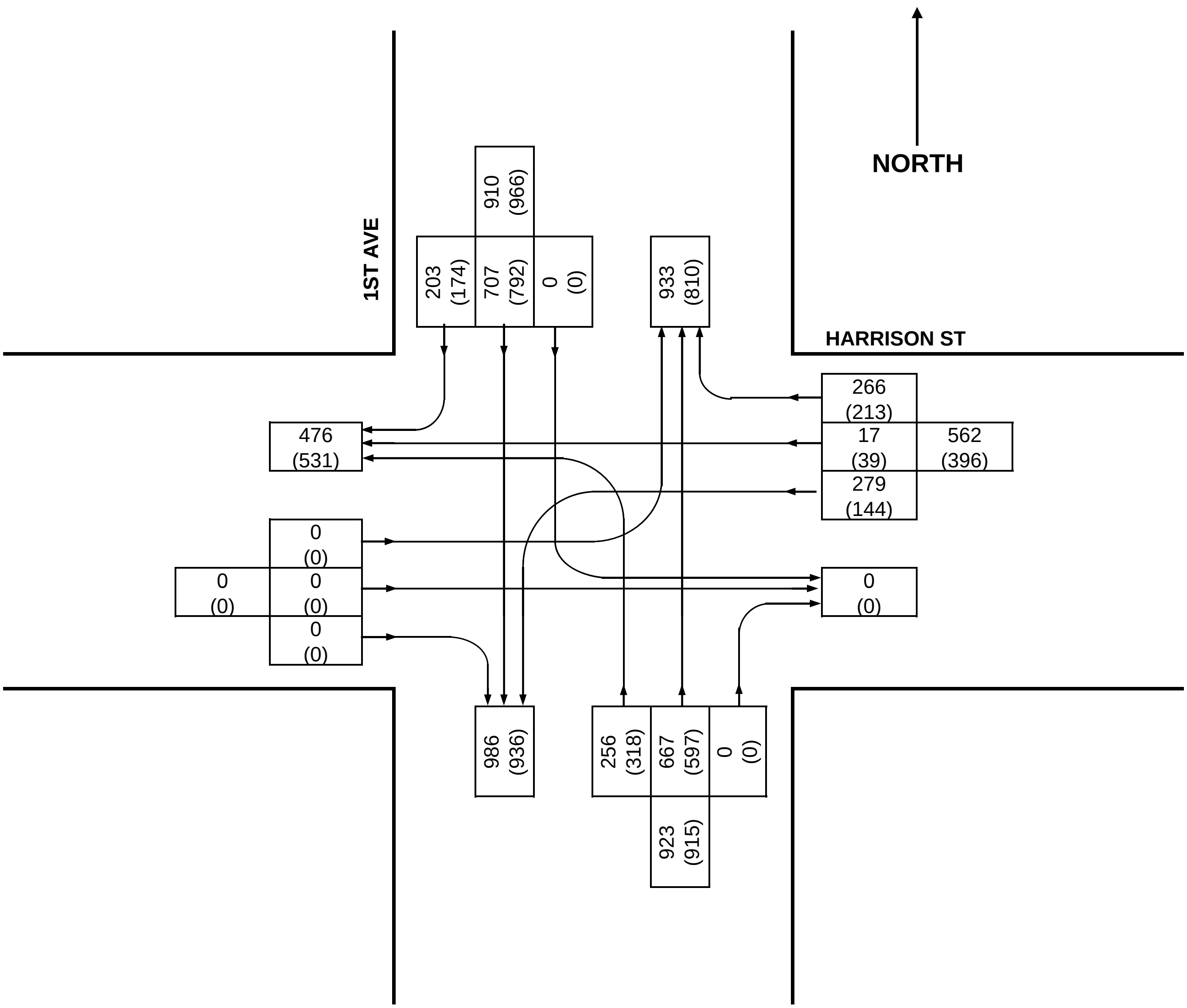
		PHASE 1	PHASE 2	PHASE 3
AM & PM	G	43	8	23
	Y	3	3	3
	AR	0	1	1

SUMMARY OF TRAFFIC SURVEY

INTERSECTION OF 1ST AVENUE & HARRISON STREET

Count Date: 1/6/2010
Made by PB

AM: 8:00-9:00
PM: 5:30-6:30



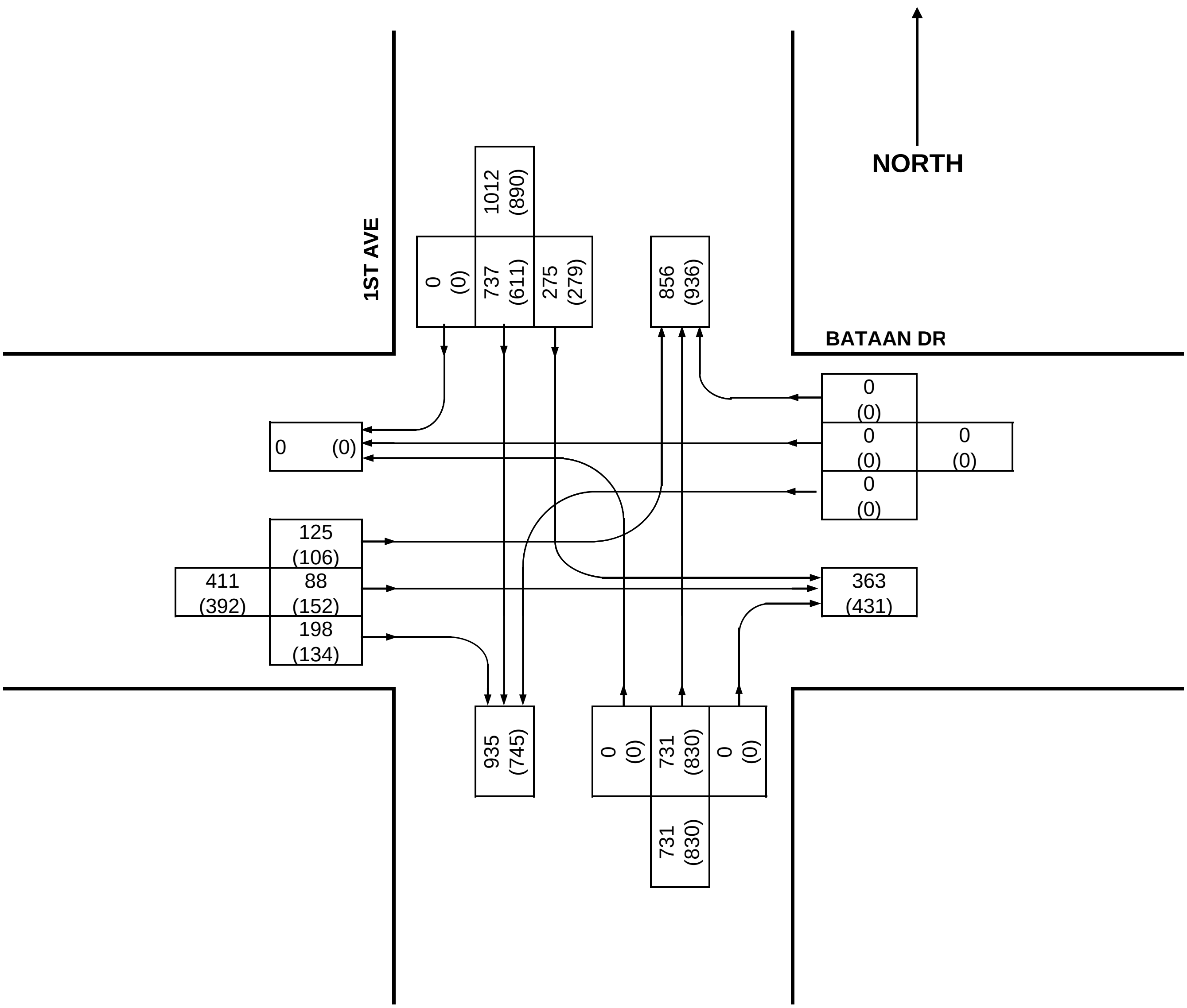
LEGEND
XXX - AM TRAFFIC
(XXX)- PM TRAFFIC

SUMMARY OF TRAFFIC SURVEY

INTERSECTION OF 1ST AVENUE & BATAAN DRIVE

Count Date: 1/6/2010
Made by PB

AM: 7:30-8:30
PM: 5:00-6:00



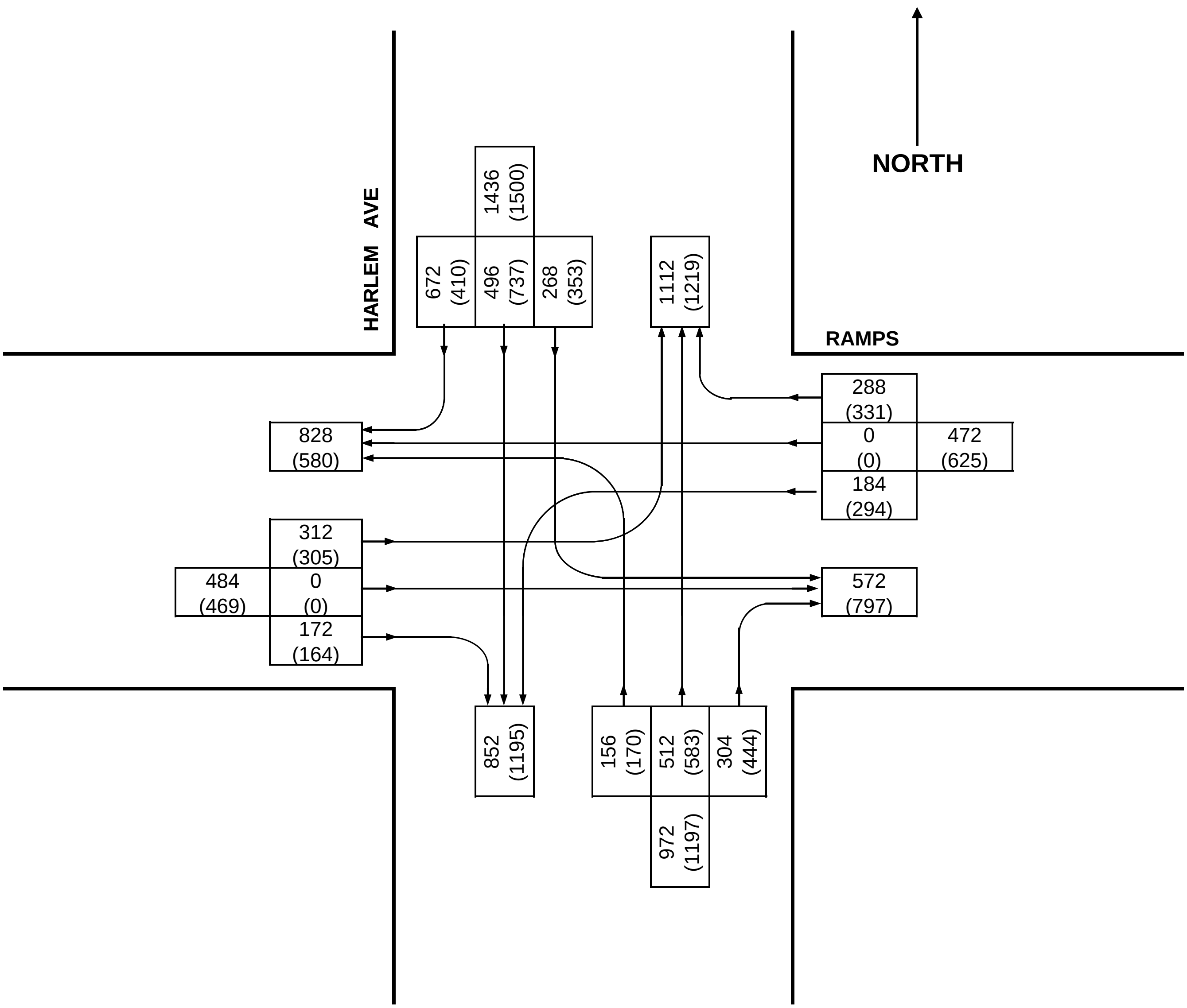
LEGEND
XXX - AM TRAFFIC
(XXX)- PM TRAFFIC

SUMMARY OF TRAFFIC SURVEY

INTERSECTION OF HARLEM AVENUE & I-290 RAMPS

Count Date: 1/6/2010
Made by PB

AM: 9:15-10:15
PM: 6:30-7:30



LEGEND
XXX - AM TRAFFIC
(XXX)- PM TRAFFIC

Cross Road Intersection ADT % Changes

Intersection	2001	2006	2009	% Change
25th Avenue				
Congress Street	22,631	24,000		6%
Lexington Street	20,425	21,100		3%
17th Ave				
Harrison Street	9,738	9,500		-2%
Bataan Drive	12,596	9,500		-25%
9th Ave				
Harrison Street	13,493	10,800		-20%
Bataan Drive	10,667	10,800		1%
1st Avene				
Harrison Street	22,636		29,000	28%
Bataan Drive	27,284		31,200	14%
Des Plains Avenue				
I-290 WB on Ramp	23,270	14,900		-36%
Harrison Street	19,550	14,900		-24%
Harlem Avenue				
I-290 Ramps	36,966		39,500	7%
Harrison/Garfield Street	33,545		35,200	5%
Austin Boulevard				
I-290 Ramps	16,671	21,700		30%
Railroad Avenue	17,375	21,700		25%
Central Avenue				
Flournoy Street	17,425	19,600		12%
EB I-290 Ramps	18,524	11,300		-39%
Laramie Avenue				
Flournoy Street	12,895	15,500		20%
Lexington Street	10,167	10,600		4%
Cicero Avenue				
Flournoy Street	28,921		29,100	1%
Lexington Street	27,500		33,000	20%
Overall	402,279	215,900	197,000	3%

Cross Road Ramp Volume % Changes

	AM Peak Hour			PM Peak Hour		
Intersection	**2001**	**2009**	**% Change**	**2001**	**2009**	**% Change**
25th Avenue						
EB Exit Ramp	107	310	190%	135	430	219%
EB Entrance Ramp	236	230	-3%	268	350	31%
EB Exit Ramp	102	60	-41%	64	100	56%
EB Entrance Ramp	285	230	-19%	276	270	-2%
WB Entrance Ramp	480	600	25%	410	490	20%
WB Exit Ramp	81	300	270%	215	250	16%
WB Exit Ramp	270	150	-44%	217	150	-31%
17th Ave						
EB Exit Ramp	187	180	-4%	246	260	6%
EB Entrance Ramp	232	200	-14%	272	300	10%
WB Entrance Ramp	477	590	24%	413	480	16%
WB Exit Ramp	99	80	-19%	170	150	-12%
9th Ave						
EB Entrance Ramp	289	390	35%	350	480	37%
WB Exit Ramp	150	100	-33%	244	190	-22%
1st Avene						
EB Exit Ramp	241	220	-9%	205	220	7%
EB Entrance Ramp	592	620	5%	440	880	100%
WB Entrance Ramp	398	550	38%	369	570	54%
WB Exit Ramp	478	480	0%	461	490	6%
Des Plains Avenue						
EB Exit Ramp	214	140	-35%	333	270	-19%
WB Entrance Ramp	669	700	5%	532	590	11%
Harlem Avenue						
EB Exit Ramp	402	400	0%	420	460	10%
EB Entrance Ramp	851	820	-4%	715	830	16%
WB Entrance Ramp	509	680	34%	542	690	27%
WB Exit Ramp	412	360	-13%	604	580	-4%
Austin Boulevard						
EB Exit Ramp	160	180	13%	350	460	31%
EB Entrance Ramp	1,281	1,180	-8%	801	960	20%
WB Entrance Ramp	374	530	42%	290	470	62%
WB Exit Ramp	1,032	890	-14%	1,047	1,100	5%
Central Avenue						
EB Exit Ramp	313	310	-1%	455	580	27%
EB Entrance Ramp	592	620	5%	389	600	54%
WB Entrance Ramp	520	500	-4%	424	660	56%
WB Exit Ramp	312	310	-1%	320	290	-9%
Laramie Avenue						
EB Entrance Ramp	607	450	-26%	380	540	42%
WB Exit Ramp	404	550	36%	578	610	6%
Cicero Avenue						
EB Exit Ramp	596	1,080	81%	752	810	8%
WB Entrance Ramp	627	630	0%	506	550	9%
Overall	14,579	15,620	7.1%	14,193	17,110	20.6%

Cross Street Intersection Turning Volume Adjustment Summary

Direction		25th Avenue Intersections																			
		Congress Street										Lexington Street									
		AM					PM					AM					PM				
		2001 Vol	% Adj.		2009 Vol	Bal-anced	2001 Vol	% Adj.		2009 Vol	Bal-anced	2001 Vol	% Adj.		2009 Vol	Bal-anced	2001 Vol	% Adj.		2009 Vol	Bal-anced
EB	Left	4	6%	A	5		11	6%	A	12		147	3%	A	152		108	3%	A	112	
	Thru											4	0%	-	4		6	0%	R	6	
	Right	75	6%	A	80		85	6%	A	91		100	3%	A	103		157	3%	A	162	
WB	Left											2	0%	-	2		9	0%	R	9	
	Thru											0	0%	-	0		5	0%	R	5	
	Right											40	3%	A	42		27	4%	R	29	
NB	Left	331	25%	R	414		202	20%	R	243		18	6%	R	20		35	3%	A	37	
	Thru	982	6%	R	1041	948	607	6%	A	644	618	1150	3%	A	1185		669	3%	A	690	741
	Right											8	13%	R	10		13	8%	R	15	
SB	Left											10	10%	R	11		34	3%	A	36	
	Thru	496	6%	A	526		1274	6%	A	1351		358	3%	A	369	616	1219	3%	A	1256	1243
	Right	250	25%	R	313		221	20%	R	266		48	4%	R	50		63	3%	A	65	

Direction		17th Avenue Intersections																			
		Harrison Street										Bataan Drive									
		AM					PM					AM					PM				
		2001 Vol	% Adj.		2009 Vol	Bal-anced	2001 Vol	% Adj.		2009 Vol	Bal-anced	2001 Vol	% Adj.		2009 Vol	Bal-anced	2001 Vol	% Adj.		2009 Vol	Bal-anced
EB	Left											68	-4%	R	65		69	6%	R	73	
	Thru											69	-4%	R	66		78	6%	R	83	
	Right											136	-4%	R	131		139	6%	R	147	
WB	Left	95	19%	R	114		174	-12%	R	153											
	Thru	263	24%	R	326		271	16%	R	314											
	Right	130	19%	R	155		147	-12%	R	129											
NB	Left	185	24%	R	230		165	16%	R	191											
	Thru	187	0%	-	187		300	0%	-	300		304	0%	-	304	351	396	0%	-	396	418
	Right											181	-14%	R	156		97	10%	R	107	
SB	Left											86	-14%	R	74		102	10%	R	112	
	Thru	168	0%	-	168	174	304	0%	R	304	335	177	0%	-	177		376	0%	-	376	
	Right	85	24%	R	106		90	16%	-	105											

Direction		9th Avenue Intersections																			
		Harrison Street										Bataan Drive									
		AM					PM					AM					PM				
		2001 Vol	% Adj.		2009 Vol	Bal-anced	2001 Vol	% Adj.		2009 Vol	Bal-anced	2001 Vol	% Adj.		2009 Vol	Bal-anced	2001 Vol	% Adj.		2009 Vol	Bal-anced
EB	Left											33	3%	A	34		30	3%	A	31	
	Thru											43	35%	R	59		41	37%	R	57	
	Right											4	0%	-	4		44	2%	A	45	
WB	Left	73	-33%	R	49		142	-22%	R	111											
	Thru	120	-33%	R	80		87	-22%	R	68											
	Right	77	-32%	R	52		152	-22%	R	118											
NB	Left	53	0%	-	53		41	0%	-	41											
	Thru	303	0%	-	303	304	359	0%	-	359	360	320	1%	A	324		368	1%	A	372	
	Right											107	35%	R	145		148	37%	R	203	
SB	Left											139	35%	R	188		210	37%	R	288	
	Thru	240	0%	R	240	314	405	0%	R	405	574	174	1%	A	176		394	1%	A	398	
	Right	41	0%	-	41		75	0%	-	75											

Direction		1st Avenue Intersections																			
		Harrison Street										Bataan Drive									
		AM					PM					AM					PM				
		2001 Vol	% Adj.		2009 Vol	Bal-anced	2001 Vol	% Adj.		2009 Vol	Bal-anced	2001 Vol	% Adj.		2009 Vol	Bal-anced	2001 Vol	% Adj.		2009 Vol	Bal-anced
EB	Left											190	-9%	R	173		161	7%	R	173	
	Thru											82	5%	R	87		42	100%	R	84	
	Right											235	-9%	R	214		282	7%	R	302	
WB	Left	98	0%	R	98		164	6%	R	174											
	Thru	40	38%	R	56		30	57%	R	48											
	Right	426	0%	R	426		267	6%	R	284											
NB	Left	278	38%	R	384		209	54%	R	322											
	Thru	608	28%	A	779	583	640	28%	A	820	635	696	14%	A	794		688	14%	A	785	
	Right											0	0%	-	0		0	0%	-	0	
SB	Left											253	5%	R	266		200	100%	R	400	
	Thru	676	28%	A	866		934	28%	A	1196		521	14%	A	594	698	798	14%	A	910	970
	Right	126	38%	R	174		138	54%	R	213											

A = Volume Adjusted by % change in Crossroad ADT
R = Volume Adjusted by % change in ramp count Volume

Cross Street Intersection Turning Volume Adjustment Summary

Direction		Des Plaines Avenue Intersections															
		CTA Station								Harrison Street							
		AM				PM				AM				PM			
		2001 Vol	% Adj.	2009 Vol	Bal-anced	2001 Vol	% Adj.	2009 Vol	Bal-anced	2001 Vol	% Adj.	2009 Vol	Bal-anced	2001 Vol	% Adj.	2009 Vol	Bal-anced
EB	Left	51	0%	51		63	0%	63		70	-34% R	47		150	-19% R	122	
	Thru									109	-35% R	71		21	-19% R	18	
	Right	7	0%	7		80	0%	80		35	-23% R	27		162	-19% R	132	
WB	Left									26	0% -	26		52	0% -	52	
	Thru																
	Right									102	0% -	102		81	0% -	81	
NB	Left	159	0%	159		157	0%	157									
	Thru	735	0%	735	744	707	0%	707	664	817	0% -	817		778	0% -	778	
	Right									10	0% -	10		29	0% -	29	
SB	Left									12	0% -	12		52	0% -	52	
	Thru	818	0%	818	847	942	0%	942	985	236	0% -	236		581	0% -	581	
	Right	81	0%	81		40	0%	40									

Direction		Harlem Avenue								Austin Boulevard							
		Ramp Intersection								Ramp Intersection							
		AM				PM				AM				PM			
		2001 Vol	% Adj.	2009 Vol	Bal-anced	2001 Vol	% Adj.	2009 Vol	Bal-anced	2001 Vol	% Adj.	2009 Vol	Bal-anced	2001 Vol	% Adj.	2009 Vol	Bal-anced
EB	Left	283	0% -	283		212	9% R	232		96	13% R	109		122	31% R	160	
	Thru																
	Right	117	0% -	117		208	10% R	229		64	13% R	73		228	32% R	301	
WB	Left	188	-13% R	164		310	-4% R	298		566	-14% R	487		730	5% R	767	
	Thru																
	Right	224	-13% R	195		294	-4% R	283		466	-14% R	401		317	5% R	333	
NB	Left	277	34% R	372		222	27% R	282		246	42% R	350		182	62% R	295	
	Thru	598	7% A	640	732	553	7% A	592	802	159	30% A	207	479	180	30% A	234	479
	Right	375	-4% R	360		310	16% R	360		686	-8% R	632		162	20% R	195	
SB	Left	476	-4% R	457		405	16% R	470		595	-8% R	548		639	20% R	767	
	Thru	394	7% A	422	434	690	7% A	739	745	202	30% A	263	481	140	30% A	182	306
	Right	232	34% R	311		320	27% R	407		128	41% R	181		108	62% R	175	

Direction		Central Avenue Intersections															
		Flournoy Street								EB Ramps							
		AM				PM				AM				PM			
		2001 Vol	% Adj.	2009 Vol	Bal-anced	2001 Vol	% Adj.	2009 Vol	Bal-anced	2001 Vol	% Adj.	2009 Vol	Bal-anced	2001 Vol	% Adj.	2009 Vol	Bal-anced
EB	Left									129	-1% R	128		227	27% R	289	
	Thru									0	0% R	0		0	0% R	0	
	Right									184	-1% R	183		228	28% R	292	
WB	Left	164	-1% R	163		138	-9% R	126									
	Thru	56	-3% R	55		88	56% R	138									
	Right	234	-1% R	232		198	-9% R	181									
NB	Left	298	-4% R	287		171	56% R	267									
	Thru	308	12% A	345	288	698	12% A	782	665	447	0% -	447		642	0% -	642	
	Right									324	5% R	341		180	54% R	278	
SB	Left									268	5% R	282		209	54% R	322	
	Thru	457	12% A	512		784	12% A	879		353	0% -	353		713	0% -	713	683
	Right	160	-4% R	154		165	56% R	258									

Direction		Laramie Avenue Intersections															
		Flournoy Street								Lexington Street							
		AM				PM				AM				PM			
		2001 Vol	% Adj.	2009 Vol	Bal-anced	2001 Vol	% Adj.	2009 Vol	Bal-anced	2001 Vol	% Adj.	2009 Vol	Bal-anced	2001 Vol	% Adj.	2009 Vol	Bal-anced
EB	Left									24	4% A	25		114	4% A	119	
	Thru									10	7% R	11		94	4% A	98	
	Right									3	0% -	3		106	4% A	111	
WB	Left	172	36% R	234		236	6% R	251									
	Thru	41	37% R	57		23	9% R	26									
	Right	286	36% R	389		339	6% R	360									
NB	Left	39	21% R	48		49	20% A	59		16	6% R	17		59	5% R	62	
	Thru	134	20% A	161	133	315	20% A	378	319	149	4% A	155		251	4% A	262	
	Right									245	-26% R	182		71	42% R	101	
SB	Left									315	-26% R	234		253	42% R	360	
	Thru	578	20% A	694		419	20% A	503		453	4% A	472	582	340	4% A	354	328
	Right	33	21% R	40		24	21% R	30		48	4% A	50		62	4% A	65	

A = Volume Adjusted by % change in Crossroad ADT

R = Volume Adjusted by % change in ramp count Volume

Cross Street Intersection Turning Volume Adjustment Summary

Direction		Cicero Avenue Intersections																			
		Flournoy Street										Lexington Street									
		AM					PM					AM					PM				
		2001 Vol	% Adj.		2009 Vol	Bal-anced	2001 Vol	% Adj.		2009 Vol	Bal-anced	2001 Vol	% Adj.		2009 Vol	Bal-anced	2001 Vol	% Adj.		2009 Vol	Bal-anced
EB	Left											278	81%	R	504		332	8%	R	359	
	Thru											18	83%	R	33		34	9%	R	38	
	Right											336	81%	R	609		406	8%	R	439	
WB	Left	4	0%	-	4		4	20%	R	5											
	Thru	8	0%	-	8		8	0%	-	8											
	Right																				
NB	Left	361	0%	R	361		336	9%	R	367											
	Thru	1153	1%	A	1165	1401	962	1%	A	972	1287	1041	20%	A	1250		973	20%	A	1168	1295
	Right											4	25%	R	5		10	20%	A	12	
SB	Left											3	33%	R	4		10	20%	A	12	
	Thru	596	1%	A	602		1049	1%	A	1060		595	30%	R	774	599	1044	20%	A	1253	1053
	Right	304	0%	R	304		298	9%	R	325											

A = Volume Adjusted by % change in Crossroad ADT

R = Volume Adjusted by % change in ramp count Volume

Summary

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
	Q % of Storage	Q % of Storage	Q % of Storage	Q % of Storage	Q % of Storage	Q % of Storage	Q % of Storage	Q % of Storage	Q % of Storage	Q % of Storage	Q % of Storage	Q % of Storage
EB Left	7%	16%										
EB Right	23%	82%										
WB Left					120%	165%						
WB Right												
NB Left	288%	168%										
NB Right												
SB Left												
SB Right												

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
	Q % of Storage	Q % of Storage	Q % of Storage	Q % of Storage	Q % of Storage	Q % of Storage	Q % of Storage	Q % of Storage	Q % of Storage	Q % of Storage	Q % of Storage	Q % of Storage
EB Left					300%	370%	94%	292%	74%	55%	76%	114%
EB Right			66%	164%	10%	90%	55%	380%	12%	44%	3%	62%
WB Left	124%	193%							31%	69%	98%	259%
WB Right	276%	178%							26%	47%	163%	104%
NB Left					43%	44%			213%	146%	528%	382%
NB Right									220%	220%	833%	105%
SB Left							24%	103%	148%	171%	348%	609%
SB Right									113%	197%	76%	65%

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
	Q % of Storage	Q % of Storage	Q % of Storage	Q % of Storage	Q % of Storage	Q % of Storage	Q % of Storage	Q % of Storage	Q % of Storage	Q % of Storage	Q % of Storage	Q % of Storage
EB Left			22%	59%							474%	287%
EB Right			7%	19%							689%	255%
WB Left	85%	65%			98%	70%			5%	5%		
WB Right	19%	15%			100%	65%						
NB Left	110%	110%							153%	147%		
NB Right												
SB Left			124%	136%			58%	71%			5%	14%
SB Right	39%	68%					14%	16%	152%	176%		

Detail

Direction	25th Avenue													
	Congress St.							Lexington St.						
	AM				PM			AM				PM		
	Eixisting Storage L	# Cars	Queue L	Q % of Storage	# Cars	Queue L	Q % of Storage	Eixisting Storage L	# Cars	Queue L	Q % of Storage	# Cars	Queue L	Q % of Storage
EB Left	76	0.2	5	7%	0.5	12.5	16%							
EB Right	76	0.7	17.5	23%	2.5	62.5	82%							
WB Left														
WB Right														
NB Left	73	8.4	210	288%	4.9	122.5	168%							
NB Right														
SB Left														
SB Right														

Direction	1st Avenue													
	Harrison Street							Bataan Drive						
	AM				PM			AM				PM		
	Eixisting Storage L	# Cars	Queue L	Q % of Storage	# Cars	Queue L	Q % of Storage	Eixisting Storage L	# Cars	Queue L	Q % of Storage	# Cars	Queue L	Q % of Storage
EB Left														
EB Right								253	6.7	167.5	66%	16.6	415	164%
WB Left	157	7.8	195	124%	12.1	302.5	193%							
WB Right	152	16.8	420	276%	10.8	270	178%							
NB Left														
NB Right														
SB Left														
SB Right														

Direction	Central Avenue													
	I-290 WB Ramp							I-290 EB Ramp						
	AM				PM			AM				PM		
	Eixisting Storage L	# Cars	Queue L	Q % of Storage	# Cars	Queue L	Q % of Storage	Eixisting Storage L	# Cars	Queue L	Q % of Storage	# Cars	Queue L	Q % of Storage
EB Left								660	5.9	147.5	22%	15.6	390	59%
EB Right								660	1.8	45	7%	4.9	122.5	19%
WB Left	200	6.8	170	85%	5.2	130	65%							
WB Right	200	1.5	37.5	19%	1.2	30	15%							
NB Left	77	3.4	85	110%	3.4	85	110%							
NB Right														
SB Left								143	7.1	177.5	124%	7.8	195	136%
SB Right	140	2.2	55	39%	3.8	95	68%							

Detail

Direction	17th Avenue													
	Harrison Street							Bataan Drive						
	AM				PM			AM				PM		
	Eixisting Storage L	# Cars	Queue L	Q % of Storage	# Cars	Queue L	Q % of Storage	Eixisting Storage L	# Cars	Queue L	Q % of Storage	# Cars	Queue L	Q % of Storage
EB Left														
EB Right														
WB Left	179	8.6	215	120%	11.8	295	165%							
WB Right														
NB Left														
NB Right														
SB Left														
SB Right														

Direction	Des Plaines Avenue													
	CTA Station							Harrison Street						
	AM				PM			AM				PM		
	Eixisting Storage L	# Cars	Queue L	Q % of Storage	# Cars	Queue L	Q % of Storage	Eixisting Storage L	# Cars	Queue L	Q % of Storage	# Cars	Queue L	Q % of Storage
EB Left	25	3.0	75	300%	3.7	92.5	370%	77	2.9	72.5	94%	9	225	292%
EB Right	25	0.1	2.5	10%	0.9	22.5	90%	77	1.7	42.5	55%	11.7	292.5	380%
WB Left														
WB Right														
NB Left	250	4.3	107.5	43%	4.4	110	44%							
NB Right														
SB Left								92	0.9	22.5	24%	3.8	95	103%
SB Right														

Direction	Laramie Avenue													
	Flournoy Street							Lexington Street						
	AM				PM			AM				PM		
	Eixisting Storage L	# Cars	Queue L	Q % of Storage	# Cars	Queue L	Q % of Storage	Eixisting Storage L	# Cars	Queue L	Q % of Storage	# Cars	Queue L	Q % of Storage
EB Left														
EB Right														
WB Left	205	8	200	98%	5.7	142.5	70%							
WB Right	205	8.2	205	100%	5.3	132.5	65%							
NB Left														
NB Right														
SB Left								259	6	150	58%	7.4	185	71%
SB Right								259	1.4	35	14%	1.7	42.5	16%

Detail

Direction	9th Avenue													
	Harrison Street							Bataan Drive						
	AM				PM			AM				PM		
	Eixisting Storage L	# Cars	Queue L	Q % of Storage	# Cars	Queue L	Q % of Storage	Eixisting Storage L	# Cars	Queue L	Q % of Storage	# Cars	Queue L	Q % of Storage
EB Left														
EB Right														
WB Left														
WB Right														
NB Left														
NB Right														
SB Left														
SB Right														

Direction	Harlem Ave.							Austin Blvd.						
	I-290 Ramps							I-290 Ramps						
	AM				PM			AM				PM		
	Eixisting Storage L	# Cars	Queue L	Q % of Storage	# Cars	Queue L	Q % of Storage	Eixisting Storage L	# Cars	Queue L	Q % of Storage	# Cars	Queue L	Q % of Storage
EB Left	750	22.2	555	74%	16.5	412.5	55%	182	5.5	137.5	76%	8.3	207.5	114%
EB Right	750	3.5	87.5	12%	13.1	327.5	44%	750	1.0	25	3%	18.5	462.5	62%
WB Left	900	11	275	31%	24.8	620	69%	880	34.5	862.5	98%	91.0	2275	259%
WB Right	900	9.2	230	26%	16.8	420	47%	530	34.6	865	163%	22.1	552.5	104%
NB Left	171	14.6	365	213%	10	250	146%	150	31.7	792.5	528%	22.9	572.5	382%
NB Right	151	13.3	332.5	220%	13.3	332.5	220%	148	49.3	1232.5	833%	6.2	155	105%
SB Left	492	29.2	730	148%	33.6	840	171%	165	23	575	348%	40.2	1005	609%
SB Right	220	9.9	247.5	113%	17.3	432.5	197%	135	4.1	102.5	76%	3.5	87.5	65%

Direction	Cicero Avenue													
	Flournoy Street							Lexington Street						
	AM				PM			AM				PM		
	Eixisting Storage L	# Cars	Queue L	Q % of Storage	# Cars	Queue L	Q % of Storage	Eixisting Storage L	# Cars	Queue L	Q % of Storage	# Cars	Queue L	Q % of Storage
EB Left								95	18	450	474%	10.9	272.5	287%
EB Right								95	26.2	655	689%	9.7	242.5	255%
WB Left	105	0.2	5	5%	0.2	5	5%							
WB Right														
NB Left	80	4.9	122.5	153%	4.7	117.5	147%							
NB Right														
SB Left								54	0.1	2.5	5%	0.3	7.5	14%
SB Right	105	6.4	160	152%	7.4	185	176%							

HCS+: Signalized Intersections Release 5.4

Analyst:
Agency: PB
Date: 6/25/2010
Period: AM Peak Hour
Project ID: I-290 Phase 1 Study
E/W St: Congress Street

Inter.: Congress Street & 25th Avenue
Area Type: All other areas
Jurisd:
Year : Existing
N/S St: 25th Avenue

SIGNALIZED INTERSECTION SUMMARY

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	1	0	1	0	0	0	1	2	0	0	2	0
LGConfig	L		R				L	T			TR	
Volume	5		80				414	948			526	313
Lane Width	12.0		12.0				12.0	12.0			11.0	
RTOR Vol			55									82

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination	1	2	3	4			5	6	7	8
EB Left	A				NB	Left	A	A		
Thru						Thru	A	A		
Right	A					Right				
Peds						Peds				
WB Left					SB	Left				
Thru						Thru		A		
Right						Right		A		
Peds						Peds				
NB Right					EB	Right	A			
SB Right					WB	Right				
Green	8.0						13.0	34.0		
Yellow	4.0						4.0	4.0		
All Red	1.0						1.0	1.0		

Cycle Length: 70.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
L	191	1487	0.03	0.13	26.7	C	15.6	B
R	513	1330	0.05	0.39	13.5	B		
Westbound								
Northbound								
L	520	1487	0.84	0.76	19.3	B		
T	1613	2131	0.62	0.76	4.6	A	9.1	A
Southbound								
TR	1361	2722	0.59	0.50	13.0	B	13.0	B

Intersection Delay = 10.6 (sec/veh) Intersection LOS = B

HCS+: Signalized Intersections Release 5.4

I-290
Existing

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst:
Agency/Co.: PB
Date Performed: 6/25/2010
Analysis Time Period: AM Peak Hour
Intersection: Congress Street & 25th Avenue
Area Type: All other areas
Jurisdiction:
Analysis Year: Existing
Project ID: I-290 Phase 1 Study
E/W St: Congress Street N/S St: 25th Avenue

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	5		80				414	948			526	313
% Heavy Veh	15		15				15	15			15	15
PHF	0.95		0.95				0.95	0.95			0.95	0.95
PK 15 Vol	2		21				109	249			138	82
Hi Ln Vol												
% Grade		0						0			0	
Ideal Sat	1800		1800				1800	1300			1800	
ParkExist												
NumPark												
No. Lanes	1	0	1	0	0	0	1	2	0	0	2	0
LGConfig	L		R				L	T			TR	
Lane Width	12.0		12.0				12.0	12.0			11.0	
RTOR Vol			55									82
Adj Flow	5		26				436	998			797	
%InSharedLn												
Prop LTs							1.000	0.000			0.000	
Prop RTs			1.000					0.000			0.305	
Peds Bikes	0			0						0		
Buses	0		0				0	5			5	
%InProtPhase							0.0					

Duration 0.25 Area Type: All other areas

OPERATING PARAMETERS

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Init Unmet	0.0		0.0				0.0	0.0			0.0	
Arriv. Type	3		3				3	3			3	
Unit Ext.	3.0		3.0				3.0	3.0			3.0	
I Factor		1.000						1.000			1.000	
Lost Time	2.0		2.0				2.0	2.0			2.0	
Ext of g	3.0		3.0				3.0	3.0			3.0	
Ped Min g		3.2			3.2						3.2	

```
_________________________________PHASE DATA____________________________________

Phase Combination 1     2     3     4 |           5     6     7     8

EB  Left           A                  | NB  Left   A     A
    Thru                              |     Thru   A     A
    Right          A                  |     Right
    Peds                              |     Peds

WB  Left                              | SB  Left
    Thru                              |     Thru         A
    Right                             |     Right        A
    Peds                              |     Peds

NB  Right                             | EB  Right  A
                                      |
SB  Right                             | WB  Right
                                      |
                                      |
Green             8.0                           13.0  34.0
Yellow            4.0                           4.0   4.0
All Red           1.0                           1.0   1.0

                                                   Cycle Length: 70.0    secs

_________________VOLUME ADJUSTMENT AND SATURATION FLOW WORKSHEET_______________
Volume Adjustment
           |  Eastbound    |  Westbound    |  Northbound   |  Southbound   |
           | L    T    R   | L    T    R   | L    T    R   | L    T    R   |
           |_______________|_______________|_______________|_______________|
Volume, V  |5        80    |               |414  948       |     526  313  |
PHF        |0.95     0.95  |               |0.95 0.95      |     0.95 0.95 |
Adj flow   |5        26    |               |436  998       |     554  243  |
No. Lanes  |  1   0   1    |  0   0   0    |  1   2   0    |  0   2   0    |
Lane group | L         R   |               | L    T        |      TR       |
Adj flow   |5        26    |               |436  998       |     797       |
Prop LTs   |               |               |1.000 0.000    |      0.000    |
Prop RTs   |        1.000  |               |   0.000       |  0.305        |

Saturation Flow Rate (see Exhibit 16-7 to determine the adjustment factors)____
         Eastbound        Westbound        Northbound       Southbound
LG     L           R                      L     T                 TR
So    1800        1800                   1800  1300              1800
Lanes 1     0     1     0     0     0     1     2     0     0     2     0
fW    1.000       1.000                  1.000 1.000             0.967
fHV   0.870       0.870                  0.870 0.870             0.870
fG    1.000       1.000                  1.000 1.000             1.000
fP    1.000       1.000                  1.000 1.000             1.000
fBB   1.000       1.000                  1.000 0.990             0.990
fA    1.000       1.000                  1.000 1.000             1.000
fLU   1.000       1.000                  1.000 0.952             0.952
fRT               0.850                        1.000             0.954
fLT   0.950                              0.950 1.000             1.000
Sec.                                     0.256
fLpb  1.000                              1.000 1.000             1.000
fRpb              1.000                        1.000             1.000
S     1487        1330                   1487  2131              2722
Sec.                                     400
_________________________CAPACITY AND LOS WORKSHEET____________________________
Capacity Analysis and Lane Group Capacity
```

Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- Capacity (c)	v/c Ratio
Eastbound							
Prot							
Perm							
Left	L	5	1487	# 0.00	0.13	191	0.03
Prot							
Perm							
Thru							
Right	R	26	1330	0.02	0.39	513	0.05
Westbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru							
Right							
Northbound							
Prot		297	1487	# 0.20	0.200	297	1.00
Perm		139	400	# 0.35	0.557	223	0.62
Left	L	436			0.76	520	0.84
Prot							
Perm							
Thru	T	998	2131	0.47	0.76	1613	0.62
Right							
Southbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	TR	797	2722	0.29	0.50	1361	0.59
Right							

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.55
Total lost time per cycle, L = 8.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.62

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	Ratios g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound												
L	0.03	0.13	26.7	1.000	191	0.11	0.1	0.0	26.7	C	15.6	B
R	0.05	0.39	13.5	1.000	513	0.11	0.0	0.0	13.5	B		
Westbound												
Northbound												
L	0.84	0.76	7.7	1.000	520	0.37	11.6	0.0	19.3	B		
T	0.62	0.76	3.9	1.000	1613	0.20	0.7	0.0	4.6	A	9.1	A
Southbound												
TR	0.59	0.50	12.4	1.000	1361	0.18	0.7	0.0	13.0	B	13.0	B

```
_____________________________________________________________________________
         Intersection delay = 10.6  (sec/veh)   Intersection LOS = B



______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                              for exclusive lefts
Input
                                                       EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                           70.0    sec
Total actual green time for LT lane group, G (s)                   52.0
Effective permitted green time for LT lane group, g(s)             39.0
Opposing effective green time, go (s)                              35.0
Number of lanes in LT lane group, N                                1
Number of lanes in opposing approach, No                           2
Adjusted LT flow rate, VLT (veh/h)                                 436
Proportion of LT in LT lane group, PLT                             1.000
Proportion of LT in opposing flow, PLTo                            0.00
Adjusted opposing flow rate, Vo (veh/h)                            797
Lost time for LT lane group, tL                                    4.00
Computation
LT volume per cycle, LTC=VLTC/3600                                 8.48
Opposing lane util. factor, fLUo                                   0.952 0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)                8.14
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g                              0.0
Opposing platoon ratio, Rpo (refer Exhibit 16-11)                  1.00
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]                       0.50
gq, (see Exhibit C16-4,5,6,7,8)                                    10.61
gu=g-gq if gq>=gf, or = g-gf if gq<gf                              28.39
n=Max(gq-gf)/2,0)                                                  5.30
PTHo=1-PLTo                                                        1.00
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]                                 1.00
EL1 (refer to Exhibit C16-3)                                       2.85
EL2=Max((1-Ptho**n)/Plto, 1.0)
fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g                                 0.10
gdiff=max(gq-gf,0)                                                 0.00
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)                0.26
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
or flt=[fm+0.91(N-1)]/N**
Left-turn adjustment, fLT                                          0.256

For special case of single-lane approach opposed by multilane approach,
see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
  left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach
or when gf>gq, see text.

______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                                for shared lefts
Input
                                                       EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                           70.0    sec
Total actual green time for LT lane group, G (s)
Effective permitted green time for LT lane group, g(s)
Opposing effective green time, go (s)
Number of lanes in LT lane group, N
```

```
Number of lanes in opposing approach, No
Adjusted LT flow rate, VLT (veh/h)
Proportion of LT in LT lane group, PLT                           0.000 0.000
Proportion of LT in opposing flow, PLTo
Adjusted opposing flow rate, Vo (veh/h)
Lost time for LT lane group, tL
Computation
LT volume per cycle, LTC=VLTC/3600
Opposing lane util. factor, fLUo                                 0.952 0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g
Opposing platoon ratio, Rpo (refer Exhibit 16-11)
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]
gq, (see Exhibit C16-4,5,6,7,8)
gu=g-gq if gq>=gf, or = g-gf if gq<gf
n=Max(gq-gf)/2,0)
PTHo=1-PLTo
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]
EL1 (refer to Exhibit C16-3)
EL2=Max((1-Ptho**n)/Plto, 1.0)
fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g
gdiff=max(gq-gf,0)
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
or flt=[fm+0.91(N-1)]/N**
Left-turn adjustment, fLT

For special case of single-lane approach opposed by multilane approach,
see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
  left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach
or when gf>gq, see text.

_______________SUPPLEMENTAL PEDESTRIAN-BICYCLE EFFECTS WORKSHEET_______________
Permitted Left Turns
                                                         EB    WB    NB    SB
Effective pedestrian green time, gp (s)
Conflicting pedestrian volume, Vped (p/h)
Pedestrian flow rate, Vpedg (p/h)
OCCpedg
Opposing queue clearing green, gq (s)
Eff. ped. green consumed by opp. veh. queue, gq/gp
OCCpedu
Opposing flow rate, Vo (veh/h)
OCCr
Number of cross-street receiving lanes, Nrec
Number of turning lanes, Nturn
ApbT
Proportion of left turns, PLT
Proportion of left turns using protected phase, PLTA
Left-turn adjustment, fLpb
Permitted Right Turns
Effective pedestrian green time, gp (s)
Conflicting pedestrian volume, Vped (p/h)
Conflicting bicycle volume, Vbic (bicycles/h)
Vpedg
OCCpedg
Effective green, g (s)
Vbicg
```

OCCbicg
OCCr
Number of cross-street receiving lanes, Nrec
Number of turning lanes, Nturn
ApbT
Proportion right-turns, PRT
Proportion right-turns using protected phase, PRTA
Right turn adjustment, fRpb

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

		EBLT	WBLT	NBLT	SBLT
Cycle length, C	70.0 sec				
Adj. LT vol from Vol Adjustment Worksheet, v				436	
v/c ratio from Capacity Worksheet, X				0.84	
Protected phase effective green interval, g (s)				14.0	
Opposing queue effective green interval, gq				10.61	
Unopposed green interval, gu				28.39	
Red time r=(C-g-gq-gu)				17.0	
Arrival rate, qa=v/(3600(max[X,1.0]))				0.12	
Protected ph. departure rate, Sp=s/3600				0.413	
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)				0.15	
XPerm				1.09	
XProt				0.65	
Case				3	
Queue at beginning of green arrow, Qa				2.45	
Queue at beginning of unsaturated green, Qu				1.28	
Residual queue, Qr				0.39	
Uniform Delay, d1				7.7	

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
L	0.0	0.00	30.5	26.7	0.00	0.0	0.0	26.7
	0.0						0.0	
R	0.0	0.00	21.5	13.5	0.00	0.0	0.0	13.5
Westbound								
	0.0						0.0	
	0.0						0.0	
	0.0						0.0	
Northbound								
L	0.0	0.00		7.7	0.00	0.0	0.0	19.3
T	0.0	0.00	8.5	3.9	0.00	0.0	0.0	4.6
	0.0						0.0	
Southbound								
	0.0						0.0	
TR	0.0	0.00	17.5	12.4	0.00	0.0	0.0	13.0
	0.0						0.0	

Intersection Delay 10.6 sec/veh Intersection LOS B

BACK OF QUEUE WORKSHEET

```
               Eastbound       Westbound       Northbound      Southbound
LaneGroup   |L         R    |               |L    T         |     TR        |
Init Queue  |0.0       0.0  |               |0.0  0.0       |     0.0       |
Flow Rate   |5         26   |               |436  524       |     418       |
So          |1800      1800 |               |1800 1300      |     1800      |
No.Lanes    |1    0    1    |0    0    0    |1    2    0    |0    2    0    |
SL          |1487      1330 |               |687  1119      |     1429      |
LnCapacity  |191       513  |               |520  847       |     714       |
Flow Ratio  |0.0       0.0  |               |0.6  0.5       |     0.3       |
v/c Ratio   |0.03      0.05 |               |0.84 0.62      |     0.59      |
Grn Ratio   |0.13      0.39 |               |0.76 0.76      |     0.50      |
I Factor    |     1.000     |               |     1.000     |     1.000     |
AT or PVG   |3         3    |               |3    3         |     3         |
Pltn Ratio  |1.00      1.00 |               |1.00 1.00      |     1.00      |
PF2         |1.00      1.00 |               |1.00 1.00      |     1.00      |
Q1          |0.1       0.3  |               |2.5  4.7       |     5.7       |
kB          |0.2       0.4  |               |0.4  0.5       |     0.5       |
Q2          |0.0       0.0  |               |1.8  0.9       |     0.7       |
Q Average   |0.1       0.3  |               |4.3  5.5       |     6.4       |
Q Spacing   |25.0      25.0 |               |25.0 25.0      |     25.0      |
Q Storage   |0         90   |               |90   0         |     0         |
Q S Ratio   |          0.1  |               |1.2            |               |
70th Percentile Output:
fB%         |1.2       1.2  |               |1.2  1.2       |     1.2       |
BOQ         |0.1       0.4  |               |5.1  6.5       |     7.6       |
QSRatio     |          0.1  |               |1.4            |               |
85th Percentile Output:
fB%         |1.6       1.6  |               |1.6  1.5       |     1.5       |
BOQ         |0.1       0.5  |               |6.6  8.5       |     9.9       |
QSRatio     |          0.1  |               |1.8            |               |
90th Percentile Output:
fB%         |1.8       1.8  |               |1.7  1.7       |     1.7       |
BOQ         |0.2       0.6  |               |7.3  9.4       |     10.8      |
QSRatio     |          0.2  |               |2.0            |               |
95th Percentile Output:
fB%         |2.1       2.1  |               |2.0  1.9       |     1.9       |
BOQ         |0.2       0.7  |               |8.4  10.7      |     12.3      |
QSRatio     |          0.2  |               |2.3            |               |
98th Percentile Output:
fB%         |2.7       2.7  |               |2.4  2.4       |     2.3       |
BOQ         |0.2       0.9  |               |10.3 13.0      |     14.8      |
QSRatio     |          0.3  |               |2.9            |               |
________________________________________________________________________________

________________________________ERROR MESSAGES__________________________________

       No errors to report.
```

HCS+: Signalized Intersections Release 5.4

Analyst:
Agency: PB
Date: 6/25/2010
Period: PM Peak Hour
Project ID: I-290 Phase 1 Study
E/W St: Congress Street

Inter.: Congress Street & 25th Avenue
Area Type: All other areas
Jurisd:
Year : Existing
N/S St: 25th Avenue

SIGNALIZED INTERSECTION SUMMARY

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	1	0	1	0	0	0	1	2	0	0	2	0
LGConfig	L		R				L	T			TR	
Volume	12		91				243	618			1351	266
Lane Width	12.0		12.0				12.0	12.0			11.0	
RTOR Vol			22									21

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination	1	2	3	4			5	6	7	8
EB Left	A				NB	Left	A	A		
Thru						Thru	A	A		
Right	A					Right				
Peds						Peds				
WB Left					SB	Left				
Thru						Thru		A		
Right						Right		A		
Peds						Peds				
NB Right					EB	Right	A			
SB Right					WB	Right				
Green	7.0						10.0	43.0		
Yellow	4.0						4.0	4.0		
All Red	1.0						1.0	1.0		

Cycle Length: 75.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
L	159	1487	0.08	0.11	30.4	C		
							21.0	C
R	408	1330	0.18	0.31	19.3	B		
Westbound								
Northbound								
L	314	1487	0.82	0.79	36.6	D		
T	2321	2950	0.28	0.79	2.3	A	11.9	B
Southbound								
TR	1634	2786	1.03	0.59	45.3	D	45.3	D

Intersection Delay = 33.2 (sec/veh) Intersection LOS = C

HCS+: Signalized Intersections Release 5.4

I-290
Existing

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst:
Agency/Co.: PB
Date Performed: 6/25/2010
Analysis Time Period: PM Peak Hour
Intersection: Congress Street & 25th Avenue
Area Type: All other areas
Jurisdiction:
Analysis Year: Existing
Project ID: I-290 Phase 1 Study
E/W St: Congress Street N/S St: 25th Avenue

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	12		91				243	618			1351	266
% Heavy Veh	15		15				15	15			15	15
PHF	0.95		0.95				0.95	0.95			0.95	0.95
PK 15 Vol	3		24				64	163			356	70
Hi Ln Vol												
% Grade		0						0			0	
Ideal Sat	1800		1800				1800	1800			1800	
ParkExist												
NumPark												
No. Lanes	1	0	1	0	0	0	1	2	0	0	2	0
LGConfig	L		R				L	T			TR	
Lane Width	12.0		12.0				12.0	12.0			11.0	
RTOR Vol			22									21
Adj Flow	13		73				256	651			1680	
%InSharedLn												
Prop LTs							1.000	0.000			0.000	
Prop RTs			1.000					0.000			0.154	
Peds Bikes	0			0						0		
Buses	0		0				0	5			5	
%InProtPhase							0.0					

Duration 0.25 Area Type: All other areas

OPERATING PARAMETERS

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Init Unmet	0.0		0.0				0.0	0.0			0.0	
Arriv. Type	3		3				3	3			3	
Unit Ext.	3.0		3.0				3.0	3.0			3.0	
I Factor		1.000						1.000			1.000	
Lost Time	2.0		2.0				2.0	2.0			2.0	
Ext of g	3.0		3.0				3.0	3.0			3.0	
Ped Min g		3.2			3.2						3.2	

PHASE DATA

Phase Combination		1	2	3	4			5	6	7	8
EB	Left	A				NB	Left	A	A		
	Thru						Thru	A	A		
	Right	A					Right				
	Peds						Peds				
WB	Left					SB	Left				
	Thru						Thru		A		
	Right						Right		A		
	Peds						Peds				
NB	Right					EB	Right	A			
SB	Right					WB	Right				
Green		7.0						10.0	43.0		
Yellow		4.0						4.0	4.0		
All Red		1.0						1.0	1.0		

Cycle Length: 75.0 secs

VOLUME ADJUSTMENT AND SATURATION FLOW WORKSHEET

Volume Adjustment

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume, V	12		91				243	618			1351	266
PHF	0.95		0.95				0.95	0.95			0.95	0.95
Adj flow	13		73				256	651			1422	258
No. Lanes	1	0	1	0	0	0	1	2	0	0	2	0
Lane group	L		R				L	T			TR	
Adj flow	13		73				256	651			1680	
Prop LTs							1.000	0.000			0.000	
Prop RTs			1.000					0.000			0.154	

Saturation Flow Rate (see Exhibit 16-7 to determine the adjustment factors)

	Eastbound			Westbound			Northbound			Southbound		
LG	L		R				L	T			TR	
So	1800		1800				1800	1800			1800	
Lanes	1	0	1	0	0	0	1	2	0	0	2	0
fW	1.000		1.000				1.000	1.000			0.967	
fHV	0.870		0.870				0.870	0.870			0.870	
fG	1.000		1.000				1.000	1.000			1.000	
fP	1.000		1.000				1.000	1.000			1.000	
fBB	1.000		1.000				1.000	0.990			0.990	
fA	1.000		1.000				1.000	1.000			1.000	
fLU	1.000		1.000				1.000	0.952			0.952	
fRT			0.850					1.000			0.977	
fLT	0.950						0.950	1.000			1.000	
Sec.							0.083					
fLpb	1.000						1.000	1.000			1.000	
fRpb			1.000					1.000			1.000	
S	1487		1330				1487	2950			2786	
Sec.							130					

CAPACITY AND LOS WORKSHEET

Capacity Analysis and Lane Group Capacity

Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- Capacity (c)	v/c Ratio
Eastbound							
Prot							
Perm							
Left	L	13	1487	# 0.01	0.11	159	0.08
Prot							
Perm							
Thru							
Right	R	73	1330	0.05	0.31	408	0.18
Westbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru							
Right							
Northbound							
Prot		218	1487	# 0.15	0.147	218	1.00
Perm		38	130	0.29	0.640	96	0.40
Left	L	256			0.79	314	0.82
Prot							
Perm							
Thru	T	651	2950	0.22	0.79	2321	0.28
Right							
Southbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	TR	1680	2786	# 0.60	0.59	1634	1.03
Right							

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.76
Total lost time per cycle, L = 12.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.90

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	LOS	Approach Delay	LOS
Eastbound												
L	0.08	0.11	30.2	1.000	159	0.11	0.2	0.0	30.4	C	21.0	C
R	0.18	0.31	19.1	1.000	408	0.11	0.2	0.0	19.3	B		
Westbound												
Northbound												
L	0.82	0.79	21.3	1.000	314	0.36	15.2	0.0	36.6	D		
T	0.28	0.79	2.2	1.000	2321	0.11	0.1	0.0	2.3	A	11.9	B
Southbound												
TR	1.03	0.59	15.5	1.000	1634	0.50	29.8	0.0	45.3	D	45.3	D

```
_______________________________________________________________________________
         Intersection delay = 33.2  (sec/veh)   Intersection LOS = C



______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                              for exclusive lefts
Input
                                                       EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                           75.0    sec
Total actual green time for LT lane group, G (s)                   58.0
Effective permitted green time for LT lane group, g(s)             48.0
Opposing effective green time, go (s)                              44.0
Number of lanes in LT lane group, N                                1
Number of lanes in opposing approach, No                           2
Adjusted LT flow rate, VLT (veh/h)                                 256
Proportion of LT in LT lane group, PLT                             1.000
Proportion of LT in opposing flow, PLTo                            0.00
Adjusted opposing flow rate, Vo (veh/h)                            1680
Lost time for LT lane group, tL                                    4.00
Computation
LT volume per cycle, LTC=VLTC/3600                                 5.33
Opposing lane util. factor, fLUo                                   0.952 0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)                18.38
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g                              0.0
Opposing platoon ratio, Rpo (refer Exhibit 16-11)                  1.00
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]                       0.41
gq, (see Exhibit C16-4,5,6,7,8)                                    29.81
gu=g-gq if gq>=gf, or = g-gf if gq<gf                              18.19
n=Max(gq-gf)/2,0)                                                  14.90
PTHo=1-PLTo                                                        1.00
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]                                 1.00
EL1 (refer to Exhibit C16-3)                                       6.90
EL2=Max((1-Ptho**n)/Plto, 1.0)
fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g                                 0.08
gdiff=max(gq-gf,0)                                                 0.00
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)                0.08
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
or flt=[fm+0.91(N-1)]/N**
Left-turn adjustment, fLT                                          0.083

For special case of single-lane approach opposed by multilane approach,
see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
  left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach
or when gf>gq, see text.

______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                                for shared lefts
Input
                                                       EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                           75.0    sec
Total actual green time for LT lane group, G (s)
Effective permitted green time for LT lane group, g(s)
Opposing effective green time, go (s)
Number of lanes in LT lane group, N
```

```
Number of lanes in opposing approach, No
Adjusted LT flow rate, VLT (veh/h)
Proportion of LT in LT lane group, PLT                             0.000 0.000
Proportion of LT in opposing flow, PLTo
Adjusted opposing flow rate, Vo (veh/h)
Lost time for LT lane group, tL
Computation
LT volume per cycle, LTC=VLTC/3600
Opposing lane util. factor, fLUo                                   0.952 0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g
Opposing platoon ratio, Rpo (refer Exhibit 16-11)
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]
gq, (see Exhibit C16-4,5,6,7,8)
gu=g-gq if gq>=gf, or = g-gf if gq<gf
n=Max(gq-gf)/2,0)
PTHo=1-PLTo
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]
EL1 (refer to Exhibit C16-3)
EL2=Max((1-Ptho**n)/Plto, 1.0)
fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g
gdiff=max(gq-gf,0)
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
or flt=[fm+0.91(N-1)]/N**
Left-turn adjustment, fLT

For special case of single-lane approach opposed by multilane approach,
see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
  left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach
or when gf>gq, see text.

_______________SUPPLEMENTAL PEDESTRIAN-BICYCLE EFFECTS WORKSHEET_______________
Permitted Left Turns
                                                       EB    WB    NB    SB
Effective pedestrian green time, gp (s)
Conflicting pedestrian volume, Vped (p/h)
Pedestrian flow rate, Vpedg (p/h)
OCCpedg
Opposing queue clearing green, gq (s)
Eff. ped. green consumed by opp. veh. queue, gq/gp
OCCpedu
Opposing flow rate, Vo (veh/h)
OCCr
Number of cross-street receiving lanes, Nrec
Number of turning lanes, Nturn
ApbT
Proportion of left turns, PLT
Proportion of left turns using protected phase, PLTA
Left-turn adjustment, fLpb
Permitted Right Turns
Effective pedestrian green time, gp (s)
Conflicting pedestrian volume, Vped (p/h)
Conflicting bicycle volume, Vbic (bicycles/h)
Vpedg
OCCpedg
Effective green, g (s)
Vbicg
```

OCCbicg
OCCr
Number of cross-street receiving lanes, Nrec
Number of turning lanes, Nturn
ApbT
Proportion right-turns, PRT
Proportion right-turns using protected phase, PRTA
Right turn adjustment, fRpb

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

		EBLT	WBLT	NBLT	SBLT
Cycle length, C	75.0 sec				
Adj. LT vol from Vol Adjustment Worksheet, v				256	
v/c ratio from Capacity Worksheet, X				0.82	
Protected phase effective green interval, g (s)				11.0	
Opposing queue effective green interval, gq				29.81	
Unopposed green interval, gu				18.19	
Red time r=(C-g-gq-gu)				16.0	
Arrival rate, qa=v/(3600(max[X,1.0]))				0.07	
Protected ph. departure rate, Sp=s/3600				0.413	
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)				0.10	
XPerm				1.97	
XProt				0.42	
Case				3	
Queue at beginning of green arrow, Qa				2.82	
Queue at beginning of unsaturated green, Qu				2.12	
Residual queue, Qr				1.68	
Uniform Delay, d1				21.3	

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
L	0.0	0.00	33.5	30.2	0.00	0.0	0.0	30.4
	0.0						0.0	
R	0.0	0.00	26.0	19.1	0.00	0.0	0.0	19.3
Westbound								
	0.0						0.0	
	0.0						0.0	
	0.0						0.0	
Northbound								
L	0.0	0.00		21.3	0.00	0.0	0.0	36.6
T	0.0	0.00	8.0	2.2	0.00	0.0	0.0	2.3
	0.0						0.0	
Southbound								
	0.0						0.0	
TR	0.0	0.00	15.5	15.5	0.00	11.5	0.0	45.3
	0.0						0.0	

Intersection Delay 33.2 sec/veh Intersection LOS C

BACK OF QUEUE WORKSHEET

	Eastbound			Westbound			Northbound			Southbound		
LaneGroup	L		R				L	T			TR	
Init Queue	0.0		0.0				0.0	0.0			0.0	
Flow Rate	13		73				256	341			882	
So	1800		1800				1800	1800			1800	
No.Lanes	1	0	1	0	0	0	1	2	0	0	2	0
SL	1487		1330				383	1549			1463	
LnCapacity	159		408				314	1219			858	
Flow Ratio	0.0		0.1				0.7	0.2			0.6	
v/c Ratio	0.08		0.18				0.82	0.28			1.03	
Grn Ratio	0.11		0.31				0.79	0.79			0.59	
I Factor		1.000						1.000			1.000	
AT or PVG	3		3				3	3			3	
Pltn Ratio	1.00		1.00				1.00	1.00			1.00	
PF2	1.00		1.00				1.00	1.00			1.00	
Q1	0.2		1.1				1.3	1.9			18.4	
kB	0.2		0.4				0.3	0.7			0.6	
Q2	0.0		0.1				1.1	0.3			9.5	
Q Average	0.3		1.2				2.4	2.2			27.9	
Q Spacing	25.0		25.0				25.0	25.0			25.0	
Q Storage	0		90				90	0			0	
Q S Ratio			0.3				0.7					
70th Percentile Output:												
fB%	1.2		1.2				1.2	1.2			1.1	
BOQ	0.3		1.4				2.9	2.6			32.1	
QSRatio			0.4				0.8					
85th Percentile Output:												
fB%	1.6		1.6				1.6	1.6			1.4	
BOQ	0.4		1.9				3.8	3.5			39.6	
QSRatio			0.5				1.1					
90th Percentile Output:												
fB%	1.8		1.8				1.8	1.8			1.5	
BOQ	0.5		2.1				4.3	3.9			41.8	
QSRatio			0.6				1.2					
95th Percentile Output:												
fB%	2.1		2.1				2.0	2.0			1.6	
BOQ	0.5		2.5				4.9	4.5			45.4	
QSRatio			0.7				1.4					
98th Percentile Output:												
fB%	2.7		2.6				2.5	2.5			1.8	
BOQ	0.7		3.1				6.2	5.6			50.7	
QSRatio			0.9				1.7					

ERROR MESSAGES

No errors to report.

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                    HCS+: Signalized Intersections Release 5.4

Analyst:                                Inter.: Lexington Street & 25th Avenue
Agency: PB                              Area Type: All other areas
Date:   6/25/2010                       Jurisd:
Period: AM Peak Hour                    Year  : Existing
Project ID: I-290 Phase 1 Study
E/W St: Lexington Street                N/S St: 25th Avenue

_________________________SIGNALIZED INTERSECTION SUMMARY_______________________
           |  Eastbound     |  Westbound     |  Northbound    |  Southbound    |
           | L    T    R    | L    T    R    | L    T    R    | L    T    R    |
           |________________|________________|________________|________________|
No. Lanes  |   0   2   0    |   0   1   0    |   0   2   0    |   0   2   0    |
LGConfig   | DefL  TR       |      LTR       |      LTR       |      LTR       |
Volume     |152  4    103   |2    0    42    |20   1185 10    |11   616  50    |
Lane Width |12.0 12.0       |     12.0       |     12.0       |     12.0       |
RTOR Vol   |          80    |          38    |          0     |          3     |
_______________________________________________________________________________
Duration    0.25      Area Type: All other areas
______________________________Signal Operations________________________________
Phase Combination 1     2     3     4 |          5     6     7     8
EB  Left          A                   | NB  Left   A
    Thru          A                   |     Thru   A
    Right         A                   |     Right  A
    Peds                              |     Peds   X
WB  Left          A                   | SB  Left   A
    Thru          A                   |     Thru   A
    Right         A                   |     Right  A
    Peds          X                   |     Peds
NB  Right                             | EB  Right
SB  Right                             | WB  Right
Green            20.0                             60.0
Yellow           4.0                              4.0
All Red          1.0                              1.0
                                                   Cycle Length: 90.0    secs
____________________Intersection Performance Summary___________________________
Appr/   Lane       Adj Sat     Ratios       Lane Group   Approach
Lane    Group      Flow Rate   __________   __________   ___________
Grp     Capacity     (s)       v/c    g/C   Delay LOS    Delay LOS
_______________________________________________________________________________
Eastbound
DefL     238       1022        0.67   0.23    38.6   D
TR       318       1364        0.09   0.23    27.1   C    36.9   D

Westbound

LTR      290       1244        0.02   0.23    26.6   C    26.6   C

Northbound

LTR      1872      2762        0.68   0.68    9.7    A    9.7    A

Southbound

LTR      1835      2708        0.39   0.68    6.5    A    6.5    A

         Intersection Delay = 11.1  (sec/veh)   Intersection LOS = B

_______________________________________________________________________________
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HCS+: Signalized Intersections Release 5.4

I-290
Existing

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst:
Agency/Co.: PB
Date Performed: 6/25/2010
Analysis Time Period: AM Peak Hour
Intersection: Lexington Street & 25th Avenue
Area Type: All other areas
Jurisdiction:
Analysis Year: Existing
Project ID: I-290 Phase 1 Study
E/W St: Lexington Street N/S St: 25th Avenue

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	152	4	103	2	0	42	20	1185	10	11	616	50
% Heavy Veh	15	15	15	15	15	15	15	15	15	15	15	15
PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
PK 15 Vol	40	1	27	1	0	11	5	312	3	3	162	13
Hi Ln Vol												
% Grade		0			0			0			0	
Ideal Sat	1800	1800			1800			1800			1800	
ParkExist												
NumPark												
No. Lanes	0	2	0	0	1	0	0	2	0	0	2	0
LGConfig	DefL	TR			LTR			LTR			LTR	
Lane Width	12.0	12.0			12.0			12.0			12.0	
RTOR Vol			80			38			0			3
Adj Flow	160	28			6			1279			709	
%InSharedLn												
Prop LTs	1.000	0.000			0.333			0.016			0.017	
Prop RTs		0.857			0.667			0.009			0.069	
Peds Bikes		0			100	0		100	0		0	
Buses	0	0			0			5			5	
%InProtPhase												

Duration 0.25 Area Type: All other areas

OPERATING PARAMETERS

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Init Unmet	0.0	0.0			0.0			0.0			0.0	
Arriv. Type	3	3			3			3			3	
Unit Ext.	3.0	3.0			3.0			3.0			3.0	
I Factor		1.000			1.000			1.000			1.000	
Lost Time	2.0	2.0			2.0			2.0			2.0	
Ext of g	3.0	3.0			3.0			3.0			3.0	
Ped Min g		15.2			14.4			12.9			12.2	

PHASE DATA

Phase Combination	1	2	3	4			5	6	7	8
EB Left	A				NB	Left	A			
Thru	A					Thru	A			
Right	A					Right	A			
Peds						Peds	X			
WB Left	A				SB	Left	A			
Thru	A					Thru	A			
Right	A					Right	A			
Peds	X					Peds				
NB Right					EB	Right				
SB Right					WB	Right				
Green	20.0						60.0			
Yellow	4.0						4.0			
All Red	1.0						1.0			

Cycle Length: 90.0 secs

VOLUME ADJUSTMENT AND SATURATION FLOW WORKSHEET

Volume Adjustment

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume, V	152	4	103	2	0	42	20	1185	10	11	616	50
PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj flow	160	4	24	2	0	4	21	1247	11	12	648	49
No. Lanes	0	2	0	0	1	0	0	2	0	0	2	0
Lane group	DefL	TR			LTR			LTR			LTR	
Adj flow	160	28			6			1279			709	
Prop LTs	1.000	0.000			0.333			0.016			0.017	
Prop RTs		0.857			0.667			0.009			0.069	

Saturation Flow Rate (see Exhibit 16-7 to determine the adjustment factors)

	Eastbound		Westbound	Northbound	Southbound
LG	DefL	TR	LTR	LTR	LTR
So	1800	1800	1800	1800	1800
Lanes	0	2 0	0 1 0	0 2 0	0 2 0
fW	1.000	1.000	1.000	1.000	1.000
fHV	0.870	0.870	0.870	0.870	0.870
fG	1.000	1.000	1.000	1.000	1.000
fP	1.000	1.000	1.000	1.000	1.000
fBB	1.000	1.000	1.000	0.990	0.990
fA	1.000	1.000	1.000	1.000	1.000
fLU	1.000	1.000	1.000	0.952	0.952
fRT		0.871	0.910	0.999	0.990
fLT	0.754	1.000	0.960	0.938	0.928
Sec.					
fLpb	0.866	1.000	1.000	1.000	1.000
fRpb		1.000	0.910	1.000	1.000
S	1022	1364	1244	2762	2708
Sec.					

CAPACITY AND LOS WORKSHEET

Capacity Analysis and Lane Group Capacity

Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- Capacity (c)	v/c Ratio
Eastbound							
Prot							
Perm							
Left	DefL	160	1022	# 0.16	0.23	238	0.67
Prot							
Perm							
Thru	TR	28	1364	0.02	0.23	318	0.09
Right							
Westbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	LTR	6	1244	0.00	0.23	290	0.02
Right							
Northbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	LTR	1279	2762	# 0.46	0.68	1872	0.68
Right							
Southbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	LTR	709	2708	0.26	0.68	1835	0.39
Right							

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.62
Total lost time per cycle, L = 8.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.68

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	LOS	Approach Delay	LOS
Eastbound												
DefL	0.67	0.23	31.4	1.000	238	0.24	7.2	0.0	38.6	D		
TR	0.09	0.23	27.0	1.000	318	0.11	0.1	0.0	27.1	C	36.9	D
Westbound												
LTR	0.02	0.23	26.6	1.000	290	0.11	0.0	0.0	26.6	C	26.6	C
Northbound												
LTR	0.68	0.68	8.7	1.000	1872	0.25	1.0	0.0	9.7	A	9.7	A
Southbound												
LTR	0.39	0.68	6.3	1.000	1835	0.11	0.1	0.0	6.5	A	6.5	A

```
_______________________________________________________________________________
         Intersection delay = 11.1  (sec/veh)   Intersection LOS = B



______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                                for exclusive lefts
Input
                                                       EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                           90.0    sec
Total actual green time for LT lane group, G (s)       20.0
Effective permitted green time for LT lane group, g(s) 21.0
Opposing effective green time, go (s)                  21.0
Number of lanes in LT lane group, N                    1
Number of lanes in opposing approach, No               1
Adjusted LT flow rate, VLT (veh/h)                     160
Proportion of LT in LT lane group, PLT                 1.000
Proportion of LT in opposing flow, PLTo                0.33
Adjusted opposing flow rate, Vo (veh/h)                6
Lost time for LT lane group, tL                        4.00
Computation
LT volume per cycle, LTC=VLTC/3600                     4.00
Opposing lane util. factor, fLUo                       1.000 1.000 0.952 0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)    0.15
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g                  0.0
Opposing platoon ratio, Rpo (refer Exhibit 16-11)      1.00
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]           0.77
gq, (see Exhibit C16-4,5,6,7,8)                        0.00
gu=g-gq if gq>=gf, or = g-gf if gq<gf                  21.00
n=Max(gq-gf)/2,0)                                      0.00
PTHo=1-PLTo                                            0.67
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]                     1.00
EL1 (refer to Exhibit C16-3)                           1.33
EL2=Max((1-Ptho**n)/Plto, 1.0)                         1.00
fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g                     0.19
gdiff=max(gq-gf,0)                                     0.00
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)    0.75
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
or flt=[fm+0.91(N-1)]/N**
Left-turn adjustment, fLT                              0.754

For special case of single-lane approach opposed by multilane approach,
see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
  left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach
or when gf>gq, see text.

______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                                  for shared lefts
Input
                                                       EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                           90.0    sec
Total actual green time for LT lane group, G (s)             20.0  60.0  60.0
Effective permitted green time for LT lane group, g(s)       21.0  61.0  61.0
Opposing effective green time, go (s)                        21.0  61.0  61.0
Number of lanes in LT lane group, N                          1     2     2
```

	EB	WB	NB	SB
Number of lanes in opposing approach, No		2	2	2
Adjusted LT flow rate, VLT (veh/h)		2	21	12
Proportion of LT in LT lane group, PLT	0.000	0.333	0.016	0.017
Proportion of LT in opposing flow, PLTo		0.00	0.02	0.02
Adjusted opposing flow rate, Vo (veh/h)		28	709	1279
Lost time for LT lane group, tL		4.00	4.00	4.00
Computation				
LT volume per cycle, LTC=VLTC/3600		0.05	0.53	0.30
Opposing lane util. factor, fLUo	1.000	1.000	0.952	0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)		0.35	9.31	16.79
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g		14.0	30.4	37.4
Opposing platoon ratio, Rpo (refer Exhibit 16-11)		1.00	1.00	1.00
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]		0.77	0.32	0.32
gq, (see Exhibit C16-4,5,6,7,8)		0.00	3.56	13.27
gu=g-gq if gq>=gf, or = g-gf if gq<gf		6.96	30.58	23.64
n=Max(gq-gf)/2,0)		0.00	0.00	0.00
PTHo=1-PLTo		1.00	0.98	0.98
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]		0.33	0.04	0.04
EL1 (refer to Exhibit C16-3)		1.42	2.92	5.17
EL2=Max((1-Ptho**n)/Plto, 1.0)			1.00	1.00
fmin=2(1+PL)/g or fmin=2(1+Pl)/g		0.13	0.03	0.03
gdiff=max(gq-gf,0)		0.00	0.00	0.00
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)		0.96	0.97	0.95
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)				
or flt=[fm+0.91(N-1)]/N**				
Left-turn adjustment, fLT		0.960	0.938	0.928

For special case of single-lane approach opposed by multilane approach, see text.

* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto left-turn lane and redo calculations.

** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.

For special case of multilane approach opposed by single-lane approach or when gf>gq, see text.

SUPPLEMENTAL PEDESTRIAN-BICYCLE EFFECTS WORKSHEET

Permitted Left Turns

	EB	WB	NB	SB
Effective pedestrian green time, gp (s)	20.0			60.0
Conflicting pedestrian volume, Vped (p/h)	100			100
Pedestrian flow rate, Vpedg (p/h)	450			150
OCCpedg	0.225			0.075
Opposing queue clearing green, gq (s)	0.00			13.27
Eff. ped. green consumed by opp. veh. queue, gq/gp	0.000			0.221
OCCpedu	0.225			0.067
Opposing flow rate, Vo (veh/h)	6			1279
OCCr	0.223			0.011
Number of cross-street receiving lanes, Nrec	2			2
Number of turning lanes, Nturn	1			1
ApbT	0.866			0.993
Proportion of left turns, PLT	1.000			0.017
Proportion of left turns using protected phase, PLTA	0.000			0.000
Left-turn adjustment, fLpb	0.866			1.000

Permitted Right Turns

	EB	WB	NB	SB
Effective pedestrian green time, gp (s)		20.0	60.0	
Conflicting pedestrian volume, Vped (p/h)		100	100	
Conflicting bicycle volume, Vbic (bicycles/h)		0	0	
Vpedg		450	150	
OCCpedg		0.225	0.075	
Effective green, g (s)		21.0	61.0	
Vbicg		0	0	

OCCbicg	0.020	0.020
OCCr	0.225	0.075
Number of cross-street receiving lanes, Nrec	2	2
Number of turning lanes, Nturn	1	1
ApbT	0.865	0.955
Proportion right-turns, PRT	0.667	0.009
Proportion right-turns using protected phase, PRTA	0.000	0.000
Right turn adjustment, fRpb	0.910	1.000

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

		EBLT	WBLT	NBLT	SBLT
Cycle length, C	90.0 sec				
Adj. LT vol from Vol Adjustment Worksheet, v					
v/c ratio from Capacity Worksheet, X					
Protected phase effective green interval, g (s)					
Opposing queue effective green interval, gq					
Unopposed green interval, gu					
Red time r=(C-g-gq-gu)					
Arrival rate, qa=v/(3600(max[X,1.0]))					
Protected ph. departure rate, Sp=s/3600					
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)					
XPerm					
XProt					
Case					
Queue at beginning of green arrow, Qa					
Queue at beginning of unsaturated green, Qu					
Residual queue, Qr					
Uniform Delay, d1					

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
DefL	0.0	0.00	34.5	31.4	0.00	0.0	0.0	38.6
TR	0.0	0.00	34.5	27.0	0.00	0.0	0.0	27.1
	0.0						0.0	
Westbound								
	0.0						0.0	
LTR	0.0	0.00	34.5	26.6	0.00	0.0	0.0	26.6
	0.0						0.0	
Northbound								
	0.0						0.0	
LTR	0.0	0.00	14.5	8.7	0.00	0.0	0.0	9.7
	0.0						0.0	
Southbound								
	0.0						0.0	
LTR	0.0	0.00	14.5	6.3	0.00	0.0	0.0	6.5
	0.0						0.0	

Intersection Delay 11.1 sec/veh Intersection LOS B

BACK OF QUEUE WORKSHEET

LaneGroup	Eastbound DefL	Eastbound TR	Westbound LTR	Northbound LTR	Southbound LTR
Init Queue	0.0	0.0	0.0	0.0	0.0
Flow Rate	160	28	6	671	372
So	1800	1800	1800	1800	1800
No.Lanes	0	2 0	0 1 0	0 2 0	0 2 0
SL	1022	1364	1244	1450	1422
LnCapacity	238	318	290	983	963
Flow Ratio	0.2	0.0	0.0	0.5	0.3
v/c Ratio	0.67	0.09	0.02	0.68	0.39
Grn Ratio	0.23	0.23	0.23	0.68	0.68
I Factor		1.000	1.000	1.000	1.000
AT or PVG	3	3	3	3	3
Pltn Ratio	1.00	1.00	1.00	1.00	1.00
PF2	1.00	1.00	1.00	1.00	1.00
Q1	3.6	0.5	0.1	10.1	4.1
kB	0.3	0.3	0.3	0.7	0.7
Q2	0.6	0.0	0.0	1.4	0.4
Q Average	4.2	0.6	0.1	11.5	4.5
Q Spacing	25.0	25.0	25.0	25.0	25.0
Q Storage	0	0	0	0	0
Q S Ratio					
70th Percentile Output:					
fB%	1.2	1.2	1.2	1.2	1.2
BOQ	5.0	0.7	0.1	13.5	5.3
QSRatio					
85th Percentile Output:					
fB%	1.6	1.6	1.6	1.5	1.6
BOQ	6.6	0.9	0.2	17.3	7.0
QSRatio					
90th Percentile Output:					
fB%	1.7	1.8	1.8	1.6	1.7
BOQ	7.2	1.0	0.2	18.7	7.7
QSRatio					
95th Percentile Output:					
fB%	2.0	2.1	2.1	1.8	2.0
BOQ	8.3	1.2	0.3	20.9	8.8
QSRatio					
98th Percentile Output:					
fB%	2.4	2.7	2.7	2.1	2.4
BOQ	10.2	1.5	0.3	24.3	10.8
QSRatio					

ERROR MESSAGES

No errors to report.

HCS+: Signalized Intersections Release 5.4

Analyst:
Agency: PB
Date: 6/25/2010
Period: PM Peak Hour
Project ID: I-290 Phase 1 Study
E/W St: Lexington Street

Inter.: Lexington Street & 25th Avenue
Area Type: All other areas
Jurisd:
Year : Existing
N/S St: 25th Avenue

SIGNALIZED INTERSECTION SUMMARY

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	0	2	0	0	1	0	0	2	0	0	2	0
LGConfig		LTR			LTR			LTR			LTR	
Volume	112	6	162	9	5	29	37	741	15	36	1243	65
Lane Width		12.0			12.0			12.0			12.0	
RTOR Vol			41			24			1			2

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination		1	2	3	4			5	6	7	8
EB	Left	A				NB	Left	A			
	Thru	A					Thru	A			
	Right	A					Right	A			
	Peds						Peds	X			
WB	Left	A				SB	Left	A			
	Thru	A					Thru	A			
	Right	A					Right	A			
	Peds	X					Peds				
NB	Right					EB	Right				
SB	Right					WB	Right				
Green		17.0						63.0			
Yellow		4.0						4.0			
All Red		1.0						1.0			

Cycle Length: 90.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
LTR	415	2076	0.60	0.20	35.3	D	35.3	D
Westbound								
LTR	237	1186	0.08	0.20	29.4	C	29.4	C
Northbound								
LTR	1725	2426	0.48	0.71	5.9	A	5.9	A
Southbound								
LTR	1894	2664	0.75	0.71	9.6	A	9.6	A

Intersection Delay = 11.1 (sec/veh) Intersection LOS = B

HCS+: Signalized Intersections Release 5.4

I-290
Existing

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst:
Agency/Co.: PB
Date Performed: 6/25/2010
Analysis Time Period: PM Peak Hour
Intersection: Lexington Street & 25th Avenue
Area Type: All other areas
Jurisdiction:
Analysis Year: Existing
Project ID: I-290 Phase 1 Study
E/W St: Lexington Street N/S St: 25th Avenue

VOLUME DATA

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
Volume	112	6	162	9	5	29	37	741	15	36	1243	65
% Heavy Veh	15	15	15	15	15	15	15	15	15	15	15	15
PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
PK 15 Vol	29	2	43	3	2	8	10	195	4	9	327	17
Hi Ln Vol												
% Grade		0			0			0			0	
Ideal Sat		1800			1800			1800			1800	
ParkExist												
NumPark												
No. Lanes	0	2	0	0	1	0	0	2	0	0	2	0
LGConfig		LTR			LTR			LTR			LTR	
Lane Width		12.0			12.0			12.0			12.0	
RTOR Vol			41			24			1			2
Adj Flow		251			19			834			1412	
%InSharedLn												
Prop LTs		0.470			0.474			0.047			0.027	
Prop RTs	0.506			0.263			0.018			0.047		
Peds Bikes	0			200	0		200	0		0		
Buses		0			0			5			5	
%InProtPhase												

Duration 0.25 Area Type: All other areas

OPERATING PARAMETERS

	Eastbound	Westbound	Northbound	Southbound
	L T R	L T R	L T R	L T R
Init Unmet	0.0	0.0	0.0	0.0
Arriv. Type	3	3	3	3
Unit Ext.	3.0	3.0	3.0	3.0
I Factor	1.000	1.000	1.000	1.000
Lost Time	2.0	2.0	2.0	2.0
Ext of g	3.0	3.0	3.0	3.0
Ped Min g	15.2	16.5	13.6	12.2

PHASE DATA

Phase Combination	1	2	3	4			5	6	7	8
EB Left	A				NB	Left	A			
Thru	A					Thru	A			
Right	A					Right	A			
Peds						Peds	X			
WB Left	A				SB	Left	A			
Thru	A					Thru	A			
Right	A					Right	A			
Peds	X					Peds				
NB Right					EB	Right				
SB Right					WB	Right				
Green	17.0						63.0			
Yellow	4.0						4.0			
All Red	1.0						1.0			

Cycle Length: 90.0 secs

VOLUME ADJUSTMENT AND SATURATION FLOW WORKSHEET

Volume Adjustment

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume, V	112	6	162	9	5	29	37	741	15	36	1243	65
PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj flow	118	6	127	9	5	5	39	780	15	38	1308	66
No. Lanes	0	2	0	0	1	0	0	2	0	0	2	0
Lane group		LTR			LTR			LTR			LTR	
Adj flow		251			19			834			1412	
Prop LTs		0.470			0.474			0.047			0.027	
Prop RTs		0.506			0.263			0.018			0.047	

Saturation Flow Rate (see Exhibit 16-7 to determine the adjustment factors)

	Eastbound	Westbound	Northbound	Southbound
LG	LTR	LTR	LTR	LTR
So	1800	1800	1800	1800
Lanes 0	2 0 0	1 0 0	2 0 0	2 0
fW	1.000	1.000	1.000	1.000
fHV	0.870	0.870	0.870	0.870
fG	1.000	1.000	1.000	1.000
fP	1.000	1.000	1.000	1.000
fBB	1.000	1.000	0.990	0.990
fA	1.000	1.000	1.000	1.000
fLU	0.952	1.000	0.952	0.952
fRT	0.924	0.964	0.997	0.993
fLT	0.875	0.854	0.826	0.910
Sec.				
fLpb	0.861	1.000	1.000	0.999
fRpb	1.000	0.920	0.998	1.000
S	2076	1186	2426	2664
Sec.				

CAPACITY AND LOS WORKSHEET

Capacity Analysis and Lane Group Capacity

Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- Capacity (c)	v/c Ratio
Eastbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	LTR	251	2076	# 0.12	0.20	415	0.60
Right							
Westbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	LTR	19	1186	0.02	0.20	237	0.08
Right							
Northbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	LTR	834	2426	0.34	0.71	1725	0.48
Right							
Southbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	LTR	1412	2664	# 0.53	0.71	1894	0.75
Right							

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.65
Total lost time per cycle, L = 8.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.71

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	LOS	Approach Delay	LOS
Eastbound												
LTR	0.60	0.20	32.8	1.000	415	0.19	2.5	0.0	35.3	D	35.3	D
Westbound												
LTR	0.08	0.20	29.3	1.000	237	0.11	0.1	0.0	29.4	C	29.4	C
Northbound												
LTR	0.48	0.71	5.7	1.000	1725	0.11	0.2	0.0	5.9	A	5.9	A
Southbound												
LTR	0.75	0.71	8.0	1.000	1894	0.30	1.7	0.0	9.6	A	9.6	A

Intersection delay = 11.1 (sec/veh) Intersection LOS = B

SUPPLEMENTAL PERMITTED LT WORKSHEET
for exclusive lefts

Input

		EB	WB	NB	SB
Opposed by Single(S) or Multiple(M) lane approach					
Cycle length, C	90.0 sec				
Total actual green time for LT lane group, G (s)					
Effective permitted green time for LT lane group, g(s)					
Opposing effective green time, go (s)					
Number of lanes in LT lane group, N					
Number of lanes in opposing approach, No					
Adjusted LT flow rate, VLT (veh/h)					
Proportion of LT in LT lane group, PLT					
Proportion of LT in opposing flow, PLTo					
Adjusted opposing flow rate, Vo (veh/h)					
Lost time for LT lane group, tL					
Computation					
LT volume per cycle, LTC=VLTC/3600					
Opposing lane util. factor, fLUo		1.000	0.952	0.952	0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)					
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g					
Opposing platoon ratio, Rpo (refer Exhibit 16-11)					
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]					
gq, (see Exhibit C16-4,5,6,7,8)					
gu=g-gq if gq>=gf, or = g-gf if gq<gf					
n=Max(gq-gf)/2,0)					
PTHo=1-PLTo					
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]					
EL1 (refer to Exhibit C16-3)					
EL2=Max((1-Ptho**n)/Plto, 1.0)					
fmin=2(1+PL)/g or fmin=2(1+Pl)/g					
gdiff=max(gq-gf,0)					
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)					
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)					
or flt=[fm+0.91(N-1)]/N**					
Left-turn adjustment, fLT					

For special case of single-lane approach opposed by multilane approach, see text.

* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto left-turn lane and redo calculations.

** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.

For special case of multilane approach opposed by single-lane approach or when gf>gq, see text.

SUPPLEMENTAL PERMITTED LT WORKSHEET
for shared lefts

Input

		EB	WB	NB	SB
Opposed by Single(S) or Multiple(M) lane approach					
Cycle length, C	90.0 sec				
Total actual green time for LT lane group, G (s)		17.0	17.0	63.0	63.0
Effective permitted green time for LT lane group, g(s)		18.0	18.0	64.0	64.0
Opposing effective green time, go (s)		18.0	18.0	64.0	64.0
Number of lanes in LT lane group, N		2	1	2	2

Number of lanes in opposing approach, No	1	2	2	2
Adjusted LT flow rate, VLT (veh/h)	118	9	39	38
Proportion of LT in LT lane group, PLT	0.470	0.474	0.047	0.027
Proportion of LT in opposing flow, PLTo	0.47	0.47	0.03	0.05
Adjusted opposing flow rate, Vo (veh/h)	19	251	1412	834
Lost time for LT lane group, tL	4.00	4.00	4.00	4.00
Computation				
LT volume per cycle, LTC=VLTC/3600	2.95	0.23	0.98	0.95
Opposing lane util. factor, fLUo	1.000	0.952	0.952	0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)	0.47	3.30	18.54	10.95
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g	0.0	8.6	22.5	22.9
Opposing platoon ratio, Rpo (refer Exhibit 16-11)	1.00	1.00	1.00	1.00
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]	0.80	0.80	0.29	0.29
gq, (see Exhibit C16-4,5,6,7,8)	0.00	5.68	14.22	4.36
gu=g-gq if gq>=gf, or = g-gf if gq<gf	18.00	9.44	41.50	41.08
n=Max(gq-gf)/2,0)	0.00	0.00	0.00	0.00
PTHo=1-PLTo	0.53	0.53	0.97	0.95
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]	0.97	0.47	0.14	0.07
EL1 (refer to Exhibit C16-3)	1.40	1.81	5.90	3.31
EL2=Max((1-Ptho**n)/Plto, 1.0)	1.00	1.00	1.00	1.00
fmin=2(1+PL)/g or fmin=2(1+Pl)/g	0.22	0.16	0.04	0.03
gdiff=max(gq-gf,0)	0.00	0.00	0.00	0.00
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)	0.84	0.85	0.74	0.91
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)				
or flt=[fm+0.91(N-1)]/N**				
Left-turn adjustment, fLT	0.875	0.854	0.826	0.910

For special case of single-lane approach opposed by multilane approach, see text.

* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto left-turn lane and redo calculations.

** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.

For special case of multilane approach opposed by single-lane approach or when gf>gq, see text.

SUPPLEMENTAL PEDESTRIAN-BICYCLE EFFECTS WORKSHEET

Permitted Left Turns

	EB	WB	NB	SB
Effective pedestrian green time, gp (s)	17.0			63.0
Conflicting pedestrian volume, Vped (p/h)	200			200
Pedestrian flow rate, Vpedg (p/h)	1058			285
OCCpedg	0.506			0.143
Opposing queue clearing green, gq (s)	0.00			4.36
Eff. ped. green consumed by opp. veh. queue, gq/gp	0.000			0.069
OCCpedu	0.506			0.138
Opposing flow rate, Vo (veh/h)	19			834
OCCr	0.493			0.043
Number of cross-street receiving lanes, Nrec	2			2
Number of turning lanes, Nturn	1			1
ApbT	0.704			0.974
Proportion of left turns, PLT	0.470			0.027
Proportion of left turns using protected phase, PLTA	0.000			0.000
Left-turn adjustment, fLpb	0.861			0.999

Permitted Right Turns

	EB	WB	NB	SB
Effective pedestrian green time, gp (s)		17.0	63.0	
Conflicting pedestrian volume, Vped (p/h)		200	200	
Conflicting bicycle volume, Vbic (bicycles/h)		0	0	
Vpedg		1058	285	
OCCpedg		0.506	0.143	
Effective green, g (s)		18.0	64.0	
Vbicg		0	0	

OCCbicg	0.020	0.020
OCCr	0.506	0.143
Number of cross-street receiving lanes, Nrec	2	2
Number of turning lanes, Nturn	1	1
ApbT	0.697	0.914
Proportion right-turns, PRT	0.263	0.018
Proportion right-turns using protected phase, PRTA	0.000	0.000
Right turn adjustment, fRpb	0.920	0.998

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

		EBLT	WBLT	NBLT	SBLT
Cycle length, C	90.0 sec				
Adj. LT vol from Vol Adjustment Worksheet, v					
v/c ratio from Capacity Worksheet, X					
Protected phase effective green interval, g (s)					
Opposing queue effective green interval, gq					
Unopposed green interval, gu					
Red time r=(C-g-gq-gu)					
Arrival rate, qa=v/(3600(max[X,1.0]))					
Protected ph. departure rate, Sp=s/3600					
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)					
XPerm					
XProt					
Case					
Queue at beginning of green arrow, Qa					
Queue at beginning of unsaturated green, Qu					
Residual queue, Qr					
Uniform Delay, d1					

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
	0.0						0.0	
LTR	0.0	0.00	36.0	32.8	0.00	0.0	0.0	35.3
	0.0						0.0	
Westbound								
	0.0						0.0	
LTR	0.0	0.00	36.0	29.3	0.00	0.0	0.0	29.4
	0.0						0.0	
Northbound								
	0.0						0.0	
LTR	0.0	0.00	13.0	5.7	0.00	0.0	0.0	5.9
	0.0						0.0	
Southbound								
	0.0						0.0	
LTR	0.0	0.00	13.0	8.0	0.00	0.0	0.0	9.6
	0.0						0.0	

Intersection Delay 11.1 sec/veh Intersection LOS B

BACK OF QUEUE WORKSHEET

	Eastbound	Westbound	Northbound	Southbound
LaneGroup	LTR	LTR	LTR	LTR
Init Queue	0.0	0.0	0.0	0.0
Flow Rate	131	19	438	741
So	1800	1800	1800	1800
No.Lanes	0 2 0	0 1 0	0 2 0	0 2 0
SL	1090	1186	1274	1399
LnCapacity	217	237	905	994
Flow Ratio	0.1	0.0	0.3	0.5
v/c Ratio	0.60	0.08	0.48	0.75
Grn Ratio	0.20	0.20	0.71	0.71
I Factor	1.000	1.000	1.000	1.000
AT or PVG	3	3	3	3
Pltn Ratio	1.00	1.00	1.00	1.00
PF2	1.00	1.00	1.00	1.00
Q1	3.0	0.4	4.8	11.4
kB	0.3	0.3	0.7	0.7
Q2	0.4	0.0	0.6	1.9
Q Average	3.4	0.4	5.4	13.3
Q Spacing	25.0	25.0	25.0	25.0
Q Storage	0	0	0	0
Q S Ratio				
70th Percentile Output:				
fB%	1.2	1.2	1.2	1.2
BOQ	4.0	0.5	6.4	15.6
QSRatio				
85th Percentile Output:				
fB%	1.6	1.6	1.6	1.5
BOQ	5.3	0.7	8.4	19.8
QSRatio				
90th Percentile Output:				
fB%	1.7	1.8	1.7	1.6
BOQ	5.9	0.7	9.3	21.3
QSRatio				
95th Percentile Output:				
fB%	2.0	2.1	1.9	1.8
BOQ	6.8	0.9	10.5	23.7
QSRatio				
98th Percentile Output:				
fB%	2.5	2.7	2.4	2.1
BOQ	8.4	1.1	12.8	27.4
QSRatio				

ERROR MESSAGES

No errors to report.

HCS+: Signalized Intersections Release 5.4

Analyst:
Agency: PB
Date: 6/25/2010
Period: AM Peak Hour
Project ID: I-290 Phase 1 Study
E/W St: Bataan Drive

Inter.: Bataan Drive & 17th Avenue
Area Type: All other areas
Jurisd:
Year : Existing
N/S St: 17th Avenue

SIGNALIZED INTERSECTION SUMMARY

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
No. Lanes	0	2	0	0	0	0	0	2	0	0	2	0
LGConfig		LTR						TR		DefL	T	
Volume	65	66	131					351	156	74	177	
Lane Width		12.0						12.0		12.0	12.0	
RTOR Vol			114						51			

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination	1	2	3	4		5	6	7	8
EB Left	A				NB Left				
Thru	A				Thru		A		
Right	A				Right		A		
Peds					Peds				
WB Left					SB Left	A	A		
Thru					Thru	A	A		
Right					Right				
Peds					Peds				
NB Right					EB Right				
SB Right					WB Right				
Green	25.0					67.0	35.0		
Yellow	4.0					3.0	4.0		
All Red	1.0					0.0	1.0		

Cycle Length: 140.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
LTR	587	3162	0.26	0.19	49.0	D	49.0	D
Westbound								
Northbound								
TR	816	3175	0.59	0.26	46.6	D	46.6	D
Southbound								
DefL	933	1641	0.08	0.77	5.0	A		
T	1308	1727	0.14	0.76	1.0	A	2.2	A

Intersection Delay = 34.0 (sec/veh) Intersection LOS = C

HCS+: Signalized Intersections Release 5.4

I-290
Existing

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst:
Agency/Co.: PB
Date Performed: 6/25/2010
Analysis Time Period: AM Peak Hour
Intersection: Bataan Drive & 17th Avenue
Area Type: All other areas
Jurisdiction:
Analysis Year: Existing
Project ID: I-290 Phase 1 Study
E/W St: Bataan Drive N/S St: 17th Avenue

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	65	66	131					351	156	74	177	
% Heavy Veh	10	10	10					10	10	10	10	
PHF	0.95	0.95	0.95					0.95	0.95	0.95	0.95	
PK 15 Vol	17	17	34					92	41	19	47	
Hi Ln Vol												
% Grade		0						0			0	
Ideal Sat		1900						1900		1900	1900	
ParkExist												
NumPark												
No. Lanes	0	2	0	0	0	0	0	2	0	0	2	0
LGConfig		LTR						TR		DefL	T	
Lane Width		12.0						12.0		12.0	12.0	
RTOR Vol			114						51			
Adj Flow		155						480		78	186	
%InSharedLn												
Prop LTs		0.439						0.000		1.000	0.000	
Prop RTs		0.116						0.231			0.000	
Peds Bikes	0			0			0					
Buses		0						0		0	0	
%InProtPhase										0.0		

Duration 0.25 Area Type: All other areas

OPERATING PARAMETERS

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Init Unmet		0.0						0.0		0.0	0.0	
Arriv. Type		3						3		3	6	
Unit Ext.		3.0						3.0		3.0	3.0	
I Factor		1.000						1.000			0.963	
Lost Time		2.0						2.0		2.0	2.0	
Ext of g		3.0						3.0		3.0	3.0	
Ped Min g		3.2			3.2			3.2				

PHASE DATA

Phase Combination	1	2	3	4		5	6	7	8
EB Left	A				NB Left				
Thru	A				Thru		A		
Right	A				Right		A		
Peds					Peds				
WB Left					SB Left	A	A		
Thru					Thru	A	A		
Right					Right				
Peds					Peds				
NB Right					EB Right				
SB Right					WB Right				
Green	25.0					67.0	35.0		
Yellow	4.0					3.0	4.0		
All Red	1.0					0.0	1.0		

Cycle Length: 140.0 secs

VOLUME ADJUSTMENT AND SATURATION FLOW WORKSHEET

Volume Adjustment

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume, V	65	66	131					351	156	74	177	
PHF	0.95	0.95	0.95					0.95	0.95	0.95	0.95	
Adj flow	68	69	18					369	111	78	186	
No. Lanes	0	2	0	0	0	0	0	2	0	0	2	0
Lane group		LTR						TR		DefL	T	
Adj flow		155						480		78	186	
Prop LTs		0.439						0.000		1.000	0.000	
Prop RTs		0.116						0.231			0.000	

Saturation Flow Rate (see Exhibit 16-7 to determine the adjustment factors)

	Eastbound			Westbound			Northbound			Southbound		
LG		LTR						TR		DefL	T	
So		1900						1900		1900	1900	
Lanes	0	2	0	0	0	0	0	2	0	0	2	0
fW		1.000						1.000		1.000	1.000	
fHV		0.909						0.909		0.909	0.909	
fG		1.000						1.000		1.000	1.000	
fP		1.000						1.000		1.000	1.000	
fBB		1.000						1.000		1.000	1.000	
fA		1.000						1.000		1.000	1.000	
fLU		0.952						0.952		1.000	1.000	
fRT		0.983						0.965			1.000	
fLT		0.979						1.000		0.950	1.000	
Sec.										0.276		
fLpb		1.000						1.000		1.000	1.000	
fRpb		1.000						1.000			1.000	
S		3162						3175		1641	1727	
Sec.										476		

CAPACITY AND LOS WORKSHEET

Capacity Analysis and Lane Group Capacity

Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- Capacity (c)	v/c Ratio
Eastbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	LTR	155	3162	# 0.05	0.19	587	0.26
Right							
Westbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru							
Right							
Northbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	TR	480	3175	# 0.15	0.26	816	0.59
Right							
Southbound							
Prot		78	1641	0.05	0.486	797	0.10
Perm		0	476	0.00	0.286	136	0.00
Left	DefL	78			0.77	933	0.08
Prot							
Perm							
Thru	T	186	1727	# 0.11	0.76	1308	0.14
Right							

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.31
Total lost time per cycle, L = 12.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.34

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	LOS	Approach Delay	LOS
Eastbound												
LTR	0.26	0.19	48.8	1.000	587	0.11	0.2	0.0	49.0	D	49.0	D
Westbound												
Northbound												
TR	0.59	0.26	45.5	1.000	816	0.18	1.1	0.0	46.6	D	46.6	D
Southbound												
DefL	0.08	0.77	5.0	1.000	933	0.11	0.0	0.0	5.0	A		
T	0.14	0.76	4.6	0.206	1308	0.11	0.0	0.0	1.0	A	2.2	A

```
_______________________________________________________________________________
         Intersection delay = 34.0  (sec/veh)   Intersection LOS = C



______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                              for exclusive lefts
Input
                                                       EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                           140.0   sec
Total actual green time for LT lane group, G (s)                         105.0
Effective permitted green time for LT lane group, g(s)                   40.0
Opposing effective green time, go (s)                                    36.0
Number of lanes in LT lane group, N                                      1
Number of lanes in opposing approach, No                                 2
Adjusted LT flow rate, VLT (veh/h)                                       78
Proportion of LT in LT lane group, PLT                                   1.000
Proportion of LT in opposing flow, PLTo                                  0.00
Adjusted opposing flow rate, Vo (veh/h)                                  480
Lost time for LT lane group, tL                                          4.00
Computation
LT volume per cycle, LTC=VLTC/3600                                       3.03
Opposing lane util. factor, fLUo                             0.952 1.000 0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)                      9.80
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g                                    0.0
Opposing platoon ratio, Rpo (refer Exhibit 16-11)                        1.00
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]                             0.74
gq, (see Exhibit C16-4,5,6,7,8)                                          16.94
gu=g-gq if gq>=gf, or = g-gf if gq<gf                                    23.06
n=Max(gq-gf)/2,0)                                                        8.47
PTHo=1-PLTo                                                              1.00
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]                                       1.00
EL1 (refer to Exhibit C16-3)                                             2.09
EL2=Max((1-Ptho**n)/Plto, 1.0)
fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g                                       0.10
gdiff=max(gq-gf,0)                                                       0.00
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)                      0.28
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
or flt=[fm+0.91(N-1)]/N**
Left-turn adjustment, fLT                                                0.276

For special case of single-lane approach opposed by multilane approach,
see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
  left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach
or when gf>gq, see text.

______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                                for shared lefts
Input
                                                       EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                           140.0   sec
Total actual green time for LT lane group, G (s)
Effective permitted green time for LT lane group, g(s)
Opposing effective green time, go (s)
Number of lanes in LT lane group, N
```

```
Number of lanes in opposing approach, No
Adjusted LT flow rate, VLT (veh/h)
Proportion of LT in LT lane group, PLT                 0.439       0.000 0.000
Proportion of LT in opposing flow, PLTo
Adjusted opposing flow rate, Vo (veh/h)
Lost time for LT lane group, tL
Computation
LT volume per cycle, LTC=VLTC/3600
Opposing lane util. factor, fLUo                             0.952 1.000 0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g
Opposing platoon ratio, Rpo (refer Exhibit 16-11)
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]
gq, (see Exhibit C16-4,5,6,7,8)
gu=g-gq if gq>=gf, or = g-gf if gq<gf
n=Max(gq-gf)/2,0)
PTHo=1-PLTo
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]
EL1 (refer to Exhibit C16-3)
EL2=Max((1-Ptho**n)/Plto, 1.0)
fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g
gdiff=max(gq-gf,0)
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
or flt=[fm+0.91(N-1)]/N**
Left-turn adjustment, fLT

For special case of single-lane approach opposed by multilane approach,
see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
  left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach
or when gf>gq, see text.

_______________SUPPLEMENTAL PEDESTRIAN-BICYCLE EFFECTS WORKSHEET_______________
Permitted Left Turns
                                                       EB    WB    NB    SB
Effective pedestrian green time, gp (s)
Conflicting pedestrian volume, Vped (p/h)
Pedestrian flow rate, Vpedg (p/h)
OCCpedg
Opposing queue clearing green, gq (s)
Eff. ped. green consumed by opp. veh. queue, gq/gp
OCCpedu
Opposing flow rate, Vo (veh/h)
OCCr
Number of cross-street receiving lanes, Nrec
Number of turning lanes, Nturn
ApbT
Proportion of left turns, PLT
Proportion of left turns using protected phase, PLTA
Left-turn adjustment, fLpb
Permitted Right Turns
Effective pedestrian green time, gp (s)
Conflicting pedestrian volume, Vped (p/h)
Conflicting bicycle volume, Vbic (bicycles/h)
Vpedg
OCCpedg
Effective green, g (s)
Vbicg
```

OCCbicg
OCCr
Number of cross-street receiving lanes, Nrec
Number of turning lanes, Nturn
ApbT
Proportion right-turns, PRT
Proportion right-turns using protected phase, PRTA
Right turn adjustment, fRpb

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

		EBLT	WBLT	NBLT	SBLT
Cycle length, C	140.0 sec				
Adj. LT vol from Vol Adjustment Worksheet, v					78
v/c ratio from Capacity Worksheet, X					0.08
Protected phase effective green interval, g (s)					68.0
Opposing queue effective green interval, gq					16.94
Unopposed green interval, gu					23.06
Red time r=(C-g-gq-gu)					32.0
Arrival rate, qa=v/(3600(max[X,1.0]))					0.02
Protected ph. departure rate, Sp=s/3600					0.456
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)					0.23
XPerm					0.16
XProt					0.07
Case					1
Queue at beginning of green arrow, Qa					0.69
Queue at beginning of unsaturated green, Qu					0.37
Residual queue, Qr					0.00
Uniform Delay, d1					5.0

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
	0.0						0.0	
LTR	0.0	0.00	57.0	48.8	0.00	0.0	0.0	49.0
	0.0						0.0	
Westbound								
	0.0						0.0	
	0.0						0.0	
	0.0						0.0	
Northbound								
	0.0						0.0	
TR	0.0	0.00	52.0	45.5	0.00	0.0	0.0	46.6
	0.0						0.0	
Southbound								
DefL	0.0	0.00		5.0	0.00	0.0	0.0	5.0
T	0.0	0.00	17.0	4.6	0.00	0.0	0.0	1.0
	0.0						0.0	

Intersection Delay 34.0 sec/veh Intersection LOS C

BACK OF QUEUE WORKSHEET

	Eastbound			Westbound			Northbound			Southbound		
LaneGroup		LTR						TR		DefL	T	
Init Queue		0.0						0.0		0.0	0.0	
Flow Rate		81						252		78	186	
So		1900						1900		1900	1900	
No.Lanes	0	2	0	0	0	0	0	2	0	0	2	0
SL		1660						1667		1210	1727	
LnCapacity		308						428		933	1308	
Flow Ratio		0.0						0.2		0.1	0.1	
v/c Ratio		0.26						0.59		0.08	0.14	
Grn Ratio		0.19						0.26		0.77	0.76	
I Factor		1.000						1.000			0.963	
AT or PVG		3						3		3	6	
Pltn Ratio		1.00						1.00		1.00	1.25	
PF2		1.00						1.00		1.00	0.21	
Q1		2.7						8.6		0.7	0.4	
kB		0.4						0.5		0.8	1.0	
Q2		0.2						0.7		0.1	0.2	
Q Average		2.9						9.3		0.8	0.6	
Q Spacing		25.0						25.0		25.0	25.0	
Q Storage		0						0		0	0	
Q S Ratio												
70th Percentile Output:												
fB%		1.2						1.2		1.2	1.2	
BOQ		3.4						11.0		1.0	0.7	
QSRatio												
85th Percentile Output:												
fB%		1.6						1.5		1.6	1.6	
BOQ		4.5						14.2		1.3	0.9	
QSRatio												
90th Percentile Output:												
fB%		1.7						1.7		1.8	1.8	
BOQ		5.0						15.4		1.4	1.0	
QSRatio												
95th Percentile Output:												
fB%		2.0						1.9		2.1	2.1	
BOQ		5.7						17.3		1.7	1.2	
QSRatio												
98th Percentile Output:												
fB%		2.5						2.2		2.6	2.7	
BOQ		7.1						20.4		2.1	1.6	
QSRatio												

ERROR MESSAGES

No errors to report.

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                    HCS+: Signalized Intersections Release 5.4

Analyst:                                    Inter.: Bataan Drive & S. 17th Avenue
Agency: PB                                  Area Type: All other areas
Date:   6/25/2010                           Jurisd:
Period: PM Peak Hour                        Year  : Existing
Project ID: I-290 Phase 1 Study
E/W St: Bataan Drive                        N/S St: S. 17th Avenue

_________________________SIGNALIZED INTERSECTION SUMMARY_______________________
           |  Eastbound      |  Westbound      |  Northbound     |  Southbound     |
           | L    T    R     | L    T    R     | L    T    R     | L    T    R     |
           |_________________|_________________|_________________|_________________|
No. Lanes  |    0   2   0    |   0   0   0     |   0   2   0     |   0   2   0     |
LGConfig   |       LTR       |                 |       TR        |        LT       |
Volume     |73   83   147    |                 |     418  107    |112  376         |
Lane Width |     12.0        |                 |     12.0        |     12.0        |
RTOR Vol   |          113    |                 |          20     |                 |
_______________________________________________________________________________
Duration    0.25      Area Type: All other areas
______________________________Signal Operations________________________________
Phase Combination 1     2     3     4 |          5     6     7     8
EB  Left          A                   | NB  Left
    Thru          A                   |     Thru         A
    Right         A                   |     Right        A
    Peds                              |     Peds
WB  Left                              | SB  Left   A     A
    Thru                              |     Thru   A     A
    Right                             |     Right
    Peds                              |     Peds
NB  Right                             | EB  Right
SB  Right                             | WB  Right
Green            25.0                             67.0  35.0
Yellow           4.0                              3.0   4.0
All Red          1.0                              0.0   1.0
                                                   Cycle Length: 140.0   secs
____________________Intersection Performance Summary___________________________
Appr/   Lane        Adj Sat     Ratios        Lane Group   Approach
Lane    Group       Flow Rate  __________     __________  ___________
Grp     Capacity       (s)     v/c    g/C     Delay LOS   Delay LOS
_______________________________________________________________________________
Eastbound

LTR      583        3139       0.34   0.19    49.9   D    49.9   D

Westbound



Northbound

TR       824        3203       0.65   0.26    48.1   D    48.1   D

Southbound

LT       2064       3251       0.25   0.76    1.1    A    1.1    A

         Intersection Delay = 29.0  (sec/veh)   Intersection LOS = C

_______________________________________________________________________________
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HCS+: Signalized Intersections Release 5.4

I-290
Existing

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst:
Agency/Co.: PB
Date Performed: 6/25/2010
Analysis Time Period: PM Peak Hour
Intersection: Bataan Drive & S. 17th Avenue
Area Type: All other areas
Jurisdiction:
Analysis Year: Existing
Project ID: I-290 Phase 1 Study
E/W St: Bataan Drive N/S St: S. 17th Avenue

VOLUME DATA

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
Volume	73	83	147					418	107	112	376	
% Heavy Veh	10	10	10					10	10	10	10	
PHF	0.95	0.95	0.95					0.95	0.95	0.95	0.95	
PK 15 Vol	19	22	39					110	28	29	99	
Hi Ln Vol												
% Grade		0						0			0	
Ideal Sat		1900						1900			1900	
ParkExist												
NumPark												
No. Lanes	0	2	0	0	0	0	0	2	0	0	2	0
LGConfig		LTR						TR			LT	
Lane Width		12.0						12.0			12.0	
RTOR Vol			113						20			
Adj Flow		200						532			514	
%InSharedLn												
Prop LTs		0.385						0.000			0.230	
Prop RTs		0.180						0.173			0.000	
Peds Bikes	0			0			0					
Buses		0						0			0	
%InProtPhase										0.0		

Duration 0.25 Area Type: All other areas

OPERATING PARAMETERS

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
Init Unmet		0.0						0.0			0.0	
Arriv. Type		3						3			6	
Unit Ext.		3.0						3.0			3.0	
I Factor		1.000						1.000			0.854	
Lost Time		2.0						2.0			2.0	
Ext of g		3.0						3.0			3.0	
Ped Min g		3.2			3.2			3.2				

```
________________________________PHASE DATA____________________________________

Phase Combination 1     2     3     4 |            5     6     7     8

EB  Left          A                   | NB  Left
    Thru          A                   |     Thru          A
    Right         A                   |     Right         A
    Peds                              |     Peds

WB  Left                              | SB  Left   A     A
    Thru                              |     Thru   A     A
    Right                             |     Right
    Peds                              |     Peds

NB  Right                             | EB  Right
                                      |
SB  Right                             | WB  Right
                                      |
                                      |
Green            25.0                              67.0  35.0
Yellow           4.0                               3.0   4.0
All Red          1.0                               0.0   1.0

                                                     Cycle Length: 140.0   secs

_________________VOLUME ADJUSTMENT AND SATURATION FLOW WORKSHEET_______________
Volume Adjustment
           |  Eastbound     |  Westbound     |  Northbound    |  Southbound    |
           | L    T    R    | L    T    R    | L    T    R    | L    T    R    |
           |________________|________________|________________|________________|
Volume, V  |73   83   147   |                |     418  107   |112  376        |
PHF        |0.95 0.95 0.95  |                |     0.95 0.95  |0.95 0.95       |
Adj flow   |77   87   36    |                |     440  92    |118  396        |
No. Lanes  |  0   2   0     |  0   0   0     |  0   2   0     |  0   2   0     |
Lane group |      LTR       |                |      TR        |      LT        |
Adj flow   |     200        |                |     532        |     514        |
Prop LTs   |      0.385     |                |      0.000     |      0.230     |
Prop RTs   |  0.180         |                |  0.173         |  0.000         |

Saturation Flow Rate (see Exhibit 16-7 to determine the adjustment factors)____
         Eastbound         Westbound         Northbound        Southbound
LG          LTR                                 TR                LT
So         1900                                1900              1900
Lanes 0    2     0     0     0     0     0     2     0     0     2     0
fW         1.000                               1.000             1.000
fHV        0.909                               0.909             0.909
fG         1.000                               1.000             1.000
fP         1.000                               1.000             1.000
fBB        1.000                               1.000             1.000
fA         1.000                               1.000             1.000
fLU        0.952                               0.952             0.952
fRT        0.973                               0.974             1.000
fLT        0.981                               1.000             0.989
Sec.                                                             0.566
fLpb       1.000                               1.000             1.000
fRpb       1.000                               1.000             1.000
S          3139                                3203              3251
Sec.                                                             1860
_________________________CAPACITY AND LOS WORKSHEET____________________________
Capacity Analysis and Lane Group Capacity
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Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- Capacity (c)	v/c Ratio
Eastbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	LTR	200	3139	# 0.06	0.19	583	0.34
Right							
Westbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru							
Right							
Northbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	TR	532	3203	# 0.17	0.26	824	0.65
Right							
Southbound							
Prot							
Perm							
Left							
Prot		514	3251	# 0.16	0.471	1533	0.34
Perm		0	1860	0.00	0.286	531	0.00
Thru	LT	514			0.76	2064	0.25
Right							

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.39
Total lost time per cycle, L = 12.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.42

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	LOS	Approach Delay	LOS
Eastbound												
LTR	0.34	0.19	49.6	1.000	583	0.11	0.4	0.0	49.9	D	49.9	D
Westbound												
Northbound												
TR	0.65	0.26	46.3	1.000	824	0.22	1.8	0.0	48.1	D	48.1	D
Southbound												
LT	0.25	0.76	5.1	0.206	2064	0.11	0.1	0.0	1.1	A	1.1	A

Intersection delay = 29.0 (sec/veh) Intersection LOS = C

SUPPLEMENTAL PERMITTED LT WORKSHEET
for exclusive lefts

Input		EB	WB	NB	SB
Opposed by Single(S) or Multiple(M) lane approach					
Cycle length, C	140.0 sec				
Total actual green time for LT lane group, G (s)					
Effective permitted green time for LT lane group, g(s)					
Opposing effective green time, go (s)					
Number of lanes in LT lane group, N					
Number of lanes in opposing approach, No					
Adjusted LT flow rate, VLT (veh/h)					
Proportion of LT in LT lane group, PLT					
Proportion of LT in opposing flow, PLTo					
Adjusted opposing flow rate, Vo (veh/h)					
Lost time for LT lane group, tL					
Computation					
LT volume per cycle, LTC=VLTC/3600					
Opposing lane util. factor, fLUo			0.952	0.952	0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)					
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g					
Opposing platoon ratio, Rpo (refer Exhibit 16-11)					
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]					
gq, (see Exhibit C16-4,5,6,7,8)					
gu=g-gq if gq>=gf, or = g-gf if gq<gf					
n=Max(gq-gf)/2,0)					
PTHo=1-PLTo					
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]					
EL1 (refer to Exhibit C16-3)					
EL2=Max((1-Ptho**n)/Plto, 1.0)					
fmin=2(1+PL)/g or fmin=2(1+Pl)/g					
gdiff=max(gq-gf,0)					
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)					
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)					
or flt=[fm+0.91(N-1)]/N**					
Left-turn adjustment, fLT					

For special case of single-lane approach opposed by multilane approach, see text.

* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto left-turn lane and redo calculations.

** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.

For special case of multilane approach opposed by single-lane approach or when gf>gq, see text.

SUPPLEMENTAL PERMITTED LT WORKSHEET
for shared lefts

Input		EB	WB	NB	SB
Opposed by Single(S) or Multiple(M) lane approach					
Cycle length, C	140.0 sec				
Total actual green time for LT lane group, G (s)					105.0
Effective permitted green time for LT lane group, g(s)					40.0
Opposing effective green time, go (s)					36.0
Number of lanes in LT lane group, N					2

```
Number of lanes in opposing approach, No                                 2
Adjusted LT flow rate, VLT (veh/h)                                       118
Proportion of LT in LT lane group, PLT                 0.385       0.000 0.230
Proportion of LT in opposing flow, PLTo                                  0.00
Adjusted opposing flow rate, Vo (veh/h)                                  532
Lost time for LT lane group, tL                                          4.00
Computation
LT volume per cycle, LTC=VLTC/3600                                       4.59
Opposing lane util. factor, fLUo                             0.952 0.952 0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)                      10.87
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g                                    0.0
Opposing platoon ratio, Rpo (refer Exhibit 16-11)                        1.00
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]                             0.74
gq, (see Exhibit C16-4,5,6,7,8)                                          19.11
gu=g-gq if gq>=gf, or = g-gf if gq<gf                                    20.89
n=Max(gq-gf)/2,0)                                                        9.56
PTHo=1-PLTo                                                              1.00
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]                                       0.95
EL1 (refer to Exhibit C16-3)                                             2.44
EL2=Max((1-Ptho**n)/Plto, 1.0)
fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g                                       0.10
gdiff=max(gq-gf,0)                                                       0.00
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)                      0.22
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
or flt=[fm+0.91(N-1)]/N**
Left-turn adjustment, fLT                                                0.566

For special case of single-lane approach opposed by multilane approach,
see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
  left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach
or when gf>gq, see text.

_______________SUPPLEMENTAL PEDESTRIAN-BICYCLE EFFECTS WORKSHEET_______________
Permitted Left Turns
                                                       EB    WB    NB    SB
Effective pedestrian green time, gp (s)
Conflicting pedestrian volume, Vped (p/h)
Pedestrian flow rate, Vpedg (p/h)
OCCpedg
Opposing queue clearing green, gq (s)
Eff. ped. green consumed by opp. veh. queue, gq/gp
OCCpedu
Opposing flow rate, Vo (veh/h)
OCCr
Number of cross-street receiving lanes, Nrec
Number of turning lanes, Nturn
ApbT
Proportion of left turns, PLT
Proportion of left turns using protected phase, PLTA
Left-turn adjustment, fLpb
Permitted Right Turns
Effective pedestrian green time, gp (s)
Conflicting pedestrian volume, Vped (p/h)
Conflicting bicycle volume, Vbic (bicycles/h)
Vpedg
OCCpedg
Effective green, g (s)
Vbicg
```

OCCbicg
OCCr
Number of cross-street receiving lanes, Nrec
Number of turning lanes, Nturn
ApbT
Proportion right-turns, PRT
Proportion right-turns using protected phase, PRTA
Right turn adjustment, fRpb

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

			EBLT	WBLT	NBLT	SBLT
Cycle length, C	140.0	sec				
Adj. LT vol from Vol Adjustment Worksheet, v						
v/c ratio from Capacity Worksheet, X						
Protected phase effective green interval, g (s)						
Opposing queue effective green interval, gq						
Unopposed green interval, gu						
Red time r=(C-g-gq-gu)						
Arrival rate, qa=v/(3600(max[X,1.0]))						
Protected ph. departure rate, Sp=s/3600						
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)						
XPerm						
XProt						
Case						
Queue at beginning of green arrow, Qa						
Queue at beginning of unsaturated green, Qu						
Residual queue, Qr						
Uniform Delay, d1						

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
	0.0						0.0	
LTR	0.0	0.00	57.0	49.6	0.00	0.0	0.0	49.9
	0.0						0.0	
Westbound								
	0.0						0.0	
	0.0						0.0	
	0.0						0.0	
Northbound								
	0.0						0.0	
TR	0.0	0.00	52.0	46.3	0.00	0.0	0.0	48.1
	0.0						0.0	
Southbound								
	0.0						0.0	
LT	0.0	0.00	17.0	5.1	0.00	0.0	0.0	1.1
	0.0						0.0	

Intersection Delay 29.0 sec/veh Intersection LOS C

BACK OF QUEUE WORKSHEET

	Eastbound	Westbound	Northbound	Southbound
LaneGroup	LTR		TR	LT
Init Queue	0.0		0.0	0.0
Flow Rate	105		279	269
So	1900		1900	1900
No.Lanes	0 2 0	0 0 0	0 2 0	0 2 0
SL	1648		1682	1431
LnCapacity	306		432	1084
Flow Ratio	0.1		0.2	0.2
v/c Ratio	0.34		0.65	0.25
Grn Ratio	0.19		0.26	0.76
I Factor	1.000		1.000	0.854
AT or PVG	3		3	6
Pltn Ratio	1.00		1.00	1.25
PF2	1.00		1.00	0.22
Q1	3.6		9.7	0.6
kB	0.4		0.5	0.8
Q2	0.2		0.9	0.3
Q Average	3.8		10.6	0.9
Q Spacing	25.0		25.0	25.0
Q Storage	0		0	0
Q S Ratio				
70th Percentile Output:				
fB%	1.2		1.2	1.2
BOQ	4.5		12.5	1.1
QSRatio				
85th Percentile Output:				
fB%	1.6		1.5	1.6
BOQ	5.9		16.0	1.4
QSRatio				
90th Percentile Output:				
fB%	1.7		1.6	1.8
BOQ	6.5		17.4	1.6
QSRatio				
95th Percentile Output:				
fB%	2.0		1.8	2.1
BOQ	7.5		19.4	1.9
QSRatio				
98th Percentile Output:				
fB%	2.4		2.1	2.6
BOQ	9.3		22.7	2.4
QSRatio				

ERROR MESSAGES

No errors to report.

HCS+: Signalized Intersections Release 5.4

```
Analyst:                                  Inter.: Harrison Street &17th Avenue
Agency: PB                                Area Type: All other areas
Date:   6/25/2010                         Jurisd:
Period: AM Peak Hour                      Year  : Existing
Project ID: I-290 Phase 1 Study
E/W St: Harrison Street                   N/S St: 17th Avenue

_________________________SIGNALIZED INTERSECTION SUMMARY_______________________
           |  Eastbound     |  Westbound     |  Northbound    |  Southbound    |
           | L    T    R    | L    T    R    | L    T    R    | L    T    R    |
           |________________|________________|________________|________________|
No. Lanes  |   0    0    0  |   1    2    0  |   0    2    0  |   0    2    0  |
LGConfig   |                | L      TR      | DefL  T        |        TR      |
Volume     |                |114  326  155   |230  187        |      174  106  |
Lane Width |                |12.0 12.0       |12.0 12.0       |      12.0      |
RTOR Vol   |                |           33   |                |            63  |
_______________________________________________________________________________
Duration    0.25      Area Type: All other areas
______________________________Signal Operations________________________________
Phase Combination 1     2     3     4 |           5     6     7     8
EB  Left                              | NB  Left   A     A
    Thru                              |     Thru   A     A
    Right                             |     Right
    Peds                              |     Peds
WB  Left          A                   | SB  Left
    Thru          A                   |     Thru         A
    Right         A                   |     Right        A
    Peds                              |     Peds
NB  Right                             | EB  Right
SB  Right                             | WB  Right
Green            25.0                             67.0  35.0
Yellow           4.0                              3.0   4.0
All Red          1.0                              0.0   1.0
                                                   Cycle Length: 140.0   secs
____________________Intersection Performance Summary___________________________
Appr/   Lane       Adj Sat     Ratios       Lane Group   Approach
Lane    Group     Flow Rate   __________    __________   ___________
Grp     Capacity     (s)      v/c    g/C    Delay LOS    Delay LOS
_______________________________________________________________________________
Eastbound



Westbound
L        305       1641       0.39   0.19   50.9   D
TR       586       3155       0.80   0.19   62.6   E     60.2   E

Northbound
DefL     1030      1641       0.23   0.76   4.9    A
T        1308      1727       0.15   0.76   1.0    A     3.2    A

Southbound

TR       821       3191       0.28   0.26   41.8   D     41.8   D

         Intersection Delay = 37.0  (sec/veh)   Intersection LOS = D

_______________________________________________________________________________
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HCS+: Signalized Intersections Release 5.4

I-290
Existing

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst:
Agency/Co.: PB
Date Performed: 6/25/2010
Analysis Time Period: AM Peak Hour
Intersection: Harrison Street &17th Avenue
Area Type: All other areas
Jurisdiction:
Analysis Year: Existing
Project ID: I-290 Phase 1 Study
E/W St: Harrison Street N/S St: 17th Avenue

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume				114	326	155	230	187			174	106
% Heavy Veh				10	10	10	10	10			10	10
PHF				0.95	0.95	0.95	0.95	0.95			0.95	0.95
PK 15 Vol				30	86	41	61	49			46	28
Hi Ln Vol												
% Grade					0			0			0	
Ideal Sat				1900	1900		1900	1900			1900	
ParkExist												
NumPark												
No. Lanes	0	0	0	1	2	0	0	2	0	0	2	0
LGConfig				L	TR		DefL	T			TR	
Lane Width				12.0	12.0		12.0	12.0			12.0	
RTOR Vol						33						63
Adj Flow				120	471		242	197			228	
%InSharedLn												
Prop LTs					0.000		1.000	0.000			0.000	
Prop RTs					0.272			0.000			0.197	
Peds Bikes	0			0						0		
Buses				0	0		0	0			0	
%InProtPhase							0.0					

Duration 0.25 Area Type: All other areas

OPERATING PARAMETERS

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Init Unmet				0.0	0.0		0.0	0.0			0.0	
Arriv. Type				3	3		3	6			3	
Unit Ext.				3.0	3.0		3.0	3.0			3.0	
I Factor					1.000			0.799			1.000	
Lost Time				2.0	2.0		2.0	2.0			2.0	
Ext of g				3.0	3.0		2.0	3.0			3.0	
Ped Min g		3.2			3.2						3.2	

```
_________________________________PHASE DATA____________________________________

Phase Combination 1     2     3     4 |            5     6     7     8

EB  Left                              | NB  Left   A     A
    Thru                              |     Thru   A     A
    Right                             |     Right
    Peds                              |     Peds

WB  Left          A                   | SB  Left
    Thru          A                   |     Thru         A
    Right         A                   |     Right        A
    Peds                              |     Peds

NB  Right                             | EB  Right
                                      |
SB  Right                             | WB  Right
                                      |
                                      |
Green            25.0                             67.0  35.0
Yellow           4.0                              3.0   4.0
All Red          1.0                              0.0   1.0

                                                    Cycle Length: 140.0   secs

_________________VOLUME ADJUSTMENT AND SATURATION FLOW WORKSHEET_______________
Volume Adjustment
           |  Eastbound    |  Westbound    |  Northbound   |  Southbound   |
           | L    T    R   | L    T    R   | L    T    R   | L    T    R   |
           |_______________|_______________|_______________|_______________|
Volume, V  |               |114  326  155  |230  187       |     174  106  |
PHF        |               |0.95 0.95 0.95 |0.95 0.95      |     0.95 0.95 |
Adj flow   |               |120  343  128  |242  197       |     183  45   |
No. Lanes  |   0   0   0   |   1   2   0   |   0   2   0   |   0   2   0   |
Lane group |               | L     TR      | DefL  T       |       TR      |
Adj flow   |               |120  471       |242  197       |     228       |
Prop LTs   |               |      0.000    |1.000 0.000    |      0.000    |
Prop RTs   |               |   0.272       |   0.000       |   0.197       |

Saturation Flow Rate (see Exhibit 16-7 to determine the adjustment factors)____
         Eastbound         Westbound        Northbound        Southbound
LG                       L     TR          DefL  T                 TR
So                      1900  1900        1900  1900              1900
Lanes 0     0     0     1     2     0     0     2     0     0     2     0
fW                      1.000 1.000       1.000 1.000             1.000
fHV                     0.909 0.909       0.909 0.909             0.909
fG                      1.000 1.000       1.000 1.000             1.000
fP                      1.000 1.000       1.000 1.000             1.000
fBB                     1.000 1.000       1.000 1.000             1.000
fA                      1.000 1.000       1.000 1.000             1.000
fLU                     1.000 0.952       1.000 1.000             0.952
fRT                           0.959             1.000             0.970
fLT                     0.950 1.000       0.950 1.000             1.000
Sec.                                      0.497
fLpb                    1.000 1.000       1.000 1.000             1.000
fRpb                          1.000             1.000             1.000
S                       1641  3155        1641  1727              3191
Sec.                                      858
_________________________CAPACITY AND LOS WORKSHEET____________________________
Capacity Analysis and Lane Group Capacity
```

Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- Capacity (c)	v/c Ratio
Eastbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru							
Right							
Westbound							
Prot							
Perm							
Left	L	120	1641	0.07	0.19	305	0.39
Prot							
Perm							
Thru	TR	471	3155	# 0.15	0.19	586	0.80
Right							
Northbound							
Prot		242	1641	# 0.15	0.479	785	0.31
Perm		0	858	0.00	0.286	245	0.00
Left	DefL	242			0.76	1030	0.23
Prot							
Perm							
Thru	T	197	1727	0.11	0.76	1308	0.15
Right							
Southbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	TR	228	3191	# 0.07	0.26	821	0.28
Right							

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.37
Total lost time per cycle, L = 13.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.41

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	LOS	Approach Delay	LOS
Eastbound												
Westbound												
L	0.39	0.19	50.1	1.000	305	0.11	0.8	0.0	50.9	D		
TR	0.80	0.19	54.6	1.000	586	0.35	8.0	0.0	62.6	E	60.2	E
Northbound												
DefL	0.23	0.76	4.8	1.000	1030	0.11	0.1	0.0	4.9	A		
T	0.15	0.76	4.7	0.206	1308	0.11	0.0	0.0	1.0	A	3.2	A
Southbound												
TR	0.28	0.26	41.6	1.000	821	0.11	0.2	0.0	41.8	D	41.8	D

```
_______________________________________________________________________________
         Intersection delay = 37.0  (sec/veh)   Intersection LOS = D



______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                              for exclusive lefts
Input
                                                       EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                           140.0   sec
Total actual green time for LT lane group, G (s)                   105.0
Effective permitted green time for LT lane group, g(s)             40.0
Opposing effective green time, go (s)                              36.0
Number of lanes in LT lane group, N                                1
Number of lanes in opposing approach, No                           2
Adjusted LT flow rate, VLT (veh/h)                                 242
Proportion of LT in LT lane group, PLT                             1.000
Proportion of LT in opposing flow, PLTo                            0.00
Adjusted opposing flow rate, Vo (veh/h)                            228
Lost time for LT lane group, tL                                    5.00
Computation
LT volume per cycle, LTC=VLTC/3600                                 9.41
Opposing lane util. factor, fLUo                       0.952       0.952 1.000
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)                4.66
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g                              0.0
Opposing platoon ratio, Rpo (refer Exhibit 16-11)                  1.00
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]                       0.74
gq, (see Exhibit C16-4,5,6,7,8)                                    7.41
gu=g-gq if gq>=gf, or = g-gf if gq<gf                              32.59
n=Max(gq-gf)/2,0)                                                  3.71
PTHo=1-PLTo                                                        1.00
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]                                 1.00
EL1 (refer to Exhibit C16-3)                                       1.64
EL2=Max((1-Ptho**n)/Plto, 1.0)
fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g                                 0.10
gdiff=max(gq-gf,0)                                                 0.00
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)                0.50
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
or flt=[fm+0.91(N-1)]/N**
Left-turn adjustment, fLT                                          0.497

For special case of single-lane approach opposed by multilane approach,
see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
  left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach
or when gf>gq, see text.

______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                                for shared lefts
Input
                                                       EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                           140.0   sec
Total actual green time for LT lane group, G (s)
Effective permitted green time for LT lane group, g(s)
Opposing effective green time, go (s)
Number of lanes in LT lane group, N
```

```
Number of lanes in opposing approach, No
Adjusted LT flow rate, VLT (veh/h)
Proportion of LT in LT lane group, PLT                       0.000 0.000 0.000
Proportion of LT in opposing flow, PLTo
Adjusted opposing flow rate, Vo (veh/h)
Lost time for LT lane group, tL
Computation
LT volume per cycle, LTC=VLTC/3600
Opposing lane util. factor, fLUo                       0.952       0.952 1.000
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g
Opposing platoon ratio, Rpo (refer Exhibit 16-11)
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]
gq, (see Exhibit C16-4,5,6,7,8)
gu=g-gq if gq>=gf, or = g-gf if gq<gf
n=Max(gq-gf)/2,0)
PTHo=1-PLTo
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]
EL1 (refer to Exhibit C16-3)
EL2=Max((1-Ptho**n)/Plto, 1.0)
fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g
gdiff=max(gq-gf,0)
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
or flt=[fm+0.91(N-1)]/N**
Left-turn adjustment, fLT

For special case of single-lane approach opposed by multilane approach,
see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
  left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach
or when gf>gq, see text.

_______________SUPPLEMENTAL PEDESTRIAN-BICYCLE EFFECTS WORKSHEET_______________
Permitted Left Turns
                                                       EB    WB    NB    SB
Effective pedestrian green time, gp (s)
Conflicting pedestrian volume, Vped (p/h)
Pedestrian flow rate, Vpedg (p/h)
OCCpedg
Opposing queue clearing green, gq (s)
Eff. ped. green consumed by opp. veh. queue, gq/gp
OCCpedu
Opposing flow rate, Vo (veh/h)
OCCr
Number of cross-street receiving lanes, Nrec
Number of turning lanes, Nturn
ApbT
Proportion of left turns, PLT
Proportion of left turns using protected phase, PLTA
Left-turn adjustment, fLpb
Permitted Right Turns
Effective pedestrian green time, gp (s)
Conflicting pedestrian volume, Vped (p/h)
Conflicting bicycle volume, Vbic (bicycles/h)
Vpedg
OCCpedg
Effective green, g (s)
Vbicg
```

OCCbicg
OCCr
Number of cross-street receiving lanes, Nrec
Number of turning lanes, Nturn
ApbT
Proportion right-turns, PRT
Proportion right-turns using protected phase, PRTA
Right turn adjustment, fRpb

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

		EBLT	WBLT	NBLT	SBLT
Cycle length, C	140.0 sec				
Adj. LT vol from Vol Adjustment Worksheet, v				242	
v/c ratio from Capacity Worksheet, X				0.23	
Protected phase effective green interval, g (s)				67.0	
Opposing queue effective green interval, gq				7.41	
Unopposed green interval, gu				32.59	
Red time r=(C-g-gq-gu)				33.0	
Arrival rate, qa=v/(3600(max[X,1.0]))				0.07	
Protected ph. departure rate, Sp=s/3600				0.456	
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)				0.29	
XPerm				0.28	
XProt				0.22	
Case				1	
Queue at beginning of green arrow, Qa				2.22	
Queue at beginning of unsaturated green, Qu				0.50	
Residual queue, Qr				0.00	
Uniform Delay, d1				4.8	

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
	0.0						0.0	
	0.0						0.0	
	0.0						0.0	
Westbound								
L	0.0	0.00	57.0	50.1	0.00	0.0	0.0	50.9
TR	0.0	0.00	57.0	54.6	0.00	0.0	0.0	62.6
	0.0						0.0	
Northbound								
DefL	0.0	0.00		4.8	0.00	0.0	0.0	4.9
T	0.0	0.00	17.0	4.7	0.00	0.0	0.0	1.0
	0.0						0.0	
Southbound								
	0.0						0.0	
TR	0.0	0.00	52.0	41.6	0.00	0.0	0.0	41.8
	0.0						0.0	

Intersection Delay 37.0 sec/veh Intersection LOS D

BACK OF QUEUE WORKSHEET

	Eastbound			Westbound			Northbound			Southbound		
LaneGroup				L	TR		DefL	T			TR	
Init Queue				0.0	0.0		0.0	0.0			0.0	
Flow Rate				120	247		242	197			119	
So				1900	1900		1900	1900			1900	
No.Lanes	0	0	0	1	2	0	0	2	0	0	2	0
SL				1641	1657		1348	1727			1675	
LnCapacity				305	307		1030	1308			431	
Flow Ratio				0.1	0.1		0.2	0.1			0.1	
v/c Ratio				0.39	0.80		0.23	0.15			0.28	
Grn Ratio				0.19	0.19		0.76	0.76			0.26	
I Factor					1.000			0.799			1.000	
AT or PVG				3	3		3	6			3	
Pltn Ratio				1.00	1.00		1.00	1.25			1.00	
PF2				1.00	1.00		1.00	0.21			1.00	
Q1				4.1	9.2		2.5	0.4			3.7	
kB				0.4	0.4		0.7	0.8			0.5	
Q2				0.3	1.5		0.2	0.1			0.2	
Q Average				4.4	10.7		2.7	0.6			3.9	
Q Spacing				25.0	25.0		25.0	25.0			25.0	
Q Storage				0	0		0	0			0	
Q S Ratio												
70th Percentile Output:												
fB%				1.2	1.2		1.2	1.2			1.2	
BOQ				5.2	12.6		3.2	0.7			4.7	
QSRatio												
85th Percentile Output:												
fB%				1.6	1.5		1.6	1.6			1.6	
BOQ				6.8	16.2		4.3	1.0			6.1	
QSRatio												
90th Percentile Output:												
fB%				1.7	1.6		1.7	1.8			1.7	
BOQ				7.5	17.5		4.8	1.1			6.8	
QSRatio												
95th Percentile Output:												
fB%				2.0	1.8		2.0	2.1			2.0	
BOQ				8.6	19.6		5.5	1.2			7.7	
QSRatio												
98th Percentile Output:												
fB%				2.4	2.1		2.5	2.7			2.4	
BOQ				10.6	22.9		6.8	1.6			9.5	
QSRatio												

ERROR MESSAGES

No errors to report.

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                    HCS+: Signalized Intersections Release 5.4

Analyst:                                Inter.: Harrison Street & 17th Avenue
Agency: PB                              Area Type: All other areas
Date:   6/25/2010                       Jurisd:
Period: PM Peak Hour                    Year  : Existing
Project ID: I-290 Phase 1 Study
E/W St: Harrison Street                 N/S St: 17th Avenue

_________________________SIGNALIZED INTERSECTION SUMMARY_______________________
           |  Eastbound     |  Westbound     |  Northbound    |  Southbound    |
           | L    T    R    | L    T    R    | L    T    R    | L    T    R    |
           |________________|________________|________________|________________|
No. Lanes  |   0    0    0  |   1    2    0  |   0    2    0  |   0    2    0  |
LGConfig   |                | L     TR       | DefL  T        |       TR       |
Volume     |                |153  314  129   |191  300        |     335  105   |
Lane Width |                |12.0 12.0       |12.0 12.0       |     12.0       |
RTOR Vol   |                |          52    |                |          18    |
_______________________________________________________________________________
Duration    0.25      Area Type: All other areas
______________________________Signal Operations________________________________
Phase Combination 1     2     3     4 |          5     6     7     8
EB  Left                              | NB  Left    A     A
    Thru                              |     Thru    A     A
    Right                             |     Right
    Peds                              |     Peds
WB  Left           A                  | SB  Left
    Thru           A                  |     Thru          A
    Right          A                  |     Right         A
    Peds                              |     Peds
NB  Right                             | EB  Right
SB  Right                             | WB  Right
Green            25.0                            67.0  35.0
Yellow           4.0                             3.0   4.0
All Red          1.0                             0.0   1.0
                                                  Cycle Length: 140.0   secs
____________________Intersection Performance Summary___________________________
Appr/   Lane       Adj Sat     Ratios        Lane Group   Approach
Lane    Group      Flow Rate   __________    __________   __________
Grp     Capacity     (s)       v/c    g/C    Delay LOS    Delay LOS
_______________________________________________________________________________
Eastbound



Westbound
L        305       1641       0.53   0.19    53.2   D
TR       406       2184       1.01   0.19    105.4  F     90.8   F

Northbound
DefL     934       1641       0.22   0.76    5.6    A
T        1308      1727       0.24   0.76    1.1    A     2.9    A

Southbound

TR       820       3187       0.54   0.26    45.6   D     45.6   D

         Intersection Delay = 48.1  (sec/veh)   Intersection LOS = D

_______________________________________________________________________________
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HCS+: Signalized Intersections Release 5.4

I-290
Existing

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst:
Agency/Co.: PB
Date Performed: 6/25/2010
Analysis Time Period: PM Peak Hour
Intersection: Harrison Street & 17th Avenue
Area Type: All other areas
Jurisdiction:
Analysis Year: Existing
Project ID: I-290 Phase 1 Study
E/W St: Harrison Street N/S St: 17th Avenue

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume				153	314	129	191	300			335	105
% Heavy Veh				10	10	10	10	10			10	10
PHF				0.95	0.95	0.95	0.95	0.95			0.95	0.95
PK 15 Vol				40	83	34	50	79			88	28
Hi Ln Vol												
% Grade					0			0			0	
Ideal Sat				1900	1300		1900	1900			1900	
ParkExist												
NumPark												
No. Lanes	0	0	0	1	2	0	0	2	0	0	2	0
LGConfig				L	TR		DefL	T			TR	
Lane Width				12.0	12.0		12.0	12.0			12.0	
RTOR Vol						52						18
Adj Flow				161	412		201	316			445	
%InSharedLn												
Prop LTs					0.000		1.000	0.000			0.000	
Prop RTs					0.197			0.000			0.207	
Peds Bikes	0			0						0		
Buses				0	0		0	0			0	
%InProtPhase							0.0					

Duration 0.25 Area Type: All other areas

OPERATING PARAMETERS

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Init Unmet				0.0	0.0		0.0	0.0			0.0	
Arriv. Type				3	3		3	6			3	
Unit Ext.				3.0	3.0		3.0	3.0			3.0	
I Factor					1.000			0.796			1.000	
Lost Time				2.0	2.0		2.0	2.0			2.0	
Ext of g				3.0	3.0		2.0	3.0			3.0	
Ped Min g		3.2			3.2						3.2	

PHASE DATA

Phase Combination		1	2	3	4			5	6	7	8
EB	Left					NB	Left	A	A		
	Thru						Thru	A	A		
	Right						Right				
	Peds						Peds				
WB	Left	A				SB	Left				
	Thru	A					Thru		A		
	Right	A					Right		A		
	Peds						Peds				
NB	Right					EB	Right				
SB	Right					WB	Right				
Green		25.0						67.0	35.0		
Yellow		4.0						3.0	4.0		
All Red		1.0						0.0	1.0		

Cycle Length: 140.0 secs

VOLUME ADJUSTMENT AND SATURATION FLOW WORKSHEET

Volume Adjustment

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume, V				153	314	129	191	300			335	105
PHF				0.95	0.95	0.95	0.95	0.95			0.95	0.95
Adj flow				161	331	81	201	316			353	92
No. Lanes	0	0	0	1	2	0	0	2	0	0	2	0
Lane group				L	TR		DefL	T			TR	
Adj flow				161	412		201	316			445	
Prop LTs					0.000		1.000	0.000			0.000	
Prop RTs				0.197			0.000			0.207		

Saturation Flow Rate (see Exhibit 16-7 to determine the adjustment factors)

	Eastbound			Westbound			Northbound			Southbound		
LG				L	TR		DefL	T			TR	
So				1900	1300		1900	1900			1900	
Lanes	0	0	0	1	2	0	0	2	0	0	2	0
fW				1.000	1.000		1.000	1.000			1.000	
fHV				0.909	0.909		0.909	0.909			0.909	
fG				1.000	1.000		1.000	1.000			1.000	
fP				1.000	1.000		1.000	1.000			1.000	
fBB				1.000	1.000		1.000	1.000			1.000	
fA				1.000	1.000		1.000	1.000			1.000	
fLU				1.000	0.952		1.000	1.000			0.952	
fRT					0.971			1.000			0.969	
fLT				0.950	1.000		0.950	1.000			1.000	
Sec.							0.303					
fLpb				1.000	1.000		1.000	1.000			1.000	
fRpb					1.000			1.000			1.000	
S				1641	2184		1641	1727			3187	
Sec.							523					

CAPACITY AND LOS WORKSHEET

Capacity Analysis and Lane Group Capacity

Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- Capacity (c)	v/c Ratio
Eastbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru							
Right							
Westbound							
Prot							
Perm							
Left	L	161	1641	0.10	0.19	305	0.53
Prot							
Perm							
Thru	TR	412	2184	# 0.19	0.19	406	1.01
Right							
Northbound							
Prot		201	1641	0.12	0.479	785	0.26
Perm		0	523	0.00	0.286	149	0.00
Left	DefL	201			0.76	934	0.22
Prot							
Perm							
Thru	T	316	1727	# 0.18	0.76	1308	0.24
Right							
Southbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	TR	445	3187	# 0.14	0.26	820	0.54
Right							

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.51
Total lost time per cycle, L = 12.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.56

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	LOS	Approach Delay	LOS
Eastbound												
Westbound												
L	0.53	0.19	51.5	1.000	305	0.13	1.7	0.0	53.2	D		
TR	1.01	0.19	57.0	1.000	406	0.50	48.4	0.0	105.4	F	90.8	F
Northbound												
DefL	0.22	0.76	5.6	1.000	934	0.11	0.1	0.0	5.6	A		
T	0.24	0.76	5.1	0.206	1308	0.11	0.1	0.0	1.1	A	2.9	A
Southbound												
TR	0.54	0.26	44.9	1.000	820	0.14	0.7	0.0	45.6	D	45.6	D

Intersection delay = 48.1 (sec/veh) Intersection LOS = D

SUPPLEMENTAL PERMITTED LT WORKSHEET

for exclusive lefts

Input

	EB	WB	NB	SB
Opposed by Single(S) or Multiple(M) lane approach				
Cycle length, C 140.0 sec				
Total actual green time for LT lane group, G (s)			105.0	
Effective permitted green time for LT lane group, g(s)			40.0	
Opposing effective green time, go (s)			36.0	
Number of lanes in LT lane group, N			1	
Number of lanes in opposing approach, No			2	
Adjusted LT flow rate, VLT (veh/h)			201	
Proportion of LT in LT lane group, PLT			1.000	
Proportion of LT in opposing flow, PLTo			0.00	
Adjusted opposing flow rate, Vo (veh/h)			445	
Lost time for LT lane group, tL			5.00	
Computation				
LT volume per cycle, LTC=VLTC/3600			7.82	
Opposing lane util. factor, fLUo	0.952		0.952	1.000
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)			9.09	
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g			0.0	
Opposing platoon ratio, Rpo (refer Exhibit 16-11)			1.00	
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]			0.74	
gq, (see Exhibit C16-4,5,6,7,8)			15.52	
gu=g-gq if gq>=gf, or = g-gf if gq<gf			24.48	
n=Max(gq-gf)/2,0)			7.76	
PTHo=1-PLTo			1.00	
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]			1.00	
EL1 (refer to Exhibit C16-3)			2.02	
EL2=Max((1-Ptho**n)/Plto, 1.0)				
fmin=2(1+PL)/g or fmin=2(1+Pl)/g			0.10	
gdiff=max(gq-gf,0)			0.00	
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)			0.30	
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)				
or flt=[fm+0.91(N-1)]/N**				
Left-turn adjustment, fLT			0.303	

For special case of single-lane approach opposed by multilane approach, see text.

* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto left-turn lane and redo calculations.

** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.

For special case of multilane approach opposed by single-lane approach or when gf>gq, see text.

SUPPLEMENTAL PERMITTED LT WORKSHEET

for shared lefts

Input

	EB	WB	NB	SB
Opposed by Single(S) or Multiple(M) lane approach				
Cycle length, C 140.0 sec				
Total actual green time for LT lane group, G (s)				
Effective permitted green time for LT lane group, g(s)				
Opposing effective green time, go (s)				
Number of lanes in LT lane group, N				

```
Number of lanes in opposing approach, No
Adjusted LT flow rate, VLT (veh/h)
Proportion of LT in LT lane group, PLT                       0.000 0.000 0.000
Proportion of LT in opposing flow, PLTo
Adjusted opposing flow rate, Vo (veh/h)
Lost time for LT lane group, tL
Computation
LT volume per cycle, LTC=VLTC/3600
Opposing lane util. factor, fLUo                       0.952       0.952 1.000
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g
Opposing platoon ratio, Rpo (refer Exhibit 16-11)
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]
gq, (see Exhibit C16-4,5,6,7,8)
gu=g-gq if gq>=gf, or = g-gf if gq<gf
n=Max(gq-gf)/2,0)
PTHo=1-PLTo
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]
EL1 (refer to Exhibit C16-3)
EL2=Max((1-Ptho**n)/Plto, 1.0)
fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g
gdiff=max(gq-gf,0)
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
or flt=[fm+0.91(N-1)]/N**
Left-turn adjustment, fLT

For special case of single-lane approach opposed by multilane approach,
see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
  left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach
or when gf>gq, see text.

_______________SUPPLEMENTAL PEDESTRIAN-BICYCLE EFFECTS WORKSHEET_______________
Permitted Left Turns
                                                       EB    WB    NB    SB
Effective pedestrian green time, gp (s)
Conflicting pedestrian volume, Vped (p/h)
Pedestrian flow rate, Vpedg (p/h)
OCCpedg
Opposing queue clearing green, gq (s)
Eff. ped. green consumed by opp. veh. queue, gq/gp
OCCpedu
Opposing flow rate, Vo (veh/h)
OCCr
Number of cross-street receiving lanes, Nrec
Number of turning lanes, Nturn
ApbT
Proportion of left turns, PLT
Proportion of left turns using protected phase, PLTA
Left-turn adjustment, fLpb
Permitted Right Turns
Effective pedestrian green time, gp (s)
Conflicting pedestrian volume, Vped (p/h)
Conflicting bicycle volume, Vbic (bicycles/h)
Vpedg
OCCpedg
Effective green, g (s)
Vbicg
```

OCCbicg
OCCr
Number of cross-street receiving lanes, Nrec
Number of turning lanes, Nturn
ApbT
Proportion right-turns, PRT
Proportion right-turns using protected phase, PRTA
Right turn adjustment, fRpb

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

		EBLT	WBLT	NBLT	SBLT
Cycle length, C	140.0 sec				
Adj. LT vol from Vol Adjustment Worksheet, v				201	
v/c ratio from Capacity Worksheet, X				0.22	
Protected phase effective green interval, g (s)				67.0	
Opposing queue effective green interval, gq				15.52	
Unopposed green interval, gu				24.48	
Red time r=(C-g-gq-gu)				33.0	
Arrival rate, qa=v/(3600(max[X,1.0]))				0.06	
Protected ph. departure rate, Sp=s/3600				0.456	
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)				0.24	
XPerm				0.38	
XProt				0.18	
Case				1	
Queue at beginning of green arrow, Qa				1.84	
Queue at beginning of unsaturated green, Qu				0.87	
Residual queue, Qr				0.00	
Uniform Delay, d1				5.6	

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
	0.0						0.0	
	0.0						0.0	
	0.0						0.0	
Westbound								
L	0.0	0.00	57.0	51.5	0.00	0.0	0.0	53.2
TR	0.0	0.00	57.0	57.0	0.00	1.5	0.0	105.4
	0.0						0.0	
Northbound								
DefL	0.0	0.00		5.6	0.00	0.0	0.0	5.6
T	0.0	0.00	17.0	5.1	0.00	0.0	0.0	1.1
	0.0						0.0	
Southbound								
	0.0						0.0	
TR	0.0	0.00	52.0	44.9	0.00	0.0	0.0	45.6
	0.0						0.0	

Intersection Delay 48.1 sec/veh Intersection LOS D

BACK OF QUEUE WORKSHEET

	Eastbound			Westbound			Northbound			Southbound		
LaneGroup				L	TR		DefL	T			TR	
Init Queue				0.0	0.0		0.0	0.0			0.0	
Flow Rate				161	216		201	316			233	
So				1900	1300		1900	1900			1900	
No.Lanes	0	0	0	1	2	0	0	2	0	0	2	0
SL				1641	1147		1223	1727			1673	
LnCapacity				305	213		934	1308			430	
Flow Ratio				0.1	0.2		0.2	0.2			0.1	
v/c Ratio				0.53	1.01		0.22	0.24			0.54	
Grn Ratio				0.19	0.19		0.76	0.76			0.26	
I Factor					1.000			0.796			1.000	
AT or PVG				3	3		3	6			3	
Pltn Ratio				1.00	1.00		1.00	1.25			1.00	
PF2				1.00	1.00		1.00	0.22			1.00	
Q1				5.7	8.4		2.1	0.8			7.8	
kB				0.4	0.4		0.7	0.8			0.5	
Q2				0.5	3.3		0.2	0.3			0.6	
Q Average				6.1	11.7		2.2	1.1			8.4	
Q Spacing				25.0	25.0		25.0	25.0			25.0	
Q Storage				0	0		0	0			0	
Q S Ratio												
70th Percentile Output:												
fB%				1.2	1.2		1.2	1.2			1.2	
BOQ				7.3	13.7		2.7	1.3			10.0	
QSRatio												
85th Percentile Output:												
fB%				1.5	1.5		1.6	1.6			1.5	
BOQ				9.5	17.6		3.5	1.7			12.9	
QSRatio												
90th Percentile Output:												
fB%				1.7	1.6		1.8	1.8			1.7	
BOQ				10.4	19.0		3.9	1.9			14.0	
QSRatio												
95th Percentile Output:												
fB%				1.9	1.8		2.0	2.1			1.9	
BOQ				11.8	21.2		4.5	2.2			15.8	
QSRatio												
98th Percentile Output:												
fB%				2.3	2.1		2.5	2.6			2.2	
BOQ				14.3	24.6		5.7	2.8			18.8	
QSRatio												

ERROR MESSAGES

No errors to report.

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                   HCS+: Unsignalized Intersections Release 5.4







Phone:                                          Fax:
E-Mail:

___________________ALL-WAY STOP CONTROL(AWSC) ANALYSIS________________________

Analyst:
Agency/Co.:            PB
Date Performed:        6/25/2010
Analysis Time Period: AM Peak Hour
Intersection:          Harrison Street & 9th Avenue
Jurisdiction:
Units: U. S. Customary
Analysis Year:         Existing
Project ID:  I-290 Phase 1 Study
East/West Street:      Harrison Street
North/South Street:    9th Avenue
_________Worksheet 2 - Volume Adjustments and Site Characteristics____________

           |  Eastbound     |  Westbound     |  Northbound    |  Southbound    |
           | L    T    R    | L    T    R    | L    T    R    | L    T    R    |
           |________________|________________|________________|________________|
Volume     |0    0    0     |49   80   52    |53   304  0     |0    314  41    |
% Thrus Left Lane                        50             50             50


                    Eastbound      Westbound     Northbound     Southbound
                    L1     L2      L1     L2      L1     L2      L1     L2

Configuration                      LT     TR     LT     T       T      TR
PHF                                0.95   0.95   0.95   0.95    0.95   0.95
Flow Rate                          93     96     215    160     165    208
% Heavy Veh                        10     10     10     10      10     10
No. Lanes                               2              2              2
Opposing-Lanes                          0              2              2
Conflicting-lanes                       2              2              2
Geometry group                          1              5              5
Duration, T   0.25  hrs.

___________Worksheet 3 - Saturation Headway Adjustment Worksheet______________

                    Eastbound      Westbound     Northbound     Southbound
                    L1     L2      L1     L2      L1     L2      L1     L2

Flow Rates:
   Total in Lane                   93     96     215    160     165    208
   Left-Turn                       51     0      55     0       0      0
   Right-Turn                      0      54     0      0       0      43
Prop. Left-Turns                   0.5    0.0    0.3    0.0     0.0    0.0
Prop. Right-Turns                  0.0    0.6    0.0    0.0     0.0    0.2
Prop. Heavy Vehicle                0.1    0.1    0.1    0.1     0.1    0.1
Geometry Group                          1              5              5
Adjustments Exhibit 17-33:
   hLT-adj                              0.2            0.5            0.5
```

hRT-adj			-0.6		-0.7		-0.7	
hHV-adj			1.7		1.7		1.7	
hadj, computed			0.3	-0.2	0.3	0.2	0.2	0.0

Worksheet 4 - Departure Headway and Service Time

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow rate			93	96	215	160	165	208
hd, initial value	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20
x, initial			0.08	0.09	0.19	0.14	0.15	0.18
hd, final value			5.87	5.42	5.77	5.64	5.66	5.51
x, final value			0.15	0.14	0.34	0.25	0.26	0.32
Move-up time, m			2.0		2.3		2.3	
Service Time			3.9	3.4	3.5	3.3	3.4	3.2

Worksheet 5 - Capacity and Level of Service

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rate			93	96	215	160	165	208
Service Time			3.9	3.4	3.5	3.3	3.4	3.2
Utilization, x			0.15	0.14	0.34	0.25	0.26	0.32
Dep. headway, hd			5.87	5.42	5.77	5.64	5.66	5.51
Capacity			343	346	465	410	415	458
Delay			9.92	9.34	11.48	10.22	10.32	10.76
LOS			A	A	B	B	B	B
Approach:								
Delay			9.62		10.94		10.57	
LOS			A		B		B	

Intersection Delay 10.53 Intersection LOS B

HCS+: Unsignalized Intersections Release 5.4

Phone: Fax:
E-Mail:

ALL-WAY STOP CONTROL(AWSC) ANALYSIS

Analyst:
Agency/Co.: PB
Date Performed: 6/25/2010
Analysis Time Period: PM Peak Hour
Intersection: Harrison Street & 9th Avenue
Jurisdiction:
Units: U. S. Customary
Analysis Year: Existing
Project ID: I-290 Phase 1 Study
East/West Street: Harrison Street
North/South Street: 9th Avenue

Worksheet 2 - Volume Adjustments and Site Characteristics

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	0	0	0	111	68	118	41	360	0	0	574	75
% Thrus Left Lane						50			50			50

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Configuration			LT	TR	LT	T	T	TR
PHF			0.95	0.95	0.95	0.95	0.95	0.95
Flow Rate			151	159	232	189	302	380
% Heavy Veh			10	10	10	10	10	10
No. Lanes			2		2		2	
Opposing-Lanes			0		2		2	
Conflicting-lanes			2		2		2	
Geometry group			1		5		5	

Duration, T 0.25 hrs.

Worksheet 3 - Saturation Headway Adjustment Worksheet

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rates:								
Total in Lane			151	159	232	189	302	380
Left-Turn			116	0	43	0	0	0
Right-Turn			0	124	0	0	0	78
Prop. Left-Turns			0.8	0.0	0.2	0.0	0.0	0.0
Prop. Right-Turns			0.0	0.8	0.0	0.0	0.0	0.2
Prop. Heavy Vehicle			0.1	0.1	0.1	0.1	0.1	0.1
Geometry Group			1		5		5	
Adjustments Exhibit 17-33:								
hLT-adj			0.2		0.5		0.5	

	Eastbound L1	Eastbound L2	Westbound L1	Westbound L2	Northbound L1	Northbound L2	Southbound L1	Southbound L2
hRT-adj			-0.6		-0.7		-0.7	
hHV-adj			1.7		1.7		1.7	
hadj, computed			0.3	-0.3	0.3	0.2	0.2	0.0

Worksheet 4 - Departure Headway and Service Time

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow rate			151	159	232	189	302	380
hd, initial value	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20
x, initial			0.13	0.14	0.21	0.17	0.27	0.34
hd, final value			6.61	5.99	6.69	6.59	6.27	6.13
x, final value			0.28	0.26	0.43	0.35	0.53	0.65
Move-up time, m			2.0		2.3		2.3	
Service Time			4.6	4.0	4.4	4.3	4.0	3.8

Worksheet 5 - Capacity and Level of Service

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rate			151	159	232	189	302	380
Service Time			4.6	4.0	4.4	4.3	4.0	3.8
Utilization, x			0.28	0.26	0.43	0.35	0.53	0.65
Dep. headway, hd			6.61	5.99	6.69	6.59	6.27	6.13
Capacity			401	409	482	439	552	581
Delay			12.13	11.13	14.35	12.74	15.72	19.35
LOS			B	B	B	B	C	C
Approach:								
Delay			11.62		13.63		17.74	
LOS			B		B		C	

Intersection Delay 15.17 Intersection LOS C

HCS+: Unsignalized Intersections Release 5.4

Phone: Fax:
E-Mail:

ALL-WAY STOP CONTROL(AWSC) ANALYSIS

Analyst:
Agency/Co.: PB
Date Performed: 6/25/2010
Analysis Time Period: AM Peak Hour
Intersection: Bataan Drive & 9th Avenue
Jurisdiction:
Units: U. S. Customary
Analysis Year: Existing
Project ID: I-290 Phase 1 Study
East/West Street: Bataan Drive
North/South Street: 9th Avenue

Worksheet 2 - Volume Adjustments and Site Characteristics

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	34	59	4	0	0	0	0	324	145	188	176	0
% Thrus Left Lane	50						50			50		

	Eastbound L1	Eastbound L2	Westbound L1	Westbound L2	Northbound L1	Northbound L2	Southbound L1	Southbound L2
Configuration	LT	TR			T	TR	LT	T
PHF	0.95	0.95			0.95	0.95	0.95	0.95
Flow Rate	65	35			170	322	289	92
% Heavy Veh	10	10			10	10	10	10
No. Lanes	2				2		2	
Opposing-Lanes	0				2		2	
Conflicting-lanes	2				2		2	
Geometry group	1				5		5	

Duration, T 0.25 hrs.

Worksheet 3 - Saturation Headway Adjustment Worksheet

	Eastbound L1	Eastbound L2	Westbound L1	Westbound L2	Northbound L1	Northbound L2	Southbound L1	Southbound L2
Flow Rates:								
Total in Lane	65	35			170	322	289	92
Left-Turn	35	0			0	0	197	0
Right-Turn	0	4			0	152	0	0
Prop. Left-Turns	0.5	0.0			0.0	0.0	0.7	0.0
Prop. Right-Turns	0.0	0.1			0.0	0.5	0.0	0.0
Prop. Heavy Vehicle	0.1	0.1			0.1	0.1	0.1	0.1
Geometry Group	1				5		5	
Adjustments Exhibit 17-33:								
hLT-adj	0.2				0.5		0.5	

hRT-adj	-0.6				-0.7		-0.7	
hHV-adj	1.7				1.7		1.7	
hadj, computed	0.3	0.1			0.2	-0.2	0.5	0.2

Worksheet 4 - Departure Headway and Service Time

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow rate	65	35			170	322	289	92
hd, initial value	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20
x, initial	0.06	0.03			0.15	0.29	0.26	0.08
hd, final value	6.07	5.89			5.39	5.06	5.81	5.47
x, final value	0.11	0.06			0.25	0.45	0.47	0.14
Move-up time, m	2.0				2.3		2.3	
Service Time	4.1	3.9			3.1	2.8	3.5	3.2

Worksheet 5 - Capacity and Level of Service

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rate	65	35			170	322	289	92
Service Time	4.1	3.9			3.1	2.8	3.5	3.2
Utilization, x	0.11	0.06			0.25	0.45	0.47	0.14
Dep. headway, hd	6.07	5.89			5.39	5.06	5.81	5.47
Capacity	315	285			420	572	539	342
Delay	9.82	9.25			9.92	11.86	13.50	9.06
LOS	A	A			A	B	B	A
Approach:								
Delay	9.62				11.19		12.42	
LOS	A				B		B	

Intersection Delay 11.51 Intersection LOS B

HCS+: Unsignalized Intersections Release 5.4

Phone: Fax:
E-Mail:

ALL-WAY STOP CONTROL(AWSC) ANALYSIS

Analyst:
Agency/Co.: PB
Date Performed: 6/25/2010
Analysis Time Period: PM Peak Hour
Intersection: Bataan Drive & 9th Avenue
Jurisdiction:
Units: U. S. Customary
Analysis Year: Existing
Project ID: I-290 Phase 1 Study
East/West Street: Bataan Drive
North/South Street: 9th Avenue

Worksheet 2 - Volume Adjustments and Site Characteristics

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	31	57	45	0	0	0	0	372	203	288	398	0
% Thrus Left Lane		50						50			50	

	Eastbound L1	Eastbound L2	Westbound L1	Westbound L2	Northbound L1	Northbound L2	Southbound L1	Southbound L2
Configuration	LT	TR			T	TR	LT	T
PHF	0.95	0.95			0.95	0.95	0.95	0.95
Flow Rate	61	77			195	408	512	209
% Heavy Veh	10	10			10	10	10	10
No. Lanes	2				2		2	
Opposing-Lanes	0				2		2	
Conflicting-lanes	2				2		2	
Geometry group	1				5		5	

Duration, T 0.25 hrs.

Worksheet 3 - Saturation Headway Adjustment Worksheet

	Eastbound L1	Eastbound L2	Westbound L1	Westbound L2	Northbound L1	Northbound L2	Southbound L1	Southbound L2
Flow Rates:								
Total in Lane	61	77			195	408	512	209
Left-Turn	32	0			0	0	303	0
Right-Turn	0	47			0	213	0	0
Prop. Left-Turns	0.5	0.0			0.0	0.0	0.6	0.0
Prop. Right-Turns	0.0	0.6			0.0	0.5	0.0	0.0
Prop. Heavy Vehicle	0.1	0.1			0.1	0.1	0.1	0.1
Geometry Group	1				5		5	
Adjustments Exhibit 17-33:								
hLT-adj	0.2				0.5		0.5	

	Eastbound L1	Eastbound L2	Westbound L1	Westbound L2	Northbound L1	Northbound L2	Southbound L1	Southbound L2
hRT-adj	-0.6				-0.7		-0.7	
hHV-adj	1.7				1.7		1.7	
hadj, computed	0.3	-0.2			0.2	-0.2	0.5	0.2

Worksheet 4 - Departure Headway and Service Time

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow rate	61	77			195	408	512	209
hd, initial value	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20
x, initial	0.05	0.07			0.17	0.36	0.46	0.19
hd, final value	6.87	6.40			6.05	5.68	6.16	5.86
x, final value	0.12	0.14			0.33	0.64	0.88	0.34
Move-up time, m	2.0				2.3		2.3	
Service Time	4.9	4.4			3.7	3.4	3.9	3.6

Worksheet 5 - Capacity and Level of Service

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rate	61	77			195	408	512	209
Service Time	4.9	4.4			3.7	3.4	3.9	3.6
Utilization, x	0.12	0.14			0.33	0.64	0.88	0.34
Dep. headway, hd	6.87	6.40			6.05	5.68	6.16	5.86
Capacity	311	327			445	625	583	459
Delay	10.78	10.41			11.67	18.05	37.49	11.55
LOS	B	B			B	C	E	B
Approach:								
Delay	10.57				15.99		29.97	
LOS	B				C		D	

Intersection Delay 22.37 Intersection LOS C

HCS+: Signalized Intersections Release 5.4

Analyst:
Agency: PB
Date: 6/25/2010
Period: AM Peak Hour
Project ID: I-290 Phase 1 Study
E/W St: Harrison Street

Inter.: Harrison Street & 1st Avenue
Area Type: All other areas
Jurisd:
Year : Existing
N/S St: 1st Avenue

SIGNALIZED INTERSECTION SUMMARY

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	0	0	0	1	1	2	0	2	0	0	2	0
LGConfig				L	LT	R		LT			TR	
Volume				98	56	426	384	583			866	174
Lane Width				10.0	10.0	10.0		12.0			10.0	
RTOR Vol						0						7

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination		1	2	3	4			5	6	7	8
EB	Left					NB	Left	A			
	Thru						Thru	A			
	Right						Right				
	Peds						Peds				
WB	Left	A				SB	Left				
	Thru	A					Thru		A		
	Right	A					Right		A		
	Peds						Peds				
NB	Right					EB	Right				
SB	Right					WB	Right		A		
Green		30.0						90.0	65.0		
Yellow		4.0						4.0	4.0		
All Red		1.0						1.0	1.0		

Cycle Length: 200.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
Westbound								
L	237	1532	0.32	0.16	75.9	E		
LT	246	1587	0.35	0.16	76.4	E	42.4	D
R	1225	2425	0.37	0.50	30.2	C		
Northbound								
LT	1467	3225	0.69	0.46	7.9	A	7.9	A
Southbound								
TR	988	2995	1.10	0.33	127.5	F	127.5	F

Intersection Delay = 63.5 (sec/veh) Intersection LOS = E

HCS+: Signalized Intersections Release 5.4

I-290
Existing

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst:
Agency/Co.: PB
Date Performed: 6/25/2010
Analysis Time Period: AM Peak Hour
Intersection: Harrison Street & 1st Avenue
Area Type: All other areas
Jurisdiction:
Analysis Year: Existing
Project ID: I-290 Phase 1 Study
E/W St: Harrison Street N/S St: 1st Avenue

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume				98	56	426	384	583			866	174
% Heavy Veh				10	10	10	10	10			10	10
PHF				0.95	0.95	0.95	0.95	0.95			0.95	0.95
PK 15 Vol				26	15	112	101	153			228	46
Hi Ln Vol												
% Grade					0			0			0	
Ideal Sat				1900	1900	1900		1900			1900	
ParkExist												
NumPark												
No. Lanes	0	0	0	1	1	2	0	2	0	0	2	0
LGConfig				L	LT	R		LT			TR	
Lane Width				10.0	10.0	10.0		12.0			10.0	
RTOR Vol						0						7
Adj Flow				75	87	448		1018			1088	
%InSharedLn				27								
Prop LTs					0.320			0.397			0.000	
Prop RTs					0.000	1.000		0.000			0.162	
Peds Bikes	0			0						0		
Buses				0	0	0		0			0	
%InProtPhase												

Duration 0.25 Area Type: All other areas

OPERATING PARAMETERS

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Init Unmet				0.0	0.0	0.0		0.0			0.0	
Arriv. Type				3	3	3		6			3	
Unit Ext.				3.0	3.0	3.0		3.0			3.0	
I Factor					1.000			0.479			1.000	
Lost Time				2.0	2.0	2.0		2.0			2.0	
Ext of g				3.0	3.0	3.0		3.0			3.0	
Ped Min g		3.2			3.2						3.2	

PHASE DATA

Phase Combination		1	2	3	4			5	6	7	8
EB	Left					NB	Left	A			
	Thru						Thru	A			
	Right						Right				
	Peds						Peds				
WB	Left	A				SB	Left				
	Thru	A					Thru		A		
	Right	A					Right		A		
	Peds						Peds				
NB	Right					EB	Right				
SB	Right					WB	Right		A		
Green		30.0						90.0	65.0		
Yellow		4.0						4.0	4.0		
All Red		1.0						1.0	1.0		

Cycle Length: 200.0 secs

VOLUME ADJUSTMENT AND SATURATION FLOW WORKSHEET

Volume Adjustment

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume, V				98	56	426	384	583			866	174
PHF				0.95	0.95	0.95	0.95	0.95			0.95	0.95
Adj flow				103	59	448	404	614			912	176
No. Lanes	0	0	0	1	1	2	0	2	0	0	2	0
Lane group				L	LT	R		LT			TR	
Adj flow				75	87	448		1018			1088	
Prop LTs					0.320			0.397			0.000	
Prop RTs					0.000	1.000		0.000			0.162	

Saturation Flow Rate (see Exhibit 16-7 to determine the adjustment factors)

	Eastbound			Westbound			Northbound			Southbound		
LG				L	LT	R		LT			TR	
So				1900	1900	1900		1900			1900	
Lanes	0	0	0	1	1	2	0	2	0	0	2	0
fW				0.933	0.933	0.933		1.000			0.933	
fHV				0.909	0.909	0.909		0.909			0.909	
fG				1.000	1.000	1.000		1.000			1.000	
fP				1.000	1.000	1.000		1.000			1.000	
fBB				1.000	1.000	1.000		1.000			1.000	
fA				1.000	1.000	1.000		1.000			1.000	
fLU				1.000	1.000	0.885		0.952			0.952	
fRT					1.000	0.850		1.000			0.976	
fLT				0.950	0.984			0.981			1.000	
Sec.												
fLpb				1.000	1.000			1.000			1.000	
fRpb					1.000	1.000		1.000			1.000	
S				1532	1587	2425		3225			2995	
Sec.												

CAPACITY AND LOS WORKSHEET

Capacity Analysis and Lane Group Capacity

Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- Capacity (c)	v/c Ratio
Eastbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru							
Right							
Westbound							
Prot							
Perm							
Left	L	75	1532	0.05	0.16	237	0.32
Prot							
Perm							
Thru	LT	87	1587	# 0.05	0.16	246	0.35
Right	R	448	2425	0.18	0.50	1225	0.37
Northbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	LT	1018	3225	# 0.32	0.46	1467	0.69
Right							
Southbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	TR	1088	2995	# 0.36	0.33	988	1.10
Right							

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.73
Total lost time per cycle, L = 12.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.78

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	LOS	Approach Delay	LOS
Eastbound												
Westbound												
L	0.32	0.16	75.1	1.000	237	0.11	0.8	0.0	75.9	E		
LT	0.35	0.16	75.5	1.000	246	0.11	0.9	0.0	76.4	E	42.4	D
R	0.37	0.50	30.1	1.000	1225	0.11	0.2	0.0	30.2	C		
Northbound												
LT	0.69	0.46	43.4	0.165	1467	0.26	0.7	0.0	7.9	A	7.9	A
Southbound												
TR	1.10	0.33	67.0	1.000	988	0.50	60.5	0.0	127.5	F	127.5	F

```
_______________________________________________________________________________
         Intersection delay = 63.5  (sec/veh)   Intersection LOS = E



______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                              for exclusive lefts
Input
                                                       EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                          200.0   sec
Total actual green time for LT lane group, G (s)
Effective permitted green time for LT lane group, g(s)
Opposing effective green time, go (s)
Number of lanes in LT lane group, N
Number of lanes in opposing approach, No
Adjusted LT flow rate, VLT (veh/h)
Proportion of LT in LT lane group, PLT
Proportion of LT in opposing flow, PLTo
Adjusted opposing flow rate, Vo (veh/h)
Lost time for LT lane group, tL
Computation
LT volume per cycle, LTC=VLTC/3600
Opposing lane util. factor, fLUo                       1.000       0.952 0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g
Opposing platoon ratio, Rpo (refer Exhibit 16-11)
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]
gq, (see Exhibit C16-4,5,6,7,8)
gu=g-gq if gq>=gf, or = g-gf if gq<gf
n=Max(gq-gf)/2,0)
PTHo=1-PLTo
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]
EL1 (refer to Exhibit C16-3)
EL2=Max((1-Ptho**n)/Plto, 1.0)
fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g
gdiff=max(gq-gf,0)
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
or flt=[fm+0.91(N-1)]/N**
Left-turn adjustment, fLT

For special case of single-lane approach opposed by multilane approach,
see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
  left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach
or when gf>gq, see text.

______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                                for shared lefts
Input
                                                       EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                          200.0   sec
Total actual green time for LT lane group, G (s)
Effective permitted green time for LT lane group, g(s)
Opposing effective green time, go (s)
Number of lanes in LT lane group, N
```

```
Number of lanes in opposing approach, No
Adjusted LT flow rate, VLT (veh/h)
Proportion of LT in LT lane group, PLT                      0.320 0.397 0.000
Proportion of LT in opposing flow, PLTo
Adjusted opposing flow rate, Vo (veh/h)
Lost time for LT lane group, tL
Computation
LT volume per cycle, LTC=VLTC/3600
Opposing lane util. factor, fLUo                      1.000       0.952 0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g
Opposing platoon ratio, Rpo (refer Exhibit 16-11)
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]
gq, (see Exhibit C16-4,5,6,7,8)
gu=g-gq if gq>=gf, or = g-gf if gq<gf
n=Max(gq-gf)/2,0)
PTHo=1-PLTo
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]
EL1 (refer to Exhibit C16-3)
EL2=Max((1-Ptho**n)/Plto, 1.0)
fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g
gdiff=max(gq-gf,0)
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
or flt=[fm+0.91(N-1)]/N**
Left-turn adjustment, fLT

For special case of single-lane approach opposed by multilane approach,
see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
  left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach
or when gf>gq, see text.

_______________SUPPLEMENTAL PEDESTRIAN-BICYCLE EFFECTS WORKSHEET_______________
Permitted Left Turns
                                                       EB    WB    NB    SB
Effective pedestrian green time, gp (s)
Conflicting pedestrian volume, Vped (p/h)
Pedestrian flow rate, Vpedg (p/h)
OCCpedg
Opposing queue clearing green, gq (s)
Eff. ped. green consumed by opp. veh. queue, gq/gp
OCCpedu
Opposing flow rate, Vo (veh/h)
OCCr
Number of cross-street receiving lanes, Nrec
Number of turning lanes, Nturn
ApbT
Proportion of left turns, PLT
Proportion of left turns using protected phase, PLTA
Left-turn adjustment, fLpb
Permitted Right Turns
Effective pedestrian green time, gp (s)
Conflicting pedestrian volume, Vped (p/h)
Conflicting bicycle volume, Vbic (bicycles/h)
Vpedg
OCCpedg
Effective green, g (s)
Vbicg
```

OCCbicg
OCCr
Number of cross-street receiving lanes, Nrec
Number of turning lanes, Nturn
ApbT
Proportion right-turns, PRT
Proportion right-turns using protected phase, PRTA
Right turn adjustment, fRpb

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

		EBLT	WBLT	NBLT	SBLT
Cycle length, C	200.0 sec				
Adj. LT vol from Vol Adjustment Worksheet, v					
v/c ratio from Capacity Worksheet, X					
Protected phase effective green interval, g (s)					
Opposing queue effective green interval, gq					
Unopposed green interval, gu					
Red time r=(C-g-gq-gu)					
Arrival rate, qa=v/(3600(max[X,1.0]))					
Protected ph. departure rate, Sp=s/3600					
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)					
XPerm					
XProt					
Case					
Queue at beginning of green arrow, Qa					
Queue at beginning of unsaturated green, Qu					
Residual queue, Qr					
Uniform Delay, d1					

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
	0.0						0.0	
	0.0						0.0	
	0.0						0.0	
Westbound								
L	0.0	0.00	84.5	75.1	0.00	0.0	0.0	75.9
LT	0.0	0.00	84.5	75.5	0.00	0.0	0.0	76.4
R	0.0	0.00	49.5	30.1	0.00	0.0	0.0	30.2
Northbound								
	0.0						0.0	
LT	0.0	0.00	54.5	43.4	0.00	0.0	0.0	7.9
	0.0						0.0	
Southbound								
	0.0						0.0	
TR	0.0	0.00	67.0	67.0	0.00	25.0	0.0	127.5
	0.0						0.0	

Intersection Delay 63.5 sec/veh Intersection LOS E

BACK OF QUEUE WORKSHEET

	Eastbound			Westbound			Northbound			Southbound		
LaneGroup				L	LT	R		LT			TR	
Init Queue				0.0	0.0	0.0		0.0			0.0	
Flow Rate				75	87	253		534			571	
So				1900	1900	1900		1900			1900	
No.Lanes	0	0	0	1	1	2	0	2	0	0	2	0
SL				1532	1587	1370		1693			1573	
LnCapacity				237	246	692		770			518	
Flow Ratio				0.0	0.1	0.2		0.3			0.4	
v/c Ratio				0.32	0.35	0.37		0.69			1.10	
Grn Ratio				0.16	0.16	0.50		0.46			0.33	
I Factor					1.000			0.479			1.000	
AT or PVG				3	3	3		6			3	
Pltn Ratio				1.00	1.00	1.00		2.00			1.00	
PF2				1.00	1.00	1.00		0.31			1.00	
Q1				3.7	4.3	8.5		7.2			31.7	
kB				0.5	0.5	0.9		0.5			0.8	
Q2				0.2	0.3	0.5		1.0			11.4	
Q Average				3.9	4.6	9.0		8.2			43.1	
Q Spacing				25.0	25.0	25.0		25.0			25.0	
Q Storage				0	0	0		0			0	
Q S Ratio												
70th Percentile Output:												
fB%				1.2	1.2	1.2		1.2			1.1	
BOQ				4.7	5.4	10.7		9.7			48.8	
QSRatio												
85th Percentile Output:												
fB%				1.6	1.6	1.5		1.5			1.4	
BOQ				6.1	7.1	13.8		12.6			59.1	
QSRatio												
90th Percentile Output:												
fB%				1.7	1.7	1.7		1.7			1.4	
BOQ				6.8	7.9	15.0		13.7			62.3	
QSRatio												
95th Percentile Output:												
fB%				2.0	2.0	1.9		1.9			1.6	
BOQ				7.8	9.0	16.8		15.5			67.0	
QSRatio												
98th Percentile Output:												
fB%				2.4	2.4	2.2		2.2			1.7	
BOQ				9.6	11.0	19.9		18.4			74.8	
QSRatio												

ERROR MESSAGES

No errors to report.

HCS+: Signalized Intersections Release 5.4

Analyst:
Agency: PB
Date: 6/25/2010
Period: PM Peak Hour
Project ID: I-290 Phase 1 Study
E/W St: Harrison Street

Inter.: Harrison Street & 1st Avenue
Area Type: All other areas
Jurisd:
Year : Existing
N/S St: 1st Avenue

SIGNALIZED INTERSECTION SUMMARY

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	0	0	0	1	1	2	0	2	0	0	2	0
LGConfig				L	LT	R		LT			TR	
Volume				174	48	284	322	635			1196	213
Lane Width				10.0	10.0	10.0		12.0			10.0	
RTOR Vol						0						7

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination		1	2	3	4			5	6	7	8
EB	Left					NB	Left	A			
	Thru						Thru	A			
	Right						Right				
	Peds						Peds				
WB	Left	A				SB	Left				
	Thru	A					Thru		A		
	Right	A					Right		A		
	Peds						Peds				
NB	Right					EB	Right				
SB	Right					WB	Right		A		
Green		30.0						90.0	65.0		
Yellow		4.0						4.0	4.0		
All Red		1.0						1.0	1.0		

Cycle Length: 200.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
Westbound								
L	237	1532	0.49	0.16	78.8	E		
LT	166	1073	0.72	0.16	94.2	F	53.8	D
R	1225	2425	0.24	0.50	28.1	C		
Northbound								
LT	1471	3234	0.68	0.46	7.8	A	7.8	A
Southbound								
TR	991	3002	1.49	0.33	292.6	F	292.6	F

Intersection Delay = 155.3 (sec/veh) Intersection LOS = F

HCS+: Signalized Intersections Release 5.4

I-290
Existing

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst:
Agency/Co.: PB
Date Performed: 6/25/2010
Analysis Time Period: PM Peak Hour
Intersection: Harrison Street & 1st Avenue
Area Type: All other areas
Jurisdiction:
Analysis Year: Existing
Project ID: I-290 Phase 1 Study
E/W St: Harrison Street N/S St: 1st Avenue

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume				174	48	284	322	635			1196	213
% Heavy Veh				10	10	10	10	10			10	10
PHF				0.95	0.95	0.95	0.95	0.95			0.95	0.95
PK 15 Vol				46	13	75	85	167			315	56
Hi Ln Vol												
% Grade					0			0			0	
Ideal Sat				1900	1300	1900		1900			1900	
ParkExist												
NumPark												
No. Lanes	0	0	0	1	1	2	0	2	0	0	2	0
LGConfig				L	LT	R		LT			TR	
Lane Width				10.0	10.0	10.0		12.0			10.0	
RTOR Vol						0						7
Adj Flow				115	119	299		1007			1476	
%InSharedLn				37								
Prop LTs					0.569			0.337			0.000	
Prop RTs					0.000	1.000		0.000			0.147	
Peds Bikes	0			0						0		
Buses				0	0	0		0			0	
%InProtPhase												

Duration 0.25 Area Type: All other areas

OPERATING PARAMETERS

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Init Unmet				0.0	0.0	0.0		0.0			0.0	
Arriv. Type				3	3	3		6			3	
Unit Ext.				3.0	3.0	3.0		3.0			3.0	
I Factor					1.000			0.525			1.000	
Lost Time				2.0	2.0	2.0		2.0			2.0	
Ext of g				3.0	3.0	3.0		3.0			3.0	
Ped Min g		3.2			3.2						3.2	

```
_________________________________PHASE DATA____________________________________

Phase Combination 1     2     3     4 |            5     6     7     8

EB  Left                              | NB  Left   A
    Thru                              |     Thru   A
    Right                             |     Right
    Peds                              |     Peds

WB  Left          A                   | SB  Left
    Thru          A                   |     Thru         A
    Right         A                   |     Right        A
    Peds                              |     Peds

NB  Right                             | EB  Right
                                      |
SB  Right                             | WB  Right        A
                                      |
                                      |
Green            30.0                             90.0  65.0
Yellow           4.0                              4.0   4.0
All Red          1.0                              1.0   1.0

                                                    Cycle Length: 200.0   secs

_________________VOLUME ADJUSTMENT AND SATURATION FLOW WORKSHEET_______________
Volume Adjustment
           |  Eastbound    |  Westbound    |  Northbound   |  Southbound   |
           | L    T    R   | L    T    R   | L    T    R   | L    T    R   |
           |_______________|_______________|_______________|_______________|
Volume, V  |               |174  48   284  |322  635       |     1196 213  |
PHF        |               |0.95 0.95 0.95 |0.95 0.95      |     0.95 0.95 |
Adj flow   |               |183  51   299  |339  668       |     1259 217  |
No. Lanes  |   0   0   0   |   1   1   2   |   0   2   0   |   0   2   0   |
Lane group |               | L     LT   R  |       LT      |       TR      |
Adj flow   |               |115  119  299  |     1007      |     1476      |
Prop LTs   |               |       0.569   |      0.337    |       0.000   |
Prop RTs   |               |   0.000 1.000 |   0.000       |   0.147       |

Saturation Flow Rate (see Exhibit 16-7 to determine the adjustment factors)____
         Eastbound         Westbound        Northbound        Southbound
LG                       L     LT   R            LT                TR
So                      1900  1300  1900        1900              1900
Lanes 0     0     0     1     1     2     0     2     0     0     2     0
fW                      0.933 0.933 0.933       1.000             0.933
fHV                     0.909 0.909 0.909       0.909             0.909
fG                      1.000 1.000 1.000       1.000             1.000
fP                      1.000 1.000 1.000       1.000             1.000
fBB                     1.000 1.000 1.000       1.000             1.000
fA                      1.000 1.000 1.000       1.000             1.000
fLU                     1.000 1.000 0.885       0.952             0.952
fRT                           1.000 0.850       1.000             0.978
fLT                     0.950 0.972             0.983             1.000
Sec.
fLpb                    1.000 1.000             1.000             1.000
fRpb                          1.000 1.000       1.000             1.000
S                       1532  1073  2425        3234              3002
Sec.
_________________________CAPACITY AND LOS WORKSHEET____________________________
Capacity Analysis and Lane Group Capacity
```

Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- Capacity (c)	v/c Ratio
Eastbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru							
Right							
Westbound							
Prot							
Perm							
Left	L	115	1532	0.08	0.16	237	0.49
Prot							
Perm							
Thru	LT	119	1073	# 0.11	0.16	166	0.72
Right	R	299	2425	0.12	0.50	1225	0.24
Northbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	LT	1007	3234	# 0.31	0.46	1471	0.68
Right							
Southbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	TR	1476	3002	# 0.49	0.33	991	1.49
Right							

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.91
Total lost time per cycle, L = 12.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.97

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	LOS	Approach Delay	LOS
Eastbound												
Westbound												
L	0.49	0.16	77.2	1.000	237	0.11	1.6	0.0	78.8	E		
LT	0.72	0.16	80.3	1.000	166	0.28	13.8	0.0	94.2	F	53.8	D
R	0.24	0.50	27.9	1.000	1225	0.11	0.1	0.0	28.1	C		
Northbound												
LT	0.68	0.46	43.1	0.165	1471	0.25	0.7	0.0	7.8	A	7.8	A
Southbound												
TR	1.49	0.33	67.0	1.000	991	0.50	225.6	0.0	292.6	F	292.6	F

```
________________________________________________________________________________
         Intersection delay = 155.3 (sec/veh)   Intersection LOS = F



______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                              for exclusive lefts
Input
                                                       EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                          200.0   sec
Total actual green time for LT lane group, G (s)
Effective permitted green time for LT lane group, g(s)
Opposing effective green time, go (s)
Number of lanes in LT lane group, N
Number of lanes in opposing approach, No
Adjusted LT flow rate, VLT (veh/h)
Proportion of LT in LT lane group, PLT
Proportion of LT in opposing flow, PLTo
Adjusted opposing flow rate, Vo (veh/h)
Lost time for LT lane group, tL
Computation
LT volume per cycle, LTC=VLTC/3600
Opposing lane util. factor, fLUo                       1.000       0.952 0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g
Opposing platoon ratio, Rpo (refer Exhibit 16-11)
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]
gq, (see Exhibit C16-4,5,6,7,8)
gu=g-gq if gq>=gf, or = g-gf if gq<gf
n=Max(gq-gf)/2,0)
PTHo=1-PLTo
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]
EL1 (refer to Exhibit C16-3)
EL2=Max((1-Ptho**n)/Plto, 1.0)
fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g
gdiff=max(gq-gf,0)
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
or flt=[fm+0.91(N-1)]/N**
Left-turn adjustment, fLT

For special case of single-lane approach opposed by multilane approach,
see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
  left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach
or when gf>gq, see text.

______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                                for shared lefts
Input
                                                       EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                          200.0   sec
Total actual green time for LT lane group, G (s)
Effective permitted green time for LT lane group, g(s)
Opposing effective green time, go (s)
Number of lanes in LT lane group, N
```

```
Number of lanes in opposing approach, No
Adjusted LT flow rate, VLT (veh/h)
Proportion of LT in LT lane group, PLT                       0.569 0.337 0.000
Proportion of LT in opposing flow, PLTo
Adjusted opposing flow rate, Vo (veh/h)
Lost time for LT lane group, tL
Computation
LT volume per cycle, LTC=VLTC/3600
Opposing lane util. factor, fLUo                       1.000       0.952 0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g
Opposing platoon ratio, Rpo (refer Exhibit 16-11)
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]
gq, (see Exhibit C16-4,5,6,7,8)
gu=g-gq if gq>=gf, or = g-gf if gq<gf
n=Max(gq-gf)/2,0)
PTHo=1-PLTo
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]
EL1 (refer to Exhibit C16-3)
EL2=Max((1-Ptho**n)/Plto, 1.0)
fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g
gdiff=max(gq-gf,0)
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
or flt=[fm+0.91(N-1)]/N**
Left-turn adjustment, fLT

For special case of single-lane approach opposed by multilane approach,
see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
  left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach
or when gf>gq, see text.

_______________SUPPLEMENTAL PEDESTRIAN-BICYCLE EFFECTS WORKSHEET_______________
Permitted Left Turns
                                                       EB    WB    NB    SB
Effective pedestrian green time, gp (s)
Conflicting pedestrian volume, Vped (p/h)
Pedestrian flow rate, Vpedg (p/h)
OCCpedg
Opposing queue clearing green, gq (s)
Eff. ped. green consumed by opp. veh. queue, gq/gp
OCCpedu
Opposing flow rate, Vo (veh/h)
OCCr
Number of cross-street receiving lanes, Nrec
Number of turning lanes, Nturn
ApbT
Proportion of left turns, PLT
Proportion of left turns using protected phase, PLTA
Left-turn adjustment, fLpb
Permitted Right Turns
Effective pedestrian green time, gp (s)
Conflicting pedestrian volume, Vped (p/h)
Conflicting bicycle volume, Vbic (bicycles/h)
Vpedg
OCCpedg
Effective green, g (s)
Vbicg
```

OCCbicg
OCCr
Number of cross-street receiving lanes, Nrec
Number of turning lanes, Nturn
ApbT
Proportion right-turns, PRT
Proportion right-turns using protected phase, PRTA
Right turn adjustment, fRpb

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

		EBLT	WBLT	NBLT	SBLT
Cycle length, C	200.0 sec				
Adj. LT vol from Vol Adjustment Worksheet, v					
v/c ratio from Capacity Worksheet, X					
Protected phase effective green interval, g (s)					
Opposing queue effective green interval, gq					
Unopposed green interval, gu					
Red time r=(C-g-gq-gu)					
Arrival rate, qa=v/(3600(max[X,1.0]))					
Protected ph. departure rate, Sp=s/3600					
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)					
XPerm					
XProt					
Case					
Queue at beginning of green arrow, Qa					
Queue at beginning of unsaturated green, Qu					
Residual queue, Qr					
Uniform Delay, d1					

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
	0.0						0.0	
	0.0						0.0	
	0.0						0.0	
Westbound								
L	0.0	0.00	84.5	77.2	0.00	0.0	0.0	78.8
LT	0.0	0.00	84.5	80.3	0.00	0.0	0.0	94.2
R	0.0	0.00	49.5	27.9	0.00	0.0	0.0	28.1
Northbound								
	0.0						0.0	
LT	0.0	0.00	54.5	43.1	0.00	0.0	0.0	7.8
	0.0						0.0	
Southbound								
	0.0						0.0	
TR	0.0	0.00	67.0	67.0	0.00	121.3	0.0	292.6
	0.0						0.0	

Intersection Delay 155.3 sec/veh Intersection LOS F

BACK OF QUEUE WORKSHEET

	Eastbound			Westbound			Northbound			Southbound		
LaneGroup				L	LT	R		LT			TR	
Init Queue				0.0	0.0	0.0		0.0			0.0	
Flow Rate				115	119	168		528			775	
So				1900	1300	1900		1900			1900	
No.Lanes	0	0	0	1	1	2	0	2	0	0	2	0
SL				1532	1073	1370		1698			1576	
LnCapacity				237	166	692		772			520	
Flow Ratio				0.1	0.1	0.1		0.3			0.5	
v/c Ratio				0.49	0.72	0.24		0.68			1.49	
Grn Ratio				0.16	0.16	0.50		0.46			0.33	
I Factor					1.000			0.525			1.000	
AT or PVG				3	3	3		6			3	
Pltn Ratio				1.00	1.00	1.00		2.00			1.00	
PF2				1.00	1.00	1.00		0.30			1.00	
Q1				5.8	6.3	5.3		7.0			43.1	
kB				0.5	0.4	0.9		0.5			0.8	
Q2				0.4	0.8	0.3		1.0			34.0	
Q Average				6.3	7.1	5.6		8.0			77.1	
Q Spacing				25.0	25.0	25.0		25.0			25.0	
Q Storage				0	0	0		0			0	
Q S Ratio												
70th Percentile Output:												
fB%				1.2	1.2	1.2		1.2			1.1	
BOQ				7.4	8.4	6.6		9.5			85.9	
QSRatio												
85th Percentile Output:												
fB%				1.5	1.5	1.5		1.5			1.3	
BOQ				9.7	10.9	8.6		12.3			102	
QSRatio												
90th Percentile Output:												
fB%				1.7	1.7	1.7		1.7			1.4	
BOQ				10.6	12.0	9.5		13.4			109	
QSRatio												
95th Percentile Output:												
fB%				1.9	1.9	1.9		1.9			1.5	
BOQ				12.1	13.6	10.8		15.1			116	
QSRatio												
98th Percentile Output:												
fB%				2.3	2.3	2.4		2.2			1.7	
BOQ				14.5	16.2	13.1		18.0			131	
QSRatio												

ERROR MESSAGES

No errors to report.

HCS+: Signalized Intersections Release 5.4

Analyst:
Agency: PB
Date: 6/25/2010
Period: AM Peak Hour
Project ID: I-290 Phase 1 Study
E/W St: Bataan Drive

Inter.: Bataan Drive & 1st Avenue
Area Type: All other areas
Jurisd:
Year : Existing
N/S St: 1st Avenue

SIGNALIZED INTERSECTION SUMMARY

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	0	1	1	0	0	0	0	2	0	0	2	0
LGConfig		LT	R					TR			LT	
Volume	173	87	214					794	0	266	698	
Lane Width		12.0	12.0					11.5			11.0	
RTOR Vol			112						0			

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination		1	2	3	4			5	6	7	8
EB	Left	A				NB	Left				
	Thru	A					Thru		A		
	Right	A					Right		A		
	Peds						Peds				
WB	Left					SB	Left	A			
	Thru						Thru	A			
	Right						Right				
	Peds						Peds				
NB	Right					EB	Right		A		
SB	Right					WB	Right				
Green		30.0						90.0	65.0		
Yellow		4.0						4.0	4.0		
All Red		1.0						1.0	1.0		

Cycle Length: 200.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
LT	259	1672	1.06	0.16	156.5	F	120.0	F
R	741	1468	0.14	0.50	26.5	C		
Westbound								
Northbound								
TR	1067	3234	0.78	0.33	64.4	E	64.4	E
Southbound								
LT	1411	3136	0.72	0.45	8.6	A	8.6	A

Intersection Delay = 48.5 (sec/veh) Intersection LOS = D

HCS+: Signalized Intersections Release 5.4

I-290
Existing

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst:
Agency/Co.: PB
Date Performed: 6/25/2010
Analysis Time Period: AM Peak Hour
Intersection: Bataan Drive & 1st Avenue
Area Type: All other areas
Jurisdiction:
Analysis Year: Existing
Project ID: I-290 Phase 1 Study
E/W St: Bataan Drive N/S St: 1st Avenue

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	173	87	214					794	0	266	698	
% Heavy Veh	10	10	10					10	10	10	10	
PHF	0.95	0.95	0.95					0.95	0.95	0.95	0.95	
PK 15 Vol	46	23	56					209	0	70	184	
Hi Ln Vol												
% Grade		0						0			0	
Ideal Sat		1900	1900					1900			1900	
ParkExist												
NumPark												
No. Lanes	0	1	1	0	0	0	0	2	0	0	2	0
LGConfig		LT	R					TR			LT	
Lane Width		12.0	12.0					11.5			11.0	
RTOR Vol			112						0			
Adj Flow		274	107					836			1015	
%InSharedLn												
Prop LTs		0.664						0.000			0.276	
Prop RTs		0.000	1.000					0.000			0.000	
Peds Bikes	0			0			0					
Buses		0	0					0			0	
%InProtPhase												

Duration 0.25 Area Type: All other areas

OPERATING PARAMETERS

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Init Unmet		0.0	0.0					0.0			0.0	
Arriv. Type		3	3					3			6	
Unit Ext.		3.0	3.0					3.0			3.0	
I Factor		1.000						1.000			0.266	
Lost Time		2.0	2.0					2.0			2.0	
Ext of g		3.0	3.0					3.0			2.0	
Ped Min g		3.2			3.2			3.2				

```
_________________________________PHASE DATA____________________________________

Phase Combination 1     2     3     4 |            5     6     7     8

EB  Left          A                   | NB  Left
    Thru          A                   |     Thru          A
    Right         A                   |     Right         A
    Peds                              |     Peds

WB  Left                              | SB  Left   A
    Thru                              |     Thru   A
    Right                             |     Right
    Peds                              |     Peds

NB  Right                             | EB  Right         A
                                      |
SB  Right                             | WB  Right
                                      |
                                      |
Green            30.0                              90.0  65.0
Yellow           4.0                               4.0   4.0
All Red          1.0                               1.0   1.0

                                                     Cycle Length: 200.0   secs

_________________VOLUME ADJUSTMENT AND SATURATION FLOW WORKSHEET________________
Volume Adjustment
           |  Eastbound     |  Westbound     |  Northbound    |  Southbound    |
           | L    T    R    | L    T    R    | L    T    R    | L    T    R    |
           |________________|________________|________________|________________|
Volume, V  |173  87   214   |                |     794  0     |266  698        |
PHF        |0.95 0.95 0.95  |                |     0.95 0.95  |0.95 0.95       |
Adj flow   |182  92   107   |                |     836  0     |280  735        |
No. Lanes  |   0    1    1  |   0    0    0  |   0    2    0  |   0    2    0  |
Lane group |       LT   R   |                |       TR       |       LT       |
Adj flow   |      274  107  |                |     836        |     1015       |
Prop LTs   |       0.664    |                |      0.000     |      0.276     |
Prop RTs   |   0.000 1.000  |                |   0.000        |   0.000        |

Saturation Flow Rate (see Exhibit 16-7 to determine the adjustment factors)____
         Eastbound        Westbound        Northbound       Southbound
LG          LT   R                              TR               LT
So         1900  1900                          1900             1900
Lanes 0    1     1     0     0     0     0     2     0     0     2     0
fW         1.000 1.000                         0.983            0.967
fHV        0.909 0.909                         0.909            0.909
fG         1.000 1.000                         1.000            1.000
fP         1.000 1.000                         1.000            1.000
fBB        1.000 1.000                         1.000            1.000
fA         1.000 1.000                         1.000            1.000
fLU        1.000 1.000                         0.952            0.952
fRT        1.000 0.850                         1.000            1.000
fLT        0.968                               1.000            0.986
Sec.
fLpb       1.000                               1.000            1.000
fRpb       1.000 1.000                         1.000            1.000
S          1672  1468                          3234             3136
Sec.
_________________________CAPACITY AND LOS WORKSHEET____________________________
Capacity Analysis and Lane Group Capacity
```

Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- Capacity (c)	v/c Ratio
Eastbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	LT	274	1672	# 0.16	0.16	259	1.06
Right	R	107	1468	0.07	0.50	741	0.14
Westbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru							
Right							
Northbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	TR	836	3234	# 0.26	0.33	1067	0.78
Right							
Southbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	LT	1015	3136	# 0.32	0.45	1411	0.72
Right							

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.75
Total lost time per cycle, L = 13.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.80

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	LOS	Approach Delay	LOS
Eastbound												
LT	1.06	0.16	84.5	1.000	259	0.50	72.0	0.0	156.5	F	120.0	F
R	0.14	0.50	26.4	1.000	741	0.11	0.1	0.0	26.5	C		
Westbound												
Northbound												
TR	0.78	0.33	60.5	1.000	1067	0.33	3.9	0.0	64.4	E	64.4	E
Southbound												
LT	0.72	0.45	44.7	0.182	1411	0.28	0.5	0.0	8.6	A	8.6	A

```
________________________________________________________________________________
         Intersection delay = 48.5  (sec/veh)   Intersection LOS = D



______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                              for exclusive lefts
Input
                                                       EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                           200.0   sec
Total actual green time for LT lane group, G (s)
Effective permitted green time for LT lane group, g(s)
Opposing effective green time, go (s)
Number of lanes in LT lane group, N
Number of lanes in opposing approach, No
Adjusted LT flow rate, VLT (veh/h)
Proportion of LT in LT lane group, PLT
Proportion of LT in opposing flow, PLTo
Adjusted opposing flow rate, Vo (veh/h)
Lost time for LT lane group, tL
Computation
LT volume per cycle, LTC=VLTC/3600
Opposing lane util. factor, fLUo                             1.000 0.952 0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g
Opposing platoon ratio, Rpo (refer Exhibit 16-11)
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]
gq, (see Exhibit C16-4,5,6,7,8)
gu=g-gq if gq>=gf, or = g-gf if gq<gf
n=Max(gq-gf)/2,0)
PTHo=1-PLTo
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]
EL1 (refer to Exhibit C16-3)
EL2=Max((1-Ptho**n)/Plto, 1.0)
fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g
gdiff=max(gq-gf,0)
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
or flt=[fm+0.91(N-1)]/N**
Left-turn adjustment, fLT

For special case of single-lane approach opposed by multilane approach,
see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
  left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach
or when gf>gq, see text.

______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                              for shared lefts
Input
                                                       EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                           200.0   sec
Total actual green time for LT lane group, G (s)
Effective permitted green time for LT lane group, g(s)
Opposing effective green time, go (s)
Number of lanes in LT lane group, N
```

```
Number of lanes in opposing approach, No
Adjusted LT flow rate, VLT (veh/h)
Proportion of LT in LT lane group, PLT                     0.664       0.000 0.276
Proportion of LT in opposing flow, PLTo
Adjusted opposing flow rate, Vo (veh/h)
Lost time for LT lane group, tL
Computation
LT volume per cycle, LTC=VLTC/3600
Opposing lane util. factor, fLUo                                 1.000 0.952 0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g
Opposing platoon ratio, Rpo (refer Exhibit 16-11)
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]
gq, (see Exhibit C16-4,5,6,7,8)
gu=g-gq if gq>=gf, or = g-gf if gq<gf
n=Max(gq-gf)/2,0)
PTHo=1-PLTo
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]
EL1 (refer to Exhibit C16-3)
EL2=Max((1-Ptho**n)/Plto, 1.0)
fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g
gdiff=max(gq-gf,0)
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
or flt=[fm+0.91(N-1)]/N**
Left-turn adjustment, fLT

For special case of single-lane approach opposed by multilane approach,
see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
  left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach
or when gf>gq, see text.

_______________SUPPLEMENTAL PEDESTRIAN-BICYCLE EFFECTS WORKSHEET_______________
Permitted Left Turns
                                                           EB    WB    NB    SB
Effective pedestrian green time, gp (s)
Conflicting pedestrian volume, Vped (p/h)
Pedestrian flow rate, Vpedg (p/h)
OCCpedg
Opposing queue clearing green, gq (s)
Eff. ped. green consumed by opp. veh. queue, gq/gp
OCCpedu
Opposing flow rate, Vo (veh/h)
OCCr
Number of cross-street receiving lanes, Nrec
Number of turning lanes, Nturn
ApbT
Proportion of left turns, PLT
Proportion of left turns using protected phase, PLTA
Left-turn adjustment, fLpb
Permitted Right Turns
Effective pedestrian green time, gp (s)
Conflicting pedestrian volume, Vped (p/h)
Conflicting bicycle volume, Vbic (bicycles/h)
Vpedg
OCCpedg
Effective green, g (s)
Vbicg
```

OCCbicg
OCCr
Number of cross-street receiving lanes, Nrec
Number of turning lanes, Nturn
ApbT
Proportion right-turns, PRT
Proportion right-turns using protected phase, PRTA
Right turn adjustment, fRpb

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

		EBLT	WBLT	NBLT	SBLT
Cycle length, C	200.0 sec				
Adj. LT vol from Vol Adjustment Worksheet, v					
v/c ratio from Capacity Worksheet, X					
Protected phase effective green interval, g (s)					
Opposing queue effective green interval, gq					
Unopposed green interval, gu					
Red time r=(C-g-gq-gu)					
Arrival rate, qa=v/(3600(max[X,1.0]))					
Protected ph. departure rate, Sp=s/3600					
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)					
XPerm					
XProt					
Case					
Queue at beginning of green arrow, Qa					
Queue at beginning of unsaturated green, Qu					
Residual queue, Qr					
Uniform Delay, d1					

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
	0.0						0.0	
LT	0.0	0.00	84.5	84.5	0.00	3.8	0.0	156.5
R	0.0	0.00	49.5	26.4	0.00	0.0	0.0	26.5
Westbound								
	0.0						0.0	
	0.0						0.0	
	0.0						0.0	
Northbound								
	0.0						0.0	
TR	0.0	0.00	67.0	60.5	0.00	0.0	0.0	64.4
	0.0						0.0	
Southbound								
	0.0						0.0	
LT	0.0	0.00	55.0	44.7	0.00	0.0	0.0	8.6
	0.0						0.0	

Intersection Delay 48.5 sec/veh Intersection LOS D

BACK OF QUEUE WORKSHEET

	Eastbound			Westbound			Northbound			Southbound		
LaneGroup		LT	R					TR			LT	
Init Queue		0.0	0.0					0.0			0.0	
Flow Rate		274	107					439			533	
So		1900	1900					1900			1900	
No.Lanes	0	1	1	0	0	0	0	2	0	0	2	0
SL		1672	1468					1698			1647	
LnCapacity		259	741					560			741	
Flow Ratio		0.2	0.1					0.3			0.3	
v/c Ratio		1.06	0.14					0.78			0.72	
Grn Ratio		0.16	0.50					0.33			0.45	
I Factor		1.000						1.000			0.266	
AT or PVG		3	3					3			6	
Pltn Ratio		1.00	1.00					1.00			2.00	
PF2		1.00	1.00					1.00			0.35	
Q1		15.2	3.2					22.0			8.4	
kB		0.5	0.9					0.8			0.2	
Q2		5.2	0.2					2.5			0.6	
Q Average		20.4	3.3					24.5			9.0	
Q Spacing		25.0	25.0					25.0			25.0	
Q Storage		0	0					0			0	
Q S Ratio												
70th Percentile Output:												
fB%		1.2	1.2					1.2			1.2	
BOQ		23.6	4.0					28.3			10.6	
QSRatio												
85th Percentile Output:												
fB%		1.5	1.6					1.4			1.5	
BOQ		29.6	5.2					35.1			13.7	
QSRatio												
90th Percentile Output:												
fB%		1.5	1.7					1.5			1.7	
BOQ		31.5	5.8					37.2			14.9	
QSRatio												
95th Percentile Output:												
fB%		1.7	2.0					1.7			1.9	
BOQ		34.5	6.7					40.5			16.8	
QSRatio												
98th Percentile Output:												
fB%		1.9	2.5					1.9			2.2	
BOQ		38.9	8.2					45.4			19.8	
QSRatio												

ERROR MESSAGES

No errors to report.

HCS+: Signalized Intersections Release 5.4

Analyst:
Agency: PB
Date: 6/25/2010
Period: PM Peak Hour
Project ID: I-290 Phase 1 Study
E/W St: Bataan Drive

Inter.: Bataan Drive & 1st Avenue
Area Type: All other areas
Jurisd:
Year : Existing
N/S St: 1st Avenue

SIGNALIZED INTERSECTION SUMMARY

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	0	1	1	0	0	0	0	2	0	0	2	0
LGConfig		LT	R					TR			LT	
Volume	173	84	302					785	0	400	970	
Lane Width		12.0	12.0					11.5			11.0	
RTOR Vol			62						0			

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination	1	2	3	4
EB Left	A			
Thru	A			
Right	A			
Peds				
WB Left				
Thru				
Right				
Peds				
NB Right				
SB Right				
Green	30.0			
Yellow	4.0			
All Red	1.0			

	5	6	7	8
NB Left				
Thru		A		
Right		A		
Peds				
SB Left	A			
Thru	A			
Right				
Peds				
EB Right		A		
WB Right				
Green	90.0	65.0		
Yellow	4.0	4.0		
All Red	1.0	1.0		

Cycle Length: 200.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
LT	259	1671	1.04	0.16	151.9	F	92.9	F
R	741	1468	0.34	0.50	29.9	C		
Westbound								
Northbound								
TR	1067	3234	0.77	0.33	63.9	E	63.9	E
Southbound								
LT	1410	3133	1.02	0.45	60.0	E	60.0	E

Intersection Delay = 67.3 (sec/veh) Intersection LOS = E

HCS+: Signalized Intersections Release 5.4

I-290
Existing

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst:
Agency/Co.: PB
Date Performed: 6/25/2010
Analysis Time Period: PM Peak Hour
Intersection: Bataan Drive & 1st Avenue
Area Type: All other areas
Jurisdiction:
Analysis Year: Existing
Project ID: I-290 Phase 1 Study
E/W St: Bataan Drive N/S St: 1st Avenue

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	173	84	302					785	0	400	970	
% Heavy Veh	10	10	10					10	10	10	10	
PHF	0.95	0.95	0.95					0.95	0.95	0.95	0.95	
PK 15 Vol	46	22	79					207	0	105	255	
Hi Ln Vol												
% Grade		0						0			0	
Ideal Sat		1900	1900					1900			1900	
ParkExist												
NumPark												
No. Lanes	0	1	1	0	0	0	0	2	0	0	2	0
LGConfig		LT	R					TR			LT	
Lane Width		12.0	12.0					11.5			11.0	
RTOR Vol			62						0			
Adj Flow		270	253					826			1442	
%InSharedLn												
Prop LTs		0.674						0.000			0.292	
Prop RTs		0.000	1.000					0.000			0.000	
Peds Bikes	0			0			0					
Buses		0	0					0			0	
%InProtPhase												

Duration 0.25 Area Type: All other areas

OPERATING PARAMETERS

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Init Unmet		0.0	0.0					0.0			0.0	
Arriv. Type		3	3					3			4	
Unit Ext.		3.0	3.0					3.0			3.0	
I Factor		1.000						1.000			0.090	
Lost Time		2.0	2.0					2.0			2.0	
Ext of g		3.0	3.0					3.0			2.0	
Ped Min g		3.2			3.2			3.2				

```
_________________________________PHASE DATA____________________________________

Phase Combination 1     2     3     4 |           5     6     7     8

EB  Left           A                  | NB  Left
    Thru           A                  |     Thru          A
    Right          A                  |     Right         A
    Peds                              |     Peds

WB  Left                              | SB  Left   A
    Thru                              |     Thru   A
    Right                             |     Right
    Peds                              |     Peds

NB  Right                             | EB  Right         A
                                      |
SB  Right                             | WB  Right
                                      |
                                      |
Green             30.0                           90.0  65.0
Yellow            4.0                            4.0   4.0
All Red           1.0                            1.0   1.0

                                                     Cycle Length: 200.0   secs

_________________VOLUME ADJUSTMENT AND SATURATION FLOW WORKSHEET_______________
Volume Adjustment
           |  Eastbound     |  Westbound     |  Northbound    |  Southbound    |
           | L    T    R    | L    T    R    | L    T    R    | L    T    R    |
           |________________|________________|________________|________________|
Volume, V  |173  84   302   |                |     785  0     |400  970        |
PHF        |0.95 0.95 0.95  |                |     0.95 0.95  |0.95 0.95       |
Adj flow   |182  88   253   |                |     826  0     |421  1021       |
No. Lanes  |  0   1   1     |  0   0   0     |  0   2   0     |  0   2   0     |
Lane group |      LT   R    |                |       TR       |      LT        |
Adj flow   |     270  253   |                |     826        |     1442       |
Prop LTs   |      0.674     |                |      0.000     |      0.292     |
Prop RTs   |  0.000 1.000   |                |  0.000         |  0.000         |

Saturation Flow Rate (see Exhibit 16-7 to determine the adjustment factors)____
         Eastbound        Westbound        Northbound       Southbound
LG          LT   R                              TR               LT
So         1900  1900                          1900             1900
Lanes 0    1     1     0     0     0     0     2     0     0     2     0
fW         1.000 1.000                         0.983            0.967
fHV        0.909 0.909                         0.909            0.909
fG         1.000 1.000                         1.000            1.000
fP         1.000 1.000                         1.000            1.000
fBB        1.000 1.000                         1.000            1.000
fA         1.000 1.000                         1.000            1.000
fLU        1.000 1.000                         0.952            0.952
fRT        1.000 0.850                         1.000            1.000
fLT        0.967                               1.000            0.986
Sec.
fLpb       1.000                               1.000            1.000
fRpb       1.000 1.000                         1.000            1.000
S          1671  1468                          3234             3133
Sec.
_________________________CAPACITY AND LOS WORKSHEET____________________________
Capacity Analysis and Lane Group Capacity
```

Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- Capacity (c)	v/c Ratio
Eastbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	LT	270	1671	# 0.16	0.16	259	1.04
Right	R	253	1468	0.17	0.50	741	0.34
Westbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru							
Right							
Northbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	TR	826	3234	# 0.26	0.33	1067	0.77
Right							
Southbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	LT	1442	3133	# 0.46	0.45	1410	1.02
Right							

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.88
Total lost time per cycle, L = 13.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.94

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	Ratios g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound												
LT	1.04	0.16	84.5	1.000	259	0.50	67.4	0.0	151.9	F	92.9	F
R	0.34	0.50	29.6	1.000	741	0.11	0.3	0.0	29.9	C		
Westbound												
Northbound												
TR	0.77	0.33	60.3	1.000	1067	0.32	3.6	0.0	63.9	E	63.9	E
Southbound												
LT	1.02	0.45	55.0	0.836	1410	0.50	14.0	0.0	60.0	E	60.0	E

```
________________________________________________________________________________
         Intersection delay = 67.3  (sec/veh)   Intersection LOS = E



______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                              for exclusive lefts
Input
                                                         EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                          200.0   sec
Total actual green time for LT lane group, G (s)
Effective permitted green time for LT lane group, g(s)
Opposing effective green time, go (s)
Number of lanes in LT lane group, N
Number of lanes in opposing approach, No
Adjusted LT flow rate, VLT (veh/h)
Proportion of LT in LT lane group, PLT
Proportion of LT in opposing flow, PLTo
Adjusted opposing flow rate, Vo (veh/h)
Lost time for LT lane group, tL
Computation
LT volume per cycle, LTC=VLTC/3600
Opposing lane util. factor, fLUo                               1.000 0.952 0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g
Opposing platoon ratio, Rpo (refer Exhibit 16-11)
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]
gq, (see Exhibit C16-4,5,6,7,8)
gu=g-gq if gq>=gf, or = g-gf if gq<gf
n=Max(gq-gf)/2,0)
PTHo=1-PLTo
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]
EL1 (refer to Exhibit C16-3)
EL2=Max((1-Ptho**n)/Plto, 1.0)
fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g
gdiff=max(gq-gf,0)
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
or flt=[fm+0.91(N-1)]/N**
Left-turn adjustment, fLT

For special case of single-lane approach opposed by multilane approach,
see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
  left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach
or when gf>gq, see text.

______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                                for shared lefts
Input
                                                         EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                          200.0   sec
Total actual green time for LT lane group, G (s)
Effective permitted green time for LT lane group, g(s)
Opposing effective green time, go (s)
Number of lanes in LT lane group, N
```

```
Number of lanes in opposing approach, No
Adjusted LT flow rate, VLT (veh/h)
Proportion of LT in LT lane group, PLT                    0.674       0.000 0.292
Proportion of LT in opposing flow, PLTo
Adjusted opposing flow rate, Vo (veh/h)
Lost time for LT lane group, tL
Computation
LT volume per cycle, LTC=VLTC/3600
Opposing lane util. factor, fLUo                                1.000 0.952 0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g
Opposing platoon ratio, Rpo (refer Exhibit 16-11)
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]
gq, (see Exhibit C16-4,5,6,7,8)
gu=g-gq if gq>=gf, or = g-gf if gq<gf
n=Max(gq-gf)/2,0)
PTHo=1-PLTo
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]
EL1 (refer to Exhibit C16-3)
EL2=Max((1-Ptho**n)/Plto, 1.0)
fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g
gdiff=max(gq-gf,0)
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
or flt=[fm+0.91(N-1)]/N**
Left-turn adjustment, fLT

For special case of single-lane approach opposed by multilane approach,
see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
  left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach
or when gf>gq, see text.

_______________SUPPLEMENTAL PEDESTRIAN-BICYCLE EFFECTS WORKSHEET_______________
Permitted Left Turns
                                                          EB    WB    NB    SB
Effective pedestrian green time, gp (s)
Conflicting pedestrian volume, Vped (p/h)
Pedestrian flow rate, Vpedg (p/h)
OCCpedg
Opposing queue clearing green, gq (s)
Eff. ped. green consumed by opp. veh. queue, gq/gp
OCCpedu
Opposing flow rate, Vo (veh/h)
OCCr
Number of cross-street receiving lanes, Nrec
Number of turning lanes, Nturn
ApbT
Proportion of left turns, PLT
Proportion of left turns using protected phase, PLTA
Left-turn adjustment, fLpb
Permitted Right Turns
Effective pedestrian green time, gp (s)
Conflicting pedestrian volume, Vped (p/h)
Conflicting bicycle volume, Vbic (bicycles/h)
Vpedg
OCCpedg
Effective green, g (s)
Vbicg
```

OCCbicg
OCCr
Number of cross-street receiving lanes, Nrec
Number of turning lanes, Nturn
ApbT
Proportion right-turns, PRT
Proportion right-turns using protected phase, PRTA
Right turn adjustment, fRpb

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

		EBLT	WBLT	NBLT	SBLT
Cycle length, C	200.0 sec				
Adj. LT vol from Vol Adjustment Worksheet, v					
v/c ratio from Capacity Worksheet, X					
Protected phase effective green interval, g (s)					
Opposing queue effective green interval, gq					
Unopposed green interval, gu					
Red time r=(C-g-gq-gu)					
Arrival rate, qa=v/(3600(max[X,1.0]))					
Protected ph. departure rate, Sp=s/3600					
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)					
XPerm					
XProt					
Case					
Queue at beginning of green arrow, Qa					
Queue at beginning of unsaturated green, Qu					
Residual queue, Qr					
Uniform Delay, d1					

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
	0.0						0.0	
LT	0.0	0.00	84.5	84.5	0.00	2.8	0.0	151.9
R	0.0	0.00	49.5	29.6	0.00	0.0	0.0	29.9
Westbound								
	0.0						0.0	
	0.0						0.0	
	0.0						0.0	
Northbound								
	0.0						0.0	
TR	0.0	0.00	67.0	60.3	0.00	0.0	0.0	63.9
	0.0						0.0	
Southbound								
	0.0						0.0	
LT	0.0	0.00	55.0	55.0	0.00	8.0	0.0	60.0
	0.0						0.0	

Intersection Delay 67.3 sec/veh Intersection LOS E

BACK OF QUEUE WORKSHEET

	Eastbound			Westbound			Northbound			Southbound		
LaneGroup		LT	R					TR			LT	
Init Queue		0.0	0.0					0.0			0.0	
Flow Rate		270	253					433			757	
So		1900	1900					1900			1900	
No.Lanes	0	1	1	0	0	0	0	2	0	0	2	0
SL		1671	1468					1698			1645	
LnCapacity		259	741					560			740	
Flow Ratio		0.2	0.2					0.3			0.5	
v/c Ratio		1.04	0.34					0.77			1.02	
Grn Ratio		0.16	0.50					0.33			0.45	
I Factor		1.000						1.000			0.090	
AT or PVG		3	3					3			4	
Pltn Ratio		1.00	1.00					1.00			1.33	
PF2		1.00	1.00					1.00			1.00	
Q1		15.0	8.4					21.6			42.1	
kB		0.5	0.9					0.8			0.1	
Q2		4.8	0.5					2.3			4.1	
Q Average		19.8	8.9					24.0			46.1	
Q Spacing		25.0	25.0					25.0			25.0	
Q Storage		0	0					0			0	
Q S Ratio												
70th Percentile Output:												
fB%		1.2	1.2					1.2			1.1	
BOQ		23.0	10.5					27.7			52.2	
QSRatio												
85th Percentile Output:												
fB%		1.5	1.5					1.4			1.4	
BOQ		28.9	13.5					34.4			62.9	
QSRatio												
90th Percentile Output:												
fB%		1.5	1.7					1.5			1.4	
BOQ		30.7	14.7					36.5			66.4	
QSRatio												
95th Percentile Output:												
fB%		1.7	1.9					1.7			1.5	
BOQ		33.7	16.6					39.8			71.3	
QSRatio												
98th Percentile Output:												
fB%		1.9	2.2					1.9			1.7	
BOQ		38.0	19.6					44.6			79.7	
QSRatio												

ERROR MESSAGES

No errors to report.

HCS+: Signalized Intersections Release 5.4

Analyst:
Agency: PB
Date: 6/25/2010
Period: AM Peak Hour
Project ID: I-290 nPhase 1 Study
E/W St: CTA Station

Inter.: CTA Station & Des Plaines Aven
Area Type: CBD or Similar
Jurisd:
Year : Existing
N/S St: Des Plaines Avenve

SIGNALIZED INTERSECTION SUMMARY

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	1	0	1	0	0	0	1	2	0	0	2	0
LGConfig	L		R				L	T			TR	
Volume	51		7				159	744			847	81
Lane Width	12.0		12.0				11.0	10.0			12.0	
RTOR Vol			5									6

Duration 0.25 Area Type: CBD or Similar

Signal Operations

Phase Combination	1	2	3	4
EB Left	A			
Thru				
Right	A			
Peds				
WB Left				
Thru				
Right				
Peds				
NB Right				
SB Right				
Green	25.0			
Yellow	4.0			
All Red	1.0			

	5	6	7	8
NB Left	A	A		
Thru	A	A		
Right				
Peds				
SB Left				
Thru		A		
Right		A		
Peds		X		
EB Right				
WB Right				
Green	11.0	65.0		
Yellow	3.0	4.0		
All Red	1.0	1.0		

Cycle Length: 115.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
L	304	1343	0.18	0.23	36.2	D	36.1	D
R	272	1202	0.01	0.23	34.5	C		
Westbound								
Northbound								
L	284	1222	0.59	0.70	11.5	B		
T	1807	2565	0.43	0.70	7.4	A	8.1	A
Southbound								
TR	1524	2656	0.64	0.57	17.4	B	17.4	B

Intersection Delay = 13.4 (sec/veh) Intersection LOS = B

I-290
Existing

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst:
Agency/Co.: PB
Date Performed: 6/25/2010
Analysis Time Period: AM Peak Hour
Intersection: CTA Station & Des Plaines Aven
Area Type: CBD or Similar
Jurisdiction:
Analysis Year: Existing
Project ID: I-290 nPhase 1 Study
E/W St: CTA Station N/S St: Des Plaines Avenve

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	51		7				159	744			847	81
% Heavy Veh	10		10				10	10			10	10
PHF	0.95		0.95				0.95	0.95			0.95	0.95
PK 15 Vol	13		2				42	196			223	21
Hi Ln Vol												
% Grade		0						0			0	
Ideal Sat	1800		1800				1800	1800			1800	
ParkExist												
NumPark												
No. Lanes	1	0	1	0	0	0	1	2	0	0	2	0
LGConfig	L		R				L	T			TR	
Lane Width	12.0		12.0				11.0	10.0			12.0	
RTOR Vol			5									6
Adj Flow	54		2				167	783			971	
%InSharedLn												
Prop LTs							1.000	0.000			0.000	
Prop RTs			1.000					0.000			0.081	
Peds Bikes	0			0						300	0	
Buses	10		10				10	10			10	
%InProtPhase							0.0					

Duration 0.25 Area Type: CBD or Similar

OPERATING PARAMETERS

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Init Unmet	0.0		0.0				0.0	0.0			0.0	
Arriv. Type	3		3				3	3			3	
Unit Ext.	3.0		3.0				3.0	3.0			3.0	
I Factor		1.000						0.856			1.000	
Lost Time	2.0		2.0				2.0	2.0			2.0	
Ext of g	3.0		3.0				2.0	3.0			3.0	
Ped Min g		3.2			3.2						5.8	

```
_________________________________PHASE DATA____________________________________

Phase Combination 1     2     3     4 |           5     6     7     8

EB  Left          A                   | NB  Left   A     A
    Thru                              |     Thru   A     A
    Right         A                   |     Right
    Peds                              |     Peds

WB  Left                              | SB  Left
    Thru                              |     Thru         A
    Right                             |     Right        A
    Peds                              |     Peds         X

NB  Right                             | EB  Right
                                      |
SB  Right                             | WB  Right
                                      |
                                      |
Green            25.0                            11.0  65.0
Yellow           4.0                             3.0   4.0
All Red          1.0                             1.0   1.0

                                                   Cycle Length: 115.0   secs

_________________VOLUME ADJUSTMENT AND SATURATION FLOW WORKSHEET_______________
Volume Adjustment
           |  Eastbound     |  Westbound     |  Northbound    |  Southbound    |
           | L    T    R    | L    T    R    | L    T    R    | L    T    R    |
           |________________|________________|________________|________________|
Volume, V  |51        7     |                |159  744        |     847  81    |
PHF        |0.95      0.95  |                |0.95 0.95       |     0.95 0.95  |
Adj flow   |54        2     |                |167  783        |     892  79    |
No. Lanes  |  1   0   1     |   0   0   0    |  1   2   0     |  0   2   0     |
Lane group | L          R   |                | L    T         |      TR        |
Adj flow   |54        2     |                |167  783        |     971        |
Prop LTs   |                |                |1.000 0.000     |      0.000     |
Prop RTs   |        1.000   |                |   0.000        |  0.081         |

Saturation Flow Rate (see Exhibit 16-7 to determine the adjustment factors)____
         Eastbound        Westbound        Northbound       Southbound
LG      L           R                       L     T                 TR
So    1800        1800                    1800  1800              1800
Lanes 1     0     1     0     0     0     1     2     0     0     2     0
fW    1.000       1.000                   0.967 0.933             1.000
fHV   0.909       0.909                   0.909 0.909             0.909
fG    1.000       1.000                   1.000 1.000             1.000
fP    1.000       1.000                   1.000 1.000             1.000
fBB   0.960       0.960                   0.960 0.980             0.980
fA    0.900       0.900                   0.900 0.900             0.900
fLU   1.000       1.000                   1.000 0.952             0.952
fRT               0.850                         1.000             0.988
fLT   0.950                               0.950 1.000             1.000
Sec.                                      0.214
fLpb  1.000                               0.941 1.000             1.000
fRpb              1.000                         1.000             0.978
S     1343        1202                    1222  2565              2656
Sec.                                      275
_________________________CAPACITY AND LOS WORKSHEET____________________________
Capacity Analysis and Lane Group Capacity
```

Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- Capacity (c)	v/c Ratio
Eastbound							
Prot							
Perm							
Left	L	54	1343	# 0.04	0.23	304	0.18
Prot							
Perm							
Thru							
Right	R	2	1202	0.00	0.23	272	0.01
Westbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru							
Right							
Northbound							
Prot		117	1222	# 0.10	0.096	117	1.00
Perm		50	275	0.18	0.609	167	0.30
Left	L	167			0.70	284	0.59
Prot							
Perm							
Thru	T	783	2565	0.31	0.70	1807	0.43
Right							
Southbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	TR	971	2656	# 0.37	0.57	1524	0.64
Right							

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.50
Total lost time per cycle, L = 13.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.57

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	LOS	Approach Delay	LOS
Eastbound												
L	0.18	0.23	35.9	1.000	304	0.11	0.3	0.0	36.2	D	36.1	D
R	0.01	0.23	34.5	1.000	272	0.11	0.0	0.0	34.5	C		
Westbound												
Northbound												
L	0.59	0.70	8.7	1.000	284	0.18	2.7	0.0	11.5	B		
T	0.43	0.70	7.2	1.000	1807	0.11	0.1	0.0	7.4	A	8.1	A
Southbound												
TR	0.64	0.57	16.5	1.000	1524	0.22	0.9	0.0	17.4	B	17.4	B

```
_______________________________________________________________________________
         Intersection delay = 13.4  (sec/veh)   Intersection LOS = B



______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                              for exclusive lefts
Input
                                                       EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                           115.0   sec
Total actual green time for LT lane group, G (s)                   80.0
Effective permitted green time for LT lane group, g(s)             70.0
Opposing effective green time, go (s)                              66.0
Number of lanes in LT lane group, N                                1
Number of lanes in opposing approach, No                           2
Adjusted LT flow rate, VLT (veh/h)                                 167
Proportion of LT in LT lane group, PLT                             1.000
Proportion of LT in opposing flow, PLTo                            0.00
Adjusted opposing flow rate, Vo (veh/h)                            971
Lost time for LT lane group, tL                                    5.00
Computation
LT volume per cycle, LTC=VLTC/3600                                 5.33
Opposing lane util. factor, fLUo                                   0.952 0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)                16.29
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g                              0.0
Opposing platoon ratio, Rpo (refer Exhibit 16-11)                  1.00
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]                       0.43
gq, (see Exhibit C16-4,5,6,7,8)                                    19.37
gu=g-gq if gq>=gf, or = g-gf if gq<gf                              50.63
n=Max(gq-gf)/2,0)                                                  9.69
PTHo=1-PLTo                                                        1.00
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]                                 1.00
EL1 (refer to Exhibit C16-3)                                       3.38
EL2=Max((1-Ptho**n)/Plto, 1.0)
fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g                                 0.06
gdiff=max(gq-gf,0)                                                 0.00
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)                0.21
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
or flt=[fm+0.91(N-1)]/N**
Left-turn adjustment, fLT                                          0.214

For special case of single-lane approach opposed by multilane approach,
see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
  left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach
or when gf>gq, see text.

______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                                for shared lefts
Input
                                                       EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                           115.0   sec
Total actual green time for LT lane group, G (s)
Effective permitted green time for LT lane group, g(s)
Opposing effective green time, go (s)
Number of lanes in LT lane group, N
```

Number of lanes in opposing approach, No				
Adjusted LT flow rate, VLT (veh/h)				
Proportion of LT in LT lane group, PLT			0.000	0.000
Proportion of LT in opposing flow, PLTo				
Adjusted opposing flow rate, Vo (veh/h)				
Lost time for LT lane group, tL				
Computation				
LT volume per cycle, LTC=VLTC/3600				
Opposing lane util. factor, fLUo			0.952	0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)				
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g				
Opposing platoon ratio, Rpo (refer Exhibit 16-11)				
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]				
gq, (see Exhibit C16-4,5,6,7,8)				
gu=g-gq if gq>=gf, or = g-gf if gq<gf				
n=Max(gq-gf)/2,0)				
PTHo=1-PLTo				
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]				
EL1 (refer to Exhibit C16-3)				
EL2=Max((1-Ptho**n)/Plto, 1.0)				
fmin=2(1+PL)/g or fmin=2(1+Pl)/g				
gdiff=max(gq-gf,0)				
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)				
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)				
or flt=[fm+0.91(N-1)]/N**				
Left-turn adjustment, fLT				

For special case of single-lane approach opposed by multilane approach, see text.

* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto left-turn lane and redo calculations.

** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.

For special case of multilane approach opposed by single-lane approach or when gf>gq, see text.

SUPPLEMENTAL PEDESTRIAN-BICYCLE EFFECTS WORKSHEET

Permitted Left Turns	EB	WB	NB	SB
Effective pedestrian green time, gp (s)			65.0	
Conflicting pedestrian volume, Vped (p/h)			300	
Pedestrian flow rate, Vpedg (p/h)			530	
OCCpedg			0.265	
Opposing queue clearing green, gq (s)			19.37	
Eff. ped. green consumed by opp. veh. queue, gq/gp			0.298	
OCCpedu			0.226	
Opposing flow rate, Vo (veh/h)			971	
OCCr			0.059	
Number of cross-street receiving lanes, Nrec			1	
Number of turning lanes, Nturn			1	
ApbT			0.941	
Proportion of left turns, PLT			1.000	
Proportion of left turns using protected phase, PLTA			0.000	
Left-turn adjustment, fLpb			0.941	
Permitted Right Turns				
Effective pedestrian green time, gp (s)				65.0
Conflicting pedestrian volume, Vped (p/h)				300
Conflicting bicycle volume, Vbic (bicycles/h)				0
Vpedg				530
OCCpedg				0.265
Effective green, g (s)				66.0
Vbicg				0

OCCbicg	0.020
OCCr	0.265
Number of cross-street receiving lanes, Nrec	1
Number of turning lanes, Nturn	1
ApbT	0.735
Proportion right-turns, PRT	0.081
Proportion right-turns using protected phase, PRTA	0.000
Right turn adjustment, fRpb	0.978

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

		EBLT	WBLT	NBLT	SBLT
Cycle length, C	115.0 sec				
Adj. LT vol from Vol Adjustment Worksheet, v				167	
v/c ratio from Capacity Worksheet, X				0.59	
Protected phase effective green interval, g (s)				11.0	
Opposing queue effective green interval, gq				19.37	
Unopposed green interval, gu				50.63	
Red time r=(C-g-gq-gu)				34.0	
Arrival rate, qa=v/(3600(max[X,1.0]))				0.05	
Protected ph. departure rate, Sp=s/3600				0.339	
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)				0.11	
XPerm				0.61	
XProt				0.56	
Case				1	
Queue at beginning of green arrow, Qa				1.58	
Queue at beginning of unsaturated green, Qu				0.90	
Residual queue, Qr				0.00	
Uniform Delay, d1				8.7	

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
L	0.0	0.00	44.5	35.9	0.00	0.0	0.0	36.2
	0.0						0.0	
R	0.0	0.00	44.5	34.5	0.00	0.0	0.0	34.5
Westbound								
	0.0						0.0	
	0.0						0.0	
	0.0						0.0	
Northbound								
L	0.0	0.00		8.7	0.00	0.0	0.0	11.5
T	0.0	0.00	17.0	7.2	0.00	0.0	0.0	7.4
	0.0						0.0	
Southbound								
	0.0						0.0	
TR	0.0	0.00	24.5	16.5	0.00	0.0	0.0	17.4
	0.0						0.0	

Intersection Delay 13.4 sec/veh Intersection LOS B

BACK OF QUEUE WORKSHEET

	Eastbound			Westbound			Northbound			Southbound		
LaneGroup	L		R				L	T			TR	
Init Queue	0.0		0.0				0.0	0.0			0.0	
Flow Rate	54		2				167	411			509	
So	1800		1800				1800	1800			1800	
No.Lanes	1	0	1	0	0	0	1	2	0	0	2	0
SL	1343		1202				404	1347			1394	
LnCapacity	304		272				284	949			800	
Flow Ratio	0.0		0.0				0.4	0.3			0.4	
v/c Ratio	0.18		0.01				0.59	0.43			0.64	
Grn Ratio	0.23		0.23				0.70	0.70			0.57	
I Factor		1.000						0.856			1.000	
AT or PVG	3		3				3	3			3	
Pltn Ratio	1.00		1.00				1.00	1.00			1.00	
PF2	1.00		1.00				1.00	1.00			1.00	
Q1	1.4		0.0				1.7	5.6			10.9	
kB	0.4		0.4				0.3	0.7			0.7	
Q2	0.1		0.0				0.4	0.5			1.2	
Q Average	1.5		0.1				2.1	6.1			12.1	
Q Spacing	25.0		25.0				25.0	25.0			25.0	
Q Storage	0		80				80	0			0	
Q S Ratio			0.0				0.7					
70th Percentile Output:												
fB%	1.2		1.2				1.2	1.2			1.2	
BOQ	1.8		0.1				2.5	7.2			14.2	
QSRatio			0.0				0.8					
85th Percentile Output:												
fB%	1.6		1.6				1.6	1.5			1.5	
BOQ	2.3		0.1				3.3	9.4			18.2	
QSRatio			0.0				1.0					
90th Percentile Output:												
fB%	1.8		1.8				1.8	1.7			1.6	
BOQ	2.6		0.1				3.7	10.3			19.6	
QSRatio			0.0				1.2					
95th Percentile Output:												
fB%	2.1		2.1				2.0	1.9			1.8	
BOQ	3.0		0.1				4.3	11.7			21.9	
QSRatio			0.0				1.3					
98th Percentile Output:												
fB%	2.6		2.7				2.5	2.3			2.1	
BOQ	3.8		0.1				5.4	14.2			25.3	
QSRatio			0.0				1.7					

ERROR MESSAGES

No errors to report.

HCS+: Signalized Intersections Release 5.4

Analyst:	Inter.: CTA Station & Des Plaines Aven
Agency: PB	Area Type: CBD or Similar
Date: 6/25/2010	Jurisd:
Period: PM Peak Hour	Year : Existing
Project ID: I-290 Phase 1 Study	
E/W St: CTA Station	N/S St: Des Plaines Avenue

SIGNALIZED INTERSECTION SUMMARY

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	1	0	1	0	0	0	1	2	0	0	2	0
LGConfig	L		R				L	T			TR	
Volume	63		80				157	664			985	40
Lane Width	12.0		12.0				11.0	10.0			12.0	
RTOR Vol			65									0

Duration 0.25 Area Type: CBD or Similar

Signal Operations

Phase Combination	1	2	3	4		5	6	7	8
EB Left	A				NB Left	A	A		
Thru					Thru	A	A		
Right	A				Right				
Peds					Peds				
WB Left					SB Left				
Thru					Thru		A		
Right					Right		A		
Peds					Peds		X		
NB Right					EB Right				
SB Right					WB Right				
Green	25.0					11.0	65.0		
Yellow	4.0					3.0	4.0		
All Red	1.0					1.0	1.0		

Cycle Length: 115.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
L	304	1343	0.22	0.23	36.6	D	36.3	D
R	272	1202	0.06	0.23	35.0-	C		
Westbound								
Northbound								
L	260	1235	0.63	0.70	14.4	B		
T	1807	2565	0.39	0.70	7.0	A	8.4	A
Southbound								
TR	1552	2704	0.70	0.57	18.7	B	18.7	B

Intersection Delay = 15.1 (sec/veh) Intersection LOS = B

HCS+: Signalized Intersections Release 5.4

I-290
Existing

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst:
Agency/Co.: PB
Date Performed: 6/25/2010
Analysis Time Period: PM Peak Hour
Intersection: CTA Station & Des Plaines Aven
Area Type: CBD or Similar
Jurisdiction:
Analysis Year: Existing
Project ID: I-290 Phase 1 Study
E/W St: CTA Station N/S St: Des Plaines Avenue

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	63		80				157	664			985	40
% Heavy Veh	10		10				10	10			10	10
PHF	0.95		0.95				0.95	0.95			0.95	0.95
PK 15 Vol	17		21				41	175			259	11
Hi Ln Vol												
% Grade		0						0			0	
Ideal Sat	1800		1800				1800	1800			1800	
ParkExist												
NumPark												
No. Lanes	1	0	1	0	0	0	1	2	0	0	2	0
LGConfig	L		R				L	T			TR	
Lane Width	12.0		12.0				11.0	10.0			12.0	
RTOR Vol			65									0
Adj Flow	66		16				165	699			1079	
%InSharedLn												
Prop LTs							1.000	0.000			0.000	
Prop RTs			1.000					0.000			0.039	
Peds Bikes	0			0						300	0	
Buses	10		10				10	10			10	
%InProtPhase							0.0					

Duration 0.25 Area Type: CBD or Similar

OPERATING PARAMETERS

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Init Unmet	0.0		0.0				0.0	0.0			0.0	
Arriv. Type	3		3				3	3			3	
Unit Ext.	3.0		3.0				3.0	3.0			3.0	
I Factor		1.000						0.861			1.000	
Lost Time	2.0		2.0				2.0	2.0			2.0	
Ext of g	3.0		3.0				2.0	3.0			3.0	
Ped Min g		3.2			3.2						5.8	

PHASE DATA

Phase Combination	1	2	3	4			5	6	7	8
EB Left	A				NB	Left	A	A		
Thru						Thru	A	A		
Right	A					Right				
Peds						Peds				
WB Left					SB	Left				
Thru						Thru		A		
Right						Right		A		
Peds						Peds		X		
NB Right					EB	Right				
SB Right					WB	Right				
Green	25.0						11.0	65.0		
Yellow	4.0						3.0	4.0		
All Red	1.0						1.0	1.0		

Cycle Length: 115.0 secs

VOLUME ADJUSTMENT AND SATURATION FLOW WORKSHEET

Volume Adjustment

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume, V	63		80				157	664			985	40
PHF	0.95		0.95				0.95	0.95			0.95	0.95
Adj flow	66		16				165	699			1037	42
No. Lanes	1	0	1	0	0	0	1	2	0	0	2	0
Lane group	L		R				L	T			TR	
Adj flow	66		16				165	699			1079	
Prop LTs							1.000	0.000			0.000	
Prop RTs			1.000					0.000			0.039	

Saturation Flow Rate (see Exhibit 16-7 to determine the adjustment factors)

	Eastbound			Westbound			Northbound			Southbound		
LG	L		R				L	T			TR	
So	1800		1800				1800	1800			1800	
Lanes	1	0	1	0	0	0	1	2	0	0	2	0
fW	1.000		1.000				0.967	0.933			1.000	
fHV	0.909		0.909				0.909	0.909			0.909	
fG	1.000		1.000				1.000	1.000			1.000	
fP	1.000		1.000				1.000	1.000			1.000	
fBB	0.960		0.960				0.960	0.980			0.980	
fA	0.900		0.900				0.900	0.900			0.900	
fLU	1.000		1.000				1.000	0.952			0.952	
fRT			0.850					1.000			0.994	
fLT	0.950						0.950	1.000			1.000	
Sec.							0.180					
fLpb	1.000						0.951	1.000			1.000	
fRpb			1.000					1.000			0.990	
S	1343		1202				1235	2565			2704	
Sec.							234					

CAPACITY AND LOS WORKSHEET

Capacity Analysis and Lane Group Capacity

Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- Capacity (c)	v/c Ratio
Eastbound							
Prot							
Perm							
Left	L	66	1343	# 0.05	0.23	304	0.22
Prot							
Perm							
Thru							
Right	R	16	1202	0.01	0.23	272	0.06
Westbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru							
Right							
Northbound							
Prot		118	1235	# 0.10	0.096	118	1.00
Perm		47	234	0.20	0.609	142	0.33
Left	L	165			0.70	260	0.63
Prot							
Perm							
Thru	T	699	2565	0.27	0.70	1807	0.39
Right							
Southbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	TR	1079	2704	# 0.40	0.57	1552	0.70
Right							

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.54
Total lost time per cycle, L = 13.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.61

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	LOS	Approach Delay	LOS
Eastbound												
L	0.22	0.23	36.2	1.000	304	0.11	0.4	0.0	36.6	D	36.3	D
R	0.06	0.23	34.9	1.000	272	0.11	0.1	0.0	35.0-	C		
Westbound												
Northbound												
L	0.63	0.70	10.0	1.000	260	0.21	4.3	0.0	14.4	B		
T	0.39	0.70	6.9	1.000	1807	0.11	0.1	0.0	7.0	A	8.4	A
Southbound												
TR	0.70	0.57	17.4	1.000	1552	0.26	1.4	0.0	18.7	B	18.7	B

```
_______________________________________________________________________________
         Intersection delay = 15.1  (sec/veh)   Intersection LOS = B



______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                              for exclusive lefts
Input
                                                       EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                           115.0   sec
Total actual green time for LT lane group, G (s)                   80.0
Effective permitted green time for LT lane group, g(s)             70.0
Opposing effective green time, go (s)                              66.0
Number of lanes in LT lane group, N                                1
Number of lanes in opposing approach, No                           2
Adjusted LT flow rate, VLT (veh/h)                                 165
Proportion of LT in LT lane group, PLT                             1.000
Proportion of LT in opposing flow, PLTo                            0.00
Adjusted opposing flow rate, Vo (veh/h)                            1079
Lost time for LT lane group, tL                                    5.00
Computation
LT volume per cycle, LTC=VLTC/3600                                 5.27
Opposing lane util. factor, fLUo                                   0.952 0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)                18.10
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g                              0.0
Opposing platoon ratio, Rpo (refer Exhibit 16-11)                  1.00
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]                       0.43
gq, (see Exhibit C16-4,5,6,7,8)                                    22.52
gu=g-gq if gq>=gf, or = g-gf if gq<gf                              47.48
n=Max(gq-gf)/2,0)                                                  11.26
PTHo=1-PLTo                                                        1.00
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]                                 1.00
EL1 (refer to Exhibit C16-3)                                       3.77
EL2=Max((1-Ptho**n)/Plto, 1.0)
fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g                                 0.06
gdiff=max(gq-gf,0)                                                 0.00
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)                0.18
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
or flt=[fm+0.91(N-1)]/N**
Left-turn adjustment, fLT                                          0.180

For special case of single-lane approach opposed by multilane approach,
see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
  left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach
or when gf>gq, see text.

______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                                for shared lefts
Input
                                                       EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                           115.0   sec
Total actual green time for LT lane group, G (s)
Effective permitted green time for LT lane group, g(s)
Opposing effective green time, go (s)
Number of lanes in LT lane group, N
```

Number of lanes in opposing approach, No				
Adjusted LT flow rate, VLT (veh/h)				
Proportion of LT in LT lane group, PLT			0.000	0.000
Proportion of LT in opposing flow, PLTo				
Adjusted opposing flow rate, Vo (veh/h)				
Lost time for LT lane group, tL				
Computation				
LT volume per cycle, LTC=VLTC/3600				
Opposing lane util. factor, fLUo			0.952	0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)				
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g				
Opposing platoon ratio, Rpo (refer Exhibit 16-11)				
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]				
gq, (see Exhibit C16-4,5,6,7,8)				
gu=g-gq if gq>=gf, or = g-gf if gq<gf				
n=Max(gq-gf)/2,0)				
PTHo=1-PLTo				
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]				
EL1 (refer to Exhibit C16-3)				
EL2=Max((1-Ptho**n)/Plto, 1.0)				
fmin=2(1+PL)/g or fmin=2(1+Pl)/g				
gdiff=max(gq-gf,0)				
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)				
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)				
or flt=[fm+0.91(N-1)]/N**				
Left-turn adjustment, fLT				

For special case of single-lane approach opposed by multilane approach, see text.

* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto left-turn lane and redo calculations.

** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.

For special case of multilane approach opposed by single-lane approach or when gf>gq, see text.

SUPPLEMENTAL PEDESTRIAN-BICYCLE EFFECTS WORKSHEET

Permitted Left Turns

	EB	WB	NB	SB
Effective pedestrian green time, gp (s)			65.0	
Conflicting pedestrian volume, Vped (p/h)			300	
Pedestrian flow rate, Vpedg (p/h)			530	
OCCpedg			0.265	
Opposing queue clearing green, gq (s)			22.52	
Eff. ped. green consumed by opp. veh. queue, gq/gp			0.346	
OCCpedu			0.219	
Opposing flow rate, Vo (veh/h)			1079	
OCCr			0.049	
Number of cross-street receiving lanes, Nrec			1	
Number of turning lanes, Nturn			1	
ApbT			0.951	
Proportion of left turns, PLT			1.000	
Proportion of left turns using protected phase, PLTA			0.000	
Left-turn adjustment, fLpb			0.951	
Permitted Right Turns				
Effective pedestrian green time, gp (s)				65.0
Conflicting pedestrian volume, Vped (p/h)				300
Conflicting bicycle volume, Vbic (bicycles/h)				0
Vpedg				530
OCCpedg				0.265
Effective green, g (s)				66.0
Vbicg				0

OCCbicg	0.020
OCCr	0.265
Number of cross-street receiving lanes, Nrec	1
Number of turning lanes, Nturn	1
ApbT	0.735
Proportion right-turns, PRT	0.039
Proportion right-turns using protected phase, PRTA	0.000
Right turn adjustment, fRpb	0.990

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

		EBLT	WBLT	NBLT	SBLT
Cycle length, C	115.0 sec				
Adj. LT vol from Vol Adjustment Worksheet, v				165	
v/c ratio from Capacity Worksheet, X				0.63	
Protected phase effective green interval, g (s)				11.0	
Opposing queue effective green interval, gq				22.52	
Unopposed green interval, gu				47.48	
Red time r=(C-g-gq-gu)				34.0	
Arrival rate, qa=v/(3600(max[X,1.0]))				0.05	
Protected ph. departure rate, Sp=s/3600				0.343	
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)				0.10	
XPerm				0.71	
XProt				0.55	
Case				1	
Queue at beginning of green arrow, Qa				1.56	
Queue at beginning of unsaturated green, Qu				1.03	
Residual queue, Qr				0.00	
Uniform Delay, d1				10.0	

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
L	0.0	0.00	44.5	36.2	0.00	0.0	0.0	36.6
	0.0						0.0	
R	0.0	0.00	44.5	34.9	0.00	0.0	0.0	35.0-
Westbound								
	0.0						0.0	
	0.0						0.0	
	0.0						0.0	
Northbound								
L	0.0	0.00		10.0	0.00	0.0	0.0	14.4
T	0.0	0.00	17.0	6.9	0.00	0.0	0.0	7.0
	0.0						0.0	
Southbound								
	0.0						0.0	
TR	0.0	0.00	24.5	17.4	0.00	0.0	0.0	18.7
	0.0						0.0	

Intersection Delay 15.1 sec/veh   Intersection LOS B

BACK OF QUEUE WORKSHEET

	Eastbound			Westbound			Northbound			Southbound		
LaneGroup	L		R				L	T			TR	
Init Queue	0.0		0.0				0.0	0.0			0.0	
Flow Rate	66		16				165	367			566	
So	1800		1800				1800	1800			1800	
No.Lanes	1	0	1	0	0	0	1	2	0	0	2	0
SL	1343		1202				370	1347			1420	
LnCapacity	304		272				260	949			815	
Flow Ratio	0.0		0.0				0.4	0.3			0.4	
v/c Ratio	0.22		0.06				0.63	0.39			0.69	
Grn Ratio	0.23		0.23				0.70	0.70			0.57	
I Factor		1.000						0.861			1.000	
AT or PVG	3		3				3	3			3	
Pltn Ratio	1.00		1.00				1.00	1.00			1.00	
PF2	1.00		1.00				1.00	1.00			1.00	
Q1	1.7		0.4				1.7	4.8			12.8	
kB	0.4		0.4				0.3	0.7			0.7	
Q2	0.1		0.0				0.5	0.4			1.5	
Q Average	1.8		0.4				2.2	5.2			14.3	
Q Spacing	25.0		25.0				25.0	25.0			25.0	
Q Storage	0		0				0	0			0	
Q S Ratio												
70th Percentile Output:												
fB%	1.2		1.2				1.2	1.2			1.2	
BOQ	2.2		0.5				2.6	6.2			16.8	
QSRatio												
85th Percentile Output:												
fB%	1.6		1.6				1.6	1.6			1.5	
BOQ	2.9		0.7				3.4	8.0			21.3	
QSRatio												
90th Percentile Output:												
fB%	1.8		1.8				1.8	1.7			1.6	
BOQ	3.2		0.8				3.8	8.9			22.9	
QSRatio												
95th Percentile Output:												
fB%	2.0		2.1				2.0	1.9			1.8	
BOQ	3.7		0.9				4.4	10.1			25.4	
QSRatio												
98th Percentile Output:												
fB%	2.6		2.7				2.5	2.4			2.0	
BOQ	4.7		1.1				5.5	12.3			29.1	
QSRatio												

ERROR MESSAGES

No errors to report.

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                  HCS+: Signalized Intersections Release 5.4

Analyst:                                Inter.: Harrison Street & Des Plaines
Agency: PB                              Area Type: CBD or Similar
Date:   6/25/2010                       Jurisd:
Period: AM Peak Hour                    Year  : Existing
Project ID: I-290 Phase 1 Study
E/W St: Harrison Street                 N/S St: Des Plaines Avenue

_________________________SIGNALIZED INTERSECTION SUMMARY________________________
           |  Eastbound    |  Westbound    |  Northbound   |  Southbound   |
           | L    T    R   | L    T    R   | L    T    R   | L    T    R   |
           |_______________|_______________|_______________|_______________|
No. Lanes  |   1   1   1   |   0   1   0   |   0   2   0   |   1   2   0   |
LGConfig   | L     T    R  |       LTR     |       TR      | L     T       |
Volume     |47   71   27   |26   0    102  |     817  10   |12   236       |
Lane Width |10.0 10.5 10.0 |     10.5      |     11.0      |10.0 10.0      |
RTOR Vol   |          0    |          0    |          0    |               |
________________________________________________________________________________
Duration    0.25      Area Type: CBD or Similar
______________________________Signal Operations_________________________________
Phase Combination 1     2     3     4 |            5     6     7     8
EB  Left          A                   | NB  Left
    Thru          A                   |     Thru         A
    Right         A                   |     Right        A
    Peds                              |     Peds         X
WB  Left                A             | SB  Left   A
    Thru                A             |     Thru   A     A
    Right               A             |     Right
    Peds                X             |     Peds   X     X
NB  Right                             | EB  Right
SB  Right                             | WB  Right
Green            15.0  16.0                       6.0   55.0
Yellow           4.0   4.0                        3.0   4.0
All Red          1.0   1.0                        0.0   1.0
                                                   Cycle Length: 110.0   secs
____________________Intersection Performance Summary____________________________
Appr/   Lane       Adj Sat     Ratios       Lane Group   Approach
Lane    Group     Flow Rate   ___________    ___________  ____________
Grp     Capacity     (s)      v/c    g/C     Delay LOS    Delay LOS

________________________________________________________________________________
Eastbound
L        190       1306       0.26   0.15    42.5   D
T        203       1399       0.37   0.15    43.6   D     43.0   D
R        159       1168       0.18   0.14    42.6   D
Westbound

LTR      150       1032       0.89   0.15    90.0   F     90.0   F

Northbound

TR       1348      2648       0.65   0.51    20.8   C     20.8   C

Southbound
L        71        1306       0.18   0.05    50.9   D
T        1516      2565       0.16   0.59    10.2   B     12.3   B

         Intersection Delay = 28.2  (sec/veh)   Intersection LOS = C

________________________________________________________________________________
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HCS+: Signalized Intersections Release 5.4

I-290
Existing

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst:
Agency/Co.: PB
Date Performed: 6/25/2010
Analysis Time Period: AM Peak Hour
Intersection: Harrison Street & Des Plaines
Area Type: CBD or Similar
Jurisdiction:
Analysis Year: Existing
Project ID: I-290 Phase 1 Study
E/W St: Harrison Street N/S St: Des Plaines Avenue

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	47	71	27	26	0	102		817	10	12	236	
% Heavy Veh	10	10	10	10	10	10		10	10	10	10	
PHF	0.95	0.95	0.95	0.95	0.95	0.95		0.95	0.95	0.95	0.95	
PK 15 Vol	12	19	7	7	0	27		215	3	3	62	
Hi Ln Vol												
% Grade		0			0			0			0	
Ideal Sat	1800	1800	1800		1800			1800		1800	1800	
ParkExist												
NumPark												
No. Lanes	1	1	1	0	1	0	0	2	0	1	2	0
LGConfig	L	T	R		LTR			TR		L	T	
Lane Width	10.0	10.5	10.0		10.5			11.0		10.0	10.0	
RTOR Vol			0			0			0			
Adj Flow	49	75	28		134			871		13	248	
%InSharedLn												
Prop LTs		0.000			0.201			0.000			0.000	
Prop RTs		0.000	1.000		0.799			0.013			0.000	
Peds Bikes	0			100	0		100	0				
Buses	0	0	0		0			10		0	10	
%InProtPhase												

Duration 0.25 Area Type: CBD or Similar

OPERATING PARAMETERS

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Init Unmet	0.0	0.0	0.0		0.0			0.0		0.0	0.0	
Arriv. Type	3	3	3		3			3		3	3	
Unit Ext.	3.0	3.0	3.0		3.0			3.0		3.0	3.0	
I Factor		1.000			1.000			1.000			1.000	
Lost Time	2.0	2.0	2.0		2.0			2.0		2.0	2.0	
Ext of g	3.0	3.0	2.0		2.0			3.0		2.0	3.0	
Ped Min g		3.2			4.0			4.0				

PHASE DATA

Phase Combination		1	2	3	4			5	6	7	8
EB	Left	A				NB	Left				
	Thru	A					Thru		A		
	Right	A					Right		A		
	Peds						Peds		X		
WB	Left		A			SB	Left	A			
	Thru		A				Thru	A	A		
	Right		A				Right				
	Peds		X				Peds	X	X		
NB	Right					EB	Right				
SB	Right					WB	Right				
Green		15.0	16.0					6.0	55.0		
Yellow		4.0	4.0					3.0	4.0		
All Red		1.0	1.0					0.0	1.0		

Cycle Length: 110.0 secs

VOLUME ADJUSTMENT AND SATURATION FLOW WORKSHEET

Volume Adjustment

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume, V	47	71	27	26	0	102		817	10	12	236	
PHF	0.95	0.95	0.95	0.95	0.95	0.95		0.95	0.95	0.95	0.95	
Adj flow	49	75	28	27	0	107		860	11	13	248	
No. Lanes	1	1	1	0	1	0	0	2	0	1	2	0
Lane group	L	T	R		LTR			TR		L	T	
Adj flow	49	75	28		134			871		13	248	
Prop LTs		0.000			0.201			0.000			0.000	
Prop RTs		0.000	1.000		0.799			0.013			0.000	

Saturation Flow Rate (see Exhibit 16-7 to determine the adjustment factors)

	Eastbound			Westbound			Northbound			Southbound		
LG	L	T	R		LTR			TR		L	T	
So	1800	1800	1800		1800			1800		1800	1800	
Lanes	1	1	1	0	1	0	0	2	0	1	2	0
fW	0.933	0.950	0.933		0.950			0.967		0.933	0.933	
fHV	0.909	0.909	0.909		0.909			0.909		0.909	0.909	
fG	1.000	1.000	1.000		1.000			1.000		1.000	1.000	
fP	1.000	1.000	1.000		1.000			1.000		1.000	1.000	
fBB	1.000	1.000	1.000		1.000			0.980		1.000	0.980	
fA	0.900	0.900	0.900		0.900			0.900		0.900	0.900	
fLU	1.000	1.000	1.000		1.000			0.952		1.000	0.952	
fRT		1.000	0.850		0.892			0.998			1.000	
fLT	0.950	1.000			0.990			1.000		0.950	1.000	
Sec.												
fLpb	1.000	1.000			1.000			1.000		1.000	1.000	
fRpb		1.000	1.000		0.835			0.999			1.000	
S	1306	1399	1168		1032			2648		1306	2565	
Sec.												

CAPACITY AND LOS WORKSHEET

Capacity Analysis and Lane Group Capacity

Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- Capacity (c)	v/c Ratio
Eastbound							
Prot							
Perm							
Left	L	49	1306	0.04	0.15	190	0.26
Prot							
Perm							
Thru	T	75	1399	# 0.05	0.15	203	0.37
Right	R	28	1168	0.02	0.14	159	0.18
Westbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	LTR	134	1032	# 0.13	0.15	150	0.89
Right							
Northbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	TR	871	2648	# 0.33	0.51	1348	0.65
Right							
Southbound							
Prot							
Perm							
Left	L	13	1306	# 0.01	0.05	71	0.18
Prot							
Perm							
Thru	T	248	2565	0.10	0.59	1516	0.16
Right							

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.52
Total lost time per cycle, L = 16.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.61

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	Ratios g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound												
L	0.26	0.15	41.7	1.000	190	0.11	0.7	0.0	42.5	D		
T	0.37	0.15	42.4	1.000	203	0.11	1.1	0.0	43.6	D	43.0	D
R	0.18	0.14	42.0	1.000	159	0.11	0.5	0.0	42.6	D		
Westbound												
LTR	0.89	0.15	46.2	1.000	150	0.42	43.8	0.0	90.0	F	90.0	F
Northbound												
TR	0.65	0.51	19.8	1.000	1348	0.22	1.1	0.0	20.8	C	20.8	C
Southbound												
L	0.18	0.05	49.7	1.000	71	0.11	1.2	0.0	50.9	D		
T	0.16	0.59	10.2	1.000	1516	0.11	0.1	0.0	10.2	B	12.3	B

```
_______________________________________________________________________________
         Intersection delay = 28.2  (sec/veh)   Intersection LOS = C



______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                              for exclusive lefts
Input
                                                       EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                           110.0   sec
Total actual green time for LT lane group, G (s)
Effective permitted green time for LT lane group, g(s)
Opposing effective green time, go (s)
Number of lanes in LT lane group, N
Number of lanes in opposing approach, No
Adjusted LT flow rate, VLT (veh/h)
Proportion of LT in LT lane group, PLT
Proportion of LT in opposing flow, PLTo
Adjusted opposing flow rate, Vo (veh/h)
Lost time for LT lane group, tL
Computation
LT volume per cycle, LTC=VLTC/3600
Opposing lane util. factor, fLUo                       1.000 1.000 0.952 0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g
Opposing platoon ratio, Rpo (refer Exhibit 16-11)
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]
gq, (see Exhibit C16-4,5,6,7,8)
gu=g-gq if gq>=gf, or = g-gf if gq<gf
n=Max(gq-gf)/2,0)
PTHo=1-PLTo
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]
EL1 (refer to Exhibit C16-3)
EL2=Max((1-Ptho**n)/Plto, 1.0)
fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g
gdiff=max(gq-gf,0)
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
or flt=[fm+0.91(N-1)]/N**
Left-turn adjustment, fLT

For special case of single-lane approach opposed by multilane approach,
see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
  left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach
or when gf>gq, see text.

______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                                for shared lefts
Input
                                                       EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                           110.0   sec
Total actual green time for LT lane group, G (s)
Effective permitted green time for LT lane group, g(s)
Opposing effective green time, go (s)
Number of lanes in LT lane group, N
```

```
Number of lanes in opposing approach, No
Adjusted LT flow rate, VLT (veh/h)
Proportion of LT in LT lane group, PLT                 0.000 0.201 0.000 0.000
Proportion of LT in opposing flow, PLTo
Adjusted opposing flow rate, Vo (veh/h)
Lost time for LT lane group, tL
Computation
LT volume per cycle, LTC=VLTC/3600
Opposing lane util. factor, fLUo                       1.000 1.000 0.952 0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g
Opposing platoon ratio, Rpo (refer Exhibit 16-11)
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]
gq, (see Exhibit C16-4,5,6,7,8)
gu=g-gq if gq>=gf, or = g-gf if gq<gf
n=Max(gq-gf)/2,0)
PTHo=1-PLTo
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]
EL1 (refer to Exhibit C16-3)
EL2=Max((1-Ptho**n)/Plto, 1.0)
fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g
gdiff=max(gq-gf,0)
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
or flt=[fm+0.91(N-1)]/N**
Left-turn adjustment, fLT

For special case of single-lane approach opposed by multilane approach,
see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
  left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach
or when gf>gq, see text.

_______________SUPPLEMENTAL PEDESTRIAN-BICYCLE EFFECTS WORKSHEET_______________
Permitted Left Turns
                                                       EB    WB    NB    SB
Effective pedestrian green time, gp (s)
Conflicting pedestrian volume, Vped (p/h)
Pedestrian flow rate, Vpedg (p/h)
OCCpedg
Opposing queue clearing green, gq (s)
Eff. ped. green consumed by opp. veh. queue, gq/gp
OCCpedu
Opposing flow rate, Vo (veh/h)
OCCr
Number of cross-street receiving lanes, Nrec
Number of turning lanes, Nturn
ApbT
Proportion of left turns, PLT
Proportion of left turns using protected phase, PLTA
Left-turn adjustment, fLpb
Permitted Right Turns
Effective pedestrian green time, gp (s)                     16.0  55.0
Conflicting pedestrian volume, Vped (p/h)                   100   100
Conflicting bicycle volume, Vbic (bicycles/h)               0     0
Vpedg                                                       687   200
OCCpedg                                                     0.344 0.100
Effective green, g (s)                                      16.0  56.0
Vbicg                                                       0     0
```

OCCbicg	0.020	0.020
OCCr	0.344	0.100
Number of cross-street receiving lanes, Nrec	2	1
Number of turning lanes, Nturn	1	1
ApbT	0.794	0.900
Proportion right-turns, PRT	0.799	0.013
Proportion right-turns using protected phase, PRTA	0.000	0.000
Right turn adjustment, fRpb	0.835	0.999

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

		EBLT	WBLT	NBLT	SBLT
Cycle length, C	110.0 sec				
Adj. LT vol from Vol Adjustment Worksheet, v					
v/c ratio from Capacity Worksheet, X					
Protected phase effective green interval, g (s)					
Opposing queue effective green interval, gq					
Unopposed green interval, gu					
Red time r=(C-g-gq-gu)					
Arrival rate, qa=v/(3600(max[X,1.0]))					
Protected ph. departure rate, Sp=s/3600					
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)					
XPerm					
XProt					
Case					
Queue at beginning of green arrow, Qa					
Queue at beginning of unsaturated green, Qu					
Residual queue, Qr					
Uniform Delay, d1					

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
L	0.0	0.00	47.0	41.7	0.00	0.0	0.0	42.5
T	0.0	0.00	47.0	42.4	0.00	0.0	0.0	43.6
R	0.0	0.00	47.5	42.0	0.00	0.0	0.0	42.6
Westbound								
	0.0						0.0	
LTR	0.0	0.00	47.0	46.2	0.00	0.0	0.0	90.0
	0.0						0.0	
Northbound								
	0.0						0.0	
TR	0.0	0.00	27.0	19.8	0.00	0.0	0.0	20.8
	0.0						0.0	
Southbound								
L	0.0	0.00	52.0	49.7	0.00	0.0	0.0	50.9
T	0.0	0.00	22.5	10.2	0.00	0.0	0.0	10.2
	0.0						0.0	

Intersection Delay 28.2 sec/veh Intersection LOS C

BACK OF QUEUE WORKSHEET

	Eastbound			Westbound	Northbound	Southbound	
LaneGroup	L	T	R	LTR	TR	L	T
Init Queue	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Flow Rate	49	75	28	134	457	13	130
So	1800	1800	1800	1800	1800	1800	1800
No.Lanes	1	1	1	0 1 0	0 2 0	1	2 0
SL	1306	1399	1168	1032	1390	1306	1347
LnCapacity	190	203	159	150	707	71	796
Flow Ratio	0.0	0.1	0.0	0.1	0.3	0.0	0.1
v/c Ratio	0.26	0.37	0.18	0.89	0.65	0.18	0.16
Grn Ratio	0.15	0.15	0.14	0.15	0.51	0.05	0.59
I Factor		1.000		1.000	1.000		1.000
AT or PVG	3	3	3	3	3	3	3
Pltn Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00
PF2	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Q1	1.3	2.1	0.8	4.0	10.2	0.4	1.8
kB	0.3	0.3	0.3	0.2	0.6	0.2	0.7
Q2	0.1	0.2	0.1	1.3	1.1	0.0	0.1
Q Average	1.4	2.2	0.8	5.3	11.3	0.4	1.9
Q Spacing	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Q Storage	0	0	140	0	0	90	0
Q S Ratio			0.1			0.1	
70th Percentile Output:							
fB%	1.2	1.2	1.2	1.2	1.2	1.2	1.2
BOQ	1.7	2.7	1.0	6.3	13.3	0.5	2.3
QSRatio			0.2			0.1	
85th Percentile Output:							
fB%	1.6	1.6	1.6	1.6	1.5	1.6	1.6
BOQ	2.3	3.5	1.3	8.2	17.1	0.7	3.1
QSRatio			0.2			0.2	
90th Percentile Output:							
fB%	1.8	1.8	1.8	1.7	1.6	1.8	1.8
BOQ	2.5	3.9	1.4	9.0	18.4	0.7	3.4
QSRatio			0.3			0.2	
95th Percentile Output:							
fB%	2.1	2.0	2.1	1.9	1.8	2.1	2.0
BOQ	2.9	4.6	1.7	10.3	20.6	0.9	3.9
QSRatio			0.3			0.2	
98th Percentile Output:							
fB%	2.6	2.5	2.6	2.4	2.1	2.7	2.6
BOQ	3.7	5.7	2.1	12.5	24.0	1.1	4.9
QSRatio			0.4			0.3	

ERROR MESSAGES

No errors to report.

HCS+: Signalized Intersections Release 5.4

Analyst:
Agency: PB
Date: 6/25/2010
Period: PM Peak Hour
Project ID: I-290 Phase 1 Study
E/W St: Harrison Street

Inter.: Harrison St. & Des Plaines Ave
Area Type: CBD or Similar
Jurisd:
Year : Existing
N/S St: Des Plaines Avenue

SIGNALIZED INTERSECTION SUMMARY

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	1	1	1	0	1	0	0	2	0	1	2	0
LGConfig	L	T	R		LTR			TR		L	T	
Volume	122	18	132	52	0	81		778	29	52	581	
Lane Width	10.0	10.5	10.0		10.5			11.0		10.0	10.0	
RTOR Vol			0			0			0			

Duration 0.25 Area Type: CBD or Similar

Signal Operations

Phase Combination	1	2	3	4		5	6	7	8
EB Left	A				NB Left				
Thru	A				Thru		A		
Right	A				Right		A		
Peds					Peds		X		
WB Left		A			SB Left	A			
Thru		A			Thru	A	A		
Right		A			Right				
Peds		X			Peds	X	X		
NB Right					EB Right				
SB Right					WB Right				
Green	20.0	16.0				10.0	51.0		
Yellow	4.0	4.0				3.0	4.0		
All Red	1.0	1.0				0.0	1.0		

Cycle Length: 115.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
L	172	943	0.74	0.18	60.5	E		
T	184	1010	0.10	0.18	39.4	D	80.7	F
R	147	844	0.95	0.17	104.8	F		
Westbound								
LTR	152	1095	0.92	0.14	99.1	F	99.1	F
Northbound								
TR	1190	2631	0.71	0.45	27.6	C	27.6	C
Southbound								
L	114	1306	0.48	0.09	52.8	D		
T	1450	2565	0.42	0.57	14.4	B	17.6	B

Intersection Delay = 37.1 (sec/veh) Intersection LOS = D

I-290
Existing

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst:
Agency/Co.: PB
Date Performed: 6/25/2010
Analysis Time Period: PM Peak Hour
Intersection: Harrison St. & Des Plaines Ave
Area Type: CBD or Similar
Jurisdiction:
Analysis Year: Existing
Project ID: I-290 Phase 1 Study
E/W St: Harrison Street N/S St: Des Plaines Avenue

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	122	18	132	52	0	81		778	29	52	581	
% Heavy Veh	10	10	10	10	10	10		10	10	10	10	
PHF	0.95	0.95	0.95	0.95	0.95	0.95		0.95	0.95	0.95	0.95	
PK 15 Vol	32	5	35	14	0	21		205	8	14	153	
Hi Ln Vol												
% Grade		0			0			0			0	
Ideal Sat	1300	1300	1300		1800			1800		1800	1800	
ParkExist												
NumPark												
No. Lanes	1	1	1	0	1	0	0	2	0	1	2	0
LGConfig	L	T	R		LTR			TR		L	T	
Lane Width	10.0	10.5	10.0		10.5			11.0		10.0	10.0	
RTOR Vol			0			0			0			
Adj Flow	128	19	139		140			850		55	612	
%InSharedLn												
Prop LTs		0.000			0.393			0.000			0.000	
Prop RTs		0.000	1.000		0.607			0.036			0.000	
Peds Bikes	0			100	0		100	0				
Buses	0	0	0		0			10		0	10	
%InProtPhase												

Duration 0.25 Area Type: CBD or Similar

OPERATING PARAMETERS

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Init Unmet	0.0	0.0	0.0		0.0			0.0		0.0	0.0	
Arriv. Type	3	3	3		3			3		3	3	
Unit Ext.	3.0	3.0	3.0		3.0			3.0		3.0	3.0	
I Factor		1.000			1.000			1.000			0.874	
Lost Time	2.0	2.0	2.0		2.0			2.0		2.0	2.0	
Ext of g	3.0	3.0	2.0		2.0			3.0		2.0	3.0	
Ped Min g		3.2			4.1			4.1				

PHASE DATA

Phase Combination		1	2	3	4			5	6	7	8
EB	Left	A				NB	Left				
	Thru	A					Thru		A		
	Right	A					Right		A		
	Peds						Peds		X		
WB	Left		A			SB	Left	A			
	Thru		A				Thru	A	A		
	Right		A				Right				
	Peds		X				Peds	X	X		
NB	Right					EB	Right				
SB	Right					WB	Right				
Green		20.0	16.0					10.0	51.0		
Yellow		4.0	4.0					3.0	4.0		
All Red		1.0	1.0					0.0	1.0		

Cycle Length: 115.0 secs

VOLUME ADJUSTMENT AND SATURATION FLOW WORKSHEET

Volume Adjustment

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume, V	122	18	132	52	0	81		778	29	52	581	
PHF	0.95	0.95	0.95	0.95	0.95	0.95		0.95	0.95	0.95	0.95	
Adj flow	128	19	139	55	0	85		819	31	55	612	
No. Lanes	1	1	1	0	1	0	0	2	0	1	2	0
Lane group	L	T	R		LTR			TR		L	T	
Adj flow	128	19	139		140			850		55	612	
Prop LTs		0.000			0.393			0.000			0.000	
Prop RTs		0.000	1.000		0.607			0.036			0.000	

Saturation Flow Rate (see Exhibit 16-7 to determine the adjustment factors)

	Eastbound			Westbound			Northbound			Southbound		
LG	L	T	R		LTR			TR		L	T	
So	1300	1300	1300		1800			1800		1800	1800	
Lanes	1	1	1	0	1	0	0	2	0	1	2	0
fW	0.933	0.950	0.933		0.950			0.967		0.933	0.933	
fHV	0.909	0.909	0.909		0.909			0.909		0.909	0.909	
fG	1.000	1.000	1.000		1.000			1.000		1.000	1.000	
fP	1.000	1.000	1.000		1.000			1.000		1.000	1.000	
fBB	1.000	1.000	1.000		1.000			0.980		1.000	0.980	
fA	0.900	0.900	0.900		0.900			0.900		0.900	0.900	
fLU	1.000	1.000	1.000		1.000			0.952		1.000	0.952	
fRT		1.000	0.850		0.918			0.995			1.000	
fLT	0.950	1.000			0.981			1.000		0.950	1.000	
Sec.												
fLpb	1.000	1.000			1.000			1.000		1.000	1.000	
fRpb		1.000	1.000		0.869			0.996			1.000	
S	943	1010	844		1095			2631		1306	2565	
Sec.												

CAPACITY AND LOS WORKSHEET

Capacity Analysis and Lane Group Capacity

Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- Capacity (c)	v/c Ratio
Eastbound							
Prot							
Perm							
Left	L	128	943	0.14	0.18	172	0.74
Prot							
Perm							
Thru	T	19	1010	0.02	0.18	184	0.10
Right	R	139	844	# 0.16	0.17	147	0.95
Westbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	LTR	140	1095	# 0.13	0.14	152	0.92
Right							
Northbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	TR	850	2631	# 0.32	0.45	1190	0.71
Right							
Southbound							
Prot							
Perm							
Left	L	55	1306	# 0.04	0.09	114	0.48
Prot							
Perm							
Thru	T	612	2565	0.24	0.57	1450	0.42
Right							

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.66
Total lost time per cycle, L = 17.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.77

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	Ratios g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound												
L	0.74	0.18	44.5	1.000	172	0.30	16.1	0.0	60.5	E		
T	0.10	0.18	39.2	1.000	184	0.11	0.2	0.0	39.4	D	80.7	F
R	0.95	0.17	47.0	1.000	147	0.46	57.9	0.0	104.8	F		
Westbound												
LTR	0.92	0.14	48.9	1.000	152	0.44	50.2	0.0	99.1	F	99.1	F
Northbound												
TR	0.71	0.45	25.5	1.000	1190	0.28	2.1	0.0	27.6	C	27.6	C
Southbound												
L	0.48	0.09	50.0	1.000	114	0.11	2.8	0.0	52.8	D		
T	0.42	0.57	14.3	1.000	1450	0.11	0.2	0.0	14.4	B	17.6	B

```
_______________________________________________________________________________
         Intersection delay = 37.1  (sec/veh)   Intersection LOS = D



______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                              for exclusive lefts
Input
                                                       EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                          115.0   sec
Total actual green time for LT lane group, G (s)
Effective permitted green time for LT lane group, g(s)
Opposing effective green time, go (s)
Number of lanes in LT lane group, N
Number of lanes in opposing approach, No
Adjusted LT flow rate, VLT (veh/h)
Proportion of LT in LT lane group, PLT
Proportion of LT in opposing flow, PLTo
Adjusted opposing flow rate, Vo (veh/h)
Lost time for LT lane group, tL
Computation
LT volume per cycle, LTC=VLTC/3600
Opposing lane util. factor, fLUo                       1.000 1.000 0.952 0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g
Opposing platoon ratio, Rpo (refer Exhibit 16-11)
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]
gq, (see Exhibit C16-4,5,6,7,8)
gu=g-gq if gq>=gf, or = g-gf if gq<gf
n=Max(gq-gf)/2,0)
PTHo=1-PLTo
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]
EL1 (refer to Exhibit C16-3)
EL2=Max((1-Ptho**n)/Plto, 1.0)
fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g
gdiff=max(gq-gf,0)
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
or flt=[fm+0.91(N-1)]/N**
Left-turn adjustment, fLT

For special case of single-lane approach opposed by multilane approach,
see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
  left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach
or when gf>gq, see text.

______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                                for shared lefts
Input
                                                       EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                          115.0   sec
Total actual green time for LT lane group, G (s)
Effective permitted green time for LT lane group, g(s)
Opposing effective green time, go (s)
Number of lanes in LT lane group, N
```

```
Number of lanes in opposing approach, No
Adjusted LT flow rate, VLT (veh/h)
Proportion of LT in LT lane group, PLT                 0.000 0.393 0.000 0.000
Proportion of LT in opposing flow, PLTo
Adjusted opposing flow rate, Vo (veh/h)
Lost time for LT lane group, tL
Computation
LT volume per cycle, LTC=VLTC/3600
Opposing lane util. factor, fLUo                       1.000 1.000 0.952 0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g
Opposing platoon ratio, Rpo (refer Exhibit 16-11)
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]
gq, (see Exhibit C16-4,5,6,7,8)
gu=g-gq if gq>=gf, or = g-gf if gq<gf
n=Max(gq-gf)/2,0)
PTHo=1-PLTo
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]
EL1 (refer to Exhibit C16-3)
EL2=Max((1-Ptho**n)/Plto, 1.0)
fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g
gdiff=max(gq-gf,0)
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
or flt=[fm+0.91(N-1)]/N**
Left-turn adjustment, fLT

For special case of single-lane approach opposed by multilane approach,
see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
  left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach
or when gf>gq, see text.

_______________SUPPLEMENTAL PEDESTRIAN-BICYCLE EFFECTS WORKSHEET_______________
Permitted Left Turns
                                                       EB    WB    NB    SB
Effective pedestrian green time, gp (s)
Conflicting pedestrian volume, Vped (p/h)
Pedestrian flow rate, Vpedg (p/h)
OCCpedg
Opposing queue clearing green, gq (s)
Eff. ped. green consumed by opp. veh. queue, gq/gp
OCCpedu
Opposing flow rate, Vo (veh/h)
OCCr
Number of cross-street receiving lanes, Nrec
Number of turning lanes, Nturn
ApbT
Proportion of left turns, PLT
Proportion of left turns using protected phase, PLTA
Left-turn adjustment, fLpb
Permitted Right Turns
Effective pedestrian green time, gp (s)                     16.0  51.0
Conflicting pedestrian volume, Vped (p/h)                   100   100
Conflicting bicycle volume, Vbic (bicycles/h)               0     0
Vpedg                                                       718   225
OCCpedg                                                     0.359 0.113
Effective green, g (s)                                      16.0  52.0
Vbicg                                                       0     0
```

OCCbicg	0.020	0.020
OCCr	0.359	0.113
Number of cross-street receiving lanes, Nrec	2	1
Number of turning lanes, Nturn	1	1
ApbT	0.785	0.887
Proportion right-turns, PRT	0.607	0.036
Proportion right-turns using protected phase, PRTA	0.000	0.000
Right turn adjustment, fRpb	0.869	0.996

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

		EBLT	WBLT	NBLT	SBLT
Cycle length, C	115.0 sec				
Adj. LT vol from Vol Adjustment Worksheet, v					
v/c ratio from Capacity Worksheet, X					
Protected phase effective green interval, g (s)					
Opposing queue effective green interval, gq					
Unopposed green interval, gu					
Red time r=(C-g-gq-gu)					
Arrival rate, qa=v/(3600(max[X,1.0]))					
Protected ph. departure rate, Sp=s/3600					
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)					
XPerm					
XProt					
Case					
Queue at beginning of green arrow, Qa					
Queue at beginning of unsaturated green, Qu					
Residual queue, Qr					
Uniform Delay, d1					

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
L	0.0	0.00	47.0	44.5	0.00	0.0	0.0	60.5
T	0.0	0.00	47.0	39.2	0.00	0.0	0.0	39.4
R	0.0	0.00	47.5	47.0	0.00	0.0	0.0	104.8
Westbound								
	0.0						0.0	
LTR	0.0	0.00	49.5	48.9	0.00	0.0	0.0	99.1
	0.0						0.0	
Northbound								
	0.0						0.0	
TR	0.0	0.00	31.5	25.5	0.00	0.0	0.0	27.6
	0.0						0.0	
Southbound								
L	0.0	0.00	52.5	50.0	0.00	0.0	0.0	52.8
T	0.0	0.00	25.0	14.3	0.00	0.0	0.0	14.4
	0.0						0.0	

Intersection Delay 37.1 sec/veh Intersection LOS D

BACK OF QUEUE WORKSHEET

	Eastbound			Westbound			Northbound			Southbound		
LaneGroup	L	T	R		LTR			TR		L	T	
Init Queue	0.0	0.0	0.0		0.0			0.0		0.0	0.0	
Flow Rate	128	19	139		140			446		55	321	
So	1300	1300	1300		1800			1800		1800	1800	
No.Lanes	1	1	1	0	1	0	0	2	0	1	2	0
SL	943	1010	844		1095			1381		1306	1347	
LnCapacity	172	184	147		152			624		114	761	
Flow Ratio	0.1	0.0	0.2		0.1			0.3		0.0	0.2	
v/c Ratio	0.74	0.10	0.95		0.92			0.71		0.48	0.42	
Grn Ratio	0.18	0.18	0.17		0.14			0.45		0.09	0.57	
I Factor		1.000			1.000			1.000			0.874	
AT or PVG	3	3	3		3			3		3	3	
Pltn Ratio	1.00	1.00	1.00		1.00			1.00		1.00	1.00	
PF2	1.00	1.00	1.00		1.00			1.00		1.00	1.00	
Q1	3.9	0.5	4.4		4.4			11.5		1.7	5.9	
kB	0.3	0.3	0.3		0.3			0.6		0.2	0.6	
Q2	0.7	0.0	1.7		1.5			1.4		0.2	0.4	
Q Average	4.6	0.5	6.0		5.9			13.0		1.8	6.3	
Q Spacing	25.0	25.0	25.0		25.0			25.0		25.0	25.0	
Q Storage	0	0	140		0			0		90	0	
Q S Ratio			1.1							0.5		
70th Percentile Output:												
fB%	1.2	1.2	1.2		1.2			1.2		1.2	1.2	
BOQ	5.5	0.6	7.2		7.0			15.2		2.2	7.4	
QSRatio			1.3							0.6		
85th Percentile Output:												
fB%	1.6	1.6	1.5		1.5			1.5		1.6	1.5	
BOQ	7.1	0.9	9.3		9.2			19.4		2.9	9.7	
QSRatio			1.7							0.8		
90th Percentile Output:												
fB%	1.7	1.8	1.7		1.7			1.6		1.8	1.7	
BOQ	7.9	1.0	10.2		10.1			20.8		3.3	10.6	
QSRatio			1.8							0.9		
95th Percentile Output:												
fB%	2.0	2.1	1.9		1.9			1.8		2.0	1.9	
BOQ	9.0	1.1	11.7		11.4			23.2		3.8	12.1	
QSRatio			2.1							1.0		
98th Percentile Output:												
fB%	2.4	2.7	2.3		2.3			2.1		2.6	2.3	
BOQ	11.0	1.4	14.1		13.8			26.8		4.7	14.6	
QSRatio			2.5							1.3		

ERROR MESSAGES

No errors to report.

HCS+: Signalized Intersections Release 5.4

Analyst:
Agency: PB
Date: 6/25/2010
Period: AM Peak
Project ID: I-290 Phase 1 Study
E/W St: I-290 Ramps

Inter.: I-290 Ramps & Harlem Avenue
Area Type: CBD or Similar
Jurisd:
Year : Existing
N/S St: Harlem Avenue

SIGNALIZED INTERSECTION SUMMARY

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
No. Lanes	1	0	1	1	0	1	1	2	1	1	2	1
LGConfig	L		R	L		R	L	T	R	L	T	R
Volume	283		117	164		195	372	732	360	457	434	311
Lane Width	11.0		11.0	10.5		10.5	11.0	10.0	10.0	11.0	10.0	10.0
RTOR Vol			62			57			60			60

Duration 0.25 Area Type: CBD or Similar

Signal Operations

Phase Combination	1	2	3	4			5	6	7	8
EB Left	A				NB	Left	A	A		
Thru						Thru		A		
Right						Right		A		
Peds						Peds		X		
WB Left	A				SB	Left	A	A		
Thru						Thru		A		
Right						Right		A		
Peds						Peds		X		
NB Right	A				EB	Right	A			
SB Right	A				WB	Right	A			
Green	30.0						30.0	50.0		
Yellow	4.0						4.0	4.0		
All Red	1.0						1.0	1.0		

Cycle Length: 125.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
L	335	1352	0.89	0.25	69.5	E		
							64.2	E
R	300	1210	0.19	0.25	37.4	D		
Westbound								
L	330	1329	0.52	0.25	42.2	D		
							41.9	D
R	295	1189	0.49	0.25	41.5	D		
Northbound								
L	467	1114	0.84	0.68	24.3	C		
T	693	1698	1.11	0.41	106.4	F	64.7	E
R	502	730	0.63	0.69	13.3	B		
Southbound								
L	426	1216	1.13	0.69	110.1	F		
T	872	2137	0.52	0.41	28.4	C	57.2	E
R	502	730	0.53	0.69	10.6	B		

Intersection Delay = 59.8 (sec/veh) Intersection LOS = E

HCS+: Signalized Intersections Release 5.4

I-290
Existing

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst:
Agency/Co.: PB
Date Performed: 6/25/2010
Analysis Time Period: AM Peak
Intersection: I-290 Ramps & Harlem Avenue
Area Type: CBD or Similar
Jurisdiction:
Analysis Year: Existing
Project ID: I-290 Phase 1 Study
E/W St: I-290 Ramps N/S St: Harlem Avenue

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	283		117	164		195	372	732	360	457	434	311
% Heavy Veh	10		10	10		10	10	20	10	10	10	10
PHF	0.95		0.95	0.95		0.95	0.95	0.95	0.95	0.95	0.95	0.95
PK 15 Vol	74		31	43		51	98	193	95	120	114	82
Hi Ln Vol												
% Grade		0			0			0			0	
Ideal Sat	1800		1800	1800		1800	1800	1300	1800	1800	1500	1800
ParkExist												
NumPark												
No. Lanes	1	0	1	1	0	1	1	2	1	1	2	1
LGConfig	L		R	L		R	L	T	R	L	T	R
Lane Width	11.0		11.0	10.5		10.5	11.0	10.0	10.0	11.0	10.0	10.0
RTOR Vol			62			57			60			60
Adj Flow	298		58	173		145	392	771	316	481	457	264
%InSharedLn												
Prop LTs							1.000	0.000		1.000	0.000	
Prop RTs			1.000			1.000		0.000	1.000		0.000	1.000
Peds Bikes	0			0			300	0		300	0	
Buses	0		0	0		0	0	10	0	0	10	0
%InProtPhase							0.0		0.0	0.0		0.0

Duration 0.25 Area Type: CBD or Similar

OPERATING PARAMETERS

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Init Unmet	0.0		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
Arriv. Type	3		3	3		3	3	3	3	3	3	3
Unit Ext.	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0
I Factor		1.000			1.000			1.000			1.000	
Lost Time	2.0		2.0	2.0		2.0	2.0	2.0	2.0	2.0	2.0	2.0
Ext of g	3.0		3.0	3.0		3.0	2.0	3.0	3.0	3.0	3.0	3.0
Ped Min g		3.2			3.2			6.0			6.0	

PHASE DATA

Phase Combination		1	2	3	4			5	6	7	8
EB	Left	A				NB	Left	A	A		
	Thru						Thru		A		
	Right						Right		A		
	Peds						Peds		X		
WB	Left	A				SB	Left	A	A		
	Thru						Thru		A		
	Right						Right		A		
	Peds						Peds		X		
NB	Right	A				EB	Right	A			
SB	Right	A				WB	Right	A			
Green		30.0						30.0	50.0		
Yellow		4.0						4.0	4.0		
All Red		1.0						1.0	1.0		

Cycle Length: 125.0 secs

VOLUME ADJUSTMENT AND SATURATION FLOW WORKSHEET

Volume Adjustment

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume, V	283		117	164		195	372	732	360	457	434	311
PHF	0.95		0.95	0.95		0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj flow	298		58	173		145	392	771	316	481	457	264
No. Lanes	1	0	1	1	0	1	1	2	1	1	2	1
Lane group	L		R	L		R	L	T	R	L	T	R
Adj flow	298		58	173		145	392	771	316	481	457	264
Prop LTs							1.000	0.000		1.000	0.000	
Prop RTs			1.000			1.000		0.000	1.000		0.000	1.000

Saturation Flow Rate (see Exhibit 16-7 to determine the adjustment factors)

	Eastbound			Westbound			Northbound			Southbound		
LG	L		R	L		R	L	T	R	L	T	R
So	1800		1800	1800		1800	1800	1300	1800	1800	1500	1800
Lanes	1	0	1	1	0	1	1	2	1	1	2	1
fW	0.967		0.967	0.950		0.950	0.967	0.933	0.933	0.967	0.933	0.933
fHV	0.909		0.909	0.909		0.909	0.909	0.833	0.909	0.909	0.909	0.909
fG	1.000		1.000	1.000		1.000	1.000	1.000	1.000	1.000	1.000	1.000
fP	1.000		1.000	1.000		1.000	1.000	1.000	1.000	1.000	1.000	1.000
fBB	1.000		1.000	1.000		1.000	1.000	0.980	1.000	1.000	0.980	1.000
fA	0.900		0.900	0.900		0.900	0.900	0.900	0.900	0.900	0.900	0.900
fLU	1.000		1.000	1.000		1.000	1.000	0.952	1.000	1.000	0.952	1.000
fRT			0.850			0.850		1.000	0.850		1.000	0.850
fLT	0.950			0.950			0.950	1.000		0.950	1.000	
Sec.							0.388			0.219		
fLpb	1.000			1.000			0.824	1.000		0.899	1.000	
fRpb			1.000			1.000		1.000	0.625		1.000	0.625
S	1352		1210	1329		1189	1114	1698	730	1216	2137	730
Sec.							455			281		

CAPACITY AND LOS WORKSHEET

Capacity Analysis and Lane Group Capacity

Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- Capacity (c)	v/c Ratio
Eastbound							
Prot							
Perm							
Left	L	298	1352	# 0.22	0.25	335	0.89
Prot							
Perm							
Thru							
Right	R	58	1210	0.05	0.25	300	0.19
Westbound							
Prot							
Perm							
Left	L	173	1329	0.13	0.25	330	0.52
Prot							
Perm							
Thru							
Right	R	145	1189	0.12	0.25	295	0.49
Northbound							
Prot		267	1114	0.24	0.240	267	1.00
Perm		125	455	0.27	0.440	200	0.63
Left	L	392			0.68	467	0.84
Prot							
Perm							
Thru	T	771	1698	0.45	0.41	693	1.11
Right	R	316	730	0.43	0.69	502	0.63
Southbound							
Prot		302	1216	# 0.25	0.248	302	1.00
Perm		179	281	# 0.64	0.440	124	1.44
Left	L	481			0.69	426	1.13
Prot							
Perm							
Thru	T	457	2137	0.21	0.41	872	0.52
Right	R	264	730	0.36	0.69	502	0.53

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 1.11
Total lost time per cycle, L = 8.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 1.18

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	Ratios g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Incremental Del d2	Res Del d3	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound												
L	0.89	0.25	45.3	1.000	335	0.41	24.1	0.0	69.5	E		
											64.2	E
R	0.19	0.25	37.1	1.000	300	0.11	0.3	0.0	37.4	D		
Westbound												
L	0.52	0.25	40.6	1.000	330	0.13	1.5	0.0	42.2	D		
											41.9	D
R	0.49	0.25	40.3	1.000	295	0.11	1.3	0.0	41.5	D		
Northbound												
L	0.84	0.68	11.5	1.000	467	0.37	12.8	0.0	24.3	C		
T	1.11	0.41	37.0	1.000	693	0.50	69.4	0.0	106.4	F	64.7	E
R	0.63	0.69	10.7	1.000	502	0.21	2.5	0.0	13.3	B		
Southbound												
L	1.13	0.69	26.3	1.000	426	0.50	83.7	0.0	110.1	F		
T	0.52	0.41	27.9	1.000	872	0.13	0.6	0.0	28.4	C	57.2	E

```
R    0.53  0.69  9.5   1.000 502   0.13   1.0   0.0   10.6   B
_______________________________________________________________________________
         Intersection delay = 59.8  (sec/veh)   Intersection LOS = E



______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                              for exclusive lefts
Input
                                                        EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                           125.0   sec
Total actual green time for LT lane group, G (s)                    85.0  85.0
Effective permitted green time for LT lane group, g(s)              55.0  55.0
Opposing effective green time, go (s)                               51.0  51.0
Number of lanes in LT lane group, N                                 1     1
Number of lanes in opposing approach, No                            2     2
Adjusted LT flow rate, VLT (veh/h)                                  392   481
Proportion of LT in LT lane group, PLT                              1.000 1.000
Proportion of LT in opposing flow, PLTo                             0.00  0.00
Adjusted opposing flow rate, Vo (veh/h)                             457   771
Lost time for LT lane group, tL                                     5.00  4.00
Computation
LT volume per cycle, LTC=VLTC/3600                                  13.61 16.70
Opposing lane util. factor, fLUo                                    0.952 0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)                 8.33  14.06
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g                               0.0   0.0
Opposing platoon ratio, Rpo (refer Exhibit 16-11)                   1.00  1.00
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]                        0.59  0.59
gq, (see Exhibit C16-4,5,6,7,8)                                     11.39 21.48
gu=g-gq if gq>=gf, or = g-gf if gq<gf                               43.61 33.52
n=Max(gq-gf)/2,0)                                                   5.69  10.74
PTHo=1-PLTo                                                         1.00  1.00
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]                                  1.00  1.00
EL1 (refer to Exhibit C16-3)                                        2.04  2.78
EL2=Max((1-Ptho**n)/Plto, 1.0)
fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g                                  0.07  0.07
gdiff=max(gq-gf,0)                                                  0.00  0.00
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)                 0.39  0.22
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
or flt=[fm+0.91(N-1)]/N**
Left-turn adjustment, fLT                                           0.388 0.219

For special case of single-lane approach opposed by multilane approach,
see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
  left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach
or when gf>gq, see text.

______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                                for shared lefts
Input
                                                        EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                           125.0   sec
Total actual green time for LT lane group, G (s)
Effective permitted green time for LT lane group, g(s)
Opposing effective green time, go (s)
Number of lanes in LT lane group, N
```

	EB	WB	NB	SB
Number of lanes in opposing approach, No				
Adjusted LT flow rate, VLT (veh/h)				
Proportion of LT in LT lane group, PLT			0.000	0.000
Proportion of LT in opposing flow, PLTo				
Adjusted opposing flow rate, Vo (veh/h)				
Lost time for LT lane group, tL				
Computation				
LT volume per cycle, LTC=VLTC/3600				
Opposing lane util. factor, fLUo			0.952	0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)				
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g				
Opposing platoon ratio, Rpo (refer Exhibit 16-11)				
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]				
gq, (see Exhibit C16-4,5,6,7,8)				
gu=g-gq if gq>=gf, or = g-gf if gq<gf				
n=Max(gq-gf)/2,0)				
PTHo=1-PLTo				
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]				
EL1 (refer to Exhibit C16-3)				
EL2=Max((1-Ptho**n)/Plto, 1.0)				
fmin=2(1+PL)/g or fmin=2(1+Pl)/g				
gdiff=max(gq-gf,0)				
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)				
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)				
or flt=[fm+0.91(N-1)]/N**				
Left-turn adjustment, fLT				

For special case of single-lane approach opposed by multilane approach, see text.

* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto left-turn lane and redo calculations.

** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.

For special case of multilane approach opposed by single-lane approach or when gf>gq, see text.

SUPPLEMENTAL PEDESTRIAN-BICYCLE EFFECTS WORKSHEET

Permitted Left Turns	EB	WB	NB	SB
Effective pedestrian green time, gp (s)			50.0	50.0
Conflicting pedestrian volume, Vped (p/h)			300	300
Pedestrian flow rate, Vpedg (p/h)			750	750
OCCpedg			0.375	0.375
Opposing queue clearing green, gq (s)			11.39	21.48
Eff. ped. green consumed by opp. veh. queue, gq/gp			0.228	0.430
OCCpedu			0.332	0.294
Opposing flow rate, Vo (veh/h)			457	771
OCCr			0.176	0.101
Number of cross-street receiving lanes, Nrec			1	1
Number of turning lanes, Nturn			1	1
ApbT			0.824	0.899
Proportion of left turns, PLT			1.000	1.000
Proportion of left turns using protected phase, PLTA			0.000	0.000
Left-turn adjustment, fLpb			0.824	0.899
Permitted Right Turns				
Effective pedestrian green time, gp (s)			50.0	50.0
Conflicting pedestrian volume, Vped (p/h)			300	300
Conflicting bicycle volume, Vbic (bicycles/h)			0	0
Vpedg			750	750
OCCpedg			0.375	0.375
Effective green, g (s)			55.0	55.0
Vbicg			0	0

OCCbicg	0.020	0.020
OCCr	0.375	0.375
Number of cross-street receiving lanes, Nrec	1	1
Number of turning lanes, Nturn	1	1
ApbT	0.625	0.625
Proportion right-turns, PRT	1.000	1.000
Proportion right-turns using protected phase, PRTA	0.000	0.000
Right turn adjustment, fRpb	1.000	1.000

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

		EBLT	WBLT	NBLT	SBLT
Cycle length, C	125.0 sec				
Adj. LT vol from Vol Adjustment Worksheet, v				392	481
v/c ratio from Capacity Worksheet, X				0.84	1.13
Protected phase effective green interval, g (s)				30.0	31.0
Opposing queue effective green interval, gq				11.39	21.48
Unopposed green interval, gu				43.61	33.52
Red time r=(C-g-gq-gu)				40.0	39.0
Arrival rate, qa=v/(3600(max[X,1.0]))				0.11	0.12
Protected ph. departure rate, Sp=s/3600				0.309	0.338
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)				0.16	0.13
XPerm				0.86	1.52
XProt				0.82	0.79
Case				1	3
Queue at beginning of green arrow, Qa				4.36	6.83
Queue at beginning of unsaturated green, Qu				1.24	2.54
Residual queue, Qr				0.00	2.22
Uniform Delay, d1				11.5	26.3

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
L	0.0	0.00	47.0	45.3	0.00	0.0	0.0	69.5
	0.0						0.0	
R	0.0	0.00	47.0	37.1	0.00	0.0	0.0	37.4
Westbound								
L	0.0	0.00	47.0	40.6	0.00	0.0	0.0	42.2
	0.0						0.0	
R	0.0	0.00	47.0	40.3	0.00	0.0	0.0	41.5
Northbound								
L	0.0	0.00		11.5	0.00	0.0	0.0	24.3
T	0.0	0.00	37.0	37.0	0.00	19.5	0.0	106.4
R	0.0	0.00	19.5	10.7	0.00	0.0	0.0	13.3
Southbound								
L	0.0	0.00		26.3	0.00	13.7	0.0	110.1
T	0.0	0.00	37.0	27.9	0.00	0.0	0.0	28.4
R	0.0	0.00	19.5	9.5	0.00	0.0	0.0	10.6

Intersection Delay 59.8 sec/veh Intersection LOS E

BACK OF QUEUE WORKSHEET

	Eastbound			Westbound			Northbound			Southbound		
LaneGroup	L		R	L		R	L	T	R	L	T	R
Init Queue	0.0		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
Flow Rate	298		58	173		145	392	404	316	481	240	264
So	1800		1800	1800		1800	1800	1300	1800	1800	1500	1800
No.Lanes	1	0	1	1	0	1	1	2	1	1	2	1
SL	1352		1210	1329		1189	688	891	730	618	1122	730
LnCapacity	335		300	330		295	467	363	502	426	457	502
Flow Ratio	0.2		0.0	0.1		0.1	0.6	0.5	0.4	0.8	0.2	0.4
v/c Ratio	0.89		0.19	0.52		0.49	0.84	1.11	0.63	1.13	0.53	0.53
Grn Ratio	0.25		0.25	0.25		0.25	0.68	0.41	0.69	0.69	0.41	0.69
I Factor		1.000			1.000			1.000			1.000	
AT or PVG	3		3	3		3	3	3	3	3	3	3
Pltn Ratio	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00
PF2	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00
Q1	10.0		1.6	5.2		4.3	5.5	14.0	6.0	6.9	6.3	4.5
kB	0.4		0.4	0.4		0.4	0.5	0.5	0.6	0.5	0.5	0.6
Q2	2.3		0.1	0.5		0.4	2.2	8.0	0.9	9.9	0.6	0.6
Q Average	12.3		1.7	5.7		4.7	7.7	22.0	6.9	16.9	6.8	5.1
Q Spacing	25.0		25.0	25.0		25.0	25.0	25.0	25.0	25.0	25.0	25.0
Q Storage	0		0	0		0	170	0	155	490	0	220
Q S Ratio							1.1		1.1	0.9		0.6
70th Percentile Output:												
fB%	1.2		1.2	1.2		1.2	1.2	1.2	1.2	1.2	1.2	1.2
BOQ	14.5		2.0	6.7		5.6	9.1	25.5	8.2	19.6	8.1	6.0
QSRatio							1.3		1.3	1.0		0.7
85th Percentile Output:												
fB%	1.5		1.6	1.5		1.6	1.5	1.4	1.5	1.5	1.5	1.6
BOQ	18.5		2.7	8.8		7.3	11.8	31.8	10.7	24.8	10.5	7.9
QSRatio							1.7		1.7	1.3		0.9
90th Percentile Output:												
fB%	1.6		1.8	1.7		1.7	1.7	1.5	1.7	1.6	1.7	1.7
BOQ	19.9		3.0	9.6		8.1	12.9	33.8	11.7	26.5	11.5	8.7
QSRatio							1.9		1.9	1.4		1.0
95th Percentile Output:												
fB%	1.8		2.0	1.9		2.0	1.9	1.7	1.9	1.7	1.9	2.0
BOQ	22.2		3.5	11.0		9.2	14.6	36.9	13.3	29.2	13.1	9.9
QSRatio							2.1		2.1	1.5		1.1
98th Percentile Output:												
fB%	2.1		2.6	2.3		2.4	2.3	1.9	2.3	2.0	2.3	2.4
BOQ	25.7		4.4	13.3		11.3	17.3	41.5	15.9	33.3	15.7	12.1
QSRatio							2.6		2.6	1.7		1.4

ERROR MESSAGES

No errors to report.

HCS+: Signalized Intersections Release 5.4

Analyst:
Agency: PB
Date: 6/25/2010
Period: PM Peak
Project ID: I-290 Phase 1 Study
E/W St: I-290 Ramps

Inter.: I-290 Ramps & Harlem Avenue
Area Type: CBD or Similar
Jurisd:
Year : Existing
N/S St: Harlem Avenue

SIGNALIZED INTERSECTION SUMMARY

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	1	0	1	1	0	1	1	2	1	1	2	1
LGConfig	L		R	L		R	L	T	R	L	T	R
Volume	232		229	298		283	282	802	360	470	745	407
Lane Width	11.0		11.0	10.5		10.5	11.0	10.0	10.0	11.0	10.0	10.0
RTOR Vol			43			60			60			60

Duration 0.25 Area Type: CBD or Similar

Signal Operations

Phase Combination		1	2	3	4			5	6	7	8
EB	Left	A				NB	Left	A	A		
	Thru						Thru		A		
	Right						Right		A		
	Peds						Peds		X		
WB	Left	A				SB	Left	A	A		
	Thru						Thru		A		
	Right						Right		A		
	Peds						Peds		X		
NB	Right	A				EB	Right	A			
SB	Right	A				WB	Right	A			
Green		30.0						30.0	50.0		
Yellow		4.0						4.0	4.0		
All Red		1.0						1.0	1.0		

Cycle Length: 125.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
L	335	1352	0.73	0.25	50.9	D		
							49.3	D
R	300	1210	0.65	0.25	47.2	D		
Westbound								
L	330	1329	0.95	0.25	83.1	F		
							72.4	E
R	295	1189	0.80	0.25	58.2	E		
Northbound								
L	414	1219	0.72	0.68	21.6	C		
T	756	1852	1.12	0.41	106.6	F	69.0	E
R	502	730	0.63	0.69	13.3	B		
Southbound								
L	413	1233	1.20	0.69	139.4	F		
T	872	2137	0.90	0.41	46.8	D	68.2	E
R	502	730	0.73	0.69	17.4	B		

Intersection Delay = 67.0 (sec/veh) Intersection LOS = E

HCS+: Signalized Intersections Release 5.4

I-290
Existing

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst:
Agency/Co.: PB
Date Performed: 6/25/2010
Analysis Time Period: PM Peak
Intersection: I-290 Ramps & Harlem Avenue
Area Type: CBD or Similar
Jurisdiction:
Analysis Year: Existing
Project ID: I-290 Phase 1 Study
E/W St: I-290 Ramps N/S St: Harlem Avenue

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	232		229	298		283	282	802	360	470	745	407
% Heavy Veh	10		10	10		10	10	10	10	10	10	10
PHF	0.95		0.95	0.95		0.95	0.95	0.95	0.95	0.95	0.95	0.95
PK 15 Vol	61		60	78		74	74	211	95	124	196	107
Hi Ln Vol												
% Grade		0			0			0			0	
Ideal Sat	1800		1800	1800		1800	1800	1300	1800	1800	1500	1800
ParkExist												
NumPark												
No. Lanes	1	0	1	1	0	1	1	2	1	1	2	1
LGConfig	L		R	L		R	L	T	R	L	T	R
Lane Width	11.0		11.0	10.5		10.5	11.0	10.0	10.0	11.0	10.0	10.0
RTOR Vol			43			60			60			60
Adj Flow	244		196	314		235	297	844	316	495	784	365
%InSharedLn												
Prop LTs							1.000	0.000		1.000	0.000	
Prop RTs			1.000			1.000		0.000	1.000		0.000	1.000
Peds Bikes	0			0				300	0		300	0
Buses	0		0	0		0	0	10	0	0	10	0
%InProtPhase							0.0		0.0	0.0		0.0

Duration 0.25 Area Type: CBD or Similar

OPERATING PARAMETERS

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Init Unmet	0.0		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
Arriv. Type	3		3	3		3	3	3	3	3	3	3
Unit Ext.	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0
I Factor		1.000			1.000			1.000			1.000	
Lost Time	2.0		2.0	2.0		2.0	2.0	2.0	2.0	2.0	2.0	2.0
Ext of g	3.0		3.0	3.0		3.0	2.0	3.0	3.0	3.0	3.0	3.0
Ped Min g		3.2			3.2			6.0			6.0	

```
_________________________________PHASE DATA____________________________________

Phase Combination 1     2     3     4 |           5     6     7     8

EB  Left           A                 | NB  Left   A     A
    Thru                             |     Thru         A
    Right                            |     Right        A
    Peds                             |     Peds         X

WB  Left           A                 | SB  Left   A     A
    Thru                             |     Thru         A
    Right                            |     Right        A
    Peds                             |     Peds         X

NB  Right          A                 | EB  Right  A
                                     |
SB  Right          A                 | WB  Right  A
                                     |
                                     |
Green             30.0                         30.0  50.0
Yellow            4.0                          4.0   4.0
All Red           1.0                          1.0   1.0

                                                   Cycle Length: 125.0   secs

_________________VOLUME ADJUSTMENT AND SATURATION FLOW WORKSHEET_______________
Volume Adjustment
           |  Eastbound     |  Westbound     |  Northbound    |  Southbound    |
           | L    T    R    | L    T    R    | L    T    R    | L    T    R    |
           |________________|________________|________________|________________|
Volume, V  |232       229   |298       283   |282  802  360   |470  745  407   |
PHF        |0.95      0.95  |0.95      0.95  |0.95 0.95 0.95  |0.95 0.95 0.95  |
Adj flow   |244       196   |314       235   |297  844  316   |495  784  365   |
No. Lanes  |  1   0   1     |  1   0   1     |  1   2   1     |  1   2   1     |
Lane group | L         R    | L         R    | L    T    R    | L    T    R    |
Adj flow   |244       196   |314       235   |297  844  316   |495  784  365   |
Prop LTs   |                |                |1.000 0.000     |1.000 0.000     |
Prop RTs   |         1.000  |         1.000  |   0.000 1.000  |   0.000 1.000  |

Saturation Flow Rate (see Exhibit 16-7 to determine the adjustment factors)____
         Eastbound          Westbound         Northbound        Southbound
LG     L           R     L           R     L     T     R     L     T     R
So    1800        1800  1800        1800  1800  1300  1800  1800  1500  1800
Lanes 1     0     1     1     0     1     1     2     1     1     2     1
fW    0.967       0.967 0.950       0.950 0.967 0.933 0.933 0.967 0.933 0.933
fHV   0.909       0.909 0.909       0.909 0.909 0.909 0.909 0.909 0.909 0.909
fG    1.000       1.000 1.000       1.000 1.000 1.000 1.000 1.000 1.000 1.000
fP    1.000       1.000 1.000       1.000 1.000 1.000 1.000 1.000 1.000 1.000
fBB   1.000       1.000 1.000       1.000 1.000 0.980 1.000 1.000 0.980 1.000
fA    0.900       0.900 0.900       0.900 0.900 0.900 0.900 0.900 0.900 0.900
fLU   1.000       1.000 1.000       1.000 1.000 0.952 1.000 1.000 0.952 1.000
fRT               0.850             0.850       1.000 0.850       1.000 0.850
fLT   0.950             0.950             0.950 1.000       0.950 1.000
Sec.                                      0.214             0.188
fLpb  1.000             1.000             0.901 1.000       0.912 1.000
fRpb              1.000             1.000       1.000 0.625       1.000 0.625
S     1352        1210  1329        1189  1219  1852  730   1233  2137  730
Sec.                                      274               244
_________________________CAPACITY AND LOS WORKSHEET____________________________
Capacity Analysis and Lane Group Capacity
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Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- Capacity (c)	v/c Ratio
Eastbound							
Prot							
Perm							
Left	L	244	1352	0.18	0.25	335	0.73
Prot							
Perm							
Thru							
Right	R	196	1210	0.16	0.25	300	0.65
Westbound							
Prot							
Perm							
Left	L	314	1329	# 0.24	0.25	330	0.95
Prot							
Perm							
Thru							
Right	R	235	1189	0.20	0.25	295	0.80
Northbound							
Prot		293	1219	0.24	0.240	293	1.00
Perm		4	274	0.01	0.440	121	0.03
Left	L	297			0.68	414	0.72
Prot							
Perm							
Thru	T	844	1852	0.46	0.41	756	1.12
Right	R	316	730	0.43	0.69	502	0.63
Southbound							
Prot		306	1233	# 0.25	0.248	306	1.00
Perm		189	244	# 0.77	0.440	107	1.77
Left	L	495			0.69	413	1.20
Prot							
Perm							
Thru	T	784	2137	0.37	0.41	872	0.90
Right	R	365	730	0.50	0.69	502	0.73

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 1.26
Total lost time per cycle, L = 8.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 1.35

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	LOS	Approach Delay	LOS
Eastbound												
L	0.73	0.25	43.1	1.000	335	0.29	7.8	0.0	50.9	D		
											49.3	D
R	0.65	0.25	42.2	1.000	300	0.23	5.0	0.0	47.2	D		
Westbound												
L	0.95	0.25	46.3	1.000	330	0.46	36.8	0.0	83.1	F		
											72.4	E
R	0.80	0.25	44.0	1.000	295	0.34	14.1	0.0	58.2	E		
Northbound												
L	0.72	0.68	15.7	1.000	414	0.28	5.9	0.0	21.6	C		
T	1.12	0.41	37.0	1.000	756	0.50	69.6	0.0	106.6	F	69.0	E
R	0.63	0.69	10.7	1.000	502	0.21	2.5	0.0	13.3	B		
Southbound												
L	1.20	0.69	28.8	1.000	413	0.50	110.6	0.0	139.4	F		
T	0.90	0.41	34.6	1.000	872	0.42	12.2	0.0	46.8	D	68.2	E

```
R    0.73  0.69  12.2  1.000 502   0.29   5.3   0.0   17.4   B
________________________________________________________________________________
         Intersection delay = 67.0  (sec/veh)   Intersection LOS = E



______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                              for exclusive lefts
Input
                                                       EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                          125.0   sec
Total actual green time for LT lane group, G (s)                   85.0  85.0
Effective permitted green time for LT lane group, g(s)             55.0  55.0
Opposing effective green time, go (s)                              51.0  51.0
Number of lanes in LT lane group, N                                1     1
Number of lanes in opposing approach, No                           2     2
Adjusted LT flow rate, VLT (veh/h)                                 297   495
Proportion of LT in LT lane group, PLT                             1.000 1.000
Proportion of LT in opposing flow, PLTo                            0.00  0.00
Adjusted opposing flow rate, Vo (veh/h)                            784   844
Lost time for LT lane group, tL                                    5.00  4.00
Computation
LT volume per cycle, LTC=VLTC/3600                                 10.31 17.19
Opposing lane util. factor, fLUo                                   0.952 0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)                14.30 15.39
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g                              0.0   0.0
Opposing platoon ratio, Rpo (refer Exhibit 16-11)                  1.00  1.00
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]                       0.59  0.59
gq, (see Exhibit C16-4,5,6,7,8)                                    21.95 24.18
gu=g-gq if gq>=gf, or = g-gf if gq<gf                              33.05 30.82
n=Max(gq-gf)/2,0)                                                  10.97 12.09
PTHo=1-PLTo                                                        1.00  1.00
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]                                 1.00  1.00
EL1 (refer to Exhibit C16-3)                                       2.81  2.98
EL2=Max((1-Ptho**n)/Plto, 1.0)
fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g                                 0.07  0.07
gdiff=max(gq-gf,0)                                                 0.00  0.00
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)                0.21  0.19
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
or flt=[fm+0.91(N-1)]/N**
Left-turn adjustment, fLT                                          0.214 0.188

For special case of single-lane approach opposed by multilane approach,
see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
  left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach
or when gf>gq, see text.

______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                                for shared lefts
Input
                                                       EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                          125.0   sec
Total actual green time for LT lane group, G (s)
Effective permitted green time for LT lane group, g(s)
Opposing effective green time, go (s)
Number of lanes in LT lane group, N
```

Number of lanes in opposing approach, No				
Adjusted LT flow rate, VLT (veh/h)				
Proportion of LT in LT lane group, PLT			0.000	0.000
Proportion of LT in opposing flow, PLTo				
Adjusted opposing flow rate, Vo (veh/h)				
Lost time for LT lane group, tL				
Computation				
LT volume per cycle, LTC=VLTC/3600				
Opposing lane util. factor, fLUo			0.952	0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)				
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g				
Opposing platoon ratio, Rpo (refer Exhibit 16-11)				
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]				
gq, (see Exhibit C16-4,5,6,7,8)				
gu=g-gq if gq>=gf, or = g-gf if gq<gf				
n=Max(gq-gf)/2,0)				
PTHo=1-PLTo				
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]				
EL1 (refer to Exhibit C16-3)				
EL2=Max((1-Ptho**n)/Plto, 1.0)				
fmin=2(1+PL)/g or fmin=2(1+Pl)/g				
gdiff=max(gq-gf,0)				
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)				
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)				
or flt=[fm+0.91(N-1)]/N**				
Left-turn adjustment, fLT				

For special case of single-lane approach opposed by multilane approach, see text.

* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto left-turn lane and redo calculations.

** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.

For special case of multilane approach opposed by single-lane approach or when gf>gq, see text.

SUPPLEMENTAL PEDESTRIAN-BICYCLE EFFECTS WORKSHEET

Permitted Left Turns

	EB	WB	NB	SB
Effective pedestrian green time, gp (s)			50.0	50.0
Conflicting pedestrian volume, Vped (p/h)			300	300
Pedestrian flow rate, Vpedg (p/h)			750	750
OCCpedg			0.375	0.375
Opposing queue clearing green, gq (s)			21.95	24.18
Eff. ped. green consumed by opp. veh. queue, gq/gp			0.439	0.484
OCCpedu			0.293	0.284
Opposing flow rate, Vo (veh/h)			784	844
OCCr			0.099	0.088
Number of cross-street receiving lanes, Nrec			1	1
Number of turning lanes, Nturn			1	1
ApbT			0.901	0.912
Proportion of left turns, PLT			1.000	1.000
Proportion of left turns using protected phase, PLTA			0.000	0.000
Left-turn adjustment, fLpb			0.901	0.912
Permitted Right Turns				
Effective pedestrian green time, gp (s)			50.0	50.0
Conflicting pedestrian volume, Vped (p/h)			300	300
Conflicting bicycle volume, Vbic (bicycles/h)			0	0
Vpedg			750	750
OCCpedg			0.375	0.375
Effective green, g (s)			55.0	55.0
Vbicg			0	0

OCCbicg			0.020	0.020
OCCr			0.375	0.375
Number of cross-street receiving lanes, Nrec			1	1
Number of turning lanes, Nturn			1	1
ApbT			0.625	0.625
Proportion right-turns, PRT			1.000	1.000
Proportion right-turns using protected phase, PRTA			0.000	0.000
Right turn adjustment, fRpb			1.000	1.000

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

	EBLT	WBLT	NBLT	SBLT
Cycle length, C 125.0 sec				
Adj. LT vol from Vol Adjustment Worksheet, v			297	495
v/c ratio from Capacity Worksheet, X			0.72	1.20
Protected phase effective green interval, g (s)			30.0	31.0
Opposing queue effective green interval, gq			21.95	24.18
Unopposed green interval, gu			33.05	30.82
Red time r=(C-g-gq-gu)			40.0	39.0
Arrival rate, qa=v/(3600(max[X,1.0]))			0.08	0.11
Protected ph. departure rate, Sp=s/3600			0.339	0.343
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)			0.13	0.12
XPerm			1.08	1.69
XProt			0.57	0.76
Case			3	3
Queue at beginning of green arrow, Qa			3.65	7.06
Queue at beginning of unsaturated green, Qu			1.81	2.77
Residual queue, Qr			0.35	2.58
Uniform Delay, d1			15.7	28.8

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
L	0.0	0.00	47.0	43.1	0.00	0.0	0.0	50.9
	0.0						0.0	
R	0.0	0.00	47.0	42.2	0.00	0.0	0.0	47.2
Westbound								
L	0.0	0.00	47.0	46.3	0.00	0.0	0.0	83.1
	0.0						0.0	
R	0.0	0.00	47.0	44.0	0.00	0.0	0.0	58.2
Northbound								
L	0.0	0.00		15.7	0.00	0.0	0.0	21.6
T	0.0	0.00	37.0	37.0	0.00	22.0	0.0	106.6
R	0.0	0.00	19.5	10.7	0.00	0.0	0.0	13.3
Southbound								
L	0.0	0.00		28.8	0.00	20.5	0.0	139.4
T	0.0	0.00	37.0	34.6	0.00	0.0	0.0	46.8
R	0.0	0.00	19.5	12.2	0.00	0.0	0.0	17.4

Intersection Delay 67.0 sec/veh Intersection LOS E

BACK OF QUEUE WORKSHEET

	Eastbound			Westbound			Northbound			Southbound		
LaneGroup	L		R	L		R	L	T	R	L	T	R
Init Queue	0.0		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
Flow Rate	244		196	314		235	297	443	316	495	411	365
So	1800		1800	1800		1800	1800	1300	1800	1800	1500	1800
No.Lanes	1	0	1	1	0	1	1	2	1	1	2	1
SL	1352		1210	1329		1189	608	972	730	600	1122	730
LnCapacity	335		300	330		295	414	397	502	413	457	502
Flow Ratio	0.2		0.2	0.2		0.2	0.5	0.5	0.4	0.8	0.4	0.5
v/c Ratio	0.73		0.65	0.95		0.80	0.72	1.12	0.63	1.20	0.90	0.73
Grn Ratio	0.25		0.25	0.25		0.25	0.68	0.41	0.69	0.69	0.41	0.69
I Factor		1.000			1.000			1.000			1.000	
AT or PVG	3		3	3		3	3	3	3	3	3	3
Pltn Ratio	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00
PF2	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00
Q1	7.8		6.1	10.7		7.6	4.0	15.4	6.0	7.1	13.3	7.9
kB	0.4		0.4	0.4		0.4	0.5	0.5	0.6	0.5	0.5	0.6
Q2	1.1		0.7	3.2		1.3	1.2	8.8	0.9	12.7	3.1	1.4
Q Average	8.8		6.8	14.0		9.0	5.1	24.2	6.9	19.8	16.4	9.3
Q Spacing	25.0		25.0	25.0		25.0	25.0	25.0	25.0	25.0	25.0	25.0
Q Storage	0		0	0		0	170	0	155	490	0	220
Q S Ratio							0.8		1.1	1.0		1.1
70th Percentile Output:												
fB%	1.2		1.2	1.2		1.2	1.2	1.2	1.2	1.2	1.2	1.2
BOQ	10.4		8.1	16.3		10.6	6.1	27.9	8.2	23.0	19.1	10.9
QSRatio							0.9		1.3	1.2		1.2
85th Percentile Output:												
fB%	1.5		1.5	1.5		1.5	1.6	1.4	1.5	1.5	1.5	1.5
BOQ	13.5		10.5	20.8		13.7	8.0	34.7	10.7	28.8	24.2	14.1
QSRatio							1.2		1.7	1.5		1.6
90th Percentile Output:												
fB%	1.7		1.7	1.6		1.7	1.7	1.5	1.7	1.5	1.6	1.7
BOQ	14.7		11.5	22.3		14.9	8.8	36.7	11.7	30.7	25.9	15.3
QSRatio							1.3		1.9	1.6		1.7
95th Percentile Output:												
fB%	1.9		1.9	1.8		1.9	2.0	1.7	1.9	1.7	1.7	1.9
BOQ	16.5		13.1	24.8		16.8	10.0	40.0	13.3	33.6	28.6	17.3
QSRatio							1.5		2.1	1.7		2.0
98th Percentile Output:												
fB%	2.2		2.3	2.0		2.2	2.4	1.9	2.3	1.9	2.0	2.2
BOQ	19.5		15.7	28.5		19.8	12.2	44.9	15.9	38.0	32.5	20.3
QSRatio							1.8		2.6	1.9		2.3

ERROR MESSAGES

No errors to report.

HCS+: Signalized Intersections Release 5.4

Analyst:	Inter.: I-290 Ramps & Austin Boulevard
Agency: PB	Area Type: CBD or Similar
Date: 6/25/2010	Jurisd:
Period: AM Peak	Year : Existing
Project ID: I-290 Phase 1 Study	
E/W St: I-290 Ramps	N/S St: Austin Boulevard

SIGNALIZED INTERSECTION SUMMARY

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
No. Lanes	1	0	1	1	0	1	1	2	1	1	2	1
LGConfig	L		R	L		R	L	T	R	L	LT	R
Volume	109		73	487		401	350	479	632	548	481	181
Lane Width	10.0		10.0	10.5		11.0	11.0	10.5	10.0	10.0	10.0	10.0
RTOR Vol			57			60			17			54

Duration 0.25 Area Type: CBD or Similar

Signal Operations

Phase Combination	1	2	3	4			5	6	7	8
EB Left	A				NB	Left	A			
Thru						Thru	A			
Right						Right	A			
Peds						Peds	X			
WB Left	A				SB	Left		A		
Thru						Thru		A		
Right						Right		A		
Peds						Peds		X		
NB Right	A				EB	Right	A			
SB Right	A				WB	Right		A		
Green	50.0						30.0	30.0		
Yellow	4.0						4.0	4.0		
All Red	1.0						1.0	1.0		

Cycle Length: 125.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
L	558	1368	0.21	0.41	24.1	C		
							25.6	C
R	304	1224	0.06	0.25	35.9	D		
Westbound								
L	568	1392	0.90	0.41	52.5	D		
							89.5	F
R	314	1268	1.14	0.25	142.4	F		
Northbound								
L	351	1417	1.05	0.25	108.3	F		
T	490	1975	1.03	0.25	95.2	F	84.0	F
R	632	918	1.02	0.69	61.5	E		
Southbound								
L	339	1368	0.90	0.25	71.7	E		
LT	473	1907	1.64	0.25	345.6	F	239.6	F
R	491	714	0.27	0.69	7.8	A		

Intersection Delay = 133.8 (sec/veh) Intersection LOS = F

HCS+: Signalized Intersections Release 5.4

I-290
Existing

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst:
Agency/Co.: PB
Date Performed: 6/25/2010
Analysis Time Period: AM Peak
Intersection: I-290 Ramps & Austin Boulevard
Area Type: CBD or Similar
Jurisdiction:
Analysis Year: Existing
Project ID: I-290 Phase 1 Study
E/W St: I-290 Ramps N/S St: Austin Boulevard

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	109		73	487		401	350	479	632	548	481	181
% Heavy Veh	5		5	5		5	5	5	5	5	5	5
PHF	0.95		0.95	0.95		0.95	0.95	0.95	0.95	0.95	0.95	0.95
PK 15 Vol	29		19	128		106	92	126	166	144	127	48
Hi Ln Vol												
% Grade		0			0			0			0	
Ideal Sat	1800		1800	1800		1800	1800	1300	1800	1800	1300	1800
ParkExist												
NumPark												
No. Lanes	1	0	1	1	0	1	1	2	1	1	2	1
LGConfig	L		R	L		R	L	T	R	L	LT	R
Lane Width	10.0		10.0	10.5		11.0	11.0	10.5	10.0	10.0	10.0	10.0
RTOR Vol			57			60			17			54
Adj Flow	115		17	513		359	368	504	647	306	777	134
%InSharedLn										47		
Prop LTs								0.000			0.349	
Prop RTs			1.000			1.000		0.000	1.000		0.000	1.000
Peds Bikes	0			0			200	0		200	0	
Buses	0		0	0		0	0	10	0	0	10	0
%InProtPhase									0.0			0.0

Duration 0.25 Area Type: CBD or Similar

OPERATING PARAMETERS

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Init Unmet	0.0		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
Arriv. Type	3		3	3		3	3	3	3	3	3	3
Unit Ext.	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0
I Factor		1.000			1.000			1.000			1.000	
Lost Time	2.0		2.0	2.0		2.0	2.0	2.0	2.0	2.0	2.0	2.0
Ext of g	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0
Ped Min g		3.2			3.2			5.1			5.1	

PHASE DATA

Phase Combination		1	2	3	4			5	6	7	8
EB	Left	A				NB	Left	A			
	Thru						Thru	A			
	Right						Right	A			
	Peds						Peds	X			
WB	Left	A				SB	Left		A		
	Thru						Thru		A		
	Right						Right		A		
	Peds						Peds		X		
NB	Right	A				EB	Right	A			
SB	Right	A				WB	Right		A		
Green		50.0						30.0	30.0		
Yellow		4.0						4.0	4.0		
All Red		1.0						1.0	1.0		

Cycle Length: 125.0 secs

VOLUME ADJUSTMENT AND SATURATION FLOW WORKSHEET

Volume Adjustment

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume, V	109		73	487		401	350	479	632	548	481	181
PHF	0.95		0.95	0.95		0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj flow	115		17	513		359	368	504	647	577	506	134
No. Lanes	1	0	1	1	0	1	1	2	1	1	2	1
Lane group	L		R	L		R	L	T	R	L	LT	R
Adj flow	115		17	513		359	368	504	647	306	777	134
Prop LTs								0.000			0.349	
Prop RTs			1.000			1.000		0.000	1.000		0.000	1.000

Saturation Flow Rate (see Exhibit 16-7 to determine the adjustment factors)

	Eastbound			Westbound			Northbound			Southbound		
LG	L		R	L		R	L	T	R	L	LT	R
So	1800		1800	1800		1800	1800	1300	1800	1800	1300	1800
Lanes	1	0	1	1	0	1	1	2	1	1	2	1
fW	0.933		0.933	0.950		0.967	0.967	0.950	0.933	0.933	0.933	0.933
fHV	0.952		0.952	0.952		0.952	0.952	0.952	0.952	0.952	0.952	0.952
fG	1.000		1.000	1.000		1.000	1.000	1.000	1.000	1.000	1.000	1.000
fP	1.000		1.000	1.000		1.000	1.000	1.000	1.000	1.000	1.000	1.000
fBB	1.000		1.000	1.000		1.000	1.000	0.980	1.000	1.000	0.980	1.000
fA	0.900		0.900	0.900		0.900	0.900	0.900	0.900	0.900	0.900	0.900
fLU	1.000		1.000	1.000		1.000	1.000	0.952	1.000	1.000	0.952	1.000
fRT			0.850			0.850		1.000	0.850		1.000	0.850
fLT	0.950			0.950			0.950	1.000		0.950	0.983	
Sec.												
fLpb	1.000			1.000			1.000	1.000		1.000	1.000	
fRpb			1.000			1.000		1.000	0.750		1.000	0.583
S	1368		1224	1392		1268	1417	1975	918	1368	1907	714
Sec.												

CAPACITY AND LOS WORKSHEET

Capacity Analysis and Lane Group Capacity

Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- Capacity (c)	v/c Ratio
Eastbound							
Prot							
Perm							
Left	L	115	1368	0.08	0.41	558	0.21
Prot							
Perm							
Thru							
Right	R	17	1224	0.01	0.25	304	0.06
Westbound							
Prot							
Perm							
Left	L	513	1392	0.37	0.41	568	0.90
Prot							
Perm							
Thru							
Right	R	359	1268	0.28	0.25	314	1.14
Northbound							
Prot							
Perm							
Left	L	368	1417	0.26	0.25	351	1.05
Prot							
Perm							
Thru	T	504	1975	0.26	0.25	490	1.03
Right	R	647	918	# 0.70	0.69	632	1.02
Southbound							
Prot							
Perm							
Left	L	306	1368	0.22	0.25	339	0.90
Prot							
Perm							
Thru	LT	777	1907	# 0.41	0.25	473	1.64
Right	R	134	714	0.19	0.69	491	0.27

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 1.11
Total lost time per cycle, L = 8.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 1.19

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	LOS	Approach Delay	LOS
Eastbound												
L	0.21	0.41	23.9	1.000	558	0.11	0.2	0.0	24.1	C		
											25.6	C
R	0.06	0.25	35.8	1.000	304	0.11	0.1	0.0	35.9	D		
Westbound												
L	0.90	0.41	34.7	1.000	568	0.42	17.8	0.0	52.5	D		
											89.5	F
R	1.14	0.25	47.0	1.000	314	0.50	95.4	0.0	142.4	F		
Northbound												
L	1.05	0.25	47.0	1.000	351	0.50	61.3	0.0	108.3	F		
T	1.03	0.25	47.0	1.000	490	0.50	48.2	0.0	95.2	F	84.0	F
R	1.02	0.69	19.5	1.000	632	0.50	42.0	0.0	61.5	E		
Southbound												
L	0.90	0.25	45.5	1.000	339	0.42	26.1	0.0	71.7	E		
LT	1.64	0.25	47.0	1.000	473	0.50	298.6	0.0	345.6	F	239.6	F

```
R    0.27  0.69  7.5   1.000 491   0.11   0.3   0.0   7.8    A
_______________________________________________________________________________
         Intersection delay = 133.8 (sec/veh)   Intersection LOS = F



______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                              for exclusive lefts
Input
                                                        EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                          125.0   sec
Total actual green time for LT lane group, G (s)
Effective permitted green time for LT lane group, g(s)
Opposing effective green time, go (s)
Number of lanes in LT lane group, N
Number of lanes in opposing approach, No
Adjusted LT flow rate, VLT (veh/h)
Proportion of LT in LT lane group, PLT
Proportion of LT in opposing flow, PLTo
Adjusted opposing flow rate, Vo (veh/h)
Lost time for LT lane group, tL
Computation
LT volume per cycle, LTC=VLTC/3600
Opposing lane util. factor, fLUo                                    0.952 0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g
Opposing platoon ratio, Rpo (refer Exhibit 16-11)
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]
gq, (see Exhibit C16-4,5,6,7,8)
gu=g-gq if gq>=gf, or = g-gf if gq<gf
n=Max(gq-gf)/2,0)
PTHo=1-PLTo
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]
EL1 (refer to Exhibit C16-3)
EL2=Max((1-Ptho**n)/Plto, 1.0)
fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g
gdiff=max(gq-gf,0)
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
or flt=[fm+0.91(N-1)]/N**
Left-turn adjustment, fLT

For special case of single-lane approach opposed by multilane approach,
see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
  left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach
or when gf>gq, see text.

______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                                for shared lefts
Input
                                                        EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                          125.0   sec
Total actual green time for LT lane group, G (s)
Effective permitted green time for LT lane group, g(s)
Opposing effective green time, go (s)
Number of lanes in LT lane group, N
```

```
Number of lanes in opposing approach, No
Adjusted LT flow rate, VLT (veh/h)
Proportion of LT in LT lane group, PLT                               0.000 0.349
Proportion of LT in opposing flow, PLTo
Adjusted opposing flow rate, Vo (veh/h)
Lost time for LT lane group, tL
Computation
LT volume per cycle, LTC=VLTC/3600
Opposing lane util. factor, fLUo                                     0.952 0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g
Opposing platoon ratio, Rpo (refer Exhibit 16-11)
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]
gq, (see Exhibit C16-4,5,6,7,8)
gu=g-gq if gq>=gf, or = g-gf if gq<gf
n=Max(gq-gf)/2,0)
PTHo=1-PLTo
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]
EL1 (refer to Exhibit C16-3)
EL2=Max((1-Ptho**n)/Plto, 1.0)
fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g
gdiff=max(gq-gf,0)
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
or flt=[fm+0.91(N-1)]/N**
Left-turn adjustment, fLT

For special case of single-lane approach opposed by multilane approach,
see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
  left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach
or when gf>gq, see text.

_______________SUPPLEMENTAL PEDESTRIAN-BICYCLE EFFECTS WORKSHEET_______________
Permitted Left Turns
                                                         EB    WB    NB    SB
Effective pedestrian green time, gp (s)
Conflicting pedestrian volume, Vped (p/h)
Pedestrian flow rate, Vpedg (p/h)
OCCpedg
Opposing queue clearing green, gq (s)
Eff. ped. green consumed by opp. veh. queue, gq/gp
OCCpedu
Opposing flow rate, Vo (veh/h)
OCCr
Number of cross-street receiving lanes, Nrec
Number of turning lanes, Nturn
ApbT
Proportion of left turns, PLT
Proportion of left turns using protected phase, PLTA
Left-turn adjustment, fLpb
Permitted Right Turns
Effective pedestrian green time, gp (s)                             30.0  30.0
Conflicting pedestrian volume, Vped (p/h)                           200   200
Conflicting bicycle volume, Vbic (bicycles/h)                       0     0
Vpedg                                                               833   833
OCCpedg                                                             0.417 0.417
Effective green, g (s)                                              0.0   0.0
Vbicg                                                               0     0
```

OCCbicg	0.020	0.020
OCCr	0.417	0.417
Number of cross-street receiving lanes, Nrec	2	1
Number of turning lanes, Nturn	1	1
ApbT	0.750	0.583
Proportion right-turns, PRT	1.000	1.000
Proportion right-turns using protected phase, PRTA	0.000	0.000
Right turn adjustment, fRpb	1.000	1.000

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

		EBLT	WBLT	NBLT	SBLT
Cycle length, C	125.0 sec				
Adj. LT vol from Vol Adjustment Worksheet, v					
v/c ratio from Capacity Worksheet, X					
Protected phase effective green interval, g (s)					
Opposing queue effective green interval, gq					
Unopposed green interval, gu					
Red time r=(C-g-gq-gu)					
Arrival rate, qa=v/(3600(max[X,1.0]))					
Protected ph. departure rate, Sp=s/3600					
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)					
XPerm					
XProt					
Case					
Queue at beginning of green arrow, Qa					
Queue at beginning of unsaturated green, Qu					
Residual queue, Qr					
Uniform Delay, d1					

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
L	0.0	0.00	37.0	23.9	0.00	0.0	0.0	24.1
	0.0						0.0	
R	0.0	0.00	47.0	35.8	0.00	0.0	0.0	35.9
Westbound								
L	0.0	0.00	37.0	34.7	0.00	0.0	0.0	52.5
	0.0						0.0	
R	0.0	0.00	47.0	47.0	0.00	11.3	0.0	142.4
Northbound								
L	0.0	0.00	47.0	47.0	0.00	4.3	0.0	108.3
T	0.0	0.00	47.0	47.0	0.00	3.5	0.0	95.2
R	0.0	0.00	19.5	19.5	0.00	3.8	0.0	61.5
Southbound								
L	0.0	0.00	47.0	45.5	0.00	0.0	0.0	71.7
LT	0.0	0.00	47.0	47.0	0.00	76.0	0.0	345.6
R	0.0	0.00	19.5	7.5	0.00	0.0	0.0	7.8

Intersection Delay 133.8 sec/veh Intersection LOS F

BACK OF QUEUE WORKSHEET

	Eastbound			Westbound			Northbound			Southbound		
LaneGroup	L		R	L		R	L	T	R	L	LT	R
Init Queue	0.0		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
Flow Rate	115		17	513		359	368	264	647	306	408	134
So	1800		1800	1800		1800	1800	1300	1800	1800	1300	1800
No.Lanes	1	0	1	1	0	1	1	2	1	1	2	1
SL	1368		1224	1392		1268	1417	1037	918	1368	1001	714
LnCapacity	558		304	568		314	351	257	632	339	248	491
Flow Ratio	0.1		0.0	0.4		0.3	0.3	0.3	0.7	0.2	0.4	0.2
v/c Ratio	0.21		0.06	0.90		1.14	1.05	1.03	1.02	0.90	1.65	0.27
Grn Ratio	0.41		0.25	0.41		0.25	0.25	0.25	0.69	0.25	0.25	0.69
I Factor		1.000			1.000			1.000			1.000	
AT or PVG	3		3	3		3	3	3	3	3	3	3
Pltn Ratio	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00
PF2	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00
Q1	2.6		0.5	16.7		12.5	12.8	9.2	22.5	10.3	14.2	1.8
kB	0.6		0.4	0.6		0.4	0.4	0.4	0.6	0.4	0.4	0.5
Q2	0.2		0.0	3.6		8.0	5.7	4.0	8.2	2.5	20.9	0.2
Q Average	2.7		0.5	20.3		20.4	18.5	13.1	30.6	12.8	35.1	2.0
Q Spacing	25.0		25.0	25.0		25.0	25.0	25.0	25.0	25.0	25.0	25.0
Q Storage	0		185	530		0	150	0	200	165	0	160
Q S Ratio			0.1	1.0			3.1		3.8	1.9		0.3
70th Percentile Output:												
fB%	1.2		1.2	1.2		1.2	1.2	1.2	1.1	1.2	1.1	1.2
BOQ	3.3		0.6	23.6		23.7	21.5	15.4	35.1	15.0	40.0	2.4
QSRatio			0.1	1.1			3.6		4.4	2.3		0.4
85th Percentile Output:												
fB%	1.6		1.6	1.5		1.5	1.5	1.5	1.4	1.5	1.4	1.6
BOQ	4.3		0.8	29.5		29.7	27.1	19.6	43.1	19.2	48.8	3.1
QSRatio			0.1	1.4			4.5		5.4	2.9		0.5
90th Percentile Output:												
fB%	1.7		1.8	1.5		1.5	1.6	1.6	1.5	1.6	1.5	1.8
BOQ	4.8		0.8	31.4		31.6	28.8	21.1	45.6	20.6	51.5	3.5
QSRatio			0.1	1.5			4.8		5.7	3.1		0.5
95th Percentile Output:												
fB%	2.0		2.1	1.7		1.7	1.7	1.8	1.6	1.8	1.6	2.0
BOQ	5.5		1.0	34.5		34.6	31.7	23.5	49.3	23.0	55.6	4.1
QSRatio			0.1	1.6			5.3		6.2	3.5		0.6
98th Percentile Output:												
fB%	2.5		2.7	1.9		1.9	1.9	2.1	1.8	2.1	1.8	2.6
BOQ	6.9		1.3	38.8		39.0	35.9	27.1	55.0	26.6	62.0	5.1
QSRatio			0.2	1.8			6.0		6.9	4.0		0.8

ERROR MESSAGES

No errors to report.

HCS+: Signalized Intersections Release 5.4

Analyst:
Agency: PB
Date: 6/25/2010
Period: PM Peak
Project ID: I-290 Phase 1 Study
E/W St: I-290 Ramps

Inter.: I-290 Ramps & Austin Boulevard
Area Type: CBD or Similar
Jurisd:
Year : Existing
N/S St: Austin Boulevard

SIGNALIZED INTERSECTION SUMMARY

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	1	0	1	1	0	1	1	2	1	1	2	1
LGConfig	L		R	L		R	L	T	R	L	LT	R
Volume	160		301	767		333	295	479	195	767	306	175
Lane Width	10.0		10.0	10.5		11.0	11.0	10.5	10.0	10.0	10.0	10.0
RTOR Vol			60			60			4			63

Duration 0.25 Area Type: CBD or Similar

Signal Operations

Phase Combination		1	2	3	4			5	6	7	8
EB	Left	A				NB	Left	A			
	Thru						Thru	A			
	Right						Right	A			
	Peds						Peds	X			
WB	Left	A				SB	Left		A		
	Thru						Thru		A		
	Right						Right		A		
	Peds						Peds		X		
NB	Right	A				EB	Right	A			
SB	Right	A				WB	Right		A		
Green		50.0						30.0	30.0		
Yellow		4.0						4.0	4.0		
All Red		1.0						1.0	1.0		

Cycle Length: 125.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
L	558	1368	0.30	0.41	25.3	C		
							47.7	D
R	304	1224	0.84	0.25	62.6	E		
Westbound								
L	568	1392	1.42	0.41	236.5	F		
							194.3	F
R	314	1268	0.91	0.25	75.5	E		
Northbound								
L	351	1417	0.89	0.25	68.0	E		
T	490	1975	1.03	0.25	95.2	F	69.6	E
R	632	918	0.32	0.69	8.1	A		
Southbound								
L	339	1368	1.19	0.25	158.8	F		
LT	468	1888	1.55	0.25	304.5	F	229.2	F
R	491	714	0.24	0.69	7.5	A		

Intersection Delay = 155.9 (sec/veh) Intersection LOS = F

HCS+: Signalized Intersections Release 5.4

I-290
Existing

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst:
Agency/Co.: PB
Date Performed: 6/25/2010
Analysis Time Period: PM Peak
Intersection: I-290 Ramps & Austin Boulevard
Area Type: CBD or Similar
Jurisdiction:
Analysis Year: Existing
Project ID: I-290 Phase 1 Study
E/W St: I-290 Ramps N/S St: Austin Boulevard

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	160		301	767		333	295	479	195	767	306	175
% Heavy Veh	5		5	5		5	5	5	5	5	5	5
PHF	0.95		0.95	0.95		0.95	0.95	0.95	0.95	0.95	0.95	0.95
PK 15 Vol	42		79	202		88	78	126	51	202	81	46
Hi Ln Vol												
% Grade		0			0			0			0	
Ideal Sat	1800		1800	1800		1800	1800	1300	1800	1800	1300	1800
ParkExist												
NumPark												
No. Lanes	1	0	1	1	0	1	1	2	1	1	2	1
LGConfig	L		R	L		R	L	T	R	L	LT	R
Lane Width	10.0		10.0	10.5		11.0	11.0	10.5	10.0	10.0	10.0	10.0
RTOR Vol			60			60			4			63
Adj Flow	168		254	807		287	311	504	201	404	725	118
%InSharedLn										50		
Prop LTs								0.000			0.557	
Prop RTs			1.000			1.000		0.000	1.000		0.000	1.000
Peds Bikes	0			0			200	0		200	0	
Buses	0		0	0		0	0	10	0	0	10	0
%InProtPhase									0.0			0.0

Duration 0.25 Area Type: CBD or Similar

OPERATING PARAMETERS

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Init Unmet	0.0		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
Arriv. Type	3		3	3		3	3	3	3	3	3	3
Unit Ext.	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0
I Factor		1.000			1.000			1.000			1.000	
Lost Time	2.0		2.0	2.0		2.0	2.0	2.0	2.0	2.0	2.0	2.0
Ext of g	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0
Ped Min g		3.2			3.2			5.1			5.1	

PHASE DATA

Phase Combination		1	2	3	4			5	6	7	8
EB	Left	A				NB	Left	A			
	Thru						Thru	A			
	Right						Right	A			
	Peds						Peds	X			
WB	Left	A				SB	Left		A		
	Thru						Thru		A		
	Right						Right		A		
	Peds						Peds		X		
NB	Right	A				EB	Right	A			
SB	Right	A				WB	Right		A		
Green		50.0						30.0	30.0		
Yellow		4.0						4.0	4.0		
All Red		1.0						1.0	1.0		

Cycle Length: 125.0 secs

VOLUME ADJUSTMENT AND SATURATION FLOW WORKSHEET

Volume Adjustment

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
Volume, V	160		301	767		333	295	479	195	767	306	175
PHF	0.95		0.95	0.95		0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj flow	168		254	807		287	311	504	201	807	322	118
No. Lanes	1	0	1	1	0	1	1	2	1	1	2	1
Lane group	L		R	L		R	L	T	R	L	LT	R
Adj flow	168		254	807		287	311	504	201	404	725	118
Prop LTs								0.000			0.557	
Prop RTs			1.000			1.000		0.000	1.000		0.000	1.000

Saturation Flow Rate (see Exhibit 16-7 to determine the adjustment factors)

	Eastbound			Westbound			Northbound			Southbound		
LG	L		R	L		R	L	T	R	L	LT	R
So	1800		1800	1800		1800	1800	1300	1800	1800	1300	1800
Lanes	1	0	1	1	0	1	1	2	1	1	2	1
fW	0.933		0.933	0.950		0.967	0.967	0.950	0.933	0.933	0.933	0.933
fHV	0.952		0.952	0.952		0.952	0.952	0.952	0.952	0.952	0.952	0.952
fG	1.000		1.000	1.000		1.000	1.000	1.000	1.000	1.000	1.000	1.000
fP	1.000		1.000	1.000		1.000	1.000	1.000	1.000	1.000	1.000	1.000
fBB	1.000		1.000	1.000		1.000	1.000	0.980	1.000	1.000	0.980	1.000
fA	0.900		0.900	0.900		0.900	0.900	0.900	0.900	0.900	0.900	0.900
fLU	1.000		1.000	1.000		1.000	1.000	0.952	1.000	1.000	0.952	1.000
fRT			0.850			0.850		1.000	0.850		1.000	0.850
fLT	0.950			0.950			0.950	1.000		0.950	0.973	
Sec.												
fLpb	1.000			1.000			1.000	1.000		1.000	1.000	
fRpb			1.000			1.000		1.000	0.750		1.000	0.583
S	1368		1224	1392		1268	1417	1975	918	1368	1888	714
Sec.												

CAPACITY AND LOS WORKSHEET

Capacity Analysis and Lane Group Capacity

Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- Capacity (c)	v/c Ratio
Eastbound							
Prot							
Perm							
Left	L	168	1368	0.12	0.41	558	0.30
Prot							
Perm							
Thru							
Right	R	254	1224	0.21	0.25	304	0.84
Westbound							
Prot							
Perm							
Left	L	807	1392	# 0.58	0.41	568	1.42
Prot							
Perm							
Thru							
Right	R	287	1268	0.23	0.25	314	0.91
Northbound							
Prot							
Perm							
Left	L	311	1417	0.22	0.25	351	0.89
Prot							
Perm							
Thru	T	504	1975	# 0.26	0.25	490	1.03
Right	R	201	918	0.22	0.69	632	0.32
Southbound							
Prot							
Perm							
Left	L	404	1368	0.30	0.25	339	1.19
Prot							
Perm							
Thru	LT	725	1888	# 0.38	0.25	468	1.55
Right	R	118	714	0.17	0.69	491	0.24

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 1.22
Total lost time per cycle, L = 12.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 1.35

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	LOS	Approach Delay	LOS
Eastbound												
L	0.30	0.41	25.0	1.000	558	0.11	0.3	0.0	25.3	C		
											47.7	D
R	0.84	0.25	44.6	1.000	304	0.37	18.0	0.0	62.6	E		
Westbound												
L	1.42	0.41	37.0	1.000	568	0.50	199.5	0.0	236.5	F		
											194.3	F
R	0.91	0.25	45.7	1.000	314	0.43	29.8	0.0	75.5	E		
Northbound												
L	0.89	0.25	45.3	1.000	351	0.41	22.7	0.0	68.0	E		
T	1.03	0.25	47.0	1.000	490	0.50	48.2	0.0	95.2	F	69.6	E
R	0.32	0.69	7.8	1.000	632	0.11	0.3	0.0	8.1	A		
Southbound												
L	1.19	0.25	47.0	1.000	339	0.50	111.8	0.0	158.8	F		
LT	1.55	0.25	47.0	1.000	468	0.50	257.5	0.0	304.5	F	229.2	F

```
R    0.24  0.69  7.3   1.000 491   0.11   0.3   0.0   7.5    A
_______________________________________________________________________________
         Intersection delay = 155.9 (sec/veh)   Intersection LOS = F



______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                              for exclusive lefts
Input
                                                        EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                           125.0   sec
Total actual green time for LT lane group, G (s)
Effective permitted green time for LT lane group, g(s)
Opposing effective green time, go (s)
Number of lanes in LT lane group, N
Number of lanes in opposing approach, No
Adjusted LT flow rate, VLT (veh/h)
Proportion of LT in LT lane group, PLT
Proportion of LT in opposing flow, PLTo
Adjusted opposing flow rate, Vo (veh/h)
Lost time for LT lane group, tL
Computation
LT volume per cycle, LTC=VLTC/3600
Opposing lane util. factor, fLUo                                    0.952 0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g
Opposing platoon ratio, Rpo (refer Exhibit 16-11)
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]
gq, (see Exhibit C16-4,5,6,7,8)
gu=g-gq if gq>=gf, or = g-gf if gq<gf
n=Max(gq-gf)/2,0)
PTHo=1-PLTo
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]
EL1 (refer to Exhibit C16-3)
EL2=Max((1-Ptho**n)/Plto, 1.0)
fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g
gdiff=max(gq-gf,0)
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
or flt=[fm+0.91(N-1)]/N**
Left-turn adjustment, fLT

For special case of single-lane approach opposed by multilane approach,
see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
  left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach
or when gf>gq, see text.

______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                                for shared lefts
Input
                                                        EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                           125.0   sec
Total actual green time for LT lane group, G (s)
Effective permitted green time for LT lane group, g(s)
Opposing effective green time, go (s)
Number of lanes in LT lane group, N
```

Number of lanes in opposing approach, No				
Adjusted LT flow rate, VLT (veh/h)				
Proportion of LT in LT lane group, PLT			0.000	0.557
Proportion of LT in opposing flow, PLTo				
Adjusted opposing flow rate, Vo (veh/h)				
Lost time for LT lane group, tL				
Computation				
LT volume per cycle, LTC=VLTC/3600				
Opposing lane util. factor, fLUo			0.952	0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)				
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g				
Opposing platoon ratio, Rpo (refer Exhibit 16-11)				
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]				
gq, (see Exhibit C16-4,5,6,7,8)				
gu=g-gq if gq>=gf, or = g-gf if gq<gf				
n=Max(gq-gf)/2,0)				
PTHo=1-PLTo				
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]				
EL1 (refer to Exhibit C16-3)				
EL2=Max((1-Ptho**n)/Plto, 1.0)				
fmin=2(1+PL)/g or fmin=2(1+Pl)/g				
gdiff=max(gq-gf,0)				
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)				
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)				
or flt=[fm+0.91(N-1)]/N**				
Left-turn adjustment, fLT				

For special case of single-lane approach opposed by multilane approach,
see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
  left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach
or when gf>gq, see text.

_______________SUPPLEMENTAL PEDESTRIAN-BICYCLE EFFECTS WORKSHEET_______________

Permitted Left Turns

	EB	WB	NB	SB
Effective pedestrian green time, gp (s)				
Conflicting pedestrian volume, Vped (p/h)				
Pedestrian flow rate, Vpedg (p/h)				
OCCpedg				
Opposing queue clearing green, gq (s)				
Eff. ped. green consumed by opp. veh. queue, gq/gp				
OCCpedu				
Opposing flow rate, Vo (veh/h)				
OCCr				
Number of cross-street receiving lanes, Nrec				
Number of turning lanes, Nturn				
ApbT				
Proportion of left turns, PLT				
Proportion of left turns using protected phase, PLTA				
Left-turn adjustment, fLpb				
Permitted Right Turns				
Effective pedestrian green time, gp (s)			30.0	30.0
Conflicting pedestrian volume, Vped (p/h)			200	200
Conflicting bicycle volume, Vbic (bicycles/h)			0	0
Vpedg			833	833
OCCpedg			0.417	0.417
Effective green, g (s)			0.0	0.0
Vbicg			0	0

OCCbicg	0.020	0.020
OCCr	0.417	0.417
Number of cross-street receiving lanes, Nrec	2	1
Number of turning lanes, Nturn	1	1
ApbT	0.750	0.583
Proportion right-turns, PRT	1.000	1.000
Proportion right-turns using protected phase, PRTA	0.000	0.000
Right turn adjustment, fRpb	1.000	1.000

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

		EBLT	WBLT	NBLT	SBLT
Cycle length, C	125.0 sec				
Adj. LT vol from Vol Adjustment Worksheet, v					
v/c ratio from Capacity Worksheet, X					
Protected phase effective green interval, g (s)					
Opposing queue effective green interval, gq					
Unopposed green interval, gu					
Red time r=(C-g-gq-gu)					
Arrival rate, qa=v/(3600(max[X,1.0]))					
Protected ph. departure rate, Sp=s/3600					
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)					
XPerm					
XProt					
Case					
Queue at beginning of green arrow, Qa					
Queue at beginning of unsaturated green, Qu					
Residual queue, Qr					
Uniform Delay, d1					

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
L	0.0	0.00	37.0	25.0	0.00	0.0	0.0	25.3
	0.0						0.0	
R	0.0	0.00	47.0	44.6	0.00	0.0	0.0	62.6
Westbound								
L	0.0	0.00	37.0	37.0	0.00	59.8	0.0	236.5
	0.0						0.0	
R	0.0	0.00	47.0	45.7	0.00	0.0	0.0	75.5
Northbound								
L	0.0	0.00	47.0	45.3	0.00	0.0	0.0	68.0
T	0.0	0.00	47.0	47.0	0.00	3.5	0.0	95.2
R	0.0	0.00	19.5	7.8	0.00	0.0	0.0	8.1
Southbound								
L	0.0	0.00	47.0	47.0	0.00	16.2	0.0	158.8
LT	0.0	0.00	47.0	47.0	0.00	64.3	0.0	304.5
R	0.0	0.00	19.5	7.3	0.00	0.0	0.0	7.5

Intersection Delay 155.9 sec/veh   Intersection LOS F

BACK OF QUEUE WORKSHEET

	Eastbound			Westbound			Northbound			Southbound		
LaneGroup	L		R	L		R	L	T	R	L	LT	R
Init Queue	0.0		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
Flow Rate	168		254	807		287	311	264	201	404	380	118
So	1800		1800	1800		1800	1800	1300	1800	1800	1300	1800
No.Lanes	1	0	1	1	0	1	1	2	1	1	2	1
SL	1368		1224	1392		1268	1417	1037	918	1368	991	714
LnCapacity	558		304	568		314	351	257	632	339	245	491
Flow Ratio	0.1		0.2	0.6		0.2	0.2	0.3	0.2	0.3	0.4	0.2
v/c Ratio	0.30		0.84	1.42		0.91	0.89	1.03	0.32	1.19	1.55	0.24
Grn Ratio	0.41		0.25	0.41		0.25	0.25	0.25	0.69	0.25	0.25	0.69
I Factor		1.000			1.000			1.000			1.000	
AT or PVG	3		3	3		3	3	3	3	3	3	3
Pltn Ratio	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00
PF2	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00
Q1	3.9		8.4	28.0		9.7	10.4	9.2	2.8	14.0	13.2	1.5
kB	0.6		0.4	0.6		0.4	0.4	0.4	0.6	0.4	0.4	0.5
Q2	0.3		1.7	31.8		2.5	2.4	4.0	0.3	10.3	17.8	0.2
Q Average	4.2		10.0	59.8		12.2	12.8	13.1	3.1	24.3	31.0	1.7
Q Spacing	25.0		25.0	25.0		25.0	25.0	25.0	25.0	25.0	25.0	25.0
Q Storage	0		185	530		0	150	0	200	165	0	160
Q S Ratio			1.4	2.8			2.1		0.4	3.7		0.3
70th Percentile Output:												
fB%	1.2		1.2	1.1		1.2	1.2	1.2	1.2	1.2	1.1	1.2
BOQ	5.0		11.8	67.1		14.4	15.0	15.4	3.7	28.1	35.6	2.0
QSRatio			1.6	3.2			2.5		0.5	4.3		0.3
85th Percentile Output:												
fB%	1.6		1.5	1.3		1.5	1.5	1.5	1.6	1.4	1.4	1.6
BOQ	6.5		15.2	80.2		18.3	19.1	19.6	4.8	34.8	43.7	2.7
QSRatio			2.1	3.8			3.2		0.6	5.3		0.4
90th Percentile Output:												
fB%	1.7		1.6	1.4		1.6	1.6	1.6	1.7	1.5	1.5	1.8
BOQ	7.2		16.5	84.9		19.8	20.6	21.1	5.4	36.9	46.1	3.0
QSRatio			2.2	4.0			3.4		0.7	5.6		0.5
95th Percentile Output:												
fB%	2.0		1.8	1.5		1.8	1.8	1.8	2.0	1.7	1.6	2.0
BOQ	8.3		18.5	91.0		22.1	22.9	23.5	6.2	40.2	49.9	3.5
QSRatio			2.5	4.3			3.8		0.8	6.1		0.5
98th Percentile Output:												
fB%	2.4		2.2	1.7		2.1	2.1	2.1	2.5	1.9	1.8	2.6
BOQ	10.2		21.7	102		25.6	26.5	27.1	7.7	45.1	55.6	4.4
QSRatio			2.9	4.8			4.4		1.0	6.8		0.7

ERROR MESSAGES

No errors to report.

HCS+: Signalized Intersections Release 5.4

Analyst:
Agency: PB
Date: 6/25/2010
Period: AM Peak
Project ID: I-290 Phase 1 Study
E/W St: Flournoy Street

Inter.: Flournoy Stre & Central Avenue
Area Type: All other areas
Jurisd:
Year : Existing
N/S St: Central Avenue

SIGNALIZED INTERSECTION SUMMARY

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	0	0	0	1	1	1	1	2	0	0	2	1
LGConfig				L	LTR	R	L	T			T	R
Volume				163	55	232	287	288			512	154
Lane Width				10.0	10.0	10.5	10.0	12.0			12.0	12.0
RTOR Vol						178						88

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination	1	2	3	4		5	6	7	8
EB Left					NB Left	A	A		
Thru					Thru	A	A		
Right					Right				
Peds					Peds	X	X		
WB Left	A				SB Left				
Thru	A				Thru	A			
Right	A				Right	A			
Peds	X				Peds	X			
NB Right					EB Right				
SB Right					WB Right				
Green	23.0					40.0	16.0		
Yellow	3.0					3.0	3.0		
All Red	1.0					0.0	1.0		

Cycle Length: 90.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
Westbound								
L	409	1532	0.38	0.27	27.5	C		
LTR	412	1545	0.23	0.27	26.1	C	26.7	C
R	372	1395	0.10	0.27	25.0	C		
Northbound								
L	614	1532	0.49	0.66	12.9	B		
T	2193	3289	0.14	0.67	2.1	A	7.5	A
Southbound								
T	1498	3289	0.36	0.46	16.1	B	15.9	B
R	669	1468	0.10	0.46	14.1	B		

Intersection Delay = 14.6 (sec/veh) Intersection LOS = B

HCS+: Signalized Intersections Release 5.4

I-290
Existing

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst:
Agency/Co.: PB
Date Performed: 6/25/2010
Analysis Time Period: AM Peak
Intersection: Flournoy Stre & Central Avenue
Area Type: All other areas
Jurisdiction:
Analysis Year: Existing
Project ID: I-290 Phase 1 Study
E/W St: Flournoy Street N/S St: Central Avenue

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume				163	55	232	287	288			512	154
% Heavy Veh				10	10	10	10	10			10	10
PHF				0.95	0.95	0.95	0.95	0.95			0.95	0.95
PK 15 Vol				43	14	61	76	76			135	41
Hi Ln Vol												
% Grade					0			0			0	
Ideal Sat				1900	1900	1900	1900	1900			1900	1900
ParkExist												
NumPark												
No. Lanes	0	0	0	1	1	1	1	2	0	0	2	1
LGConfig				L	LTR	R	L	T			T	R
Lane Width				10.0	10.0	10.5	10.0	12.0			12.0	12.0
RTOR Vol						178						88
Adj Flow				155	96	36	302	303			539	69
%InSharedLn				10		37						
Prop LTs					0.179		1.000	0.000			0.000	
Prop RTs					0.220	1.000		0.000			0.000	1.000
Peds Bikes	0			0	0					0	0	
Buses				0	0	0	0	0			0	0
%InProtPhase							0.0					

Duration 0.25 Area Type: All other areas

OPERATING PARAMETERS

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Init Unmet				0.0	0.0	0.0	0.0	0.0			0.0	0.0
Arriv. Type				3	3	3	4	4			3	3
Unit Ext.				3.0	3.0	3.0	3.0	3.0			3.0	3.0
I Factor					1.000			0.818			1.000	
Lost Time				2.0	2.0	2.0	2.0	2.0			2.0	2.0
Ext of g				3.0	3.0	3.0	2.0	3.0			3.0	3.0
Ped Min g		3.2			3.2						3.2	

PHASE DATA

Phase Combination		1	2	3	4			5	6	7	8
EB	Left					NB	Left	A	A		
	Thru						Thru	A	A		
	Right						Right				
	Peds						Peds	X	X		
WB	Left	A				SB	Left				
	Thru	A					Thru	A			
	Right	A					Right	A			
	Peds	X					Peds	X			
NB	Right					EB	Right				
SB	Right					WB	Right				
Green		23.0						40.0	16.0		
Yellow		3.0						3.0	3.0		
All Red		1.0						0.0	1.0		

Cycle Length: 90.0 secs

VOLUME ADJUSTMENT AND SATURATION FLOW WORKSHEET

Volume Adjustment

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume, V				163	55	232	287	288			512	154
PHF				0.95	0.95	0.95	0.95	0.95			0.95	0.95
Adj flow				172	58	57	302	303			539	69
No. Lanes	0	0	0	1	1	1	1	2	0	0	2	1
Lane group				L	LTR	R	L	T			T	R
Adj flow				155	96	36	302	303			539	69
Prop LTs					0.179		1.000	0.000			0.000	
Prop RTs					0.220	1.000		0.000			0.000	1.000

Saturation Flow Rate (see Exhibit 16-7 to determine the adjustment factors)

	Eastbound			Westbound			Northbound			Southbound		
LG				L	LTR	R	L	T			T	R
So				1900	1900	1900	1900	1900			1900	1900
Lanes	0	0	0	1	1	1	1	2	0	0	2	1
fW				0.933	0.933	0.950	0.933	1.000			1.000	1.000
fHV				0.909	0.909	0.909	0.909	0.909			0.909	0.909
fG				1.000	1.000	1.000	1.000	1.000			1.000	1.000
fP				1.000	1.000	1.000	1.000	1.000			1.000	1.000
fBB				1.000	1.000	1.000	1.000	1.000			1.000	1.000
fA				1.000	1.000	1.000	1.000	1.000			1.000	1.000
fLU				1.000	1.000	1.000	1.000	0.952			0.952	1.000
fRT					0.967	0.850		1.000			1.000	0.850
fLT				0.950	0.991		0.950	1.000			1.000	
Sec.							0.392					
fLpb				1.000	1.000		1.000	1.000			1.000	
fRpb					1.000	1.000		1.000			1.000	1.000
S				1532	1545	1395	1532	3289			3289	1468
Sec.							632					

CAPACITY AND LOS WORKSHEET

Capacity Analysis and Lane Group Capacity

Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	Lane Group Capacity (c)	Lane Group v/c Ratio
Eastbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru							
Right							
Westbound							
Prot							
Perm							
Left	L	155	1532	# 0.10	0.27	409	0.38
Prot							
Perm							
Thru	LTR	96	1545	0.06	0.27	412	0.23
Right	R	36	1395	0.03	0.27	372	0.10
Northbound							
Prot		28	1532	# 0.02	0.222	340	0.08
Perm		274	632	# 0.43	0.433	274	1.00
Left	L	302			0.66	614	0.49
Prot							
Perm							
Thru	T	303	3289	0.09	0.67	2193	0.14
Right							
Southbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	T	539	3289	0.16	0.46	1498	0.36
Right	R	69	1468	0.05	0.46	669	0.10

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.55
Total lost time per cycle, L = 7.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.60

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	Ratios g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound												
Westbound												
L	0.38	0.27	26.9	1.000	409	0.11	0.6	0.0	27.5	C		
LTR	0.23	0.27	25.8	1.000	412	0.11	0.3	0.0	26.1	C	26.7	C
R	0.10	0.27	24.8	1.000	372	0.11	0.1	0.0	25.0	C		
Northbound												
L	0.49	0.66	12.4	1.000	614	0.11	0.5	0.0	12.9	B		
T	0.14	0.67	5.5	0.383	2193	0.11	0.0	0.0	2.1	A	7.5	A
Southbound												
T	0.36	0.46	16.0	1.000	1498	0.11	0.1	0.0	16.1	B	15.9	B

```
R    0.10  0.46  14.0  1.000 669   0.11   0.1   0.0   14.1   B
_______________________________________________________________________________
         Intersection delay = 14.6  (sec/veh)   Intersection LOS = B



______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                              for exclusive lefts
Input
                                                       EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                           90.0    sec
Total actual green time for LT lane group, G (s)                   59.0
Effective permitted green time for LT lane group, g(s)             39.0
Opposing effective green time, go (s)                              41.0
Number of lanes in LT lane group, N                                1
Number of lanes in opposing approach, No                           2
Adjusted LT flow rate, VLT (veh/h)                                 302
Proportion of LT in LT lane group, PLT                             1.000
Proportion of LT in opposing flow, PLTo                            0.00
Adjusted opposing flow rate, Vo (veh/h)                            539
Lost time for LT lane group, tL                                    4.00
Computation
LT volume per cycle, LTC=VLTC/3600                                 7.55
Opposing lane util. factor, fLUo                       1.000       0.952 0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)                7.08
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g                              0.0
Opposing platoon ratio, Rpo (refer Exhibit 16-11)                  1.00
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]                       0.54
gq, (see Exhibit C16-4,5,6,7,8)                                    5.14
gu=g-gq if gq>=gf, or = g-gf if gq<gf                              33.86
n=Max(gq-gf)/2,0)                                                  2.57
PTHo=1-PLTo                                                        1.00
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]                                 1.00
EL1 (refer to Exhibit C16-3)                                       2.21
EL2=Max((1-Ptho**n)/Plto, 1.0)
fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g                                 0.10
gdiff=max(gq-gf,0)                                                 0.00
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)                0.39
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
or flt=[fm+0.91(N-1)]/N**
Left-turn adjustment, fLT                                          0.392

For special case of single-lane approach opposed by multilane approach,
see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
  left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach
or when gf>gq, see text.

______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                                for shared lefts
Input
                                                       EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                           90.0    sec
Total actual green time for LT lane group, G (s)
Effective permitted green time for LT lane group, g(s)
Opposing effective green time, go (s)
Number of lanes in LT lane group, N
```

	EB	WB	NB	SB
Number of lanes in opposing approach, No				
Adjusted LT flow rate, VLT (veh/h)				
Proportion of LT in LT lane group, PLT		0.179	0.000	0.000
Proportion of LT in opposing flow, PLTo				
Adjusted opposing flow rate, Vo (veh/h)				
Lost time for LT lane group, tL				
Computation				
LT volume per cycle, LTC=VLTC/3600				
Opposing lane util. factor, fLUo	1.000		0.952	0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)				
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g				
Opposing platoon ratio, Rpo (refer Exhibit 16-11)				
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]				
gq, (see Exhibit C16-4,5,6,7,8)				
gu=g-gq if gq>=gf, or = g-gf if gq<gf				
n=Max(gq-gf)/2,0)				
PTHo=1-PLTo				
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]				
EL1 (refer to Exhibit C16-3)				
EL2=Max((1-Ptho**n)/Plto, 1.0)				
fmin=2(1+PL)/g or fmin=2(1+Pl)/g				
gdiff=max(gq-gf,0)				
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)				
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)				
or flt=[fm+0.91(N-1)]/N**				
Left-turn adjustment, fLT				

For special case of single-lane approach opposed by multilane approach, see text.

* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto left-turn lane and redo calculations.

** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.

For special case of multilane approach opposed by single-lane approach or when gf>gq, see text.

SUPPLEMENTAL PEDESTRIAN-BICYCLE EFFECTS WORKSHEET

Permitted Left Turns	EB	WB	NB	SB
Effective pedestrian green time, gp (s)			40.0	
Conflicting pedestrian volume, Vped (p/h)			0	
Pedestrian flow rate, Vpedg (p/h)			0	
OCCpedg			0.000	
Opposing queue clearing green, gq (s)			5.14	
Eff. ped. green consumed by opp. veh. queue, gq/gp			0.129	
OCCpedu			0.000	
Opposing flow rate, Vo (veh/h)			539	
OCCr			0.000	
Number of cross-street receiving lanes, Nrec			1	
Number of turning lanes, Nturn			1	
ApbT			1.000	
Proportion of left turns, PLT			1.000	
Proportion of left turns using protected phase, PLTA			0.000	
Left-turn adjustment, fLpb			1.000	
Permitted Right Turns				
Effective pedestrian green time, gp (s)		23.0		40.0
Conflicting pedestrian volume, Vped (p/h)		0		0
Conflicting bicycle volume, Vbic (bicycles/h)		0		0
Vpedg		0		0
OCCpedg		0.000		0.000
Effective green, g (s)		24.0		41.0
Vbicg		0		0

OCCbicg	0.020	0.020
OCCr	0.000	0.000
Number of cross-street receiving lanes, Nrec	2	1
Number of turning lanes, Nturn	2	1
ApbT	1.000	1.000
Proportion right-turns, PRT	1.000	1.000
Proportion right-turns using protected phase, PRTA	0.000	0.000
Right turn adjustment, fRpb	1.000	

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

	EBLT	WBLT	NBLT	SBLT
Cycle length, C 90.0 sec				
Adj. LT vol from Vol Adjustment Worksheet, v			302	
v/c ratio from Capacity Worksheet, X			0.49	
Protected phase effective green interval, g (s)			20.0	
Opposing queue effective green interval, gq			5.14	
Unopposed green interval, gu			33.86	
Red time r=(C-g-gq-gu)			31.0	
Arrival rate, qa=v/(3600(max[X,1.0]))			0.08	
Protected ph. departure rate, Sp=s/3600			0.426	
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)			0.20	
XPerm			0.86	
XProt				
Case			4	
Queue at beginning of green arrow, Qa			0.00	
Queue at beginning of unsaturated green, Qu			3.03	
Residual queue, Qr			0.00	
Uniform Delay, d1			12.4	

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
	0.0						0.0	
	0.0						0.0	
	0.0						0.0	
Westbound								
L	0.0	0.00	33.0	26.9	0.00	0.0	0.0	27.5
LTR	0.0	0.00	33.0	25.8	0.00	0.0	0.0	26.1
R	0.0	0.00	33.0	24.8	0.00	0.0	0.0	25.0
Northbound								
L	0.0	0.00		12.4	0.00	0.0	0.0	12.9
T	0.0	0.00	15.0	5.5	0.00	0.0	0.0	2.1
	0.0						0.0	
Southbound								
	0.0						0.0	
T	0.0	0.00	24.5	16.0	0.00	0.0	0.0	16.1
R	0.0	0.00	24.5	14.0	0.00	0.0	0.0	14.1

Intersection Delay 14.6 sec/veh Intersection LOS B

BACK OF QUEUE WORKSHEET

	Eastbound			Westbound			Northbound			Southbound		
LaneGroup				L	LTR	R	L	T			T	R
Init Queue				0.0	0.0	0.0	0.0	0.0			0.0	0.0
Flow Rate				155	96	36	302	159			283	69
So				1900	1900	1900	1900	1900			1900	1900
No.Lanes	0	0	0	1	1	1	1	2	0	0	2	1
SL				1532	1545	1395	937	1727			1727	1468
LnCapacity				409	412	372	614	1151			786	669
Flow Ratio				0.1	0.1	0.0	0.3	0.1			0.2	0.0
v/c Ratio				0.38	0.23	0.10	0.49	0.14			0.36	0.10
Grn Ratio				0.27	0.27	0.27	0.66	0.67			0.46	0.46
I Factor					1.000			0.818			1.000	
AT or PVG				3	3	3	4	4			3	3
Pltn Ratio				1.00	1.00	1.00	1.33	1.33			1.00	1.00
PF2				1.00	1.00	1.00	0.43	0.34			1.00	1.00
Q1				3.2	1.9	0.7	1.3	0.5			4.6	1.0
kB				0.4	0.4	0.4	0.4	0.6			0.6	0.5
Q2				0.2	0.1	0.0	0.4	0.1			0.3	0.1
Q Average				3.4	2.0	0.7	1.7	0.6			4.9	1.0
Q Spacing				25.0	25.0	25.0	25.0	25.0			25.0	25.0
Q Storage				0	0	0	0	0			0	0
Q S Ratio												
70th Percentile Output:												
fB%				1.2	1.2	1.2	1.2	1.2			1.2	1.2
BOQ				4.1	2.4	0.9	2.0	0.7			5.9	1.3
QSRatio												
85th Percentile Output:												
fB%				1.6	1.6	1.6	1.6	1.6			1.6	1.6
BOQ				5.3	3.2	1.1	2.6	1.0			7.7	1.7
QSRatio												
90th Percentile Output:												
fB%				1.7	1.8	1.8	1.8	1.8			1.7	1.8
BOQ				5.9	3.5	1.3	3.0	1.1			8.5	1.9
QSRatio												
95th Percentile Output:												
fB%				2.0	2.0	2.1	2.0	2.1			2.0	2.1
BOQ				6.8	4.1	1.5	3.4	1.3			9.7	2.2
QSRatio												
98th Percentile Output:												
fB%				2.5	2.6	2.6	2.6	2.7			2.4	2.6
BOQ				8.4	5.1	1.9	4.3	1.6			11.8	2.7
QSRatio												

ERROR MESSAGES

No errors to report.

HCS+: Signalized Intersections Release 5.4

Analyst:
Agency: PB
Date: 6/25/2010
Period: PM Peak
Project ID: I-290 Phase 1 Study
E/W St: Flournoy Street

Inter.: Flournoy Stre & Central Avenue
Area Type: All other areas
Jurisd:
Year : Existing
N/S St: Central Avenue

SIGNALIZED INTERSECTION SUMMARY

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	0	0	0	1	1	1	1	2	0	0	2	1
LGConfig				L	LTR	R	L	T			T	R
Volume				126	138	181	267	665			879	258
Lane Width				10.0	10.0	10.5	10.0	12.0			12.0	12.0
RTOR Vol						148						147

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination		1	2	3	4			5	6	7	8
EB	Left					NB	Left	A	A		
	Thru						Thru	A	A		
	Right						Right				
	Peds						Peds	X	X		
WB	Left	A				SB	Left				
	Thru	A					Thru	A			
	Right	A					Right	A			
	Peds	X					Peds	X			
NB	Right					EB	Right				
SB	Right					WB	Right				
Green		23.0						40.0	16.0		
Yellow		3.0						3.0	3.0		
All Red		1.0						0.0	1.0		

Cycle Length: 90.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
Westbound								
L	409	1532	0.29	0.27	26.7	C		
LTR	425	1595	0.39	0.27	27.6	C	27.0	C
R	372	1395	0.08	0.27	24.8	C		
Northbound								
L	478	1532	0.59	0.66	23.1	C		
T	2193	3289	0.32	0.67	2.5	A	8.4	A
Southbound								
T	1498	3289	0.62	0.46	19.3	B	18.8	B
R	669	1468	0.17	0.46	14.6	B		

Intersection Delay = 15.5 (sec/veh) Intersection LOS = B

HCS+: Signalized Intersections Release 5.4

I-290
Existing

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst:
Agency/Co.: PB
Date Performed: 6/25/2010
Analysis Time Period: PM Peak
Intersection: Flournoy Stre & Central Avenue
Area Type: All other areas
Jurisdiction:
Analysis Year: Existing
Project ID: I-290 Phase 1 Study
E/W St: Flournoy Street N/S St: Central Avenue

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume				126	138	181	267	665			879	258
% Heavy Veh				10	10	10	10	10			10	10
PHF				0.95	0.95	0.95	0.95	0.95			0.95	0.95
PK 15 Vol				33	36	48	70	175			231	68
Hi Ln Vol												
% Grade					0			0			0	
Ideal Sat				1900	1900	1900	1900	1900			1900	1900
ParkExist												
NumPark												
No. Lanes	0	0	0	1	1	1	1	2	0	0	2	1
LGConfig				L	LTR	R	L	T			T	R
Lane Width				10.0	10.0	10.5	10.0	12.0			12.0	12.0
RTOR Vol						148						147
Adj Flow				120	165	28	281	700			925	117
%InSharedLn				10		21						
Prop LTs					0.081		1.000	0.000			0.000	
Prop RTs					0.045	1.000		0.000			0.000	1.000
Peds Bikes	0			0	0					0	0	
Buses				0	0	0	0	0			0	0
%InProtPhase							0.0					

Duration 0.25 Area Type: All other areas

OPERATING PARAMETERS

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Init Unmet				0.0	0.0	0.0	0.0	0.0			0.0	0.0
Arriv. Type				3	3	3	4	4			3	3
Unit Ext.				3.0	3.0	3.0	3.0	3.0			3.0	3.0
I Factor					1.000			0.575			1.000	
Lost Time				2.0	2.0	2.0	2.0	2.0			2.0	2.0
Ext of g				3.0	3.0	3.0	2.0	3.0			3.0	3.0
Ped Min g		3.2			3.2						3.2	

PHASE DATA

Phase Combination		1	2	3	4			5	6	7	8
EB	Left					NB	Left	A	A		
	Thru						Thru	A	A		
	Right						Right				
	Peds						Peds	X	X		
WB	Left	A				SB	Left				
	Thru	A					Thru	A			
	Right	A					Right	A			
	Peds	X					Peds	X			
NB	Right					EB	Right				
SB	Right					WB	Right				
Green		23.0						40.0	16.0		
Yellow		3.0						3.0	3.0		
All Red		1.0						0.0	1.0		

Cycle Length: 90.0 secs

VOLUME ADJUSTMENT AND SATURATION FLOW WORKSHEET

Volume Adjustment

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume, V				126	138	181	267	665			879	258
PHF				0.95	0.95	0.95	0.95	0.95			0.95	0.95
Adj flow				133	145	35	281	700			925	117
No. Lanes	0	0	0	1	1	1	1	2	0	0	2	1
Lane group				L	LTR	R	L	T			T	R
Adj flow				120	165	28	281	700			925	117
Prop LTs					0.081		1.000	0.000			0.000	
Prop RTs					0.045	1.000		0.000			0.000	1.000

Saturation Flow Rate (see Exhibit 16-7 to determine the adjustment factors)

	Eastbound			Westbound			Northbound			Southbound		
LG				L	LTR	R	L	T			T	R
So				1900	1900	1900	1900	1900			1900	1900
Lanes	0	0	0	1	1	1	1	2	0	0	2	1
fW				0.933	0.933	0.950	0.933	1.000			1.000	1.000
fHV				0.909	0.909	0.909	0.909	0.909			0.909	0.909
fG				1.000	1.000	1.000	1.000	1.000			1.000	1.000
fP				1.000	1.000	1.000	1.000	1.000			1.000	1.000
fBB				1.000	1.000	1.000	1.000	1.000			1.000	1.000
fA				1.000	1.000	1.000	1.000	1.000			1.000	1.000
fLU				1.000	1.000	1.000	1.000	0.952			0.952	1.000
fRT					0.993	0.850		1.000			1.000	0.850
fLT				0.950	0.996		0.950	1.000			1.000	
Sec.							0.197					
fLpb				1.000	1.000		1.000	1.000			1.000	
fRpb					1.000	1.000		1.000			1.000	1.000
S				1532	1595	1395	1532	3289			3289	1468
Sec.							318					

CAPACITY AND LOS WORKSHEET

Capacity Analysis and Lane Group Capacity

Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- Capacity (c)	v/c Ratio
Eastbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru							
Right							
Westbound							
Prot							
Perm							
Left	L	120	1532	0.08	0.27	409	0.29
Prot							
Perm							
Thru	LTR	165	1595	# 0.10	0.27	425	0.39
Right	R	28	1395	0.02	0.27	372	0.08
Northbound							
Prot		143	1532	# 0.09	0.222	340	0.42
Perm		138	318	# 0.43	0.433	138	1.00
Left	L	281			0.66	478	0.59
Prot							
Perm							
Thru	T	700	3289	0.21	0.67	2193	0.32
Right							
Southbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	T	925	3289	0.28	0.46	1498	0.62
Right	R	117	1468	0.08	0.46	669	0.17

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.63
Total lost time per cycle, L = 7.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.68

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	Ratios g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound												
Westbound												
L	0.29	0.27	26.3	1.000	409	0.11	0.4	0.0	26.7	C		
LTR	0.39	0.27	27.0	1.000	425	0.11	0.6	0.0	27.6	C	27.0	C
R	0.08	0.27	24.7	1.000	372	0.11	0.1	0.0	24.8	C		
Northbound												
L	0.59	0.66	22.0	1.000	478	0.18	1.1	0.0	23.1	C		
T	0.32	0.67	6.4	0.383	2193	0.11	0.0	0.0	2.5	A	8.4	A
Southbound												
T	0.62	0.46	18.6	1.000	1498	0.20	0.8	0.0	19.3	B	18.8	B

```
R    0.17  0.46  14.5  1.000 669   0.11   0.1   0.0   14.6   B
_______________________________________________________________________________
         Intersection delay = 15.5  (sec/veh)   Intersection LOS = B



______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                              for exclusive lefts
Input
                                                       EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                           90.0    sec
Total actual green time for LT lane group, G (s)                   59.0
Effective permitted green time for LT lane group, g(s)             39.0
Opposing effective green time, go (s)                              41.0
Number of lanes in LT lane group, N                                1
Number of lanes in opposing approach, No                           2
Adjusted LT flow rate, VLT (veh/h)                                 281
Proportion of LT in LT lane group, PLT                             1.000
Proportion of LT in opposing flow, PLTo                            0.00
Adjusted opposing flow rate, Vo (veh/h)                            925
Lost time for LT lane group, tL                                    4.00
Computation
LT volume per cycle, LTC=VLTC/3600                                 7.03
Opposing lane util. factor, fLUo                       1.000       0.952 0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)                12.15
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g                              0.0
Opposing platoon ratio, Rpo (refer Exhibit 16-11)                  1.00
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]                       0.54
gq, (see Exhibit C16-4,5,6,7,8)                                    14.11
gu=g-gq if gq>=gf, or = g-gf if gq<gf                              24.89
n=Max(gq-gf)/2,0)                                                  7.06
PTHo=1-PLTo                                                        1.00
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]                                 1.00
EL1 (refer to Exhibit C16-3)                                       3.23
EL2=Max((1-Ptho**n)/Plto, 1.0)
fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g                                 0.10
gdiff=max(gq-gf,0)                                                 0.00
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)                0.20
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
or flt=[fm+0.91(N-1)]/N**
Left-turn adjustment, fLT                                          0.197

For special case of single-lane approach opposed by multilane approach,
see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
  left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach
or when gf>gq, see text.

______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                                for shared lefts
Input
                                                       EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                           90.0    sec
Total actual green time for LT lane group, G (s)
Effective permitted green time for LT lane group, g(s)
Opposing effective green time, go (s)
Number of lanes in LT lane group, N
```

	EB	WB	NB	SB
Number of lanes in opposing approach, No				
Adjusted LT flow rate, VLT (veh/h)				
Proportion of LT in LT lane group, PLT		0.081	0.000	0.000
Proportion of LT in opposing flow, PLTo				
Adjusted opposing flow rate, Vo (veh/h)				
Lost time for LT lane group, tL				
Computation				
LT volume per cycle, LTC=VLTC/3600				
Opposing lane util. factor, fLUo	1.000		0.952	0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)				
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g				
Opposing platoon ratio, Rpo (refer Exhibit 16-11)				
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]				
gq, (see Exhibit C16-4,5,6,7,8)				
gu=g-gq if gq>=gf, or = g-gf if gq<gf				
n=Max(gq-gf)/2,0)				
PTHo=1-PLTo				
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]				
EL1 (refer to Exhibit C16-3)				
EL2=Max((1-Ptho**n)/Plto, 1.0)				
fmin=2(1+PL)/g or fmin=2(1+Pl)/g				
gdiff=max(gq-gf,0)				
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)				
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)				
or flt=[fm+0.91(N-1)]/N**				
Left-turn adjustment, fLT				

For special case of single-lane approach opposed by multilane approach, see text.

* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto left-turn lane and redo calculations.

** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.

For special case of multilane approach opposed by single-lane approach or when gf>gq, see text.

SUPPLEMENTAL PEDESTRIAN-BICYCLE EFFECTS WORKSHEET

Permitted Left Turns

	EB	WB	NB	SB
Effective pedestrian green time, gp (s)			40.0	
Conflicting pedestrian volume, Vped (p/h)			0	
Pedestrian flow rate, Vpedg (p/h)			0	
OCCpedg			0.000	
Opposing queue clearing green, gq (s)			14.11	
Eff. ped. green consumed by opp. veh. queue, gq/gp			0.353	
OCCpedu			0.000	
Opposing flow rate, Vo (veh/h)			925	
OCCr			0.000	
Number of cross-street receiving lanes, Nrec			1	
Number of turning lanes, Nturn			1	
ApbT			1.000	
Proportion of left turns, PLT			1.000	
Proportion of left turns using protected phase, PLTA			0.000	
Left-turn adjustment, fLpb			1.000	

Permitted Right Turns

	EB	WB	NB	SB
Effective pedestrian green time, gp (s)		23.0		40.0
Conflicting pedestrian volume, Vped (p/h)		0		0
Conflicting bicycle volume, Vbic (bicycles/h)		0		0
Vpedg		0		0
OCCpedg		0.000		0.000
Effective green, g (s)		24.0		41.0
Vbicg		0		0

OCCbicg	0.020	0.020
OCCr	0.000	0.000
Number of cross-street receiving lanes, Nrec	2	1
Number of turning lanes, Nturn	2	1
ApbT	1.000	1.000
Proportion right-turns, PRT	1.000	1.000
Proportion right-turns using protected phase, PRTA	0.000	0.000
Right turn adjustment, fRpb	1.000	

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

		EBLT	WBLT	NBLT	SBLT
Cycle length, C	90.0 sec				
Adj. LT vol from Vol Adjustment Worksheet, v				281	
v/c ratio from Capacity Worksheet, X				0.59	
Protected phase effective green interval, g (s)				20.0	
Opposing queue effective green interval, gq				14.11	
Unopposed green interval, gu				24.89	
Red time r=(C-g-gq-gu)				31.0	
Arrival rate, qa=v/(3600(max[X,1.0]))				0.08	
Protected ph. departure rate, Sp=s/3600				0.426	
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)				0.14	
XPerm				1.59	
XProt					
Case				5	
Queue at beginning of green arrow, Qa				2.02	
Queue at beginning of unsaturated green, Qu				3.52	
Residual queue, Qr				0.00	
Uniform Delay, d1				22.0	

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
	0.0						0.0	
	0.0						0.0	
	0.0						0.0	
Westbound								
L	0.0	0.00	33.0	26.3	0.00	0.0	0.0	26.7
LTR	0.0	0.00	33.0	27.0	0.00	0.0	0.0	27.6
R	0.0	0.00	33.0	24.7	0.00	0.0	0.0	24.8
Northbound								
L	0.0	0.00		22.0	0.00	0.0	0.0	23.1
T	0.0	0.00	15.0	6.4	0.00	0.0	0.0	2.5
	0.0						0.0	
Southbound								
	0.0						0.0	
T	0.0	0.00	24.5	18.6	0.00	0.0	0.0	19.3
R	0.0	0.00	24.5	14.5	0.00	0.0	0.0	14.6

Intersection Delay 15.5 sec/veh Intersection LOS B

BACK OF QUEUE WORKSHEET

	Eastbound			Westbound			Northbound			Southbound		
LaneGroup				L	LTR	R	L	T			T	R
Init Queue				0.0	0.0	0.0	0.0	0.0			0.0	0.0
Flow Rate				120	165	28	281	367			485	117
So				1900	1900	1900	1900	1900			1900	1900
No.Lanes	0	0	0	1	1	1	1	2	0	0	2	1
SL				1532	1595	1395	730	1727			1727	1468
LnCapacity				409	425	372	478	1151			786	669
Flow Ratio				0.1	0.1	0.0	0.4	0.2			0.3	0.1
v/c Ratio				0.29	0.39	0.08	0.59	0.32			0.62	0.17
Grn Ratio				0.27	0.27	0.27	0.66	0.67			0.46	0.46
I Factor					1.000			0.575			1.000	
AT or PVG				3	3	3	4	4			3	3
Pltn Ratio				1.00	1.00	1.00	1.33	1.33			1.00	1.00
PF2				1.00	1.00	1.00	0.46	0.37			1.00	1.00
Q1				2.4	3.4	0.5	1.3	1.4			9.2	1.7
kB				0.4	0.4	0.4	0.3	0.4			0.6	0.5
Q2				0.2	0.3	0.0	0.4	0.2			0.9	0.1
Q Average				2.6	3.6	0.6	1.6	1.6			10.1	1.8
Q Spacing				25.0	25.0	25.0	25.0	25.0			25.0	25.0
Q Storage				0	0	0	0	0			0	0
Q S Ratio												
70th Percentile Output:												
fB%				1.2	1.2	1.2	1.2	1.2			1.2	1.2
BOQ				3.0	4.3	0.7	2.0	1.9			11.9	2.2
QSRatio												
85th Percentile Output:												
fB%				1.6	1.6	1.6	1.6	1.6			1.5	1.6
BOQ				4.0	5.7	0.9	2.6	2.6			15.3	2.9
QSRatio												
90th Percentile Output:												
fB%				1.8	1.7	1.8	1.8	1.8			1.6	1.8
BOQ				4.5	6.3	1.0	2.9	2.9			16.6	3.3
QSRatio												
95th Percentile Output:												
fB%				2.0	2.0	2.1	2.0	2.0			1.8	2.0
BOQ				5.2	7.2	1.2	3.4	3.3			18.6	3.8
QSRatio												
98th Percentile Output:												
fB%				2.5	2.5	2.7	2.6	2.6			2.2	2.6
BOQ				6.4	8.9	1.5	4.2	4.2			21.9	4.7
QSRatio												

ERROR MESSAGES

No errors to report.

```
                    HCS+: Signalized Intersections Release 5.4

Analyst:                                Inter.: Eastbound Ramp & Central Avenu
Agency: AM Peak                         Area Type: All other areas
Date:   6/25/2010                       Jurisd:
Period: AM Peak                         Year  : Existing
Project ID: I-290 Phase 1 Study
E/W St: Eastbound Ramp                  N/S St: Central Avenue

_________________________SIGNALIZED INTERSECTION SUMMARY_______________________
           |  Eastbound      |  Westbound      |  Northbound     |  Southbound     |
           | L    T    R     | L    T    R     | L    T    R     | L    T    R     |
           |_________________|_________________|_________________|_________________|
No. Lanes  |   0   1   1     |   0   0   0     |   0   2   0     |   2   2   0     |
LGConfig   |       LT   R    |                 |       TR        | L      T        |
Volume     |128  0    183    |                 |      447  341   |282  353         |
Lane Width |     10.0 10.0   |                 |      12.0       |10.0 12.0        |
RTOR Vol   |          143    |                 |           130   |                 |
_______________________________________________________________________________
Duration    0.25      Area Type: All other areas
______________________________Signal Operations________________________________
Phase Combination 1     2     3     4 |          5     6     7     8
EB  Left          A                   | NB  Left
    Thru          A                   |     Thru   A
    Right         A                   |     Right  A
    Peds                              |     Peds   X
WB  Left                              | SB  Left         A
    Thru                              |     Thru   A     A
    Right                             |     Right
    Peds                              |     Peds   X     X
NB  Right                             | EB  Right
SB  Right                             | WB  Right
Green            23.0                             35.0  20.0
Yellow           3.0                              3.0   3.0
All Red          1.0                              1.0   1.0
                                                   Cycle Length: 90.0    secs
____________________Intersection Performance Summary___________________________
Appr/   Lane       Adj Sat     Ratios       Lane Group   Approach
Lane    Group      Flow Rate   ___________  ___________  ___________
Grp     Capacity     (s)       v/c    g/C   Delay LOS    Delay LOS
_______________________________________________________________________________
Eastbound

LT       392       1535      0.34   0.26    27.9   C    27.4   C
R        350       1370      0.12   0.26    25.9   C
Westbound



Northbound

TR       1252      3131      0.55   0.40    21.3   C    21.3   C

Southbound
L        661       2974      0.45   0.22    30.7   C
T        2193      3289      0.17   0.67    2.2    A    14.9   B

         Intersection Delay = 19.2  (sec/veh)   Intersection LOS = B

_______________________________________________________________________________
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HCS+: Signalized Intersections Release 5.4

I-290
Existing

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst:
Agency/Co.: AM Peak
Date Performed: 6/25/2010
Analysis Time Period: AM Peak
Intersection: Eastbound Ramp & Central Avenu
Area Type: All other areas
Jurisdiction:
Analysis Year: Existing
Project ID: I-290 Phase 1 Study
E/W St: Eastbound Ramp N/S St: Central Avenue

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	128	0	183					447	341	282	353	
% Heavy Veh	10	10	10					10	10	10	10	
PHF	0.95	0.95	0.95					0.95	0.95	0.95	0.95	
PK 15 Vol	34	0	48					118	90	74	93	
Hi Ln Vol												
% Grade		0						0			0	
Ideal Sat		1900	1900					1900		1900	1900	
ParkExist												
NumPark												
No. Lanes	0	1	1	0	0	0	0	2	0	2	2	0
LGConfig		LT	R					TR		L	T	
Lane Width		10.0	10.0					12.0		10.0	12.0	
RTOR Vol			143						130			
Adj Flow		135	42					693		297	372	
%InSharedLn												
Prop LTs		1.000						0.000			0.000	
Prop RTs		0.000	1.000					0.320			0.000	
Peds Bikes	0			0			0	0				
Buses		0	0					0		0	0	
%InProtPhase												

Duration 0.25 Area Type: All other areas

OPERATING PARAMETERS

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Init Unmet		0.0	0.0					0.0		0.0	0.0	
Arriv. Type		3	3					3		3	4	
Unit Ext.		3.0	3.0					3.0		3.0	3.0	
I Factor		1.000						1.000			0.943	
Lost Time		2.0	2.0					2.0		2.0	2.0	
Ext of g		2.0	2.0					3.0		2.0	3.0	
Ped Min g		3.2			3.2			3.2				

PHASE DATA

Phase Combination		1	2	3	4			5	6	7	8
EB	Left	A				NB	Left				
	Thru	A					Thru	A			
	Right	A					Right	A			
	Peds						Peds	X			
WB	Left					SB	Left		A		
	Thru						Thru	A	A		
	Right						Right				
	Peds						Peds	X	X		
NB	Right					EB	Right				
SB	Right					WB	Right				
Green		23.0						35.0	20.0		
Yellow		3.0						3.0	3.0		
All Red		1.0						1.0	1.0		

Cycle Length: 90.0 secs

VOLUME ADJUSTMENT AND SATURATION FLOW WORKSHEET

Volume Adjustment

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume, V	128	0	183					447	341	282	353	
PHF	0.95	0.95	0.95					0.95	0.95	0.95	0.95	
Adj flow	135	0	42					471	222	297	372	
No. Lanes	0	1	1	0	0	0	0	2	0	2	2	0
Lane group		LT	R					TR		L	T	
Adj flow		135	42					693		297	372	
Prop LTs		1.000						0.000			0.000	
Prop RTs		0.000	1.000					0.320			0.000	

Saturation Flow Rate (see Exhibit 16-7 to determine the adjustment factors)

	Eastbound			Westbound			Northbound			Southbound		
LG		LT	R					TR		L	T	
So		1900	1900					1900		1900	1900	
Lanes	0	1	1	0	0	0	0	2	0	2	2	0
fW		0.933	0.933					1.000		0.933	1.000	
fHV		0.909	0.909					0.909		0.909	0.909	
fG		1.000	1.000					1.000		1.000	1.000	
fP		1.000	1.000					1.000		1.000	1.000	
fBB		1.000	1.000					1.000		1.000	1.000	
fA		1.000	1.000					1.000		1.000	1.000	
fLU		1.000	1.000					0.952		0.971	0.952	
fRT		1.000	0.850					0.952			1.000	
fLT		0.952						1.000		0.950	1.000	
Sec.												
fLpb		1.000						1.000		1.000	1.000	
fRpb		1.000	1.000					1.000			1.000	
S		1535	1370					3131		2974	3289	
Sec.												

CAPACITY AND LOS WORKSHEET

Capacity Analysis and Lane Group Capacity

Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- Capacity (c)	v/c Ratio
Eastbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	LT	135	1535	# 0.09	0.26	392	0.34
Right	R	42	1370	0.03	0.26	350	0.12
Westbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru							
Right							
Northbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	TR	693	3131	# 0.22	0.40	1252	0.55
Right							
Southbound							
Prot							
Perm							
Left	L	297	2974	# 0.10	0.22	661	0.45
Prot							
Perm							
Thru	T	372	3289	0.11	0.67	2193	0.17
Right							

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.41
Total lost time per cycle, L = 11.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.47

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	LOS	Approach Delay	LOS
Eastbound												
LT	0.34	0.26	27.3	1.000	392	0.11	0.5	0.0	27.9	C	27.4	C
R	0.12	0.26	25.7	1.000	350	0.11	0.2	0.0	25.9	C		
Westbound												
Northbound												
TR	0.55	0.40	20.8	1.000	1252	0.15	0.5	0.0	21.3	C	21.3	C
Southbound												
L	0.45	0.22	30.2	1.000	661	0.11	0.5	0.0	30.7	C		
T	0.17	0.67	5.6	0.383	2193	0.11	0.0	0.0	2.2	A	14.9	B

```
_____________________________________________________________________________
         Intersection delay = 19.2  (sec/veh)   Intersection LOS = B



______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                              for exclusive lefts
Input
                                                       EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                          90.0    sec
Total actual green time for LT lane group, G (s)
Effective permitted green time for LT lane group, g(s)
Opposing effective green time, go (s)
Number of lanes in LT lane group, N
Number of lanes in opposing approach, No
Adjusted LT flow rate, VLT (veh/h)
Proportion of LT in LT lane group, PLT
Proportion of LT in opposing flow, PLTo
Adjusted opposing flow rate, Vo (veh/h)
Lost time for LT lane group, tL
Computation
LT volume per cycle, LTC=VLTC/3600
Opposing lane util. factor, fLUo                             1.000 0.952 0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g
Opposing platoon ratio, Rpo (refer Exhibit 16-11)
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]
gq, (see Exhibit C16-4,5,6,7,8)
gu=g-gq if gq>=gf, or = g-gf if gq<gf
n=Max(gq-gf)/2,0)
PTHo=1-PLTo
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]
EL1 (refer to Exhibit C16-3)
EL2=Max((1-Ptho**n)/Plto, 1.0)
fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g
gdiff=max(gq-gf,0)
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
or flt=[fm+0.91(N-1)]/N**
Left-turn adjustment, fLT

For special case of single-lane approach opposed by multilane approach,
see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
  left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach
or when gf>gq, see text.

______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                              for shared lefts
Input
                                                       EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                          90.0    sec
Total actual green time for LT lane group, G (s)
Effective permitted green time for LT lane group, g(s)
Opposing effective green time, go (s)
Number of lanes in LT lane group, N
```

Number of lanes in opposing approach, No				
Adjusted LT flow rate, VLT (veh/h)				
Proportion of LT in LT lane group, PLT	1.000		0.000	0.000
Proportion of LT in opposing flow, PLTo				
Adjusted opposing flow rate, Vo (veh/h)				
Lost time for LT lane group, tL				
Computation				
LT volume per cycle, LTC=VLTC/3600				
Opposing lane util. factor, fLUo		1.000	0.952	0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)				
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g				
Opposing platoon ratio, Rpo (refer Exhibit 16-11)				
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]				
gq, (see Exhibit C16-4,5,6,7,8)				
gu=g-gq if gq>=gf, or = g-gf if gq<gf				
n=Max(gq-gf)/2,0)				
PTHo=1-PLTo				
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]				
EL1 (refer to Exhibit C16-3)				
EL2=Max((1-Ptho**n)/Plto, 1.0)				
fmin=2(1+PL)/g or fmin=2(1+Pl)/g				
gdiff=max(gq-gf,0)				
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)				
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)				
or flt=[fm+0.91(N-1)]/N**				
Left-turn adjustment, fLT				

For special case of single-lane approach opposed by multilane approach, see text.

* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto left-turn lane and redo calculations.

** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.

For special case of multilane approach opposed by single-lane approach or when gf>gq, see text.

SUPPLEMENTAL PEDESTRIAN-BICYCLE EFFECTS WORKSHEET

Permitted Left Turns	EB	WB	NB	SB
Effective pedestrian green time, gp (s)				
Conflicting pedestrian volume, Vped (p/h)				
Pedestrian flow rate, Vpedg (p/h)				
OCCpedg				
Opposing queue clearing green, gq (s)				
Eff. ped. green consumed by opp. veh. queue, gq/gp				
OCCpedu				
Opposing flow rate, Vo (veh/h)				
OCCr				
Number of cross-street receiving lanes, Nrec				
Number of turning lanes, Nturn				
ApbT				
Proportion of left turns, PLT				
Proportion of left turns using protected phase, PLTA				
Left-turn adjustment, fLpb				
Permitted Right Turns				
Effective pedestrian green time, gp (s)			35.0	
Conflicting pedestrian volume, Vped (p/h)			0	
Conflicting bicycle volume, Vbic (bicycles/h)			0	
Vpedg			0	
OCCpedg			0.000	
Effective green, g (s)			36.0	
Vbicg			0	

OCCbicg	0.020
OCCr	0.000
Number of cross-street receiving lanes, Nrec	2
Number of turning lanes, Nturn	1
ApbT	1.000
Proportion right-turns, PRT	0.320
Proportion right-turns using protected phase, PRTA	0.000
Right turn adjustment, fRpb	1.000

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

		EBLT	WBLT	NBLT	SBLT
Cycle length, C	90.0 sec				
Adj. LT vol from Vol Adjustment Worksheet, v					
v/c ratio from Capacity Worksheet, X					
Protected phase effective green interval, g (s)					
Opposing queue effective green interval, gq					
Unopposed green interval, gu					
Red time r=(C-g-gq-gu)					
Arrival rate, qa=v/(3600(max[X,1.0]))					
Protected ph. departure rate, Sp=s/3600					
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)					
XPerm					
XProt					
Case					
Queue at beginning of green arrow, Qa					
Queue at beginning of unsaturated green, Qu					
Residual queue, Qr					
Uniform Delay, d1					

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
	0.0						0.0	
LT	0.0	0.00	33.5	27.3	0.00	0.0	0.0	27.9
R	0.0	0.00	33.5	25.7	0.00	0.0	0.0	25.9
Westbound								
	0.0						0.0	
	0.0						0.0	
	0.0						0.0	
Northbound								
	0.0						0.0	
TR	0.0	0.00	27.0	20.8	0.00	0.0	0.0	21.3
	0.0						0.0	
Southbound								
L	0.0	0.00	35.0	30.2	0.00	0.0	0.0	30.7
T	0.0	0.00	15.0	5.6	0.00	0.0	0.0	2.2
	0.0						0.0	

Intersection Delay 19.2 sec/veh Intersection LOS B

BACK OF QUEUE WORKSHEET

```
                     Eastbound        Westbound       Northbound       Southbound
LaneGroup   |      LT   R    |                |      TR        |L    T         |
Init Queue |      0.0  0.0  |                |      0.0       |0.0  0.0       |
Flow Rate  |      135  42   |                |      363       |152  195       |
So          |      1900 1900 |                |      1900      |1900 1900      |
No.Lanes    |0    1    1    |0    0    0    |0    2    0    |2    2    0    |
SL          |      1535 1370 |                |      1644      |1531 1727      |
LnCapacity |      392  350  |                |      657       |340  1151      |
Flow Ratio |      0.1  0.0  |                |      0.2       |0.1  0.1       |
v/c Ratio  |      0.34 0.12 |                |      0.55      |0.45 0.17      |
Grn Ratio  |      0.26 0.26 |                |      0.40      |0.22 0.67      |
I Factor   |      1.000     |                |      1.000     |     0.943     |
AT or PVG  |      3    3    |                |      3         |3    4         |
Pltn Ratio |      1.00 1.00 |                |      1.00      |1.00 1.33      |
PF2         |      1.00 1.00 |                |      1.00      |1.00 0.35      |
Q1          |      2.8  0.8  |                |      7.0       |3.3  0.6       |
kB          |      0.4  0.4  |                |      0.5       |0.3  0.7       |
Q2          |      0.2  0.1  |                |      0.7       |0.3  0.1       |
Q Average  |      3.0  0.9  |                |      7.6       |3.6  0.8       |
Q Spacing  |      25.0 25.0 |                |      25.0      |25.0 25.0      |
Q Storage  |      0    0    |                |      0         |0    0         |
Q S Ratio  |                |                |                |               |
70th Percentile Output:
fB%         |      1.2  1.2  |                |      1.2       |1.2  1.2       |
BOQ         |      3.5  1.0  |                |      9.0       |4.2  0.9       |
QSRatio     |                |                |                |               |
85th Percentile Output:
fB%         |      1.6  1.6  |                |      1.5       |1.6  1.6       |
BOQ         |      4.7  1.4  |                |      11.7      |5.6  1.2       |
QSRatio     |                |                |                |               |
90th Percentile Output:
fB%         |      1.7  1.8  |                |      1.7       |1.7  1.8       |
BOQ         |      5.2  1.5  |                |      12.8      |6.2  1.4       |
QSRatio     |                |                |                |               |
95th Percentile Output:
fB%         |      2.0  2.1  |                |      1.9       |2.0  2.1       |
BOQ         |      5.9  1.8  |                |      14.5      |7.1  1.6       |
QSRatio     |                |                |                |               |
98th Percentile Output:
fB%         |      2.5  2.6  |                |      2.3       |2.5  2.6       |
BOQ         |      7.4  2.3  |                |      17.2      |8.7  2.1       |
QSRatio     |                |                |                |               |
_______________________________________________________________________________

________________________________ERROR MESSAGES_________________________________

       No errors to report.
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                    HCS+: Signalized Intersections Release 5.4

Analyst:                                   Inter.: Eastbound Ramp & Central Avenu
Agency: PB                                 Area Type: All other areas
Date:   6/25/2010                          Jurisd:
Period: PM Peak                            Year  : Existing
Project ID: I-290 Phase 1 Study
E/W St: Eastbound Ramp                     N/S St: Central Avenue

_________________________SIGNALIZED INTERSECTION SUMMARY_______________________
           |  Eastbound      |  Westbound      |  Northbound     |  Southbound     |
           | L    T    R     | L    T    R     | L    T    R     | L    T    R     |
           |_________________|_________________|_________________|_________________|
No. Lanes  |   0    1    1   |   0    0    0   |   0    2    0   |   2    2    0   |
LGConfig   |        LT   R   |                 |        TR       | L      T        |
Volume     |289  0    292    |                 |      642  278   |322  683         |
Lane Width |     10.0 10.0   |                 |      12.0       |10.0 12.0        |
RTOR Vol   |          187    |                 |           41    |                 |
_______________________________________________________________________________
Duration    0.25      Area Type: All other areas
______________________________Signal Operations________________________________
Phase Combination 1     2     3     4 |          5     6     7     8
EB  Left          A                   | NB  Left
    Thru          A                   |     Thru   A
    Right         A                   |     Right  A
    Peds                              |     Peds   X
WB  Left                              | SB  Left         A
    Thru                              |     Thru   A     A
    Right                             |     Right
    Peds                              |     Peds   X     X
NB  Right                             | EB  Right
SB  Right                             | WB  Right
Green            23.0                            35.0  20.0
Yellow           3.0                             3.0   3.0
All Red          1.0                             1.0   1.0
                                                  Cycle Length: 90.0    secs
____________________Intersection Performance Summary__________________________
Appr/   Lane       Adj Sat     Ratios        Lane Group   Approach
Lane    Group      Flow Rate   __________    __________   ___________
Grp     Capacity     (s)       v/c    g/C    Delay LOS    Delay LOS
_______________________________________________________________________________
Eastbound

LT       392       1535        0.78   0.26   40.5   D     37.1   D
R        350       1370        0.32   0.26   27.7   C
Westbound



Northbound

TR       1262      3156        0.73   0.40   25.2   C     25.2   C

Southbound
L        661       2974        0.51   0.22   31.3   C
T        2193      3289        0.33   0.67   1.0    A     10.7   B

         Intersection Delay = 20.9  (sec/veh)   Intersection LOS = C

_______________________________________________________________________________
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HCS+: Signalized Intersections Release 5.4

I-290
Existing

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst:
Agency/Co.: PB
Date Performed: 6/25/2010
Analysis Time Period: PM Peak
Intersection: Eastbound Ramp & Central Avenu
Area Type: All other areas
Jurisdiction:
Analysis Year: Existing
Project ID: I-290 Phase 1 Study
E/W St: Eastbound Ramp N/S St: Central Avenue

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	289	0	292					642	278	322	683	
% Heavy Veh	10	10	10					10	10	10	10	
PHF	0.95	0.95	0.95					0.95	0.95	0.95	0.95	
PK 15 Vol	76	0	77					169	73	85	180	
Hi Ln Vol												
% Grade		0						0			0	
Ideal Sat		1900	1900					1900		1900	1900	
ParkExist												
NumPark												
No. Lanes	0	1	1	0	0	0	0	2	0	2	2	0
LGConfig		LT	R					TR		L	T	
Lane Width		10.0	10.0					12.0		10.0	12.0	
RTOR Vol			187						41			
Adj Flow		304	111					925		339	719	
%InSharedLn												
Prop LTs		1.000						0.000			0.000	
Prop RTs		0.000	1.000					0.269			0.000	
Peds Bikes	0			0			0	0				
Buses		0	0					0		0	0	
%InProtPhase												

Duration 0.25 Area Type: All other areas

OPERATING PARAMETERS

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Init Unmet		0.0	0.0					0.0		0.0	0.0	
Arriv. Type		3	3					3		4	5	
Unit Ext.		3.0	3.0					3.0		3.0	3.0	
I Factor		1.000						1.000			0.819	
Lost Time		2.0	2.0					2.0		2.0	2.0	
Ext of g		2.0	2.0					3.0		2.0	3.0	
Ped Min g		3.2			3.2			3.2				

PHASE DATA

Phase Combination	1	2	3	4			5	6	7	8
EB Left	A				NB	Left				
Thru	A					Thru	A			
Right	A					Right	A			
Peds						Peds	X			
WB Left					SB	Left		A		
Thru						Thru	A	A		
Right						Right				
Peds						Peds	X	X		
NB Right					EB	Right				
SB Right					WB	Right				
Green	23.0						35.0	20.0		
Yellow	3.0						3.0	3.0		
All Red	1.0						1.0	1.0		

Cycle Length: 90.0 secs

VOLUME ADJUSTMENT AND SATURATION FLOW WORKSHEET

Volume Adjustment

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume, V	289	0	292					642	278	322	683	
PHF	0.95	0.95	0.95					0.95	0.95	0.95	0.95	
Adj flow	304	0	111					676	249	339	719	
No. Lanes	0	1	1	0	0	0	0	2	0	2	2	0
Lane group		LT	R					TR		L	T	
Adj flow		304	111					925		339	719	
Prop LTs		1.000						0.000			0.000	
Prop RTs		0.000	1.000					0.269			0.000	

Saturation Flow Rate (see Exhibit 16-7 to determine the adjustment factors)

	Eastbound			Westbound			Northbound			Southbound		
LG		LT	R					TR		L	T	
So		1900	1900					1900		1900	1900	
Lanes	0	1	1	0	0	0	0	2	0	2	2	0
fW		0.933	0.933					1.000		0.933	1.000	
fHV		0.909	0.909					0.909		0.909	0.909	
fG		1.000	1.000					1.000		1.000	1.000	
fP		1.000	1.000					1.000		1.000	1.000	
fBB		1.000	1.000					1.000		1.000	1.000	
fA		1.000	1.000					1.000		1.000	1.000	
fLU		1.000	1.000					0.952		0.971	0.952	
fRT		1.000	0.850					0.960			1.000	
fLT		0.952						1.000		0.950	1.000	
Sec.												
fLpb		1.000						1.000		1.000	1.000	
fRpb		1.000	1.000					1.000			1.000	
S		1535	1370					3156		2974	3289	
Sec.												

CAPACITY AND LOS WORKSHEET

Capacity Analysis and Lane Group Capacity

Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- Capacity (c)	v/c Ratio
Eastbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	LT	304	1535	# 0.20	0.26	392	0.78
Right	R	111	1370	0.08	0.26	350	0.32
Westbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru							
Right							
Northbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	TR	925	3156	# 0.29	0.40	1262	0.73
Right							
Southbound							
Prot							
Perm							
Left	L	339	2974	# 0.11	0.22	661	0.51
Prot							
Perm							
Thru	T	719	3289	0.22	0.67	2193	0.33
Right							

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.61
Total lost time per cycle, L = 11.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.69

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	Ratios g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound												
LT	0.78	0.26	31.1	1.000	392	0.32	9.4	0.0	40.5	D	37.1	D
R	0.32	0.26	27.1	1.000	350	0.11	0.5	0.0	27.7	C		
Westbound												
Northbound												
TR	0.73	0.40	22.9	1.000	1262	0.29	2.2	0.0	25.2	C	25.2	C
Southbound												
L	0.51	0.22	30.7	1.000	661	0.12	0.6	0.0	31.3	C		
T	0.33	0.67	6.4	0.150	2193	0.11	0.1	0.0	1.0	A	10.7	B

```
_______________________________________________________________________________
         Intersection delay = 20.9  (sec/veh)   Intersection LOS = C



______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                              for exclusive lefts
Input
                                                       EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                           90.0    sec
Total actual green time for LT lane group, G (s)
Effective permitted green time for LT lane group, g(s)
Opposing effective green time, go (s)
Number of lanes in LT lane group, N
Number of lanes in opposing approach, No
Adjusted LT flow rate, VLT (veh/h)
Proportion of LT in LT lane group, PLT
Proportion of LT in opposing flow, PLTo
Adjusted opposing flow rate, Vo (veh/h)
Lost time for LT lane group, tL
Computation
LT volume per cycle, LTC=VLTC/3600
Opposing lane util. factor, fLUo                             1.000 0.952 0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g
Opposing platoon ratio, Rpo (refer Exhibit 16-11)
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]
gq, (see Exhibit C16-4,5,6,7,8)
gu=g-gq if gq>=gf, or = g-gf if gq<gf
n=Max(gq-gf)/2,0)
PTHo=1-PLTo
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]
EL1 (refer to Exhibit C16-3)
EL2=Max((1-Ptho**n)/Plto, 1.0)
fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g
gdiff=max(gq-gf,0)
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
or flt=[fm+0.91(N-1)]/N**
Left-turn adjustment, fLT

For special case of single-lane approach opposed by multilane approach,
see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
  left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach
or when gf>gq, see text.

______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                                for shared lefts
Input
                                                       EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                           90.0    sec
Total actual green time for LT lane group, G (s)
Effective permitted green time for LT lane group, g(s)
Opposing effective green time, go (s)
Number of lanes in LT lane group, N
```

```
Number of lanes in opposing approach, No
Adjusted LT flow rate, VLT (veh/h)
Proportion of LT in LT lane group, PLT                 1.000       0.000 0.000
Proportion of LT in opposing flow, PLTo
Adjusted opposing flow rate, Vo (veh/h)
Lost time for LT lane group, tL
Computation
LT volume per cycle, LTC=VLTC/3600
Opposing lane util. factor, fLUo                             1.000 0.952 0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g
Opposing platoon ratio, Rpo (refer Exhibit 16-11)
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]
gq, (see Exhibit C16-4,5,6,7,8)
gu=g-gq if gq>=gf, or = g-gf if gq<gf
n=Max(gq-gf)/2,0)
PTHo=1-PLTo
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]
EL1 (refer to Exhibit C16-3)
EL2=Max((1-Ptho**n)/Plto, 1.0)
fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g
gdiff=max(gq-gf,0)
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
or flt=[fm+0.91(N-1)]/N**
Left-turn adjustment, fLT

For special case of single-lane approach opposed by multilane approach,
see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
  left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach
or when gf>gq, see text.

_______________SUPPLEMENTAL PEDESTRIAN-BICYCLE EFFECTS WORKSHEET_______________
Permitted Left Turns
                                                       EB    WB    NB    SB
Effective pedestrian green time, gp (s)
Conflicting pedestrian volume, Vped (p/h)
Pedestrian flow rate, Vpedg (p/h)
OCCpedg
Opposing queue clearing green, gq (s)
Eff. ped. green consumed by opp. veh. queue, gq/gp
OCCpedu
Opposing flow rate, Vo (veh/h)
OCCr
Number of cross-street receiving lanes, Nrec
Number of turning lanes, Nturn
ApbT
Proportion of left turns, PLT
Proportion of left turns using protected phase, PLTA
Left-turn adjustment, fLpb
Permitted Right Turns
Effective pedestrian green time, gp (s)                          35.0
Conflicting pedestrian volume, Vped (p/h)                        0
Conflicting bicycle volume, Vbic (bicycles/h)                    0
Vpedg                                                            0
OCCpedg                                                          0.000
Effective green, g (s)                                           36.0
Vbicg                                                            0
```

OCCbicg	0.020
OCCr	0.000
Number of cross-street receiving lanes, Nrec	2
Number of turning lanes, Nturn	1
ApbT	1.000
Proportion right-turns, PRT	0.269
Proportion right-turns using protected phase, PRTA	0.000
Right turn adjustment, fRpb	1.000

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

		EBLT	WBLT	NBLT	SBLT
Cycle length, C	90.0 sec				
Adj. LT vol from Vol Adjustment Worksheet, v					
v/c ratio from Capacity Worksheet, X					
Protected phase effective green interval, g (s)					
Opposing queue effective green interval, gq					
Unopposed green interval, gu					
Red time r=(C-g-gq-gu)					
Arrival rate, qa=v/(3600(max[X,1.0]))					
Protected ph. departure rate, Sp=s/3600					
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)					
XPerm					
XProt					
Case					
Queue at beginning of green arrow, Qa					
Queue at beginning of unsaturated green, Qu					
Residual queue, Qr					
Uniform Delay, d1					

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
	0.0						0.0	
LT	0.0	0.00	33.5	31.1	0.00	0.0	0.0	40.5
R	0.0	0.00	33.5	27.1	0.00	0.0	0.0	27.7
Westbound								
	0.0						0.0	
	0.0						0.0	
	0.0						0.0	
Northbound								
	0.0						0.0	
TR	0.0	0.00	27.0	22.9	0.00	0.0	0.0	25.2
	0.0						0.0	
Southbound								
L	0.0	0.00	35.0	30.7	0.00	0.0	0.0	31.3
T	0.0	0.00	15.0	6.4	0.00	0.0	0.0	1.0
	0.0						0.0	

Intersection Delay 20.9 sec/veh Intersection LOS C

BACK OF QUEUE WORKSHEET

```
               Eastbound       Westbound       Northbound      Southbound
LaneGroup  |     LT   R    |               |     TR        |L    T         |
Init Queue |     0.0  0.0  |               |     0.0       |0.0  0.0       |
Flow Rate  |     304  111  |               |     485       |174  377       |
So         |     1900 1900 |               |     1900      |1900 1900      |
No.Lanes   |0    1    1    |0    0    0    |0    2    0    |2    2    0    |
SL         |     1535 1370 |               |     1657      |1531 1727      |
LnCapacity |     392  350  |               |     662       |340  1151      |
Flow Ratio |     0.2  0.1  |               |     0.3       |0.1  0.2       |
v/c Ratio  |     0.78 0.32 |               |     0.73      |0.51 0.33      |
Grn Ratio  |     0.26 0.26 |               |     0.40      |0.22 0.67      |
I Factor   |     1.000     |               |     1.000     |     0.819     |
AT or PVG  |     3    3    |               |     3         |4    5         |
Pltn Ratio |     1.00 1.00 |               |     1.00      |1.33 1.42      |
PF2        |     1.00 1.00 |               |     1.00      |0.95 0.17      |
Q1         |     7.1  2.2  |               |     10.3      |3.6  0.7       |
kB         |     0.4  0.4  |               |     0.5       |0.3  0.6       |
Q2         |     1.2  0.2  |               |     1.4       |0.3  0.3       |
Q Average  |     8.3  2.4  |               |     11.7      |3.9  1.0       |
Q Spacing  |     25.0 25.0 |               |     25.0      |25.0 25.0      |
Q Storage  |     0    0    |               |     0         |0    0         |
Q S Ratio  |               |               |               |               |
70th Percentile Output:
fB%        |     1.2  1.2  |               |     1.2       |1.2  1.2       |
BOQ        |     9.8  2.9  |               |     13.7      |4.7  1.2       |
QSRatio    |               |               |               |               |
85th Percentile Output:
fB%        |     1.5  1.6  |               |     1.5       |1.6  1.6       |
BOQ        |     12.6 3.8  |               |     17.6      |6.1  1.6       |
QSRatio    |               |               |               |               |
90th Percentile Output:
fB%        |     1.7  1.8  |               |     1.6       |1.7  1.8       |
BOQ        |     13.8 4.2  |               |     19.0      |6.8  1.7       |
QSRatio    |               |               |               |               |
95th Percentile Output:
fB%        |     1.9  2.0  |               |     1.8       |2.0  2.1       |
BOQ        |     15.6 4.9  |               |     21.2      |7.8  2.0       |
QSRatio    |               |               |               |               |
98th Percentile Output:
fB%        |     2.2  2.5  |               |     2.1       |2.4  2.6       |
BOQ        |     18.5 6.1  |               |     24.6      |9.5  2.6       |
QSRatio    |               |               |               |               |
________________________________________________________________________________

________________________________ERROR MESSAGES__________________________________

       No errors to report.
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HCS+: Signalized Intersections Release 5.4

Analyst:
Agency: PB
Date: 6/25/2010
Period: AM Peak
Project ID: I-290 Phase 1 Study
E/W St: Flournoy Street

Inter.: Flournoy Street & Laramie Aven
Area Type: CBD or Similar
Jurisd:
Year : Existing
N/S St: Laramie Avenue

SIGNALIZED INTERSECTION SUMMARY

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	0	0	0	1	2	1	0	2	0	0	2	0
LGConfig				L	LTR	R		LT			TR	
Volume				234	57	389	48	133			694	40
Lane Width				10.0	10.0	10.0		11.0			11.0	
RTOR Vol						80						5

Duration 0.25 Area Type: CBD or Similar

Signal Operations

Phase Combination		1	2	3	4			5	6	7	8
EB	Left					NB	Left	A	A		
	Thru						Thru	A	A		
	Right						Right				
	Peds						Peds	X	X		
WB	Left	A				SB	Left				
	Thru	A					Thru		A		
	Right	A					Right		A		
	Peds	X					Peds		X		
NB	Right					EB	Right				
SB	Right					WB	Right				
Green		20.0						10.0	47.0		
Yellow		3.0						0.0	3.0		
All Red		1.0						0.0	1.0		

Cycle Length: 85.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
Westbound								
L	316	1280	0.56	0.25	30.2	C		
LTR	516	2089	0.56	0.25	29.4	C	32.3	C
R	227	920	0.72	0.25	39.7	D		
Northbound								
LT	1303	2663	0.15	0.68	4.8	A	4.8	A
Southbound								
TR	1500	2657	0.51	0.56	11.6	B	11.6	B

Intersection Delay = 19.0 (sec/veh) Intersection LOS = B

HCS+: Signalized Intersections Release 5.4

I-290
Existing

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst:
Agency/Co.: PB
Date Performed: 6/25/2010
Analysis Time Period: AM Peak
Intersection: Flournoy Street & Laramie Aven
Area Type: CBD or Similar
Jurisdiction:
Analysis Year: Existing
Project ID: I-290 Phase 1 Study
E/W St: Flournoy Street N/S St: Laramie Avenue

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume				234	57	389	48	133			694	40
% Heavy Veh				10	10	10	10	10			10	10
PHF				0.95	0.95	0.95	0.95	0.95			0.95	0.95
PK 15 Vol				62	15	102	13	35			183	11
Hi Ln Vol												
% Grade					0			0			0	
Ideal Sat				1800	1800	1800		1800			1800	
ParkExist												
NumPark												
No. Lanes	0	0	0	1	2	1	0	2	0	0	2	0
LGConfig				L	LTR	R		LT			TR	
Lane Width				10.0	10.0	10.0		11.0			11.0	
RTOR Vol						80						5
Adj Flow				177	291	163		191			768	
%InSharedLn				28		50						
Prop LTs					0.237			0.267			0.000	
Prop RTs					0.558	1.000		0.000			0.048	
Peds Bikes	0			100	0					100	0	
Buses				5	0	0		0			5	
%InProtPhase							0.0					

Duration 0.25 Area Type: CBD or Similar

OPERATING PARAMETERS

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Init Unmet				0.0	0.0	0.0		0.0			0.0	
Arriv. Type				3	3	3		3			3	
Unit Ext.				3.0	3.0	3.0		3.0			3.0	
I Factor					1.000			0.966			1.000	
Lost Time				2.0	2.0	2.0		2.0			2.0	
Ext of g				3.0	3.0	3.0		3.0			3.0	
Ped Min g		3.2			3.8						3.8	

PHASE DATA

Phase Combination		1	2	3	4			5	6	7	8
EB	Left					NB	Left	A	A		
	Thru						Thru	A	A		
	Right						Right				
	Peds						Peds	X	X		
WB	Left	A				SB	Left				
	Thru	A					Thru		A		
	Right	A					Right		A		
	Peds	X					Peds		X		
NB	Right					EB	Right				
SB	Right					WB	Right				
Green		20.0						10.0	47.0		
Yellow		3.0						0.0	3.0		
All Red		1.0						0.0	1.0		

Cycle Length: 85.0 secs

VOLUME ADJUSTMENT AND SATURATION FLOW WORKSHEET

Volume Adjustment

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume, V				234	57	389	48	133			694	40
PHF				0.95	0.95	0.95	0.95	0.95			0.95	0.95
Adj flow				246	60	325	51	140			731	37
No. Lanes	0	0	0	1	2	1	0	2	0	0	2	0
Lane group				L	LTR	R		LT			TR	
Adj flow				177	291	163		191			768	
Prop LTs					0.237			0.267			0.000	
Prop RTs					0.558	1.000		0.000			0.048	

Saturation Flow Rate (see Exhibit 16-7 to determine the adjustment factors)

	Eastbound			Westbound			Northbound			Southbound		
LG				L	LTR	R		LT			TR	
So				1800	1800	1800		1800			1800	
Lanes	0	0	0	1	2	1	0	2	0	0	2	0
fW				0.933	0.933	0.933		0.967			0.967	
fHV				0.909	0.909	0.909		0.909			0.909	
fG				1.000	1.000	1.000		1.000			1.000	
fP				1.000	1.000	1.000		1.000			1.000	
fBB				0.980	1.000	1.000		1.000			0.990	
fA				0.900	0.900	0.900		0.900			0.900	
fLU				1.000	0.952	1.000		0.952			0.952	
fRT					0.916	0.850		1.000			0.993	
fLT				0.950	0.988			0.987			1.000	
Sec.								0.670				
fLpb				1.000	1.000			0.996			1.000	
fRpb					0.881	0.788		1.000			0.997	
S				1280	2089	920		2663			2657	
Sec.								1807				

CAPACITY AND LOS WORKSHEET

Capacity Analysis and Lane Group Capacity

Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- Capacity (c)	v/c Ratio
Eastbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru							
Right							
Westbound							
Prot							
Perm							
Left	L	177	1280	0.14	0.25	316	0.56
Prot							
Perm							
Thru	LTR	291	2089	0.14	0.25	516	0.56
Right	R	163	920	# 0.18	0.25	227	0.72
Northbound							
Prot							
Perm							
Left							
Prot		191	2663	# 0.07	0.082	219	0.87
Perm		0	1807	0.00	0.600	1084	0.00
Thru	LT	191			0.68	1303	0.15
Right							
Southbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	TR	768	2657	# 0.29	0.56	1500	0.51
Right							

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.54
Total lost time per cycle, L = 9.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.60

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	LOS	Approach Delay	LOS
Eastbound												
Westbound												
L	0.56	0.25	28.0	1.000	316	0.16	2.3	0.0	30.2	C		
LTR	0.56	0.25	28.0	1.000	516	0.16	1.4	0.0	29.4	C	32.3	C
R	0.72	0.25	29.3	1.000	227	0.28	10.5	0.0	39.7	D		
Northbound												
LT	0.15	0.68	4.8	1.000	1303	0.11	0.1	0.0	4.8	A	4.8	A
Southbound												
TR	0.51	0.56	11.3	1.000	1500	0.12	0.3	0.0	11.6	B	11.6	B

Intersection delay = 19.0 (sec/veh) Intersection LOS = B

SUPPLEMENTAL PERMITTED LT WORKSHEET
for exclusive lefts

Input		EB	WB	NB	SB
Opposed by Single(S) or Multiple(M) lane approach					
Cycle length, C	85.0 sec				
Total actual green time for LT lane group, G (s)					
Effective permitted green time for LT lane group, g(s)					
Opposing effective green time, go (s)					
Number of lanes in LT lane group, N					
Number of lanes in opposing approach, No					
Adjusted LT flow rate, VLT (veh/h)					
Proportion of LT in LT lane group, PLT					
Proportion of LT in opposing flow, PLTo					
Adjusted opposing flow rate, Vo (veh/h)					
Lost time for LT lane group, tL					
Computation					
LT volume per cycle, LTC=VLTC/3600					
Opposing lane util. factor, fLUo		0.952		0.952	0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)					
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g					
Opposing platoon ratio, Rpo (refer Exhibit 16-11)					
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]					
gq, (see Exhibit C16-4,5,6,7,8)					
gu=g-gq if gq>=gf, or = g-gf if gq<gf					
n=Max(gq-gf)/2,0)					
PTHo=1-PLTo					
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]					
EL1 (refer to Exhibit C16-3)					
EL2=Max((1-Ptho**n)/Plto, 1.0)					
fmin=2(1+PL)/g or fmin=2(1+Pl)/g					
gdiff=max(gq-gf,0)					
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)					
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)					
or flt=[fm+0.91(N-1)]/N**					
Left-turn adjustment, fLT					

For special case of single-lane approach opposed by multilane approach, see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach or when gf>gq, see text.

SUPPLEMENTAL PERMITTED LT WORKSHEET
for shared lefts

Input		EB	WB	NB	SB
Opposed by Single(S) or Multiple(M) lane approach					
Cycle length, C	85.0 sec				
Total actual green time for LT lane group, G (s)				57.0	
Effective permitted green time for LT lane group, g(s)				51.0	
Opposing effective green time, go (s)				48.0	
Number of lanes in LT lane group, N				2	

```
Number of lanes in opposing approach, No                           2
Adjusted LT flow rate, VLT (veh/h)                                 51
Proportion of LT in LT lane group, PLT                       0.237 0.267 0.000
Proportion of LT in opposing flow, PLTo                            0.00
Adjusted opposing flow rate, Vo (veh/h)                            768
Lost time for LT lane group, tL                                    3.00
Computation
LT volume per cycle, LTC=VLTC/3600                                 1.20
Opposing lane util. factor, fLUo                       0.952       0.952 0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)                9.52
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g                              7.2
Opposing platoon ratio, Rpo (refer Exhibit 16-11)                  1.00
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]                       0.44
gq, (see Exhibit C16-4,5,6,7,8)                                    10.69
gu=g-gq if gq>=gf, or = g-gf if gq<gf                              40.31
n=Max(gq-gf)/2,0)                                                  1.76
PTHo=1-PLTo                                                        1.00
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]                                 0.83
EL1 (refer to Exhibit C16-3)                                       3.10
EL2=Max((1-Ptho**n)/Plto, 1.0)
fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g                                 0.07
gdiff=max(gq-gf,0)                                                 0.00
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)                0.43
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
or flt=[fm+0.91(N-1)]/N**
Left-turn adjustment, fLT                                          0.670

For special case of single-lane approach opposed by multilane approach,
see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
  left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach
or when gf>gq, see text.

_______________SUPPLEMENTAL PEDESTRIAN-BICYCLE EFFECTS WORKSHEET_______________
Permitted Left Turns
                                                       EB    WB    NB    SB
Effective pedestrian green time, gp (s)                           47.0
Conflicting pedestrian volume, Vped (p/h)                         100
Pedestrian flow rate, Vpedg (p/h)                                 180
OCCpedg                                                           0.090
Opposing queue clearing green, gq (s)                             10.69
Eff. ped. green consumed by opp. veh. queue, gq/gp                0.227
OCCpedu                                                           0.080
Opposing flow rate, Vo (veh/h)                                    768
OCCr                                                              0.027
Number of cross-street receiving lanes, Nrec                      2
Number of turning lanes, Nturn                                    1
ApbT                                                              0.984
Proportion of left turns, PLT                                     0.267
Proportion of left turns using protected phase, PLTA              0.000
Left-turn adjustment, fLpb                                        0.996
Permitted Right Turns
Effective pedestrian green time, gp (s)                     20.0        47.0
Conflicting pedestrian volume, Vped (p/h)                   100         100
Conflicting bicycle volume, Vbic (bicycles/h)               0           0
Vpedg                                                       425         180
OCCpedg                                                     0.213       0.090
Effective green, g (s)                                      21.0        48.0
Vbicg                                                       0           0
```

OCCbicg	0.020	0.020
OCCr	0.213	0.090
Number of cross-street receiving lanes, Nrec	2	2
Number of turning lanes, Nturn	2	1
ApbT	0.788	0.946
Proportion right-turns, PRT	1.000	0.048
Proportion right-turns using protected phase, PRTA	0.000	0.000
Right turn adjustment, fRpb	1.000	0.997

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

		EBLT	WBLT	NBLT	SBLT
Cycle length, C	85.0 sec				
Adj. LT vol from Vol Adjustment Worksheet, v					
v/c ratio from Capacity Worksheet, X					
Protected phase effective green interval, g (s)					
Opposing queue effective green interval, gq					
Unopposed green interval, gu					
Red time r=(C-g-gq-gu)					
Arrival rate, qa=v/(3600(max[X,1.0]))					
Protected ph. departure rate, Sp=s/3600					
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)					
XPerm					
XProt					
Case					
Queue at beginning of green arrow, Qa					
Queue at beginning of unsaturated green, Qu					
Residual queue, Qr					
Uniform Delay, d1					

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
	0.0						0.0	
	0.0						0.0	
	0.0						0.0	
Westbound								
L	0.0	0.00	32.0	28.0	0.00	0.0	0.0	30.2
LTR	0.0	0.00	32.0	28.0	0.00	0.0	0.0	29.4
R	0.0	0.00	32.0	29.3	0.00	0.0	0.0	39.7
Northbound								
	0.0						0.0	
LT	0.0	0.00	13.5	4.8	0.00	0.0	0.0	4.8
	0.0						0.0	
Southbound								
	0.0						0.0	
TR	0.0	0.00	18.5	11.3	0.00	0.0	0.0	11.6
	0.0						0.0	

Intersection Delay 19.0 sec/veh Intersection LOS B

BACK OF QUEUE WORKSHEET

	Eastbound			Westbound			Northbound			Southbound		
LaneGroup				L	LTR	R		LT			TR	
Init Queue				0.0	0.0	0.0		0.0			0.0	
Flow Rate				177	152	163		100			403	
So				1800	1800	1800		1800			1800	
No.Lanes	0	0	0	1	2	1	0	2	0	0	2	0
SL				1280	1097	920		1003			1395	
LnCapacity				316	271	227		684			787	
Flow Ratio				0.1	0.1	0.2		0.1			0.3	
v/c Ratio				0.56	0.56	0.72		0.15			0.51	
Grn Ratio				0.25	0.25	0.25		0.68			0.56	
I Factor					1.000			0.966			1.000	
AT or PVG				3	3	3		3			3	
Pltn Ratio				1.00	1.00	1.00		1.00			1.00	
PF2				1.00	1.00	1.00		1.00			1.00	
Q1				3.7	3.1	3.5		0.8			5.8	
kB				0.3	0.3	0.3		0.5			0.6	
Q2				0.4	0.4	0.6		0.1			0.6	
Q Average				4.1	3.5	4.2		0.8			6.4	
Q Spacing				25.0	25.0	25.0		25.0			25.0	
Q Storage				0	0	0		0			0	
Q S Ratio												
70th Percentile Output:												
fB%				1.2	1.2	1.2		1.2			1.2	
BOQ				4.8	4.2	5.0		1.0			7.6	
QSRatio												
85th Percentile Output:												
fB%				1.6	1.6	1.6		1.6			1.5	
BOQ				6.4	5.5	6.5		1.3			9.9	
QSRatio												
90th Percentile Output:												
fB%				1.7	1.7	1.7		1.8			1.7	
BOQ				7.0	6.1	7.2		1.5			10.9	
QSRatio												
95th Percentile Output:												
fB%				2.0	2.0	2.0		2.1			1.9	
BOQ				8.0	7.0	8.2		1.8			12.3	
QSRatio												
98th Percentile Output:												
fB%				2.4	2.5	2.4		2.6			2.3	
BOQ				9.9	8.7	10.1		2.2			14.8	
QSRatio												

ERROR MESSAGES

No errors to report.

HCS+: Signalized Intersections Release 5.4

Analyst:
Agency: PB
Date: 6/25/2010
Period: PM Peak
Project ID: I-290 Phase 1 Study
E/W St: Flournoy Street

Inter.: Flournoy Street & Laramie Aven
Area Type: CBD or Similar
Jurisd:
Year : Existing
N/S St: Laramie Avenue

SIGNALIZED INTERSECTION SUMMARY

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
No. Lanes	0	0	0	1	2	1	0	2	0	0	2	0
LGConfig				L	LTR	R		LT			TR	
Volume				251	26	360	59	319			503	30
Lane Width				10.0	10.0	10.0		11.0			11.0	
RTOR Vol						80						5

Duration 0.25 Area Type: CBD or Similar

Signal Operations

Phase Combination	1	2	3	4		5	6	7	8
EB Left					NB Left	A	A		
Thru					Thru	A	A		
Right					Right				
Peds					Peds	X	X		
WB Left	A				SB Left				
Thru	A				Thru		A		
Right	A				Right		A		
Peds	X				Peds		X		
NB Right					EB Right				
SB Right					WB Right				
Green	34.0					7.0	36.0		
Yellow	3.0					0.0	3.0		
All Red	1.0					0.0	1.0		

Cycle Length: 85.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
Westbound								
L	527	1280	0.31	0.41	17.2	B		
LTR	907	2202	0.30	0.41	17.0	B	17.2	B
R	421	1022	0.35	0.41	17.7	B		
Northbound								
LT	1062	2678	0.37	0.52	12.5	B	12.5	B
Southbound								
TR	1156	2656	0.48	0.44	17.4	B	17.4	B

Intersection Delay = 16.1 (sec/veh) Intersection LOS = B

HCS+: Signalized Intersections Release 5.4

I-290
Existing

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst:
Agency/Co.: PB
Date Performed: 6/25/2010
Analysis Time Period: PM Peak
Intersection: Flournoy Street & Laramie Aven
Area Type: CBD or Similar
Jurisdiction:
Analysis Year: Existing
Project ID: I-290 Phase 1 Study
E/W St: Flournoy Street N/S St: Laramie Avenue

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume				251	26	360	59	319			503	30
% Heavy Veh				10	10	10	10	10			10	10
PHF				0.95	0.95	0.95	0.95	0.95			0.95	0.95
PK 15 Vol				66	7	95	16	84			132	8
Hi Ln Vol												
% Grade					0			0			0	
Ideal Sat				1800	1800	1800		1800			1800	
ParkExist												
NumPark												
No. Lanes	0	0	0	1	2	1	0	2	0	0	2	0
LGConfig				L	LTR	R		LT			TR	
Lane Width				10.0	10.0	10.0		11.0			11.0	
RTOR Vol						80						5
Adj Flow				166	272	148		398			555	
%InSharedLn				37		50						
Prop LTs					0.359			0.156			0.000	
Prop RTs					0.542	1.000		0.000			0.047	
Peds Bikes	0				100	0					100	0
Buses				5	0	0		0			5	
%InProtPhase							0.0					

Duration 0.25 Area Type: CBD or Similar

OPERATING PARAMETERS

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Init Unmet				0.0	0.0	0.0		0.0			0.0	
Arriv. Type				3	3	3		3			3	
Unit Ext.				3.0	3.0	3.0		3.0			3.0	
I Factor					1.000			0.888			1.000	
Lost Time				2.0	2.0	2.0		2.0			2.0	
Ext of g				3.0	3.0	3.0		3.0			3.0	
Ped Min g		3.2			3.8						3.8	

```
_________________________________PHASE DATA____________________________________

Phase Combination 1     2     3     4 |            5     6     7     8

EB  Left                              | NB  Left   A     A
    Thru                              |     Thru   A     A
    Right                             |     Right
    Peds                              |     Peds   X     X

WB  Left          A                   | SB  Left
    Thru          A                   |     Thru         A
    Right         A                   |     Right        A
    Peds          X                   |     Peds         X

NB  Right                             | EB  Right
                                      |
SB  Right                             | WB  Right
                                      |
                                      |
Green            34.0                             7.0   36.0
Yellow           3.0                              0.0   3.0
All Red          1.0                              0.0   1.0

                                                    Cycle Length: 85.0    secs

_________________VOLUME ADJUSTMENT AND SATURATION FLOW WORKSHEET_______________
Volume Adjustment
           |  Eastbound    |  Westbound    |  Northbound   |  Southbound   |
           | L    T    R   | L    T    R   | L    T    R   | L    T    R   |
           |_______________|_______________|_______________|_______________|
Volume, V  |               |251  26   360  |59   319       |     503  30   |
PHF        |               |0.95 0.95 0.95 |0.95 0.95      |     0.95 0.95 |
Adj flow   |               |264  27   295  |62   336       |     529  26   |
No. Lanes  |   0   0   0   |   1   2   1   |   0   2   0   |   0   2   0   |
Lane group |               | L     LTR  R  |      LT       |      TR       |
Adj flow   |               |166  272  148  |     398       |     555       |
Prop LTs   |               |      0.359    |      0.156    |      0.000    |
Prop RTs   |               |   0.542 1.000 |   0.000       |   0.047       |

Saturation Flow Rate (see Exhibit 16-7 to determine the adjustment factors)____
         Eastbound         Westbound        Northbound        Southbound
LG                        L     LTR  R            LT                TR
So                       1800  1800  1800        1800              1800
Lanes 0     0     0     1     2     1     0     2     0     0     2     0
fW                       0.933 0.933 0.933       0.967             0.967
fHV                      0.909 0.909 0.909       0.909             0.909
fG                       1.000 1.000 1.000       1.000             1.000
fP                       1.000 1.000 1.000       1.000             1.000
fBB                      0.980 1.000 1.000       1.000             0.990
fA                       0.900 0.900 0.900       0.900             0.900
fLU                      1.000 0.952 1.000       0.952             0.952
fRT                            0.919 0.850       1.000             0.993
fLT                      0.950 0.982             0.992             1.000
Sec.                                             0.737
fLpb                     1.000 1.000             0.996             1.000
fRpb                           0.932 0.875       1.000             0.997
S                        1280  2202  1022        2678              2656
Sec.                                             1990
_________________________CAPACITY AND LOS WORKSHEET____________________________
Capacity Analysis and Lane Group Capacity
```

Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- Capacity (c)	v/c Ratio
Eastbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru							
Right							
Westbound							
Prot							
Perm							
Left	L	166	1280	0.13	0.41	527	0.31
Prot							
Perm							
Thru	LTR	272	2202	0.12	0.41	907	0.30
Right	R	148	1022	# 0.14	0.41	421	0.35
Northbound							
Prot							
Perm							
Left							
Prot		126	2678	# 0.05	0.047	126	1.00
Perm		272	1990	0.14	0.471	936	0.29
Thru	LT	398			0.52	1062	0.37
Right							
Southbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	TR	555	2656	# 0.21	0.44	1156	0.48
Right							

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.40
Total lost time per cycle, L = 9.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.45

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	Ratios g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound												
Westbound												
L	0.31	0.41	16.9	1.000	527	0.11	0.3	0.0	17.2	B		
LTR	0.30	0.41	16.8	1.000	907	0.11	0.2	0.0	17.0	B	17.2	B
R	0.35	0.41	17.2	1.000	421	0.11	0.5	0.0	17.7	B		
Northbound												
LT	0.37	0.52	12.3	1.000	1062	0.11	0.2	0.0	12.5	B	12.5	B
Southbound												
TR	0.48	0.44	17.1	1.000	1156	0.11	0.3	0.0	17.4	B	17.4	B

Intersection delay = 16.1 (sec/veh) Intersection LOS = B

SUPPLEMENTAL PERMITTED LT WORKSHEET
for exclusive lefts

Input		EB	WB	NB	SB
Opposed by Single(S) or Multiple(M) lane approach					
Cycle length, C	85.0 sec				
Total actual green time for LT lane group, G (s)					
Effective permitted green time for LT lane group, g(s)					
Opposing effective green time, go (s)					
Number of lanes in LT lane group, N					
Number of lanes in opposing approach, No					
Adjusted LT flow rate, VLT (veh/h)					
Proportion of LT in LT lane group, PLT					
Proportion of LT in opposing flow, PLTo					
Adjusted opposing flow rate, Vo (veh/h)					
Lost time for LT lane group, tL					
Computation					
LT volume per cycle, LTC=VLTC/3600					
Opposing lane util. factor, fLUo		0.952		0.952	0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)					
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g					
Opposing platoon ratio, Rpo (refer Exhibit 16-11)					
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]					
gq, (see Exhibit C16-4,5,6,7,8)					
gu=g-gq if gq>=gf, or = g-gf if gq<gf					
n=Max(gq-gf)/2,0)					
PTHo=1-PLTo					
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]					
EL1 (refer to Exhibit C16-3)					
EL2=Max((1-Ptho**n)/Plto, 1.0)					
fmin=2(1+PL)/g or fmin=2(1+Pl)/g					
gdiff=max(gq-gf,0)					
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)					
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)					
or flt=[fm+0.91(N-1)]/N**					
Left-turn adjustment, fLT					

For special case of single-lane approach opposed by multilane approach, see text.

* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto left-turn lane and redo calculations.

** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.

For special case of multilane approach opposed by single-lane approach or when gf>gq, see text.

SUPPLEMENTAL PERMITTED LT WORKSHEET
for shared lefts

Input		EB	WB	NB	SB
Opposed by Single(S) or Multiple(M) lane approach					
Cycle length, C	85.0 sec				
Total actual green time for LT lane group, G (s)				43.0	
Effective permitted green time for LT lane group, g(s)				40.0	
Opposing effective green time, go (s)				37.0	
Number of lanes in LT lane group, N				2	

```
Number of lanes in opposing approach, No                           2
Adjusted LT flow rate, VLT (veh/h)                                 62
Proportion of LT in LT lane group, PLT                       0.359 0.156 0.000
Proportion of LT in opposing flow, PLTo                            0.00
Adjusted opposing flow rate, Vo (veh/h)                            555
Lost time for LT lane group, tL                                    3.00
Computation
LT volume per cycle, LTC=VLTC/3600                                 1.46
Opposing lane util. factor, fLUo                       0.952       0.952 0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)                6.88
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g                              4.3
Opposing platoon ratio, Rpo (refer Exhibit 16-11)                  1.00
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]                       0.56
gq, (see Exhibit C16-4,5,6,7,8)                                    9.28
gu=g-gq if gq>=gf, or = g-gf if gq<gf                              30.72
n=Max(gq-gf)/2,0)                                                  2.49
PTHo=1-PLTo                                                        1.00
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]                                 0.45
EL1 (refer to Exhibit C16-3)                                       2.50
EL2=Max((1-Ptho**n)/Plto, 1.0)
fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g                                 0.07
gdiff=max(gq-gf,0)                                                 0.00
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)                0.56
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
or flt=[fm+0.91(N-1)]/N**
Left-turn adjustment, fLT                                          0.737

For special case of single-lane approach opposed by multilane approach,
see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
  left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach
or when gf>gq, see text.

_______________SUPPLEMENTAL PEDESTRIAN-BICYCLE EFFECTS WORKSHEET_______________
Permitted Left Turns
                                                       EB    WB    NB    SB
Effective pedestrian green time, gp (s)                           36.0
Conflicting pedestrian volume, Vped (p/h)                         100
Pedestrian flow rate, Vpedg (p/h)                                 236
OCCpedg                                                           0.118
Opposing queue clearing green, gq (s)                             9.28
Eff. ped. green consumed by opp. veh. queue, gq/gp                0.258
OCCpedu                                                           0.103
Opposing flow rate, Vo (veh/h)                                    555
OCCr                                                              0.048
Number of cross-street receiving lanes, Nrec                      2
Number of turning lanes, Nturn                                    1
ApbT                                                              0.971
Proportion of left turns, PLT                                     0.156
Proportion of left turns using protected phase, PLTA              0.000
Left-turn adjustment, fLpb                                        0.996
Permitted Right Turns
Effective pedestrian green time, gp (s)                     34.0        36.0
Conflicting pedestrian volume, Vped (p/h)                   100         100
Conflicting bicycle volume, Vbic (bicycles/h)               0           0
Vpedg                                                       250         236
OCCpedg                                                     0.125       0.118
Effective green, g (s)                                      35.0        37.0
Vbicg                                                       0           0
```

OCCbicg	0.020	0.020
OCCr	0.125	0.118
Number of cross-street receiving lanes, Nrec	2	2
Number of turning lanes, Nturn	2	1
ApbT	0.875	0.929
Proportion right-turns, PRT	1.000	0.047
Proportion right-turns using protected phase, PRTA	0.000	0.000
Right turn adjustment, fRpb	1.000	0.997

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

		EBLT	WBLT	NBLT	SBLT
Cycle length, C	85.0 sec				
Adj. LT vol from Vol Adjustment Worksheet, v					
v/c ratio from Capacity Worksheet, X					
Protected phase effective green interval, g (s)					
Opposing queue effective green interval, gq					
Unopposed green interval, gu					
Red time r=(C-g-gq-gu)					
Arrival rate, qa=v/(3600(max[X,1.0]))					
Protected ph. departure rate, Sp=s/3600					
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)					
XPerm					
XProt					
Case					
Queue at beginning of green arrow, Qa					
Queue at beginning of unsaturated green, Qu					
Residual queue, Qr					
Uniform Delay, d1					

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
	0.0						0.0	
	0.0						0.0	
	0.0						0.0	
Westbound								
L	0.0	0.00	25.0	16.9	0.00	0.0	0.0	17.2
LTR	0.0	0.00	25.0	16.8	0.00	0.0	0.0	17.0
R	0.0	0.00	25.0	17.2	0.00	0.0	0.0	17.7
Northbound								
	0.0						0.0	
LT	0.0	0.00	20.5	12.3	0.00	0.0	0.0	12.5
	0.0						0.0	
Southbound								
	0.0						0.0	
TR	0.0	0.00	24.0	17.1	0.00	0.0	0.0	17.4
	0.0						0.0	

Intersection Delay 16.1 sec/veh Intersection LOS B

BACK OF QUEUE WORKSHEET

	Eastbound			Westbound			Northbound			Southbound		
LaneGroup				L	LTR	R		LT			TR	
Init Queue				0.0	0.0	0.0		0.0			0.0	
Flow Rate				166	142	148		209			291	
So				1800	1800	1800		1800			1800	
No.Lanes	0	0	0	1	2	1	0	2	0	0	2	0
SL				1280	1156	1022		1078			1394	
LnCapacity				527	476	421		557			607	
Flow Ratio				0.1	0.1	0.1		0.2			0.2	
v/c Ratio				0.31	0.30	0.35		0.38			0.48	
Grn Ratio				0.41	0.41	0.41		0.52			0.44	
I Factor					1.000			0.888			1.000	
AT or PVG				3	3	3		3			3	
Pltn Ratio				1.00	1.00	1.00		1.00			1.00	
PF2				1.00	1.00	1.00		1.00			1.00	
Q1				2.6	2.2	2.4		2.4			4.9	
kB				0.5	0.4	0.4		0.4			0.5	
Q2				0.2	0.2	0.2		0.2			0.4	
Q Average				2.9	2.4	2.6		2.7			5.4	
Q Spacing				25.0	25.0	25.0		25.0			25.0	
Q Storage				0	0	0		0			0	
Q S Ratio												
70th Percentile Output:												
fB%				1.2	1.2	1.2		1.2			1.2	
BOQ				3.4	2.9	3.1		3.2			6.4	
QSRatio												
85th Percentile Output:												
fB%				1.6	1.6	1.6		1.6			1.6	
BOQ				4.5	3.8	4.1		4.2			8.3	
QSRatio												
90th Percentile Output:												
fB%				1.7	1.8	1.8		1.7			1.7	
BOQ				5.0	4.3	4.6		4.7			9.1	
QSRatio												
95th Percentile Output:												
fB%				2.0	2.0	2.0		2.0			1.9	
BOQ				5.7	4.9	5.3		5.4			10.4	
QSRatio												
98th Percentile Output:												
fB%				2.5	2.5	2.5		2.5			2.4	
BOQ				7.2	6.1	6.6		6.7			12.6	
QSRatio												

ERROR MESSAGES

No errors to report.

```
                    HCS+: Signalized Intersections Release 5.4

Analyst:                                Inter.: Lexington Street & Laramie Ave
Agency: PB                              Area Type: CBD or Similar
Date:   6/25/2010                       Jurisd:
Period: AM Peak                         Year  : Existing
Project ID: I-290 Phase 1 Study
E/W St: Lexington Street                N/S St: Laramie Avenue

_________________________SIGNALIZED INTERSECTION SUMMARY_______________________
           |  Eastbound     |  Westbound     |  Northbound    |  Southbound    |
           | L    T    R    | L    T    R    | L    T    R    | L    T    R    |
           |________________|________________|________________|________________|
No. Lanes  |   0    1    0  |   0    0    0  |   0    2    0  |   1    2    1  |
LGConfig   |       LTR      |                |       LTR      | L      LT   R  |
Volume     |25   11   3     |                |17   155  182   |234  582  50    |
Lane Width |     12.0       |                |     11.5       |11.0 11.0 11.0  |
RTOR Vol   |          3     |                |          80    |          17    |
_______________________________________________________________________________
Duration    0.25      Area Type: CBD or Similar
______________________________Signal Operations________________________________
Phase Combination 1     2     3     4 |           5     6     7     8
EB  Left          A                   | NB  Left        A
    Thru          A                   |     Thru        A
    Right         A                   |     Right       A
    Peds          X                   |     Peds        X
WB  Left                              | SB  Left  A     A
    Thru                              |     Thru  A     A
    Right                             |     Right A     A
    Peds                              |     Peds  X     X
NB  Right                             | EB  Right
SB  Right                             | WB  Right
Green            20.0                             20.0  34.0
Yellow           3.0                              3.0   3.0
All Red          1.0                              0.0   1.0
                                                   Cycle Length: 85.0    secs
____________________Intersection Performance Summary___________________________
Appr/   Lane       Adj Sat     Ratios        Lane Group   Approach
Lane    Group      Flow Rate  __________     __________  ___________
Grp     Capacity     (s)      v/c    g/C     Delay LOS   Delay LOS
_______________________________________________________________________________
Eastbound

LTR      352       1424      0.11   0.25    24.9   C    24.9   C

Westbound



Northbound

LTR      940       2283      0.31   0.41    17.0   B    17.0   B

Southbound
L        590       1247      0.28   0.68    6.4    A
LT       1573      2645      0.44   0.68    15.1   B    13.3   B
R        764       1120      0.05   0.68    10.8   B
         Intersection Delay = 14.5  (sec/veh)   Intersection LOS = B
_______________________________________________________________________________
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HCS+: Signalized Intersections Release 5.4

I-290
Existing

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst:
Agency/Co.: PB
Date Performed: 6/25/2010
Analysis Time Period: AM Peak
Intersection: Lexington Street & Laramie Ave
Area Type: CBD or Similar
Jurisdiction:
Analysis Year: Existing
Project ID: I-290 Phase 1 Study
E/W St: Lexington Street N/S St: Laramie Avenue

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	25	11	3				17	155	182	234	582	50
% Heavy Veh	10	10	10				10	10	10	10	10	10
PHF	0.95	0.95	0.95				0.95	0.95	0.95	0.95	0.95	0.95
PK 15 Vol	7	3	1				5	41	48	62	153	13
Hi Ln Vol												
% Grade		0						0			0	
Ideal Sat		1800						1800		1800	1800	1800
ParkExist												
NumPark												
No. Lanes	0	1	0	0	0	0	0	2	0	1	2	1
LGConfig		LTR						LTR		L	LT	R
Lane Width		12.0						11.5		11.0	11.0	11.0
RTOR Vol			3						80			17
Adj Flow		38						288		167	692	35
%InSharedLn										32		
Prop LTs		0.684						0.063		1.000	0.114	
Prop RTs		0.000						0.372			0.000	1.000
Peds Bikes	100	0		0			100	0		100	0	
Buses		0						0		0	5	0
%InProtPhase										0.0		

Duration 0.25 Area Type: CBD or Similar

OPERATING PARAMETERS

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Init Unmet		0.0						0.0		0.0	0.0	0.0
Arriv. Type		3						3		1	1	1
Unit Ext.		3.0						3.0		3.0	3.0	3.0
I Factor		1.000						1.000			0.897	
Lost Time		2.0						2.0		2.0	2.0	2.0
Ext of g		3.0						3.0		2.0	3.0	3.0
Ped Min g		3.8			3.2			3.8			3.8	

PHASE DATA

Phase Combination		1	2	3	4
EB	Left	A			
	Thru	A			
	Right	A			
	Peds	X			
WB	Left				
	Thru				
	Right				
	Peds				
NB	Right				
SB	Right				
Green		20.0			
Yellow		3.0			
All Red		1.0			

		5	6	7	8
NB	Left		A		
	Thru		A		
	Right		A		
	Peds		X		
SB	Left	A	A		
	Thru	A	A		
	Right	A	A		
	Peds	X	X		
EB	Right				
WB	Right				
Green		20.0	34.0		
Yellow		3.0	3.0		
All Red		0.0	1.0		

Cycle Length: 85.0 secs

VOLUME ADJUSTMENT AND SATURATION FLOW WORKSHEET

Volume Adjustment

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume, V	25	11	3				17	155	182	234	582	50
PHF	0.95	0.95	0.95				0.95	0.95	0.95	0.95	0.95	0.95
Adj flow	26	12	0				18	163	107	246	613	35
No. Lanes	0	1	0	0	0	0	0	2	0	1	2	1
Lane group		LTR						LTR		L	LT	R
Adj flow		38						288		167	692	35
Prop LTs		0.684						0.063		1.000	0.114	
Prop RTs		0.000						0.372			0.000	1.000

Saturation Flow Rate (see Exhibit 16-7 to determine the adjustment factors)

	Eastbound			Westbound			Northbound		Southbound		
LG	LTR						LTR		L	LT	R
So	1800						1800		1800	1800	1800
Lanes 0	1	0	0	0	0	0	2	0	1	2	1
fW	1.000						0.983		0.967	0.967	0.967
fHV	0.909						0.909		0.909	0.909	0.909
fG	1.000						1.000		1.000	1.000	1.000
fP	1.000						1.000		1.000	1.000	1.000
fBB	1.000						1.000		1.000	0.990	1.000
fA	0.900						0.900		0.900	0.900	0.900
fLU	1.000						0.952		1.000	0.952	1.000
fRT	1.000						0.944			1.000	0.850
fLT	0.967						0.905		0.950	0.994	
Sec.									0.506	0.800	
fLpb	1.000						0.997		0.922	0.991	
fRpb	1.000						0.972			1.000	0.925
S	1424						2283		1247	2645	1120
Sec.									664	2127	

CAPACITY AND LOS WORKSHEET

Capacity Analysis and Lane Group Capacity

Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- Capacity (c)	v/c Ratio
Eastbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	LTR	38	1424	# 0.03	0.25	352	0.11
Right							
Westbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru							
Right							
Northbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	LTR	288	2283	# 0.13	0.41	940	0.31
Right							
Southbound							
Prot		167	1247	0.13	0.235	293	0.57
Perm		0	664	0.00	0.447	297	0.00
Left	L	167			0.68	590	0.28
Prot		622	2645	# 0.24	0.235	622	1.00
Perm		70	2127	0.03	0.447	951	0.07
Thru	LT	692			0.68	1573	0.44
Right	R	35	1120	0.03	0.68	764	0.05

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.39
Total lost time per cycle, L = 9.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.43

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	LOS	Approach Delay	LOS
Eastbound												
LTR	0.11	0.25	24.8	1.000	352	0.11	0.1	0.0	24.9	C	24.9	C
Westbound												
Northbound												
LTR	0.31	0.41	16.8	1.000	940	0.11	0.2	0.0	17.0	B	17.0	B
Southbound												
L	0.28	0.68	5.1	1.205	590	0.11	0.2	0.0	6.4	A		
LT	0.44	0.68	6.1	2.432	1573	0.11	0.2	0.0	15.1	B	13.3	B

```
R    0.05  0.68  4.4   2.432 764   0.11   0.0   0.0   10.8   B
_______________________________________________________________________________
         Intersection delay = 14.5  (sec/veh)   Intersection LOS = B



______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                              for exclusive lefts
Input
                                                       EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                           85.0    sec
Total actual green time for LT lane group, G (s)                         57.0
Effective permitted green time for LT lane group, g(s)                   38.0
Opposing effective green time, go (s)                                    35.0
Number of lanes in LT lane group, N                                      1
Number of lanes in opposing approach, No                                 2
Adjusted LT flow rate, VLT (veh/h)                                       167
Proportion of LT in LT lane group, PLT                                   1.000
Proportion of LT in opposing flow, PLTo                                  0.06
Adjusted opposing flow rate, Vo (veh/h)                                  288
Lost time for LT lane group, tL                                          4.00
Computation
LT volume per cycle, LTC=VLTC/3600                                       3.94
Opposing lane util. factor, fLUo                             1.000 0.952 0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)                      3.57
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g                                    0.0
Opposing platoon ratio, Rpo (refer Exhibit 16-11)                        1.00
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]                             0.59
gq, (see Exhibit C16-4,5,6,7,8)                                          4.59
gu=g-gq if gq>=gf, or = g-gf if gq<gf                                    33.41
n=Max(gq-gf)/2,0)                                                        2.29
PTHo=1-PLTo                                                              0.94
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]                                       1.00
EL1 (refer to Exhibit C16-3)                                             1.74
EL2=Max((1-Ptho**n)/Plto, 1.0)                                           2.20
fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g                                       0.11
gdiff=max(gq-gf,0)                                                       4.59
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)                      0.51
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
or flt=[fm+0.91(N-1)]/N**
Left-turn adjustment, fLT                                                0.506

For special case of single-lane approach opposed by multilane approach,
see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
  left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach
or when gf>gq, see text.

______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                                for shared lefts
Input
                                                       EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                           85.0    sec
Total actual green time for LT lane group, G (s)                   34.0  57.0
Effective permitted green time for LT lane group, g(s)             35.0  38.0
Opposing effective green time, go (s)                              58.0  35.0
Number of lanes in LT lane group, N                                2     2
```

	EB	WB	NB	SB
Number of lanes in opposing approach, No			2	2
Adjusted LT flow rate, VLT (veh/h)			18	78
Proportion of LT in LT lane group, PLT	0.684		0.063	0.114
Proportion of LT in opposing flow, PLTo			0.11	0.06
Adjusted opposing flow rate, Vo (veh/h)			692	288
Lost time for LT lane group, tL			3.00	3.00
Computation				
LT volume per cycle, LTC=VLTC/3600			0.43	1.84
Opposing lane util. factor, fLUo		1.000	0.952	0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)			8.58	3.57
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g			18.1	0.0
Opposing platoon ratio, Rpo (refer Exhibit 16-11)			0.33	1.00
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]			0.77	0.59
gq, (see Exhibit C16-4,5,6,7,8)			0.00	4.59
gu=g-gq if gq>=gf, or = g-gf if gq<gf			16.91	33.41
n=Max(gq-gf)/2,0)			0.00	2.29
PTHo=1-PLTo			0.89	0.94
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]			0.14	0.31
EL1 (refer to Exhibit C16-3)			2.87	1.89
EL2=Max((1-Ptho**n)/Plto, 1.0)			1.00	2.20
fmin=2(1+PL)/g or fmin=2(1+Pl)/g			0.07	0.07
gdiff=max(gq-gf,0)			0.00	4.59
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)			0.90	0.69
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)				
or flt=[fm+0.91(N-1)]/N**				
Left-turn adjustment, fLT			0.905	0.800

For special case of single-lane approach opposed by multilane approach, see text.

* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto left-turn lane and redo calculations.

** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.

For special case of multilane approach opposed by single-lane approach or when gf>gq, see text.

SUPPLEMENTAL PEDESTRIAN-BICYCLE EFFECTS WORKSHEET

Permitted Left Turns

	EB	WB	NB	SB
Effective pedestrian green time, gp (s)			34.0	34.0
Conflicting pedestrian volume, Vped (p/h)			100	100
Pedestrian flow rate, Vpedg (p/h)			250	250
OCCpedg			0.125	0.125
Opposing queue clearing green, gq (s)			0.00	4.59
Eff. ped. green consumed by opp. veh. queue, gq/gp			0.000	0.135
OCCpedu			0.125	0.117
Opposing flow rate, Vo (veh/h)			692	288
OCCr			0.048	0.078
Number of cross-street receiving lanes, Nrec			1	2
Number of turning lanes, Nturn			1	2
ApbT			0.952	0.922
Proportion of left turns, PLT			0.063	1.000
Proportion of left turns using protected phase, PLTA			0.000	0.000
Left-turn adjustment, fLpb			0.997	0.922
Permitted Right Turns				
Effective pedestrian green time, gp (s)	20.0		34.0	57.0
Conflicting pedestrian volume, Vped (p/h)	100		100	100
Conflicting bicycle volume, Vbic (bicycles/h)	0		0	0
Vpedg	425		250	149
OCCpedg	0.213		0.125	0.075
Effective green, g (s)	21.0		35.0	58.0
Vbicg	0		0	0

OCCbicg	0.020		0.020	0.020
OCCr	0.213		0.125	0.075
Number of cross-street receiving lanes, Nrec	2		2	1
Number of turning lanes, Nturn	1		1	1
ApbT	0.873		0.925	0.925
Proportion right-turns, PRT	0.000		0.372	1.000
Proportion right-turns using protected phase, PRTA	0.000		0.000	0.000
Right turn adjustment, fRpb	1.000		0.972	1.000

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

Cycle length, C 85.0 sec

	EBLT	WBLT	NBLT	SBLT
Adj. LT vol from Vol Adjustment Worksheet, v				167
v/c ratio from Capacity Worksheet, X				0.28
Protected phase effective green interval, g (s)				20.0
Opposing queue effective green interval, gq				4.59
Unopposed green interval, gu				33.41
Red time r=(C-g-gq-gu)				27.0
Arrival rate, qa=v/(3600(max[X,1.0]))				0.05
Protected ph. departure rate, Sp=s/3600				0.346
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)				0.21
XPerm				0.25
XProt				0.31
Case				1
Queue at beginning of green arrow, Qa				1.25
Queue at beginning of unsaturated green, Qu				0.21
Residual queue, Qr				0.00
Uniform Delay, d1				5.1

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
	0.0						0.0	
LTR	0.0	0.00	32.0	24.8	0.00	0.0	0.0	24.9
	0.0						0.0	
Westbound								
	0.0						0.0	
	0.0						0.0	
	0.0						0.0	
Northbound								
	0.0						0.0	
LTR	0.0	0.00	25.0	16.8	0.00	0.0	0.0	17.0
	0.0						0.0	
Southbound								
L	0.0	0.00		5.1	0.00	0.0	0.0	6.4
LT	0.0	0.00	13.5	6.1	0.00	0.0	0.0	15.1
R	0.0	0.00	13.5	4.4	0.00	0.0	0.0	10.8

Intersection Delay 14.5 sec/veh Intersection LOS B

BACK OF QUEUE WORKSHEET

	Eastbound			Westbound			Northbound			Southbound		
LaneGroup		LTR						LTR		L	LT	R
Init Queue		0.0						0.0		0.0	0.0	0.0
Flow Rate		38						151		167	363	35
So		1800						1800		1800	1800	1800
No.Lanes	0	1	0	0	0	0	0	2	0	1	2	1
SL		1424						1199		865	1210	1120
LnCapacity		352						493		590	826	764
Flow Ratio		0.0						0.1		0.2	0.3	0.0
v/c Ratio		0.11						0.31		0.28	0.44	0.05
Grn Ratio		0.25						0.41		0.68	0.68	0.68
I Factor		1.000						1.000			0.897	
AT or PVG		3						3		1	1	1
Pltn Ratio		1.00						1.00		0.33	0.33	0.33
PF2		1.00						1.00		2.10	1.89	2.38
Q1		0.7						2.4		2.8	5.7	0.6
kB		0.4						0.4		0.4	0.5	0.5
Q2		0.0						0.2		0.2	0.4	0.0
Q Average		0.7						2.6		3.0	6.2	0.7
Q Spacing		25.0						25.0		25.0	25.0	25.0
Q Storage		0						0		0	0	0
Q S Ratio												
70th Percentile Output:												
fB%		1.2						1.2		1.2	1.2	1.2
BOQ		0.9						3.1		3.6	7.3	0.8
QSRatio												
85th Percentile Output:												
fB%		1.6						1.6		1.6	1.5	1.6
BOQ		1.2						4.1		4.7	9.5	1.1
QSRatio												
90th Percentile Output:												
fB%		1.8						1.8		1.7	1.7	1.8
BOQ		1.3						4.5		5.2	10.4	1.2
QSRatio												
95th Percentile Output:												
fB%		2.1						2.0		2.0	1.9	2.1
BOQ		1.5						5.2		6.0	11.9	1.4
QSRatio												
98th Percentile Output:												
fB%		2.6						2.5		2.5	2.3	2.6
BOQ		1.9						6.5		7.4	14.3	1.8
QSRatio												

ERROR MESSAGES

No errors to report.

HCS+: Signalized Intersections Release 5.4

Analyst:
Agency: PB
Date: 6/25/2010
Period: PM Peak
Project ID: I-290 Phase 1 Study
E/W St: W. Lexington Street

Inter.: W. Lexington Street & Laramie
Area Type: CBD or Similar
Jurisd:
Year : Existing
N/S St: Laramie Avenue

SIGNALIZED INTERSECTION SUMMARY

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
No. Lanes	0	1	0	0	0	0	0	2	0	1	2	1
LGConfig		LTR						LTR		L	LT	R
Volume	119	98	111				62	262	101	360	328	65
Lane Width		12.0						11.5		11.0	11.0	11.0
RTOR Vol			19						27			26

Duration 0.25 Area Type: CBD or Similar

Signal Operations

Phase Combination	1	2	3	4		5	6	7	8
EB Left	A				NB Left		A		
Thru	A				Thru		A		
Right	A				Right		A		
Peds	X				Peds		X		
WB Left					SB Left	A	A		
Thru					Thru	A	A		
Right					Right	A	A		
Peds					Peds	X	X		
NB Right					EB Right				
SB Right					WB Right				
Green	24.0					7.0	43.0		
Yellow	3.0					3.0	3.0		
All Red	1.0					0.0	1.0		

Cycle Length: 85.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
LTR	395	1343	0.82	0.29	41.1	D	41.1	D
Westbound								
Northbound								
LTR	1118	2159	0.37	0.52	12.5	B	12.5	B
Southbound								
L	439	1283	0.52	0.64	8.6	A		
LT	1188	2602	0.42	0.64	16.9	B	14.2	B
R	707	1113	0.06	0.64	12.7	B		

Intersection Delay = 19.5 (sec/veh) Intersection LOS = B

HCS+: Signalized Intersections Release 5.4

I-290
Existing

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst:
Agency/Co.: PB
Date Performed: 6/25/2010
Analysis Time Period: PM Peak
Intersection: W. Lexington Street & Laramie
Area Type: CBD or Similar
Jurisdiction:
Analysis Year: Existing
Project ID: I-290 Phase 1 Study
E/W St: W. Lexington Street N/S St: Laramie Avenue

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	119	98	111				62	262	101	360	328	65
% Heavy Veh	10	10	10				10	10	10	10	10	10
PHF	0.95	0.95	0.95				0.95	0.95	0.95	0.95	0.95	0.95
PK 15 Vol	31	26	29				16	69	27	95	86	17
Hi Ln Vol												
% Grade		0						0			0	
Ideal Sat		1800						1800		1800	1800	1800
ParkExist												
NumPark												
No. Lanes	0	1	0	0	0	0	0	2	0	1	2	1
LGConfig		LTR						LTR		L	LT	R
Lane Width		12.0						11.5		11.0	11.0	11.0
RTOR Vol			19						27			26
Adj Flow		325						419		227	497	41
%InSharedLn										40		
Prop LTs		0.385						0.155		1.000	0.305	
Prop RTs		0.298						0.186			0.000	1.000
Peds Bikes		100 0			0			100 0			100 0	
Buses		0						0		0	5	0
%InProtPhase										0.0		

Duration 0.25 Area Type: CBD or Similar

OPERATING PARAMETERS

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Init Unmet		0.0						0.0		0.0	0.0	0.0
Arriv. Type		3						3		1	1	1
Unit Ext.		3.0						3.0		3.0	3.0	3.0
I Factor		1.000						1.000			0.955	
Lost Time		2.0						2.0		2.0	2.0	2.0
Ext of g		3.0						3.0		2.0	3.0	3.0
Ped Min g		3.8			3.2			3.8			3.8	

PHASE DATA

Phase Combination		1	2	3	4			5	6	7	8
EB	Left	A				NB	Left		A		
	Thru	A					Thru		A		
	Right	A					Right		A		
	Peds	X					Peds		X		
WB	Left					SB	Left	A	A		
	Thru						Thru	A	A		
	Right						Right	A	A		
	Peds						Peds	X	X		
NB	Right					EB	Right				
SB	Right					WB	Right				
Green		24.0						7.0	43.0		
Yellow		3.0						3.0	3.0		
All Red		1.0						0.0	1.0		

Cycle Length: 85.0 secs

VOLUME ADJUSTMENT AND SATURATION FLOW WORKSHEET

Volume Adjustment

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume, V	119	98	111				62	262	101	360	328	65
PHF	0.95	0.95	0.95				0.95	0.95	0.95	0.95	0.95	0.95
Adj flow	125	103	97				65	276	78	379	345	41
No. Lanes	0	1	0	0	0	0	0	2	0	1	2	1
Lane group		LTR						LTR		L	LT	R
Adj flow		325						419		227	497	41
Prop LTs		0.385						0.155		1.000	0.305	
Prop RTs		0.298						0.186			0.000	1.000

Saturation Flow Rate (see Exhibit 16-7 to determine the adjustment factors)

	Eastbound	Westbound	Northbound	Southbound		
LG	LTR		LTR	L	LT	R
So	1800		1800	1800	1800	1800
Lanes 0	1 0	0 0 0 0	2 0	1	2	1
fW	1.000		0.983	0.967	0.967	0.967
fHV	0.909		0.909	0.909	0.909	0.909
fG	1.000		1.000	1.000	1.000	1.000
fP	1.000		1.000	1.000	1.000	1.000
fBB	1.000		1.000	1.000	0.990	1.000
fA	0.900		0.900	0.900	0.900	0.900
fLU	1.000		0.952	1.000	0.952	1.000
fRT	0.960		0.972		1.000	0.850
fLT	0.981		0.821	0.950	0.985	
Sec.				0.446	0.667	
fLpb	1.000		0.992	0.949	0.984	
fRpb	0.968		0.989		1.000	0.920
S	1343		2159	1283	2602	1113
Sec.				602	1761	

CAPACITY AND LOS WORKSHEET

Capacity Analysis and Lane Group Capacity

Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- Capacity (c)	v/c Ratio
Eastbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	LTR	325	1343	# 0.24	0.29	395	0.82
Right							
Westbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru							
Right							
Northbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	LTR	419	2159	0.19	0.52	1118	0.37
Right							
Southbound							
Prot		106	1283	# 0.08	0.082	106	1.00
Perm		121	602	# 0.20	0.553	333	0.36
Left	L	227			0.64	439	0.52
Prot		214	2602	0.08	0.082	214	1.00
Perm		283	1761	0.16	0.553	974	0.29
Thru	LT	497			0.64	1188	0.42
Right	R	41	1113	0.04	0.64	707	0.06

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.53
Total lost time per cycle, L = 7.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.57

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	LOS	Approach Delay	LOS
Eastbound												
LTR	0.82	0.29	27.9	1.000	395	0.36	13.1	0.0	41.1	D	41.1	D
Westbound												
Northbound												
LTR	0.37	0.52	12.3	1.000	1118	0.11	0.2	0.0	12.5	B	12.5	B
Southbound												
L	0.52	0.64	7.2	1.060	439	0.12	1.0	0.0	8.6	A		
LT	0.42	0.64	7.7	2.161	1188	0.11	0.2	0.0	16.9	B	14.2	B

```
R    0.06  0.64  5.9   2.161 707   0.11   0.0   0.0   12.7   B
_______________________________________________________________________________
         Intersection delay = 19.5  (sec/veh)   Intersection LOS = B



______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                              for exclusive lefts
Input
                                                       EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                           85.0    sec
Total actual green time for LT lane group, G (s)                         53.0
Effective permitted green time for LT lane group, g(s)                   47.0
Opposing effective green time, go (s)                                    44.0
Number of lanes in LT lane group, N                                      1
Number of lanes in opposing approach, No                                 2
Adjusted LT flow rate, VLT (veh/h)                                       227
Proportion of LT in LT lane group, PLT                                   1.000
Proportion of LT in opposing flow, PLTo                                  0.16
Adjusted opposing flow rate, Vo (veh/h)                                  419
Lost time for LT lane group, tL                                          4.00
Computation
LT volume per cycle, LTC=VLTC/3600                                       5.36
Opposing lane util. factor, fLUo                             1.000 0.952 0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)                      5.20
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g                                    0.0
Opposing platoon ratio, Rpo (refer Exhibit 16-11)                        1.00
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]                             0.48
gq, (see Exhibit C16-4,5,6,7,8)                                          5.71
gu=g-gq if gq>=gf, or = g-gf if gq<gf                                    41.29
n=Max(gq-gf)/2,0)                                                        2.86
PTHo=1-PLTo                                                              0.84
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]                                       1.00
EL1 (refer to Exhibit C16-3)                                             1.97
EL2=Max((1-Ptho**n)/Plto, 1.0)                                           2.46
fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g                                       0.09
gdiff=max(gq-gf,0)                                                       5.71
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)                      0.45
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
or flt=[fm+0.91(N-1)]/N**
Left-turn adjustment, fLT                                                0.446

For special case of single-lane approach opposed by multilane approach,
see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
  left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach
or when gf>gq, see text.

______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                                for shared lefts
Input
                                                       EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                           85.0    sec
Total actual green time for LT lane group, G (s)                   43.0  53.0
Effective permitted green time for LT lane group, g(s)             44.0  47.0
Opposing effective green time, go (s)                              54.0  44.0
Number of lanes in LT lane group, N                                2     2
```

```
Number of lanes in opposing approach, No                           2     2
Adjusted LT flow rate, VLT (veh/h)                                 65    151
Proportion of LT in LT lane group, PLT                 0.385       0.155 0.305
Proportion of LT in opposing flow, PLTo                            0.31  0.16
Adjusted opposing flow rate, Vo (veh/h)                            497   419
Lost time for LT lane group, tL                                    3.00  3.00
Computation
LT volume per cycle, LTC=VLTC/3600                                 1.53  3.57
Opposing lane util. factor, fLUo                             1.000 0.952 0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)                6.16  5.20
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g                              10.0  0.0
Opposing platoon ratio, Rpo (refer Exhibit 16-11)                  0.33  1.00
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]                       0.79  0.48
gq, (see Exhibit C16-4,5,6,7,8)                                    0.00  5.71
gu=g-gq if gq>=gf, or = g-gf if gq<gf                              34.04 41.29
n=Max(gq-gf)/2,0)                                                  0.00  2.86
PTHo=1-PLTo                                                        0.69  0.84
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]                                 0.39  0.92
EL1 (refer to Exhibit C16-3)                                       2.35  2.17
EL2=Max((1-Ptho**n)/Plto, 1.0)                                     1.00  2.46
fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g                                 0.06  0.08
gdiff=max(gq-gf,0)                                                 0.00  5.71
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)                0.73  0.42
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
or flt=[fm+0.91(N-1)]/N**
Left-turn adjustment, fLT                                          0.821 0.667

For special case of single-lane approach opposed by multilane approach,
see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
  left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach
or when gf>gq, see text.

_______________SUPPLEMENTAL PEDESTRIAN-BICYCLE EFFECTS WORKSHEET_______________
Permitted Left Turns
                                                       EB    WB     NB    SB
Effective pedestrian green time, gp (s)                           43.0  43.0
Conflicting pedestrian volume, Vped (p/h)                         100   100
Pedestrian flow rate, Vpedg (p/h)                                 197   197
OCCpedg                                                           0.099 0.099
Opposing queue clearing green, gq (s)                             0.00  5.71
Eff. ped. green consumed by opp. veh. queue, gq/gp                0.000 0.133
OCCpedu                                                           0.099 0.092
Opposing flow rate, Vo (veh/h)                                    497   419
OCCr                                                              0.049 0.051
Number of cross-street receiving lanes, Nrec                      1     2
Number of turning lanes, Nturn                                    1     2
ApbT                                                              0.951 0.949
Proportion of left turns, PLT                                     0.155 1.000
Proportion of left turns using protected phase, PLTA              0.000 0.000
Left-turn adjustment, fLpb                                        0.992 0.949
Permitted Right Turns
Effective pedestrian green time, gp (s)               24.0        43.0  53.0
Conflicting pedestrian volume, Vped (p/h)             100         100   100
Conflicting bicycle volume, Vbic (bicycles/h)         0           0     0
Vpedg                                                 354         197   160
OCCpedg                                               0.177       0.099 0.080
Effective green, g (s)                                25.0        44.0  54.0
Vbicg                                                 0           0     0
```

OCCbicg	0.020		0.020	0.020
OCCr	0.177		0.099	0.080
Number of cross-street receiving lanes, Nrec	2		2	1
Number of turning lanes, Nturn	1		1	1
ApbT	0.894		0.941	0.920
Proportion right-turns, PRT	0.298		0.186	1.000
Proportion right-turns using protected phase, PRTA	0.000		0.000	0.000
Right turn adjustment, fRpb	0.968		0.989	1.000

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

Cycle length, C 85.0 sec

	EBLT	WBLT	NBLT	SBLT
Adj. LT vol from Vol Adjustment Worksheet, v				227
v/c ratio from Capacity Worksheet, X				0.52
Protected phase effective green interval, g (s)				7.0
Opposing queue effective green interval, gq				5.71
Unopposed green interval, gu				41.29
Red time r=(C-g-gq-gu)				31.0
Arrival rate, qa=v/(3600(max[X,1.0]))				0.06
Protected ph. departure rate, Sp=s/3600				0.356
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)				0.19
XPerm				0.38
XProt				0.96
Case				1
Queue at beginning of green arrow, Qa				1.95
Queue at beginning of unsaturated green, Qu				0.36
Residual queue, Qr				0.00
Uniform Delay, d1				7.2

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
	0.0						0.0	
LTR	0.0	0.00	30.0	27.9	0.00	0.0	0.0	41.1
	0.0						0.0	
Westbound								
	0.0						0.0	
	0.0						0.0	
	0.0						0.0	
Northbound								
	0.0						0.0	
LTR	0.0	0.00	20.5	12.3	0.00	0.0	0.0	12.5
	0.0						0.0	
Southbound								
L	0.0	0.00		7.2	0.00	0.0	0.0	8.6
LT	0.0	0.00	15.5	7.7	0.00	0.0	0.0	16.9
R	0.0	0.00	15.5	5.9	0.00	0.0	0.0	12.7

Intersection Delay 19.5 sec/veh Intersection LOS B

BACK OF QUEUE WORKSHEET

	Eastbound			Westbound			Northbound			Southbound		
LaneGroup		LTR						LTR		L	LT	R
Init Queue		0.0						0.0		0.0	0.0	0.0
Flow Rate		325						220		227	261	41
So		1800						1800		1800	1800	1800
No.Lanes	0	1	0	0	0	0	0	2	0	1	2	1
SL		1343						1133		690	982	1113
LnCapacity		395						587		439	623	707
Flow Ratio		0.2						0.2		0.3	0.3	0.0
v/c Ratio		0.82						0.37		0.52	0.42	0.06
Grn Ratio		0.29						0.52		0.64	0.64	0.64
I Factor		1.000						1.000			0.955	
AT or PVG		3						3		1	1	1
Pltn Ratio		1.00						1.00		0.33	0.33	0.33
PF2		1.00						1.00		1.63	1.74	2.11
Q1		7.1						3.1		3.3	4.1	0.8
kB		0.4						0.5		0.4	0.5	0.5
Q2		1.5						0.3		0.4	0.3	0.0
Q Average		8.7						3.4		3.7	4.4	0.8
Q Spacing		25.0						25.0		25.0	25.0	25.0
Q Storage		0						0		0	0	0
Q S Ratio												
70th Percentile Output:												
fB%		1.2						1.2		1.2	1.2	1.2
BOQ		10.2						4.0		4.4	5.2	1.0
QSRatio												
85th Percentile Output:												
fB%		1.5						1.6		1.6	1.6	1.6
BOQ		13.2						5.3		5.8	6.9	1.3
QSRatio												
90th Percentile Output:												
fB%		1.7						1.7		1.7	1.7	1.8
BOQ		14.4						5.9		6.5	7.6	1.4
QSRatio												
95th Percentile Output:												
fB%		1.9						2.0		2.0	2.0	2.1
BOQ		16.2						6.8		7.4	8.7	1.7
QSRatio												
98th Percentile Output:												
fB%		2.2						2.5		2.5	2.4	2.6
BOQ		19.2						8.4		9.1	10.6	2.1
QSRatio												

ERROR MESSAGES

No errors to report.

2001 I-290 AM Cicero_Flournoy 0716.txt

HCS+: Signalized Intersections Release 5.4

Analyst:
Agency: PB
Date: 6/25/2010
Period: AM Peak
Project ID: I-290 Phase 1 Study
E/W St: Flournoy Street

Inter.: Flournoy Street & Cicero Avenu
Area Type: CBD or Similar
Jurisd:
Year : Existing
N/S St: Cicero Avenue

SIGNALIZED INTERSECTION SUMMARY

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	0	0	0	1	2	0	2	2	0	0	2	1
LGConfig				L	T		L	T			T	R
Volume				4	8		361	1401			602	304
Lane Width				12.0	12.0		11.0	11.0			11.0	11.0
RTOR Vol												120

Duration 0.25 Area Type: CBD or Similar

Signal Operations

Phase Combination	1	2	3	4		5	6	7	8
EB Left					NB Left	A	A		
Thru					Thru	A	A		
Right					Right				
Peds					Peds	X	X		
WB Left	A				SB Left				
Thru	A				Thru	A			
Right					Right	A			
Peds	X				Peds	X			
NB Right					EB Right				
SB Right					WB Right				
Green	23.0					43.0	8.0		
Yellow	3.0					3.0	3.0		
All Red	1.0					0.0	1.0		

Cycle Length: 85.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
Westbound								
L	346	1399	0.01	0.25	24.2	C		
T	693	2804	0.01	0.25	24.2	C	24.2	C
Northbound								
L	588	2421	0.65	0.61	22.0	C		
T	1169	1911	1.26	0.61	139.8	F	115.7	F
Southbound								
T	922	1911	0.69	0.48	18.9	B	17.9	B
R	515	1067	0.38	0.48	14.3	B		

Intersection Delay = 85.2 (sec/veh) Intersection LOS = F

HCS+: Signalized Intersections Release 5.4

I-290
Existing

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst:
Agency/Co.: PB
Date Performed: 6/25/2010
Analysis Time Period: AM Peak
Intersection: Flournoy Street & Cicero Avenu
Area Type: CBD or Similar
Jurisdiction:
Analysis Year: Existing
Project ID: I-290 Phase 1 Study
E/W St: Flournoy Street N/S St: Cicero Avenue

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume				4	8		361	1401			602	304
% Heavy Veh				10	10		10	10			10	10
PHF				0.95	0.95		0.95	0.95			0.95	0.95
PK 15 Vol				1	2		95	369			158	80
Hi Ln Vol												
% Grade					0			0			0	
Ideal Sat				1800	1800		1800	1300			1300	1800
ParkExist												
NumPark												
No. Lanes	0	0	0	1	2	0	2	2	0	0	2	1
LGConfig				L	T		L	T			T	R
Lane Width				12.0	12.0		11.0	11.0			11.0	11.0
RTOR Vol												120
Adj Flow				4	8		380	1475			634	194
%InSharedLn												
Prop LTs					0.000		1.000	0.000			0.000	
Prop RTs					0.000			0.000			0.000	1.000
Peds Bikes	0										200	0
Buses				0	0		0	12			12	0
%InProtPhase							0.0					

Duration 0.25 Area Type: CBD or Similar

OPERATING PARAMETERS

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Init Unmet				0.0	0.0		0.0	0.0			0.0	0.0
Arriv. Type				3	3		3	3			3	3
Unit Ext.				3.0	3.0		3.0	3.0			3.0	3.0
I Factor					1.000			0.775			0.872	
Lost Time				2.0	2.0		2.0	2.0			2.0	2.0
Ext of g				0.0	0.0		0.0	0.0			0.0	0.0
Ped Min g		3.2									4.5	

PHASE DATA

Phase Combination		1	2	3	4
EB	Left				
	Thru				
	Right				
	Peds				
WB	Left	A			
	Thru	A			
	Right				
	Peds	X			
NB	Right				
SB	Right				

		5	6	7	8
NB	Left	A	A		
	Thru	A	A		
	Right				
	Peds	X	X		
SB	Left				
	Thru	A			
	Right	A			
	Peds	X			
EB	Right				
WB	Right				

Green	23.0		43.0	8.0
Yellow	3.0		3.0	3.0
All Red	1.0		0.0	1.0

Cycle Length: 85.0 secs

VOLUME ADJUSTMENT AND SATURATION FLOW WORKSHEET

Volume Adjustment

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume, V				4	8		361	1401			602	304
PHF				0.95	0.95		0.95	0.95			0.95	0.95
Adj flow				4	8		380	1475			634	194
No. Lanes	0	0	0	1	2	0	2	2	0	0	2	1
Lane group				L	T		L	T			T	R
Adj flow				4	8		380	1475			634	194
Prop LTs					0.000		1.000	0.000			0.000	
Prop RTs					0.000			0.000			0.000	1.000

Saturation Flow Rate (see Exhibit 16-7 to determine the adjustment factors)

	Eastbound			Westbound			Northbound			Southbound		
LG				L	T		L	T			T	R
So				1800	1800		1800	1300			1300	1800
Lanes	0	0	0	1	2	0	2	2	0	0	2	1
fW				1.000	1.000		0.967	0.967			0.967	0.967
fHV				0.909	0.909		0.909	0.909			0.909	0.909
fG				1.000	1.000		1.000	1.000			1.000	1.000
fP				1.000	1.000		1.000	1.000			1.000	1.000
fBB				1.000	1.000		1.000	0.976			0.976	1.000
fA				0.900	0.900		0.900	0.900			0.900	0.900
fLU				1.000	0.952		0.971	0.952			0.952	1.000
fRT					1.000			1.000			1.000	0.850
fLT				0.950	1.000		0.950	1.000			1.000	
Sec.							0.205					
fLpb				1.000	1.000		0.922	1.000			1.000	
fRpb					1.000			1.000			1.000	0.882
S				1399	2804		2421	1911			1911	1067
Sec.							522					

CAPACITY AND LOS WORKSHEET

Capacity Analysis and Lane Group Capacity

Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- Capacity (c)	v/c Ratio
Eastbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru							
Right							
Westbound							
Prot							
Perm							
Left	L	4	1399	# 0.00	0.25	346	0.01
Prot							
Perm							
Thru	T	8	2804	0.00	0.25	693	0.01
Right							
Northbound							
Prot		134	2421	0.06	0.141	342	0.39
Perm		246	522	0.47	0.471	246	1.00
Left	L	380			0.61	588	0.65
Prot							
Perm							
Thru	T	1475	1911	# 0.77	0.61	1169	1.26

Right						
Southbound						
Prot						
Perm						
Left						
Prot						
Perm						
Thru	T	634	1911	0.33	0.48	922	0.69
Right	R	194	1067	0.18	0.48	515	0.38

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.77
Total lost time per cycle, L = 12.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.90

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	Ratios g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound												
Westbound												
L	0.01	0.25	24.2	1.000	346	0.11	0.0	0.0	24.2	C		
T	0.01	0.25	24.2	1.000	693	0.11	0.0	0.0	24.2	C	24.2	C
Northbound												
L	0.65	0.61	20.1	1.000	588	0.22	1.9	0.0	22.0	C		
T	1.26	0.61	16.5	1.000	1169	0.50	123.3	0.0	139.8	F	115.7	F
Southbound												
T	0.69	0.48	17.0	1.000	922	0.26	1.9	0.0	18.9	B	17.9	B
R	0.38	0.48	13.9	1.000	515	0.11	0.4	0.0	14.3	B		

Intersection delay = 85.2 (sec/veh) Intersection LOS = F

SUPPLEMENTAL PERMITTED LT WORKSHEET
for exclusive lefts

Input	EB	WB	NB	SB
Opposed by Single(S) or Multiple(M) lane approach				
Cycle length, C 85.0 sec				
Total actual green time for LT lane group, G (s)			54.0	
Effective permitted green time for LT lane group, g(s)			40.0	
Opposing effective green time, go (s)			41.0	
Number of lanes in LT lane group, N			2	
Number of lanes in opposing approach, No			2	
Adjusted LT flow rate, VLT (veh/h)			380	
Proportion of LT in LT lane group, PLT			1.000	
Proportion of LT in opposing flow, PLTo			0.00	
Adjusted opposing flow rate, Vo (veh/h)			634	
Lost time for LT lane group, tL			6.00	
Computation				
LT volume per cycle, LTC=VLTC/3600			8.97	
Opposing lane util. factor, fLUo	0.952		0.952	0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)			7.86	
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g			0.0	
Opposing platoon ratio, Rpo (refer Exhibit 16-11)			1.00	
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]			0.52	
gq, (see Exhibit C16-4,5,6,7,8)			3.99	
gu=g-gq if gq>=gf, or = g-gf if gq<gf			36.01	
n=Max(gq-gf)/2,0)			1.99	
PTHo=1-PLTo			1.00	
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]			3.10	
EL1 (refer to Exhibit C16-3)			2.43	
EL2=Max((1-Ptho**n)/Plto, 1.0)				

```
fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g                                 0.20
gdiff=max(gq-gf,0)                                                 0.00
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)                0.20
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
or flt=[fm+0.91(N-1)]/N**
Left-turn adjustment, fLT                                          0.205

For special case of single-lane approach opposed by multilane approach,
see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
  left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach
or when gf>gq, see text.

______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                                for shared lefts
Input
                                                       EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                           85.0    sec
Total actual green time for LT lane group, G (s)
Effective permitted green time for LT lane group, g(s)
Opposing effective green time, go (s)
Number of lanes in LT lane group, N
Number of lanes in opposing approach, No
Adjusted LT flow rate, VLT (veh/h)
Proportion of LT in LT lane group, PLT                       0.000 0.000 0.000
Proportion of LT in opposing flow, PLTo
Adjusted opposing flow rate, Vo (veh/h)
Lost time for LT lane group, tL
Computation
LT volume per cycle, LTC=VLTC/3600
Opposing lane util. factor, fLUo                       0.952       0.952 0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g
Opposing platoon ratio, Rpo (refer Exhibit 16-11)
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]
gq, (see Exhibit C16-4,5,6,7,8)
gu=g-gq if gq>=gf, or = g-gf if gq<gf
n=Max(gq-gf)/2,0)
PTHo=1-PLTo
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]
EL1 (refer to Exhibit C16-3)
EL2=Max((1-Ptho**n)/Plto, 1.0)
fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g
gdiff=max(gq-gf,0)
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
or flt=[fm+0.91(N-1)]/N**
Left-turn adjustment, fLT

For special case of single-lane approach opposed by multilane approach,
see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
  left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach
or when gf>gq, see text.

_______________SUPPLEMENTAL PEDESTRIAN-BICYCLE EFFECTS WORKSHEET_______________
Permitted Left Turns
                                                       EB    WB     NB    SB
Effective pedestrian green time, gp (s)                           43.0
Conflicting pedestrian volume, Vped (p/h)                         200
Pedestrian flow rate, Vpedg (p/h)                                 395
OCCpedg                                                           0.198
Opposing queue clearing green, gq (s)                             3.99
Eff. ped. green consumed by opp. veh. queue, gq/gp                0.093
OCCpedu                                                           0.188
```

Opposing flow rate, Vo (veh/h)				634	
OCCr				0.078	
Number of cross-street receiving lanes, Nrec				2	
Number of turning lanes, Nturn				2	
ApbT				0.922	
Proportion of left turns, PLT				1.000	
Proportion of left turns using protected phase, PLTA				0.000	
Left-turn adjustment, fLpb				0.922	
Permitted Right Turns					
Effective pedestrian green time, gp (s)					43.0
Conflicting pedestrian volume, Vped (p/h)					200
Conflicting bicycle volume, Vbic (bicycles/h)					0
Vpedg					395
OCCpedg					0.198
Effective green, g (s)					41.0
Vbicg					0
OCCbicg					0.020
OCCr					0.198
Number of cross-street receiving lanes, Nrec					2
Number of turning lanes, Nturn					1
ApbT					0.882
Proportion right-turns, PRT					1.000
Proportion right-turns using protected phase, PRTA					0.000
Right turn adjustment, fRpb					

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

		EBLT	WBLT	NBLT	SBLT
Cycle length, C	85.0 sec				
Adj. LT vol from Vol Adjustment Worksheet, v				380	
v/c ratio from Capacity Worksheet, X				0.65	
Protected phase effective green interval, g (s)				12.0	
Opposing queue effective green interval, gq				3.99	
Unopposed green interval, gu				36.01	
Red time r=(C-g-gq-gu)				33.0	
Arrival rate, qa=v/(3600(max[X,1.0]))				0.11	
Protected ph. departure rate, Sp=s/3600				0.673	
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)				0.16	
XPerm				1.33	
XProt					
Case				5	
Queue at beginning of green arrow, Qa				1.91	
Queue at beginning of unsaturated green, Qu				3.90	
Residual queue, Qr				0.00	
Uniform Delay, d1				20.1	

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
	0.0						0.0	
	0.0						0.0	
	0.0						0.0	
Westbound								
L	0.0	0.00	32.0	24.2	0.00	0.0	0.0	24.2
T	0.0	0.00	32.0	24.2	0.00	0.0	0.0	24.2
	0.0						0.0	
Northbound								
L	0.0	0.00		20.1	0.00	0.0	0.0	22.0
T	0.0	0.00	16.5	16.5	0.00	76.5	0.0	139.8
	0.0						0.0	
Southbound								
	0.0						0.0	

T	0.0	0.00	22.0	17.0	0.00	0.0	0.0	18.9
R	0.0	0.00	22.0	13.9	0.00	0.0	0.0	14.3

Intersection Delay 85.2 sec/veh Intersection LOS F

BACK OF QUEUE WORKSHEET

	Eastbound			Westbound			Northbound			Southbound		
LaneGroup				L	T		L	T			T	R
Init Queue				0.0	0.0		0.0	0.0			0.0	0.0
Flow Rate				4	4		195	774			332	194
So				1800	1800		1800	1300			1300	1800
No.Lanes	0	0	0	1	2	0	2	2	0	0	2	1
SL				1399	1472		494	1003			1003	1067
LnCapacity				346	363		302	613			484	515
Flow Ratio				0.0	0.0		0.4	0.8			0.3	0.2
v/c Ratio				0.01	0.01		0.65	1.26			0.69	0.38
Grn Ratio				0.25	0.25		0.61	0.61			0.48	0.48
I Factor					1.000			0.775			0.872	
AT or PVG				3	3		3	3			3	3
Pltn Ratio				1.00	1.00		1.00	1.00			1.00	1.00
PF2				1.00	1.00		1.00	1.00			1.00	1.00
Q1				0.1	0.1		2.0	18.3			6.1	2.9
kB				0.4	0.4		0.3	0.4			0.4	0.4
Q2				0.0	0.0		0.4	21.8			0.8	0.2
Q Average				0.1	0.1		2.4	40.1			6.9	3.1
Q Spacing				25.0	25.0		25.0	25.0			25.0	25.0
Q Storage				90	0		155	0			0	100
Q S Ratio				0.0			0.4					0.8
70th Percentile Output:												
fB%				1.2	1.2		1.2	1.1			1.2	1.2
BOQ				0.1	0.1		2.9	45.6			8.1	3.7
QSRatio				0.0			0.5					0.9
85th Percentile Output:												
fB%				1.6	1.6		1.6	1.4			1.5	1.6
BOQ				0.1	0.1		3.8	55.3			10.5	4.9
QSRatio				0.0			0.6					1.2
90th Percentile Output:												
fB%				1.8	1.8		1.8	1.5			1.7	1.7
BOQ				0.1	0.1		4.2	58.3			11.5	5.5
QSRatio				0.0			0.7					1.4
95th Percentile Output:												
fB%				2.1	2.1		2.0	1.6			1.9	2.0
BOQ				0.2	0.2		4.9	62.8			13.1	6.3
QSRatio				0.0			0.8					1.6
98th Percentile Output:												
fB%				2.7	2.7		2.5	1.7			2.3	2.5
BOQ				0.2	0.2		6.1	70.0			15.7	7.8
QSRatio				0.1			1.0					1.9

ERROR MESSAGES

No errors to report.

HCS+: Signalized Intersections Release 5.4

```
Analyst:                                Inter.: Flournoy Street & Cicero Avenu
Agency: PB                              Area Type: CBD or Similar
Date:   6/25/2010                       Jurisd:
Period: PM Peak                         Year  : Existing
Project ID: I-290 Phase 1 Study
E/W St: Flournoy Street                 N/S St: Cicero Avenue

_________________________SIGNALIZED INTERSECTION SUMMARY________________________
           |  Eastbound     |  Westbound     |  Northbound    |  Southbound    |
           | L    T    R    | L    T    R    | L    T    R    | L    T    R    |
           |________________|________________|________________|________________|
No. Lanes  |  0    0    0   |   1    2    0  |   2    2    0  |  0    2    1   |
LGConfig   |                | L     T        | L     T        |       T    R   |
Volume     |                |5    8          |367  1287       |     1060 325   |
Lane Width |                |12.0 12.0       |11.0 11.0       |     11.0 11.0  |
RTOR Vol   |                |                |                |          114   |
________________________________________________________________________________
Duration    0.25      Area Type: CBD or Similar
____________________________Signal Operations__________________________________
Phase Combination 1     2     3     4 |          5     6     7     8
EB  Left                              | NB  Left   A     A
    Thru                              |     Thru   A     A
    Right                             |     Right
    Peds                              |     Peds   X     X
WB  Left          A                   | SB  Left
    Thru          A                   |     Thru   A
    Right                             |     Right  A
    Peds          X                   |     Peds   X
NB  Right                             | EB  Right
SB  Right                             | WB  Right
Green            23.0                               43.0  8.0
Yellow           3.0                                3.0   3.0
All Red          1.0                                0.0   1.0
                                                     Cycle Length: 85.0    secs
____________________Intersection Performance Summary___________________________
Appr/   Lane       Adj Sat     Ratios        Lane Group   Approach
Lane    Group      Flow Rate  ___________    __________   ___________
Grp     Capacity     (s)      v/c     g/C    Delay LOS    Delay LOS
________________________________________________________________________________
Eastbound



Westbound
L         346        1399      0.01   0.25    24.2   C
T         693        2804      0.01   0.25    24.2   C     24.2   C

Northbound
L         721        2536      0.54   0.61    20.5   C
T         1169       1911      1.16   0.61    96.5   F     79.6   E

Southbound

T         922        1911      1.21   0.48    123.2  F     105.2  F
R         515        1067      0.43   0.48    14.7   B
          Intersection Delay = 90.5  (sec/veh)   Intersection LOS = F
________________________________________________________________________________
```

HCS+: Signalized Intersections Release 5.4

I-290
Existing

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst:
Agency/Co.: PB
Date Performed: 6/25/2010
Analysis Time Period: PM Peak
Intersection: Flournoy Street & Cicero Avenu
Area Type: CBD or Similar
Jurisdiction:
Analysis Year: Existing
Project ID: I-290 Phase 1 Study
E/W St: Flournoy Street N/S St: Cicero Avenue

VOLUME DATA

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
Volume				5	8		367	1287			1060	325
% Heavy Veh				10	10		10	10			10	10
PHF				0.95	0.95		0.95	0.95			0.95	0.95
PK 15 Vol				2	2		97	339			279	86
Hi Ln Vol												
% Grade					0			0			0	
Ideal Sat				1800	1800		1800	1300			1300	1800
ParkExist												
NumPark												
No. Lanes	0	0	0	1	2	0	2	2	0	0	2	1
LGConfig				L	T		L	T			T	R
Lane Width				12.0	12.0		11.0	11.0			11.0	11.0
RTOR Vol												114
Adj Flow				5	8		386	1355			1116	222
%InSharedLn												
Prop LTs					0.000		1.000	0.000			0.000	
Prop RTs					0.000			0.000			0.000	1.000
Peds Bikes	0										200	0
Buses				0	0		0	12			12	0
%InProtPhase							0.0					

Duration 0.25 Area Type: CBD or Similar

OPERATING PARAMETERS

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
Init Unmet				0.0	0.0		0.0	0.0			0.0	0.0
Arriv. Type				3	3		3	3			3	3
Unit Ext.				3.0	3.0		3.0	3.0			3.0	3.0
I Factor					1.000			0.836			0.622	
Lost Time				2.0	2.0		2.0	2.0			2.0	2.0
Ext of g				0.0	0.0		0.0	0.0			0.0	0.0
Ped Min g		3.2									4.5	

PHASE DATA

Phase Combination		1	2	3	4			5	6	7	8
EB	Left					NB	Left	A	A		
	Thru						Thru	A	A		
	Right						Right				
	Peds						Peds	X	X		
WB	Left	A				SB	Left				
	Thru	A					Thru	A			
	Right						Right	A			
	Peds	X					Peds	X			
NB	Right					EB	Right				
SB	Right					WB	Right				

Green	23.0		43.0	8.0
Yellow	3.0		3.0	3.0
All Red	1.0		0.0	1.0

Cycle Length: 85.0 secs

VOLUME ADJUSTMENT AND SATURATION FLOW WORKSHEET

Volume Adjustment

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume, V				5	8		367	1287			1060	325
PHF				0.95	0.95		0.95	0.95			0.95	0.95
Adj flow				5	8		386	1355			1116	222
No. Lanes	0	0	0	1	2	0	2	2	0	0	2	1
Lane group				L	T		L	T			T	R
Adj flow				5	8		386	1355			1116	222
Prop LTs					0.000		1.000	0.000			0.000	
Prop RTs					0.000			0.000			0.000	1.000

Saturation Flow Rate (see Exhibit 16-7 to determine the adjustment factors)

	Eastbound			Westbound			Northbound			Southbound		
LG				L	T		L	T			T	R
So				1800	1800		1800	1300			1300	1800
Lanes	0	0	0	1	2	0	2	2	0	0	2	1
fW				1.000	1.000		0.967	0.967			0.967	0.967
fHV				0.909	0.909		0.909	0.909			0.909	0.909
fG				1.000	1.000		1.000	1.000			1.000	1.000
fP				1.000	1.000		1.000	1.000			1.000	1.000
fBB				1.000	1.000		1.000	0.976			0.976	1.000
fA				0.900	0.900		0.900	0.900			0.900	0.900
fLU				1.000	0.952		0.971	0.952			0.952	1.000
fRT					1.000			1.000			1.000	0.850
fLT				0.950	1.000		0.950	1.000			1.000	
Sec.							0.289					
fLpb				1.000	1.000		0.966	1.000			1.000	
fRpb					1.000			1.000			1.000	0.882
S				1399	2804		2536	1911			1911	1067
Sec.							772					

CAPACITY AND LOS WORKSHEET

Capacity Analysis and Lane Group Capacity

Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- Capacity (c)	v/c Ratio
Eastbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru							
Right							
Westbound							
Prot							
Perm							
Left	L	5	1399	# 0.00	0.25	346	0.01
Prot							
Perm							
Thru	T	8	2804	0.00	0.25	693	0.01
Right							
Northbound							
Prot		23	2536	0.01	0.141	358	0.06
Perm		363	772	0.47	0.471	363	1.00
Left	L	386			0.61	721	0.54
Prot							
Perm							
Thru	T	1355	1911	# 0.71	0.61	1169	1.16

```
   Right
Southbound
   Prot
   Perm
   Left
   Prot
   Perm
   Thru   T          1116       1911      0.58     0.48    922      1.21
   Right  R          222        1067      0.21     0.48    515      0.43
_______________________________________________________________________________
Sum of flow ratios for critical lane groups, Yc =   Sum (v/s)   = 0.71
Total lost time per cycle,  L = 12.00 sec
Critical flow rate to capacity ratio,        Xc = (Yc)(C)/(C-L) = 0.83

Control Delay and LOS Determination___________________________________________
Appr/   Ratios    Unf    Prog  Lane   Incremental  Res    Lane Group   Approach
Lane  _________   Del    Adj   Grp    Factor Del   Del    __________  __________
Grp   v/c   g/C   d1     Fact  Cap    k      d2    d3      Delay LOS   Delay LOS
_______________________________________________________________________________
Eastbound



Westbound
L     0.01  0.25  24.2  1.000 346    0.11   0.0   0.0    24.2   C
T     0.01  0.25  24.2  1.000 693    0.11   0.0   0.0    24.2   C    24.2   C

Northbound
L     0.54  0.61  19.8  1.000 721    0.14   0.7   0.0    20.5   C
T     1.16  0.61  16.5  1.000 1169   0.50   80.0  0.0    96.5   F    79.6   E

Southbound

T     1.21  0.48  22.0  1.000 922    0.50   101.2 0.0    123.2  F    105.2  F
R     0.43  0.48  14.4  1.000 515    0.11   0.4   0.0    14.7   B
_______________________________________________________________________________
         Intersection delay = 90.5  (sec/veh)   Intersection LOS = F



______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                               for exclusive lefts
Input
                                                            EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                                  85.0    sec
Total actual green time for LT lane group, G (s)                        54.0
Effective permitted green time for LT lane group, g(s)                  40.0
Opposing effective green time, go (s)                                   41.0
Number of lanes in LT lane group, N                                     2
Number of lanes in opposing approach, No                                2
Adjusted LT flow rate, VLT (veh/h)                                      386
Proportion of LT in LT lane group, PLT                                  1.000
Proportion of LT in opposing flow, PLTo                                 0.00
Adjusted opposing flow rate, Vo (veh/h)                                 1116
Lost time for LT lane group, tL                                         6.00
Computation
LT volume per cycle, LTC=VLTC/3600                                      9.11
Opposing lane util. factor, fLUo                            0.952       0.952 0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)                     13.84
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g                                   0.0
Opposing platoon ratio, Rpo (refer Exhibit 16-11)                       1.00
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]                            0.52
gq, (see Exhibit C16-4,5,6,7,8)                                         15.25
gu=g-gq if gq>=gf, or = g-gf if gq<gf                                   24.75
n=Max(gq-gf)/2,0)                                                       7.62
PTHo=1-PLTo                                                             1.00
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]                                      4.78
EL1 (refer to Exhibit C16-3)                                            3.91
EL2=Max((1-Ptho**n)/Plto, 1.0)
```

```
fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g                                 0.29
gdiff=max(gq-gf,0)                                                 0.00
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)                0.29
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
or flt=[fm+0.91(N-1)]/N**
Left-turn adjustment, fLT                                          0.289

For special case of single-lane approach opposed by multilane approach,
see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
  left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach
or when gf>gq, see text.

______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                                for shared lefts
Input
                                                       EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                          85.0    sec
Total actual green time for LT lane group, G (s)
Effective permitted green time for LT lane group, g(s)
Opposing effective green time, go (s)
Number of lanes in LT lane group, N
Number of lanes in opposing approach, No
Adjusted LT flow rate, VLT (veh/h)
Proportion of LT in LT lane group, PLT                       0.000 0.000 0.000
Proportion of LT in opposing flow, PLTo
Adjusted opposing flow rate, Vo (veh/h)
Lost time for LT lane group, tL
Computation
LT volume per cycle, LTC=VLTC/3600
Opposing lane util. factor, fLUo                       0.952       0.952 0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g
Opposing platoon ratio, Rpo (refer Exhibit 16-11)
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]
gq, (see Exhibit C16-4,5,6,7,8)
gu=g-gq if gq>=gf, or = g-gf if gq<gf
n=Max(gq-gf)/2,0)
PTHo=1-PLTo
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]
EL1 (refer to Exhibit C16-3)
EL2=Max((1-Ptho**n)/Plto, 1.0)
fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g
gdiff=max(gq-gf,0)
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
or flt=[fm+0.91(N-1)]/N**
Left-turn adjustment, fLT

For special case of single-lane approach opposed by multilane approach,
see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
  left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach
or when gf>gq, see text.

_______________SUPPLEMENTAL PEDESTRIAN-BICYCLE EFFECTS WORKSHEET_______________
Permitted Left Turns
                                                       EB    WB    NB    SB
Effective pedestrian green time, gp (s)                           43.0
Conflicting pedestrian volume, Vped (p/h)                         200
Pedestrian flow rate, Vpedg (p/h)                                 395
OCCpedg                                                           0.198
Opposing queue clearing green, gq (s)                             15.25
Eff. ped. green consumed by opp. veh. queue, gq/gp                0.355
OCCpedu                                                           0.162
```

Opposing flow rate, Vo (veh/h)	1116	
OCCr	0.034	
Number of cross-street receiving lanes, Nrec	2	
Number of turning lanes, Nturn	2	
ApbT	0.966	
Proportion of left turns, PLT	1.000	
Proportion of left turns using protected phase, PLTA	0.000	
Left-turn adjustment, fLpb	0.966	
Permitted Right Turns		
Effective pedestrian green time, gp (s)		43.0
Conflicting pedestrian volume, Vped (p/h)		200
Conflicting bicycle volume, Vbic (bicycles/h)		0
Vpedg		395
OCCpedg		0.198
Effective green, g (s)		41.0
Vbicg		0
OCCbicg		0.020
OCCr		0.198
Number of cross-street receiving lanes, Nrec		2
Number of turning lanes, Nturn		1
ApbT		0.882
Proportion right-turns, PRT		1.000
Proportion right-turns using protected phase, PRTA		0.000
Right turn adjustment, fRpb		

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

Cycle length, C 85.0 sec

	EBLT	WBLT	NBLT	SBLT
Adj. LT vol from Vol Adjustment Worksheet, v			386	
v/c ratio from Capacity Worksheet, X			0.54	
Protected phase effective green interval, g (s)			12.0	
Opposing queue effective green interval, gq			15.25	
Unopposed green interval, gu			24.75	
Red time r=(C-g-gq-gu)			33.0	
Arrival rate, qa=v/(3600(max[X,1.0]))			0.11	
Protected ph. departure rate, Sp=s/3600			0.704	
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)			0.35	
XPerm			0.91	
XProt				
Case			4	
Queue at beginning of green arrow, Qa			0.00	
Queue at beginning of unsaturated green, Qu			5.17	
Residual queue, Qr			0.00	
Uniform Delay, d1			19.8	

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
	0.0						0.0	
	0.0						0.0	
	0.0						0.0	
Westbound								
L	0.0	0.00	32.0	24.2	0.00	0.0	0.0	24.2
T	0.0	0.00	32.0	24.2	0.00	0.0	0.0	24.2
	0.0						0.0	
Northbound								
L	0.0	0.00		19.8	0.00	0.0	0.0	20.5
T	0.0	0.00	16.5	16.5	0.00	46.5	0.0	96.5
	0.0						0.0	
Southbound								
	0.0						0.0	

T	0.0	0.00	22.0	22.0	0.00	48.5	0.0	123.2
R	0.0	0.00	22.0	14.4	0.00	0.0	0.0	14.7

Intersection Delay 90.5 sec/veh Intersection LOS F

BACK OF QUEUE WORKSHEET

	Eastbound			Westbound			Northbound			Southbound		
LaneGroup				L	T		L	T			T	R
Init Queue				0.0	0.0		0.0	0.0			0.0	0.0
Flow Rate				5	4		198	711			586	222
So				1800	1800		1800	1300			1300	1800
No.Lanes	0	0	0	1	2	0	2	2	0	0	2	1
SL				1399	1472		607	1003			1003	1067
LnCapacity				346	363		371	613			484	515
Flow Ratio				0.0	0.0		0.3	0.7			0.6	0.2
v/c Ratio				0.01	0.01		0.53	1.16			1.21	0.43
Grn Ratio				0.25	0.25		0.61	0.61			0.48	0.48
I Factor					1.000			0.836			0.622	
AT or PVG				3	3		3	3			3	3
Pltn Ratio				1.00	1.00		1.00	1.00			1.00	1.00
PF2				1.00	1.00		1.00	1.00			1.00	1.00
Q1				0.1	0.1		2.0	16.8			13.8	3.4
kB				0.4	0.4		0.3	0.4			0.3	0.3
Q2				0.0	0.0		0.3	14.8			14.1	0.2
Q Average				0.1	0.1		2.3	31.5			28.0	3.6
Q Spacing				25.0	25.0		25.0	25.0			25.0	25.0
Q Storage				90	0		155	0			0	100
Q S Ratio				0.0			0.4					0.9
70th Percentile Output:												
fB%				1.2	1.2		1.2	1.1			1.1	1.2
BOQ				0.1	0.1		2.8	36.1			32.2	4.3
QSRatio				0.0			0.4					1.1
85th Percentile Output:												
fB%				1.6	1.6		1.6	1.4			1.4	1.6
BOQ				0.2	0.1		3.6	44.3			39.7	5.7
QSRatio				0.0			0.6					1.4
90th Percentile Output:												
fB%				1.8	1.8		1.8	1.5			1.5	1.7
BOQ				0.2	0.1		4.1	46.8			41.9	6.3
QSRatio				0.0			0.7					1.6
95th Percentile Output:												
fB%				2.1	2.1		2.0	1.6			1.6	2.0
BOQ				0.2	0.2		4.7	50.6			45.5	7.2
QSRatio				0.1			0.8					1.8
98th Percentile Output:												
fB%				2.7	2.7		2.5	1.8			1.8	2.5
BOQ				0.3	0.2		5.9	56.4			50.8	8.9
QSRatio				0.1			0.9					2.2

ERROR MESSAGES

No errors to report.

```
                    HCS+: Signalized Intersections Release 5.4

Analyst:                                Inter.: Lexington Street & Cicero Aven
Agency: PB                              Area Type: CBD or Similar
Date:   6/25/2010                       Jurisd:
Period: AM Peak                         Year  : Existing
Project ID: I-290 Phase 1 Study
E/W St: Lexington Street                N/S St: Cicero Avenue

_________________________SIGNALIZED INTERSECTION SUMMARY_______________________
           |  Eastbound      |  Westbound      |  Northbound     |  Southbound     |
           | L    T    R     | L    T    R     | L    T    R     | L    T    R     |
           |_________________|_________________|_________________|_________________|
No. Lanes  |   1   2   1     |   0   0   0     |   0   3   0     |   1   2   0     |
LGConfig   | L     LTR  R    |                 |      TR         | L     T         |
Volume     |504  33   609    |                 |     1250 5      |4    559         |
Lane Width |10.5 11.5 12.0   |                 |     11.0        |11.0 11.0        |
RTOR Vol   |          120    |                 |          1      |                 |
_______________________________________________________________________________
Duration    0.25      Area Type: CBD or Similar
______________________________Signal Operations________________________________
Phase Combination 1     2     3     4 |          5     6     7     8
EB  Left          A                   | NB  Left
    Thru          A                   |     Thru   A
    Right         A                   |     Right  A
    Peds          X                   |     Peds   X
WB  Left                              | SB  Left   A     A
    Thru                              |     Thru   A     A
    Right                             |     Right
    Peds                              |     Peds   X     X
NB  Right                             | EB  Right
SB  Right                             | WB  Right
Green            23.0                             43.0  8.0
Yellow           3.0                              3.0   3.0
All Red          1.0                              0.0   1.0
                                                   Cycle Length: 85.0    secs
___________________Intersection Performance Summary___________________________
Appr/   Lane       Adj Sat     Ratios        Lane Group   Approach
Lane    Group      Flow Rate   __________    __________   ___________
Grp     Capacity     (s)       v/c    g/C    Delay LOS    Delay LOS
_______________________________________________________________________________
Eastbound
L        328       1329       0.94   0.25    65.5   E
LTR      363       1470       1.42   0.25    236.0  F    180.8  F
R        195       789        1.32   0.25    208.5  F
Westbound



Northbound

TR       1839      3813       0.72   0.48    18.8   B    18.8   B

Southbound
L        284       1330       0.01   0.61    11.2   B
T        1619      2646       0.36   0.61    8.4    A    8.4    A

         Intersection Delay = 75.3  (sec/veh)   Intersection LOS = E

_______________________________________________________________________________
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HCS+: Signalized Intersections Release 5.4

I-290
Existing

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst:
Agency/Co.: PB
Date Performed: 6/25/2010
Analysis Time Period: AM Peak
Intersection: Lexington Street & Cicero Aven
Area Type: CBD or Similar
Jurisdiction:
Analysis Year: Existing
Project ID: I-290 Phase 1 Study
E/W St: Lexington Street N/S St: Cicero Avenue

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	504	33	609					1250	5	4	559	
% Heavy Veh	10	10	10					10	10	10	10	
PHF	0.95	0.95	0.95					0.95	0.95	0.95	0.95	
PK 15 Vol	133	9	160					329	2	1	147	
Hi Ln Vol												
% Grade		0						0			0	
Ideal Sat	1800	1300	1800					1800		1800	1800	
ParkExist												
NumPark												
No. Lanes	1	2	1	0	0	0	0	3	0	1	2	0
LGConfig	L	LTR	R					TR		L	T	
Lane Width	10.5	11.5	12.0					11.0		11.0	11.0	
RTOR Vol			120						1			
Adj Flow	308	515	258					1320		4	588	
%InSharedLn	42		50									
Prop LTs		0.433						0.000		1.000	0.000	
Prop RTs		0.500	1.000					0.003			0.000	
Peds Bikes	200	0		0			200	0				
Buses	0	0	0					12		0	12	
%InProtPhase										0.0		

Duration 0.25 Area Type: CBD or Similar

OPERATING PARAMETERS

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Init Unmet	0.0	0.0	0.0					0.0		0.0	0.0	
Arriv. Type	3	3	3					3		3	3	
Unit Ext.	3.0	3.0	3.0					3.0		3.0	3.0	
I Factor		1.000						1.000			0.928	
Lost Time	2.0	2.0	2.0					2.0		2.0	2.0	
Ext of g	0.0	0.0	0.0					0.0		0.0	0.0	
Ped Min g		4.5			3.2			4.5				

```
_________________________________PHASE DATA____________________________________

Phase Combination 1     2     3     4 |           5     6     7     8

EB  Left           A                  | NB  Left
    Thru           A                  |     Thru   A
    Right          A                  |     Right  A
    Peds           X                  |     Peds   X

WB  Left                              | SB  Left   A     A
    Thru                              |     Thru   A     A
    Right                             |     Right
    Peds                              |     Peds   X     X

NB  Right                             | EB  Right
                                      |
SB  Right                             | WB  Right
                                      |
                                      |
Green             23.0                           43.0  8.0
Yellow            3.0                            3.0   3.0
All Red           1.0                            0.0   1.0

                                                   Cycle Length: 85.0    secs

_________________VOLUME ADJUSTMENT AND SATURATION FLOW WORKSHEET________________
Volume Adjustment
           |  Eastbound     |  Westbound     |  Northbound    |  Southbound    |
           | L    T    R    | L    T    R    | L    T    R    | L    T    R    |
           |________________|________________|________________|________________|
Volume, V  |504  33   609   |                |     1250 5     |4    559        |
PHF        |0.95 0.95 0.95  |                |     0.95 0.95  |0.95 0.95       |
Adj flow   |531  35   515   |                |     1316 4     |4    588        |
No. Lanes  |   1   2   1    |   0   0   0    |   0   3   0    |   1   2   0    |
Lane group | L     LTR  R   |                |      TR        | L     T        |
Adj flow   |308  515  258   |                |     1320       |4    588        |
Prop LTs   |      0.433     |                |      0.000     |1.000 0.000     |
Prop RTs   |   0.500 1.000  |                |   0.003        |   0.000        |

Saturation Flow Rate (see Exhibit 16-7 to determine the adjustment factors)____
         Eastbound         Westbound         Northbound        Southbound
LG     L     LTR  R                               TR           L     T
So    1800  1300  1800                           1800         1800  1800
Lanes 1     2     1     0     0     0     0     3     0     1     2     0
fW    0.950 0.983 1.000                          0.967        0.967 0.967
fHV   0.909 0.909 0.909                          0.909        0.909 0.909
fG    1.000 1.000 1.000                          1.000        1.000 1.000
fP    1.000 1.000 1.000                          1.000        1.000 1.000
fBB   1.000 1.000 1.000                          0.984        1.000 0.976
fA    0.900 0.900 0.900                          0.900        0.900 0.900
fLU   1.000 0.952 1.000                          0.908        1.000 0.952
fRT         0.925 0.850                          1.000              1.000
fLT   0.950 0.979                                1.000        0.950 1.000
Sec.                                                          0.146
fLpb  1.000 1.000                                1.000        0.983 1.000
fRpb        0.815 0.630                          1.000              1.000
S     1329  1470  789                            3813         1330  2646
Sec.                                                          204
_________________________CAPACITY AND LOS WORKSHEET____________________________
Capacity Analysis and Lane Group Capacity
```

Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- Capacity (c)	v/c Ratio
Eastbound							
Prot							
Perm							
Left	L	308	1329	0.23	0.25	328	0.94
Prot							
Perm							
Thru	LTR	515	1470	# 0.35	0.25	363	1.42
Right	R	258	789	0.33	0.25	195	1.32
Westbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru							
Right							
Northbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	TR	1320	3813	# 0.35	0.48	1839	0.72
Right							
Southbound							
Prot		0	1330	# 0.00	0.141	188	0.00
Perm		4	204	0.02	0.471	96	0.04
Left	L	4			0.61	284	0.01
Prot							
Perm							
Thru	T	588	2646	0.22	0.61	1619	0.36
Right							

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.70
Total lost time per cycle, L = 11.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.80

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	LOS	Approach Delay	LOS
Eastbound												
L	0.94	0.25	31.4	1.000	328	0.45	34.1	0.0	65.5	E		
LTR	1.42	0.25	32.0	1.000	363	0.50	204.0	0.0	236.0	F	180.8	F
R	1.32	0.25	32.0	1.000	195	0.50	176.5	0.0	208.5	F		
Westbound												
Northbound												
TR	0.72	0.48	17.4	1.000	1839	0.28	1.4	0.0	18.8	B	18.8	B
Southbound												
L	0.01	0.61	11.1	1.000	284	0.11	0.0	0.0	11.2	B		
T	0.36	0.61	8.2	1.000	1619	0.11	0.1	0.0	8.4	A	8.4	A

```
_______________________________________________________________________________
         Intersection delay = 75.3  (sec/veh)   Intersection LOS = E



______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                              for exclusive lefts
Input
                                                        EB     WB     NB     SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                           85.0    sec
Total actual green time for LT lane group, G (s)                             54.0
Effective permitted green time for LT lane group, g(s)                       40.0
Opposing effective green time, go (s)                                        41.0
Number of lanes in LT lane group, N                                          1
Number of lanes in opposing approach, No                                     3
Adjusted LT flow rate, VLT (veh/h)                                           4
Proportion of LT in LT lane group, PLT                                       1.000
Proportion of LT in opposing flow, PLTo                                      0.00
Adjusted opposing flow rate, Vo (veh/h)                                      1320
Lost time for LT lane group, tL                                              6.00
Computation
LT volume per cycle, LTC=VLTC/3600                                           0.09
Opposing lane util. factor, fLUo                              0.952 0.952 0.908
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)                          11.44
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g                                        0.0
Opposing platoon ratio, Rpo (refer Exhibit 16-11)                            1.00
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]                                 0.52
gq, (see Exhibit C16-4,5,6,7,8)                                              10.21
gu=g-gq if gq>=gf, or = g-gf if gq<gf                                        29.79
n=Max(gq-gf)/2,0)                                                            5.10
PTHo=1-PLTo                                                                  1.00
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]                                           1.00
EL1 (refer to Exhibit C16-3)                                                 5.11
EL2=Max((1-Ptho**n)/Plto, 1.0)
fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g                                           0.10
gdiff=max(gq-gf,0)                                                           0.00
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)                          0.15
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
or flt=[fm+0.91(N-1)]/N**
Left-turn adjustment, fLT                                                    0.146

For special case of single-lane approach opposed by multilane approach,
see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
  left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach
or when gf>gq, see text.

______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                                for shared lefts
Input
                                                        EB     WB     NB     SB
Opposed by Single(S) or Multiple(M) lane approach
Cycle length, C                           85.0    sec
Total actual green time for LT lane group, G (s)
Effective permitted green time for LT lane group, g(s)
Opposing effective green time, go (s)
Number of lanes in LT lane group, N
```

Number of lanes in opposing approach, No				
Adjusted LT flow rate, VLT (veh/h)				
Proportion of LT in LT lane group, PLT	0.433		0.000	0.000
Proportion of LT in opposing flow, PLTo				
Adjusted opposing flow rate, Vo (veh/h)				
Lost time for LT lane group, tL				
Computation				
LT volume per cycle, LTC=VLTC/3600				
Opposing lane util. factor, fLUo		0.952	0.952	0.908
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)				
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g				
Opposing platoon ratio, Rpo (refer Exhibit 16-11)				
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]				
gq, (see Exhibit C16-4,5,6,7,8)				
gu=g-gq if gq>=gf, or = g-gf if gq<gf				
n=Max(gq-gf)/2,0)				
PTHo=1-PLTo				
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]				
EL1 (refer to Exhibit C16-3)				
EL2=Max((1-Ptho**n)/Plto, 1.0)				
fmin=2(1+PL)/g or fmin=2(1+Pl)/g				
gdiff=max(gq-gf,0)				
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)				
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)				
or flt=[fm+0.91(N-1)]/N**				
Left-turn adjustment, fLT				

For special case of single-lane approach opposed by multilane approach, see text.

* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto left-turn lane and redo calculations.

** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.

For special case of multilane approach opposed by single-lane approach or when gf>gq, see text.

SUPPLEMENTAL PEDESTRIAN-BICYCLE EFFECTS WORKSHEET

Permitted Left Turns	EB	WB	NB	SB
Effective pedestrian green time, gp (s)				43.0
Conflicting pedestrian volume, Vped (p/h)				200
Pedestrian flow rate, Vpedg (p/h)				395
OCCpedg				0.198
Opposing queue clearing green, gq (s)				10.21
Eff. ped. green consumed by opp. veh. queue, gq/gp				0.237
OCCpedu				0.174
Opposing flow rate, Vo (veh/h)				1320
OCCr				0.028
Number of cross-street receiving lanes, Nrec				2
Number of turning lanes, Nturn				1
ApbT				0.983
Proportion of left turns, PLT				1.000
Proportion of left turns using protected phase, PLTA				0.000
Left-turn adjustment, fLpb				0.983
Permitted Right Turns				
Effective pedestrian green time, gp (s)	23.0		43.0	
Conflicting pedestrian volume, Vped (p/h)	200		200	
Conflicting bicycle volume, Vbic (bicycles/h)	0		0	
Vpedg	739		395	
OCCpedg	0.370		0.198	
Effective green, g (s)	21.0		41.0	
Vbicg	0		0	

OCCbicg	0.020	0.020
OCCr	0.370	0.198
Number of cross-street receiving lanes, Nrec	2	2
Number of turning lanes, Nturn	2	1
ApbT	0.630	0.882
Proportion right-turns, PRT	1.000	0.003
Proportion right-turns using protected phase, PRTA	0.000	0.000
Right turn adjustment, fRpb	1.000	1.000

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

		EBLT	WBLT	NBLT	SBLT
Cycle length, C	85.0 sec				
Adj. LT vol from Vol Adjustment Worksheet, v					4
v/c ratio from Capacity Worksheet, X					0.01
Protected phase effective green interval, g (s)					12.0
Opposing queue effective green interval, gq					10.21
Unopposed green interval, gu					29.79
Red time r=(C-g-gq-gu)					33.0
Arrival rate, qa=v/(3600(max[X,1.0]))					0.00
Protected ph. departure rate, Sp=s/3600					0.369
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)					0.08
XPerm					0.04
XProt					
Case					4
Queue at beginning of green arrow, Qa					0.00
Queue at beginning of unsaturated green, Qu					0.05
Residual queue, Qr					0.00
Uniform Delay, d1					11.1

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
L	0.0	0.00	32.0	31.4	0.00	0.0	0.0	65.5
LTR	0.0	0.00	32.0	32.0	0.00	38.0	0.0	236.0
R	0.0	0.00	32.0	32.0	0.00	15.8	0.0	208.5
Westbound								
	0.0						0.0	
	0.0						0.0	
	0.0						0.0	
Northbound								
	0.0						0.0	
TR	0.0	0.00	22.0	17.4	0.00	0.0	0.0	18.8
	0.0						0.0	
Southbound								
L	0.0	0.00		11.1	0.00	0.0	0.0	11.2
T	0.0	0.00	16.5	8.2	0.00	0.0	0.0	8.4
	0.0						0.0	

Intersection Delay 75.3 sec/veh Intersection LOS E

BACK OF QUEUE WORKSHEET

	Eastbound			Westbound			Northbound			Southbound		
LaneGroup	L	LTR	R					TR		L	T	
Init Queue	0.0	0.0	0.0					0.0		0.0	0.0	
Flow Rate	308	270	258					484		4	308	
So	1800	1300	1800					1800		1800	1800	
No.Lanes	1	2	1	0	0	0	0	3	0	1	2	0
SL	1329	772	789					1399		464	1389	
LnCapacity	328	190	195					675		284	850	
Flow Ratio	0.2	0.3	0.3					0.3		0.0	0.2	
v/c Ratio	0.94	1.42	1.32					0.72		0.01	0.36	
Grn Ratio	0.25	0.25	0.25					0.48		0.61	0.61	
I Factor		1.000						1.000			0.928	
AT or PVG	3	3	3					3		3	3	
Pltn Ratio	1.00	1.00	1.00					1.00		1.00	1.00	
PF2	1.00	1.00	1.00					1.00		1.00	1.00	
Q1	7.1	6.4	6.1					9.0		0.0	3.6	
kB	0.3	0.2	0.2					0.5		0.3	0.6	
Q2	2.6	10.8	8.8					1.3		0.0	0.3	
Q Average	9.7	17.1	14.9					10.3		0.0	3.9	
Q Spacing	25.0	25.0	25.0					25.0		25.0	25.0	
Q Storage	95	0	100					0		50	0	
Q S Ratio	2.6		3.7							0.0		
70th Percentile Output:												
fB%	1.2	1.2	1.2					1.2		1.2	1.2	
BOQ	11.4	20.0	17.4					12.1		0.0	4.7	
QSRatio	3.0		4.3							0.0		
85th Percentile Output:												
fB%	1.5	1.5	1.5					1.5		1.6	1.6	
BOQ	14.7	25.2	22.1					15.6		0.1	6.2	
QSRatio	3.9		5.5							0.0		
90th Percentile Output:												
fB%	1.6	1.6	1.6					1.6		1.8	1.7	
BOQ	16.0	26.9	23.7					16.9		0.1	6.8	
QSRatio	4.2		5.9							0.0		
95th Percentile Output:												
fB%	1.8	1.7	1.8					1.8		2.1	2.0	
BOQ	18.0	29.7	26.2					19.0		0.1	7.8	
QSRatio	4.7		6.6							0.0		
98th Percentile Output:												
fB%	2.2	2.0	2.0					2.2		2.7	2.4	
BOQ	21.1	33.7	30.0					22.2		0.1	9.6	
QSRatio	5.6		7.5							0.1		

ERROR MESSAGES

No errors to report.

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                    HCS+: Signalized Intersections Release 5.4

Analyst:                                Inter.: Lexington Street & Cicero Aven
Agency: PB                              Area Type: CBD or Similar
Date:   6/25/2010                       Jurisd:
Period: PM Peak                         Year  : Existing
Project ID: I-290 Phase 1 Study
E/W St: Lexington Street                N/S St: Cicero Avenue

_________________________SIGNALIZED INTERSECTION SUMMARY_______________________
           |  Eastbound     |  Westbound     |  Northbound    |  Southbound    |
           | L    T    R    | L    T    R    | L    T    R    | L    T    R    |
           |________________|________________|________________|________________|
No. Lanes  |   1   2   1    |   0   0   0    |   0   3   0    |   1   2   0    |
LGConfig   | L     LTR  R   |                |      TR        | L     T        |
Volume     |359  38   439   |                |     1295 12    |12   1053       |
Lane Width |10.5 11.5 12.0  |                |     11.0       |11.0 11.0       |
RTOR Vol   |          120   |                |          1     |                |
_______________________________________________________________________________
Duration    0.25      Area Type: CBD or Similar
______________________________Signal Operations________________________________
Phase Combination 1     2     3     4 |          5     6     7     8
EB  Left          A                   | NB  Left
    Thru          A                   |     Thru   A
    Right         A                   |     Right  A
    Peds          X                   |     Peds   X
WB  Left                              | SB  Left   A     A
    Thru                              |     Thru   A     A
    Right                             |     Right
    Peds                              |     Peds   X     X
NB  Right                             | EB  Right
SB  Right                             | WB  Right
Green            23.0                              43.0  8.0
Yellow           3.0                               3.0   3.0
All Red          1.0                               0.0   1.0
                                                    Cycle Length: 85.0    secs
____________________Intersection Performance Summary___________________________
Appr/   Lane       Adj Sat     Ratios       Lane Group   Approach
Lane    Group      Flow Rate  __________    __________  ___________
Grp     Capacity     (s)      v/c    g/C    Delay LOS   Delay LOS
_______________________________________________________________________________
Eastbound
L        328       1329       0.69   0.25    35.2   D
LTR      371       1500       0.97   0.25    69.8   E    57.4   E
R        195       789        0.86   0.25    60.9   E
Westbound



Northbound

TR       1836      3807       0.75   0.48    19.6   B    19.6   B

Southbound
L        276       1332       0.05   0.61    12.1   B
T        1619      2646       0.68   0.61    11.8   B    11.8   B

         Intersection Delay = 25.7  (sec/veh)   Intersection LOS = C
_______________________________________________________________________________
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HCS+: Signalized Intersections Release 5.4

I-290
Existing

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst:
Agency/Co.: PB
Date Performed: 6/25/2010
Analysis Time Period: PM Peak
Intersection: Lexington Street & Cicero Aven
Area Type: CBD or Similar
Jurisdiction:
Analysis Year: Existing
Project ID: I-290 Phase 1 Study
E/W St: Lexington Street N/S St: Cicero Avenue

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	359	38	439					1295	12	12	1053	
% Heavy Veh	10	10	10					10	10	10	10	
PHF	0.95	0.95	0.95					0.95	0.95	0.95	0.95	
PK 15 Vol	94	10	116					341	3	3	277	
Hi Ln Vol												
% Grade		0						0			0	
Ideal Sat	1800	1300	1800					1800		1800	1800	
ParkExist												
NumPark												
No. Lanes	1	2	1	0	0	0	0	3	0	1	2	0
LGConfig	L	LTR	R					TR		L	T	
Lane Width	10.5	11.5	12.0					11.0		11.0	11.0	
RTOR Vol			120						1			
Adj Flow	227	359	168					1375		13	1108	
%InSharedLn	40		50									
Prop LTs		0.421						0.000		1.000	0.000	
Prop RTs		0.468	1.000					0.009			0.000	
Peds Bikes		200	0	0				200	0			
Buses	0	0	0					12		0	12	
%InProtPhase										0.0		

Duration 0.25 Area Type: CBD or Similar

OPERATING PARAMETERS

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Init Unmet	0.0	0.0	0.0					0.0		0.0	0.0	
Arriv. Type	3	3	3					3		3	3	
Unit Ext.	3.0	3.0	3.0					3.0		3.0	3.0	
I Factor		1.000						1.000			0.671	
Lost Time	2.0	2.0	2.0					2.0		2.0	2.0	
Ext of g	0.0	0.0	0.0					0.0		0.0	0.0	
Ped Min g		4.5			3.2			4.5				

PHASE DATA

Phase Combination		1	2	3	4			5	6	7	8
EB	Left	A				NB	Left				
	Thru	A					Thru	A			
	Right	A					Right	A			
	Peds	X					Peds	X			
WB	Left					SB	Left	A	A		
	Thru						Thru	A	A		
	Right						Right				
	Peds						Peds	X	X		
NB	Right					EB	Right				
SB	Right					WB	Right				
Green		23.0						43.0	8.0		
Yellow		3.0						3.0	3.0		
All Red		1.0						0.0	1.0		

Cycle Length: 85.0 secs

VOLUME ADJUSTMENT AND SATURATION FLOW WORKSHEET

Volume Adjustment

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume, V	359	38	439					1295	12	12	1053	
PHF	0.95	0.95	0.95					0.95	0.95	0.95	0.95	
Adj flow	378	40	336					1363	12	13	1108	
No. Lanes	1	2	1	0	0	0	0	3	0	1	2	0
Lane group	L	LTR	R					TR		L	T	
Adj flow	227	359	168					1375		13	1108	
Prop LTs		0.421						0.000		1.000	0.000	
Prop RTs		0.468	1.000					0.009			0.000	

Saturation Flow Rate (see Exhibit 16-7 to determine the adjustment factors)

	Eastbound			Westbound			Northbound			Southbound		
LG	L	LTR	R					TR		L	T	
So	1800	1300	1800					1800		1800	1800	
Lanes	1	2	1	0	0	0	0	3	0	1	2	0
fW	0.950	0.983	1.000					0.967		0.967	0.967	
fHV	0.909	0.909	0.909					0.909		0.909	0.909	
fG	1.000	1.000	1.000					1.000		1.000	1.000	
fP	1.000	1.000	1.000					1.000		1.000	1.000	
fBB	1.000	1.000	1.000					0.984		1.000	0.976	
fA	0.900	0.900	0.900					0.900		0.900	0.900	
fLU	1.000	0.952	1.000					0.908		1.000	0.952	
fRT		0.930	0.850					0.999			1.000	
fLT	0.950	0.979						1.000		0.950	1.000	
Sec.										0.133		
fLpb	1.000	1.000						1.000		0.985	1.000	
fRpb		0.827	0.630					0.999			1.000	
S	1329	1500	789					3807		1332	2646	
Sec.										187		

CAPACITY AND LOS WORKSHEET

Capacity Analysis and Lane Group Capacity

Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	Lane Group Capacity (c)	Lane Group v/c Ratio
Eastbound							
Prot							
Perm							
Left	L	227	1329	0.17	0.25	328	0.69
Prot							
Perm							
Thru	LTR	359	1500	# 0.24	0.25	371	0.97
Right	R	168	789	0.21	0.25	195	0.86
Westbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru							
Right							
Northbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	TR	1375	3807	0.36	0.48	1836	0.75
Right							
Southbound							
Prot		0	1332	0.00	0.141	188	0.00
Perm		13	187	0.07	0.471	88	0.15
Left	L	13			0.61	276	0.05
Prot							
Perm							
Thru	T	1108	2646	# 0.42	0.61	1619	0.68
Right							

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.66
Total lost time per cycle, L = 12.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.77

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	Ratios g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound												
L	0.69	0.25	29.1	1.000	328	0.26	6.1	0.0	35.2	D		
LTR	0.97	0.25	31.7	1.000	371	0.47	38.1	0.0	69.8	E	57.4	E
R	0.86	0.25	30.6	1.000	195	0.39	30.3	0.0	60.9	E		
Westbound												
Northbound												
TR	0.75	0.48	17.8	1.000	1836	0.30	1.8	0.0	19.6	B	19.6	B
Southbound												
L	0.05	0.61	12.1	1.000	276	0.11	0.0	0.0	12.1	B		
T	0.68	0.61	11.0	1.000	1619	0.25	0.8	0.0	11.8	B	11.8	B

Intersection delay = 25.7 (sec/veh)   Intersection LOS = C

SUPPLEMENTAL PERMITTED LT WORKSHEET
for exclusive lefts

Input

	EB	WB	NB	SB
Opposed by Single(S) or Multiple(M) lane approach				
Cycle length, C 85.0 sec				
Total actual green time for LT lane group, G (s)				54.0
Effective permitted green time for LT lane group, g(s)				40.0
Opposing effective green time, go (s)				41.0
Number of lanes in LT lane group, N				1
Number of lanes in opposing approach, No				3
Adjusted LT flow rate, VLT (veh/h)				13
Proportion of LT in LT lane group, PLT				1.000
Proportion of LT in opposing flow, PLTo				0.00
Adjusted opposing flow rate, Vo (veh/h)				1375
Lost time for LT lane group, tL				6.00
Computation				
LT volume per cycle, LTC=VLTC/3600				0.31
Opposing lane util. factor, fLUo		0.952	0.952	0.908
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)				11.92
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g				0.0
Opposing platoon ratio, Rpo (refer Exhibit 16-11)				1.00
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]				0.52
gq, (see Exhibit C16-4,5,6,7,8)				11.15
gu=g-gq if gq>=gf, or = g-gf if gq<gf				28.85
n=Max(gq-gf)/2,0)				5.57
PTHo=1-PLTo				1.00
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]				1.00
EL1 (refer to Exhibit C16-3)				5.42
EL2=Max((1-Ptho**n)/Plto, 1.0)				
fmin=2(1+PL)/g or fmin=2(1+Pl)/g				0.10
gdiff=max(gq-gf,0)				0.00
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)				0.13
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)				
or flt=[fm+0.91(N-1)]/N**				
Left-turn adjustment, fLT				0.133

For special case of single-lane approach opposed by multilane approach, see text.

* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto left-turn lane and redo calculations.

** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.

For special case of multilane approach opposed by single-lane approach or when gf>gq, see text.

SUPPLEMENTAL PERMITTED LT WORKSHEET
for shared lefts

Input

	EB	WB	NB	SB
Opposed by Single(S) or Multiple(M) lane approach				
Cycle length, C 85.0 sec				
Total actual green time for LT lane group, G (s)				
Effective permitted green time for LT lane group, g(s)				
Opposing effective green time, go (s)				
Number of lanes in LT lane group, N				

	EB	WB	NB	SB
Number of lanes in opposing approach, No				
Adjusted LT flow rate, VLT (veh/h)				
Proportion of LT in LT lane group, PLT	0.421		0.000	0.000
Proportion of LT in opposing flow, PLTo				
Adjusted opposing flow rate, Vo (veh/h)				
Lost time for LT lane group, tL				
Computation				
LT volume per cycle, LTC=VLTC/3600				
Opposing lane util. factor, fLUo		0.952	0.952	0.908
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)				
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g				
Opposing platoon ratio, Rpo (refer Exhibit 16-11)				
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]				
gq, (see Exhibit C16-4,5,6,7,8)				
gu=g-gq if gq>=gf, or = g-gf if gq<gf				
n=Max(gq-gf)/2,0)				
PTHo=1-PLTo				
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]				
EL1 (refer to Exhibit C16-3)				
EL2=Max((1-Ptho**n)/Plto, 1.0)				
fmin=2(1+PL)/g or fmin=2(1+Pl)/g				
gdiff=max(gq-gf,0)				
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)				
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)				
or flt=[fm+0.91(N-1)]/N**				
Left-turn adjustment, fLT				

For special case of single-lane approach opposed by multilane approach, see text.

* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto left-turn lane and redo calculations.

** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.

For special case of multilane approach opposed by single-lane approach or when gf>gq, see text.

SUPPLEMENTAL PEDESTRIAN-BICYCLE EFFECTS WORKSHEET

Permitted Left Turns	EB	WB	NB	SB
Effective pedestrian green time, gp (s)				43.0
Conflicting pedestrian volume, Vped (p/h)				200
Pedestrian flow rate, Vpedg (p/h)				395
OCCpedg				0.198
Opposing queue clearing green, gq (s)				11.15
Eff. ped. green consumed by opp. veh. queue, gq/gp				0.259
OCCpedu				0.172
Opposing flow rate, Vo (veh/h)				1375
OCCr				0.025
Number of cross-street receiving lanes, Nrec				2
Number of turning lanes, Nturn				1
ApbT				0.985
Proportion of left turns, PLT				1.000
Proportion of left turns using protected phase, PLTA				0.000
Left-turn adjustment, fLpb				0.985
Permitted Right Turns				
Effective pedestrian green time, gp (s)	23.0		43.0	
Conflicting pedestrian volume, Vped (p/h)	200		200	
Conflicting bicycle volume, Vbic (bicycles/h)	0		0	
Vpedg	739		395	
OCCpedg	0.370		0.198	
Effective green, g (s)	21.0		41.0	
Vbicg	0		0	

OCCbicg	0.020	0.020
OCCr	0.370	0.198
Number of cross-street receiving lanes, Nrec	2	2
Number of turning lanes, Nturn	2	1
ApbT	0.630	0.882
Proportion right-turns, PRT	1.000	0.009
Proportion right-turns using protected phase, PRTA	0.000	0.000
Right turn adjustment, fRpb	1.000	0.999

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

		EBLT	WBLT	NBLT	SBLT
Cycle length, C	85.0 sec				
Adj. LT vol from Vol Adjustment Worksheet, v					13
v/c ratio from Capacity Worksheet, X					0.05
Protected phase effective green interval, g (s)					12.0
Opposing queue effective green interval, gq					11.15
Unopposed green interval, gu					28.85
Red time r=(C-g-gq-gu)					33.0
Arrival rate, qa=v/(3600(max[X,1.0]))					0.00
Protected ph. departure rate, Sp=s/3600					0.370
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)					0.07
XPerm					0.13
XProt					
Case					4
Queue at beginning of green arrow, Qa					0.00
Queue at beginning of unsaturated green, Qu					0.16
Residual queue, Qr					0.00
Uniform Delay, d1					12.1

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
L	0.0	0.00	32.0	29.1	0.00	0.0	0.0	35.2
LTR	0.0	0.00	32.0	31.7	0.00	0.0	0.0	69.8
R	0.0	0.00	32.0	30.6	0.00	0.0	0.0	60.9
Westbound								
	0.0						0.0	
	0.0						0.0	
	0.0						0.0	
Northbound								
	0.0						0.0	
TR	0.0	0.00	22.0	17.8	0.00	0.0	0.0	19.6
	0.0						0.0	
Southbound								
L	0.0	0.00		12.1	0.00	0.0	0.0	12.1
T	0.0	0.00	16.5	11.0	0.00	0.0	0.0	11.8
	0.0						0.0	

Intersection Delay 25.7 sec/veh Intersection LOS C

BACK OF QUEUE WORKSHEET

	Eastbound			Westbound			Northbound			Southbound		
LaneGroup	L	LTR	R					TR		L	T	
Init Queue	0.0	0.0	0.0					0.0		0.0	0.0	
Flow Rate	227	188	168					504		13	581	
So	1800	1300	1800					1800		1800	1800	
No.Lanes	1	2	1	0	0	0	0	3	0	1	2	0
SL	1329	787	789					1397		451	1389	
LnCapacity	328	194	195					674		276	850	
Flow Ratio	0.2	0.2	0.2					0.4		0.0	0.4	
v/c Ratio	0.69	0.97	0.86					0.75		0.05	0.68	
Grn Ratio	0.25	0.25	0.25					0.48		0.61	0.61	
I Factor		1.000						1.000			0.671	
AT or PVG	3	3	3					3		3	3	
Pltn Ratio	1.00	1.00	1.00					1.00		1.00	1.00	
PF2	1.00	1.00	1.00					1.00		1.00	1.00	
Q1	4.9	4.4	3.8					9.6		0.1	9.2	
kB	0.3	0.2	0.2					0.5		0.2	0.4	
Q2	0.7	2.1	1.2					1.5		0.0	0.9	
Q Average	5.6	6.5	5.0					11.1		0.1	10.0	
Q Spacing	25.0	25.0	25.0					25.0		25.0	25.0	
Q Storage	95	0	100					0		50	0	
Q S Ratio	1.5		1.2							0.1		
70th Percentile Output:												
fB%	1.2	1.2	1.2					1.2		1.2	1.2	
BOQ	6.6	7.7	5.9					13.0		0.2	11.8	
QSRatio	1.7		1.5							0.1		
85th Percentile Output:												
fB%	1.5	1.5	1.6					1.5		1.6	1.5	
BOQ	8.7	10.0	7.7					16.7		0.2	15.2	
QSRatio	2.3		1.9							0.1		
90th Percentile Output:												
fB%	1.7	1.7	1.7					1.6		1.8	1.6	
BOQ	9.5	10.9	8.5					18.1		0.2	16.4	
QSRatio	2.5		2.1							0.1		
95th Percentile Output:												
fB%	1.9	1.9	2.0					1.8		2.1	1.8	
BOQ	10.9	12.4	9.7					20.2		0.3	18.5	
QSRatio	2.9		2.4							0.1		
98th Percentile Output:												
fB%	2.4	2.3	2.4					2.1		2.7	2.2	
BOQ	13.1	14.9	11.8					23.6		0.4	21.6	
QSRatio	3.5		3.0							0.2		

ERROR MESSAGES

No errors to report.