DEVELOPING A CORRIDOR SYSTEM MANAGEMENT PLAN FOR I-215, CA

Dhruva Lahon

ABSTRACT

The I-215 Corridor System Management Plan for Caltrans is aimed at improving mobility on I-215 in the Riverside and San Bernardino Counties in California. We assessed corridor-wide performance of 44 miles of I-215 with several interacting bottlenecks, 4 major system interchanges, 35 service interchanges, HOV lanes and multiple ramp meter locations. As part of the data needs assessment, we used an extensive data collection plan. We conducted turning movement counts at all the signalized intersections and strategically-located freeway mainlane counts. We visited every study intersection, performed field reconnaissance, noted lane utilizations, spillbacks, and bottlenecks for each peak period. We also identified the bottlenecks causes such as lane drops, merging freeways, weaving, hilly terrain, land use, geometric design, etc. We collected travel time runs using the floating car technique and GPS systems. We also developed existing conditions models with adaptive ramp metering using the VISSIM® traffic simulation program. We calibrated our model using counts and travel time runs to reflect existing traffic conditions. We validated our model using queue lengths for four hours each of AM and PM peak periods. Based on our assessment of density, speed, travel time, delay, and level of service, we recommended corridor management strategies to improve mobility along I-215. We will develop and analyze future models and evaluate the impact of managed lanes, auxiliary lanes, ramps, multimodal considerations and other improvements. This helped us prioritize the corridor needs and develop a phased implementation of improvements.

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Introduction

The I-215 Freeway has been the focus of major development growth in California for many years. I-215 is one of western Riverside and San Bernardino County's primary north-south routes with a substantial amount of future development planned along it.

A Corridor System Management Plan (CSMP) is a comprehensive, integrated management program for increasing transportation options, reducing congestion, and improving travel times along a corridor. A CSMP includes all travel modes in a defined corridor - highways and freeways, parallel and connecting roadways, public transit (bus, bus rapid transit, light rail, intercity rail) and bikeways, along with intelligent transportation technologies, such as ramp metering, coordinated traffic signals, managed lanes, carpool/vanpool programs, changeable message signs, incident management, and transit strategies. A CSMP incorporates both capital and operational improvements. This paper describes the performance of the I-215 travel corridor, identifies bottleneck locations, and recommends system management strategies to address these bottlenecks within the context of a long-range planning vision.

Project Overview

The project limits for the I-215 CSMP were between the Murrieta/Hot Springs Road interchange on the south end and Auto Plaza interchange on the north end, as shown in Figure 1. One of the major tasks in this study was the development of microsimulation models using VISSIM. The objective of this task was to develop calibrated existing conditions models of over 44 miles of the I-215 corridor for four hours each of the AM and PM peak periods. These would be the base models for horizon year modeling and help investigate the effects of improvement alternatives.

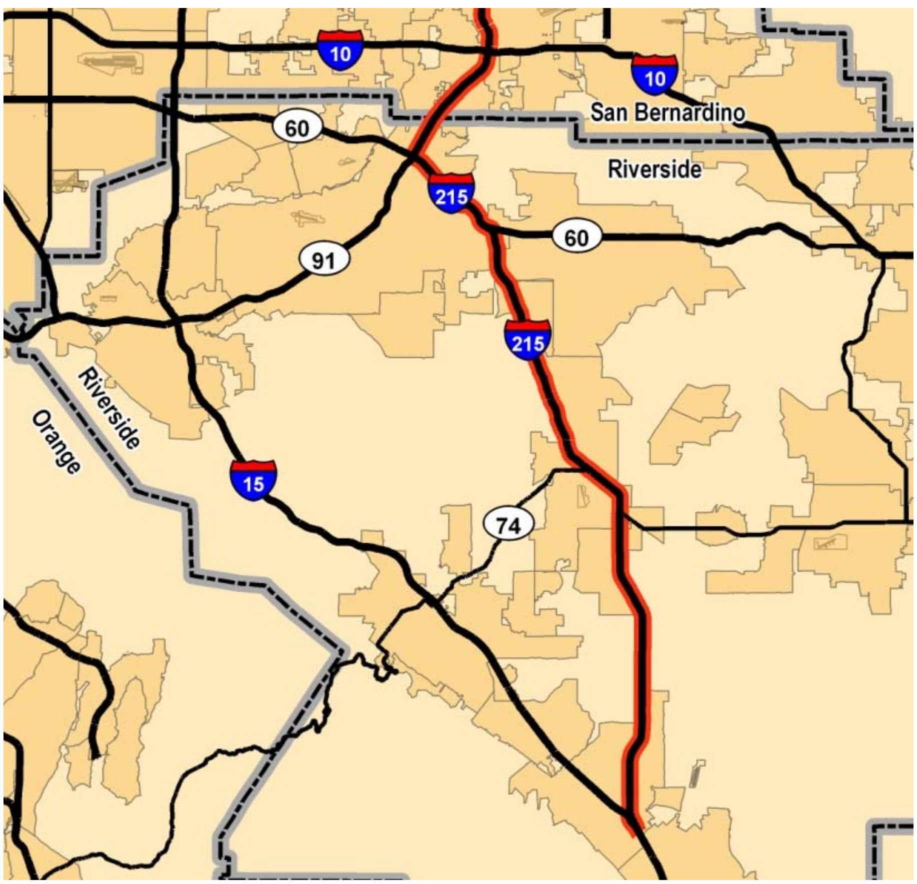

Figure 1: I-215 Study Corridor Extent

Data Collection

AM and PM peak period turning movements were counted at signalized intersections and freeway mainlane counts were strategically-located within the project limits. Counts at the SR 60/SR 91/I-215 interchange were obtained from Caltrans. HOV lane counts were obtained from Caltrans' Performance Assessment System (PeMS). Counts were then balanced to account for traffic variation. Study intersections were visited and field reconnaissance was performed using field inventory sheets. AM and PM peak period travel time runs were conducted using the floating car technique as part of the data collection plan. Existing signal timing data was obtained from Caltrans and the concerned Cities. Existing ramp meter timing sheets were obtained from Caltrans. The entire study segment was divided into four segments, with more than a mile or one or two interchanges overlap between each segment. This allowed increased efficiency and manageability. A major parallel arterial corridor (Ironwood Avenue/Box Springs Road between the I-215/Box Springs interchange and Day Street) was added to model alternate routes during the peak periods.

Network Development

VISSIM models were developed for the baseline year for AM and PM peak periods using VISSIM 5.10. The models were developed for four hours each of AM and PM peak periods:

1. AM Peak Period: 6:00 AM to 10:00 AM
2. PM Peak Period: 3:00 PM to 7:00 PM

The models covered the following extents:

1. Segment 1: I-215 from Murrieta/Hot Springs Road to D Street
2. Segment 2: I-215 from D Street to SR 60/I-215 interchange; including the SR 60 truck lane merge at Day Street
3. Segment 3: SR 60/I-215 combination segment (from SR 60/I-215 interchange to SR 60/SR 91/I-215 interchange)
4. Segment 4: I-215 from SR 60/SR 91/I-215 interchange to Auto Center Drive
5. SR 91 between SR 60/SR 91/I-215 interchange and University Avenue to model weaving (Part of Segments 3 and 4)
6. Box Springs Road/Ironwood Avenue between the I-215/Box Springs interchange and Day Street to analyze alternate routes (Part of Segments 2 and 3)

Base models for segments 1, 2, and 4 were obtained from Caltrans. These models were updated with respect to various inputs (volumes, routing, signal timing, lane geometry etc), then fine-tuned, and calibrated. Segment 3 was developed from scratch. Freeway links, entrance/exit ramps, lane drops, merge/diverge locations, auxiliary lanes, and "foot-of-ramp" intersections were coded. Volumes were input at network entry points after balancing counts. Freeway mainlanes, ramps, and intersection vehicle routings were defined. Travel speeds were specified and reduced speed areas were defined for right-turning and left-turning vehicles. Conflict areas were defined by specifying the movement that yields to another conflicting movement. Right-turns on red were coded, where applicable. Existing HOV lanes were coded in Segment 3. Truck percentages were based on 2007 Annual Average Daily Truck Traffic on the California State Highway System. For roadways that did not have any data, a default value of 2% heavy vehicles was used. Truck bypass lanes were modeled from eastbound SR60/I-215 to eastbound SR 60 and southbound I-215. Signal heads and detectors were coded to simulate actuated traffic signals. Existing operational ramp meters were modeled as adaptive ramp meters at the following locations:

1. Box Springs
2. Central/Watkins
3. Martin Luther King
4. University
5. Blaine
6. Columbia

Adaptive ramp metering plugin developed for Caltrans CSMP projects was used to model hourly variation of the ramp metering operation. Mainlane detectors, on-ramp detectors, demand detectors, and queue detectors were placed appropriately to model metering rates based on the variation of AM and PM peak period traffic.

Each simulation begins without any vehicles in the model network so some period of time is required to seed the network prior to collecting operational data. It is recommended in the 2004 report titled Traffic Analysis Toolbox volume III: Guidelines for Applying Traffic Microsimulation Modeling Software by the Federal Highway Administration (FHWA), that the seeding period be as long as necessary for the model to reach equilibrium. Equilibrium is reached when the number of vehicles entering the network is approximately equal to vehicles exiting the network. The number of vehicles entering and exiting the network was tracked during simulations. The network segments reached their closest level of equilibrium within the first fifteen minutes of the model run. Therefore, an initialization period of fifteen was chosen for all models.

Calibration and Validation

The baseline year models were calibrated using counts and travel time runs. Volume calibration was based on comparison of the field peak hour volumes and the peak hour volume simulated. Travel time calibration for the baseline year models was performed by comparing model travel time data with actual travel time data. Calibration is an important process in the model development because the effectiveness of the baseline and horizon year comparisons depends on how closely each model represents actual conditions. Baseline year models were run, driver behavior fine-tuned, and calibrated till these acceptability targets were met.

Driver behaviors were consolidated in the models by using the following:

a. Urban (motorized) for arterials
b. Freeway free lane selection for basic freeway segments
c. Freeway weave for weaving segments, with non-default values

Tables 1 and 2 below present driver behavior changes that were made along weaving segments in VISSIM as part of the calibration process. The primary objective was to create more gaps in the mainlane traffic while making the on-ramp vehicle more aggressive. The non-default, extreme values were used, as need, along weaving segments.

Table 1: Lane Change General Behavior: Free Lane Selection for I-215 Corridor				
Necessary Lane Change (route)	Own	Unit	Trailing Vehicle	Unit
Maximum deceleration:	-13 to -12	ft/s^2	-13 to -10	ft/s^2
-1 ft/s^2 per distance:	50 to 200	ft	50 to 200	ft
Accepted deceleration:	-2.5 to -4	ft/s^2	-0.8 to -3.3	ft/s^2
Waiting time before diffusion:			30 to 60	s
Min. headway (front/rear):			1.5 to 2	ft
Safety distance reduction factor:			0.1 to 0.8, lower values in merge areas	
Maximum deceleration for cooperative braking:			-8 to -10	ft/s^2

Table 2. Wiedemann 99 Car Following Parameters for I-215 Corridor			
Parameter		Range	Unit
CC1	Headway Time	0.9 to 1.2	s
CC2	'Following' Variation	13 o 25	ft

In order to verify if model behavior and output statistics represent actual traffic system operations, AM and PM peak hour model speeds were compared with field-recorded speeds. Each model was also examined as part of the error checking process. Simulations were visually observed to identify areas within the model that may contain coding errors. These visual checks helped confirm the bottleneck locations, speed-flow relationships, and traffic operations in the models. Once the visual audits and calibration processes were completed and each model was revised, the models were set-up to obtain final results. Developing such calibrated and validated models is imperative prior to obtaining results from them or building horizon year models.

Output and Results

Each model relies on random number seeds to generate the operating conditions of each run. It is necessary to run the model multiple times with different random number seeds to minimize variations in the operational data. The baseline year output data was obtained from the average values of five (5) simulation runs with different seed values for each analysis scenario. The models were set-up to obtain output data (volume, speed, and travel time) for each segment, in both directions.

The following peak hours were identified within each peak period for each segment:

Peak Hour & Direction	Segment 1	Segment 2	Segment 3	Segment 4
AM Northbound	7:00 AM – 8:00 AM	7:00 AM – 8:00 AM	7:00 AM – 8:00 AM	7:00 AM – 8:00 AM
AM Southbound	7:00 AM – 8:00 AM	7:00 AM – 8:00 AM	7:00 AM – 8:00 AM	7:00 AM – 8:00 AM
PM Northbound	5:00 PM – 6:00 PM	5:00 PM – 6:00 PM	4:00 PM – 5:00 PM	4:00 PM – 5:00 PM
PM Southbound	5:00 PM – 6:00 PM	5:00 PM – 6:00 PM	4:00 PM – 5:00 PM	4:00 PM – 5:00 PM

Output volumes were collected north and south of every interchange. Output speeds were collected in five minute increments for each peak hour at every interchange to study the congestion build-up and dissipation. Output travel times were collected between interchanges for the peak hour. The output data was processed, formatted, analyzed, and reported in the form of tables, charts and 3D graphs, for both the AM and PM peak hours.

Appendices A through D show a few representative comparisons between the field and model output values. Appendix A presents travel time comparisons between the field and model output values. The VISSIM output travel times closely match the field travel times. Appendix B shows the three-dimensional speed contours every five minute of the peak hour. The color coded speed contours show the queue build up and dissipation and also the bottleneck locations. Appendix C presents speed trendlines between the field and model output values. They show that the speed drops and increases in the field and the models are at the same locations. Appendix D shows GEH calculations for peak hour volumes. The calibration acceptability target of GEH less than 5 for more than 85% of the locations is met.

Bottleneck Locations and Recommended Improvements

Bottlenecks along the I-215 corridor between Murrieta/Hot Springs Road and Auto Plaza Drive were identified by field observations, State Highway Congestion Monitoring Program (HICOMP) reports, and were confirmed by observing the VISSIM existing conditions models and speed profiles. The observed bottleneck locations and the corresponding potential improvements are discussed below.

- Bottleneck # 1: AM and PM Peak Northbound bottleneck at I-215/SR-60 interchange
  This northbound bottleneck is caused by the large volume of traffic that diverges to northbound I-215 and eastbound SR-60 as well as merging and weaving traffic from Eucalyptus Avenue. The bottleneck occurs in both AM and PM peak periods, but is more widespread during AM peak periods when queues could extend all the way to Alessandro Boulevard.

A fourth travel lane, which connects the northbound on-ramp of Eucalyptus Avenue to eastbound SR-60 mainline needs to be constructed for this weaving/diverging section. This auxiliary lane would reduce the friction caused by merging traffic from Eucalyptus Avenue and provide more capacity to eastbound SR-60 traffic.

- Bottleneck # 2: AM and PM Peak Northbound bottleneck between I-215/SR-60 northbound connector and Columbia Avenue
  A northbound bottleneck exists on I-215 and SR-91 as traffic from northbound I-215/SR-60 connector and northbound SR-91 forms a weaving section before Columbia Avenue. The northbound on-ramp merging traffic from Columbia Avenue also contributes to this bottleneck even when ramp metering is activated. This bottleneck occurs in both AM and PM peak periods and is worse during the PM peak period. The northbound queues could extend to 3rd Street on SR-91.

  The recommended improvement would be to add a northbound lane along I-215 between the I-215/SR-60 northbound connector and Center Street or provide braided ramps between the Columbia Avenue off-ramp and the northbound direct connector from I-215/SR-60.

- Bottleneck # 3: PM Peak Southbound bottleneck between SR-91 and University Avenue on I-215/SR-60

  This southbound bottleneck between SR-91 and University Avenue on I-215/SR-60 is caused by the large volume of weaving traffic. The short weaving section between the southbound I-215/SR-91 connector and the southbound off-ramp at Blaine Street has a lot of turbulence. This is worsened by the lane drop along I-215/SR-60 mainlane near Blaine Street. This bottleneck occurs in the PM peak period. The mainlane speeds pick up considerably after University Avenue.

  One of the recommended improvements is to eliminate the lane drop at Blaine Street and extend the additional lane to connect to the off-ramp at University Avenue. The weaving section between University Avenue and Blaine Street would then have six lanes, providing more capacity to the weaving traffic.

- Bottleneck # 4: PM Peak Northbound bottleneck at Clinton Keith Road and Los Alamos Road
  A northbound bottleneck exists at the on-ramp merge areas of Clinton Keith Road and Los Alamos Road during the PM peak period. This bottleneck is formed due to the near-capacity volume along northbound I-215 mainlanes at Clinton Keith Road and Los Alamos Road and the large unmetered on-ramp volumes.

  Potential improvements to address this bottleneck include installing ramp meters at the northbound on-ramps to meter the on-ramp volumes during the PM peak period and lengthening the merge areas.

- Bottleneck # 5: PM Peak Northbound bottleneck north of I-10
  This northbound bottleneck forms north of the I-215/I-10 interchange because of weaving traffic from the eastbound I-10/northbound I-215 direct connector and the Auto Plaza Drive off-ramp. The platoon of merging vehicles interrupts the mainlane flow and causes noticeable speed drops.

  An improvement would be to extend the northbound auxiliary lane along I-215 beyond Auto Plaza Drive to provide additional capacity to the weaving traffic.

- Bottleneck # 6: AM and PM Peak Northbound bottleneck at Box Springs Road
  A northbound bottleneck exists near Box Springs Road where the direct connectors from northbound I-215 and westbound SR-60 merge together. This bottleneck occurs in both AM and PM peak periods. This bottleneck is formed because of the following:

i. Merging of the two direct connectors (northbound I-215 and westbound SR-60)
ii. On-ramp traffic merging from Box Springs Road
iii. HOV vehicles weaving to the inside HOV lane
iv. Exiting traffic weaving to the outside lane to take the Central Avenue off-ramp

An improvement would be to start the HOV lane along westbound I-215, south or east of Box Springs Road. This would provide a bigger window for HOV vehicles to weave to the inside HOV lane.

- Bottleneck # 7: PM Peak Southbound bottleneck between Columbia Avenue and southbound I-215/SR-60 direct connector

  A southbound bottleneck forms as traffic from southbound I-215 mainlane and on-ramp from Columbia Avenue weaves to get to either the I-215/SR-60 southbound direct connector or SR-91 southbound mainline. The shock wave effect of this bottleneck during the PM peak period sometimes extends to Barton Road.

  Potential improvements to address this bottleneck include installing ramp meters at the southbound on-ramp to meter the on-ramp volume and southbound on-ramp realignment at Columbia Avenue. The recommended improvement is to provide southbound on-ramps south of the existing on-ramp. The first southbound on-ramp would be for the traffic from Columbia Avenue heading to southbound SR-91 under the direct connector from southbound I-215 to eastbound I-215/SR-60. The second on-ramp would be for the Columbia Avenue traffic heading to eastbound I-215/SR-60 by tying to the direct connector from southbound I-215 to eastbound I-215/SR-60.

- Bottleneck # 8: PM Peak Southbound bottleneck at Washington Street
  A southbound bottleneck forms near Washington Street as I-215 southbound mainlane and I-10 eastbound/westbound direct connectors form a weaving section with the off-ramp traffic at Washington Street. Moreover, the large PM peak platoon of on-ramp merging traffic from Washington Street impedes the mainlane flow.

  An improvement would be constructing an auxiliary lane along this merging section till Barton Road to provide additional capacity.

Conclusions
The operations analysis along the I-215 corridor identified the major and minor bottleneck locations. Various system management strategies were recommended for each bottleneck location to improve mobility along the I-215 corridor. Calibrated existing traffic conditions models were also developed to further understand the corridor performance. The recommended improvements can be modeled for the evaluation and prioritization of improvements.

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Disclaimer
The contents of this paper reflect the views and findings of the author who is responsible for the opinions, findings and conclusions presented herein. The contents do not necessarily reflect the views or policies of Caltrans.

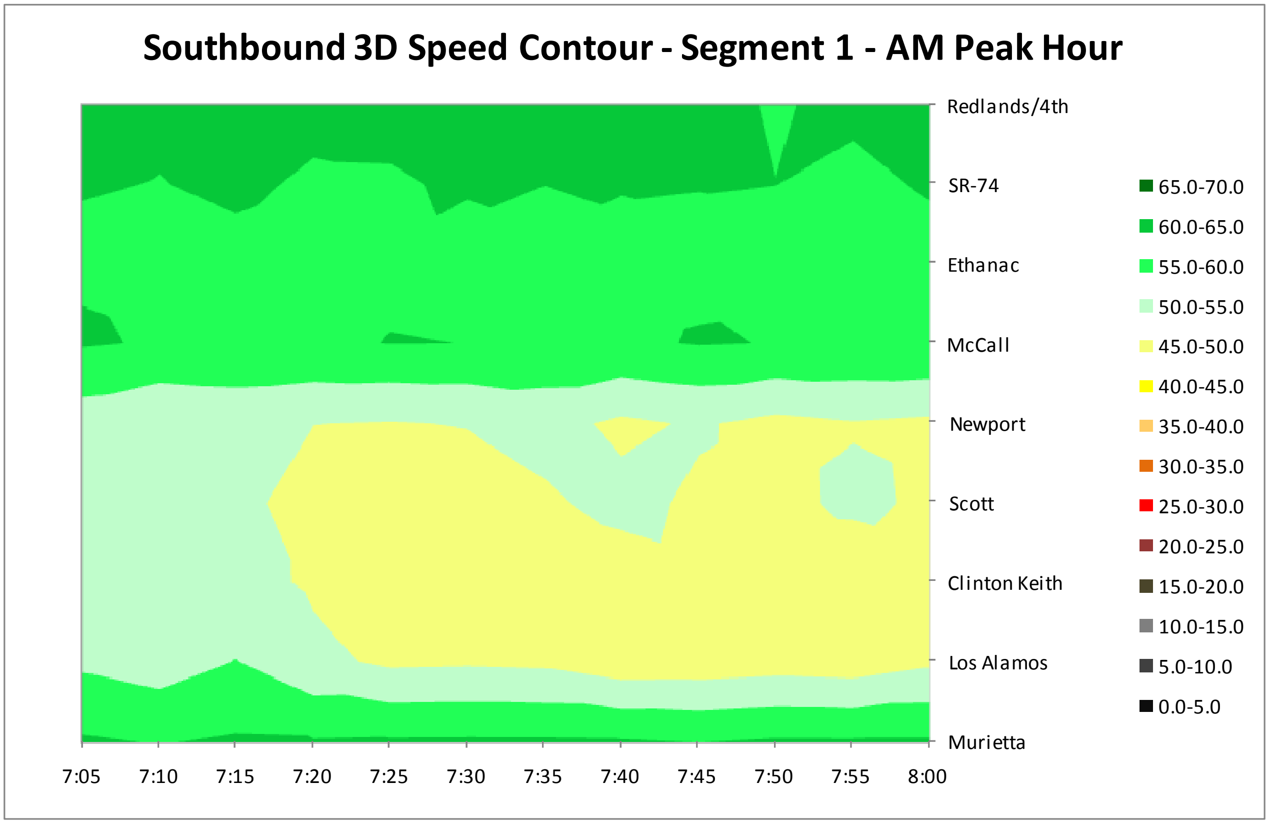
Appendix A: Travel Time Comparisons

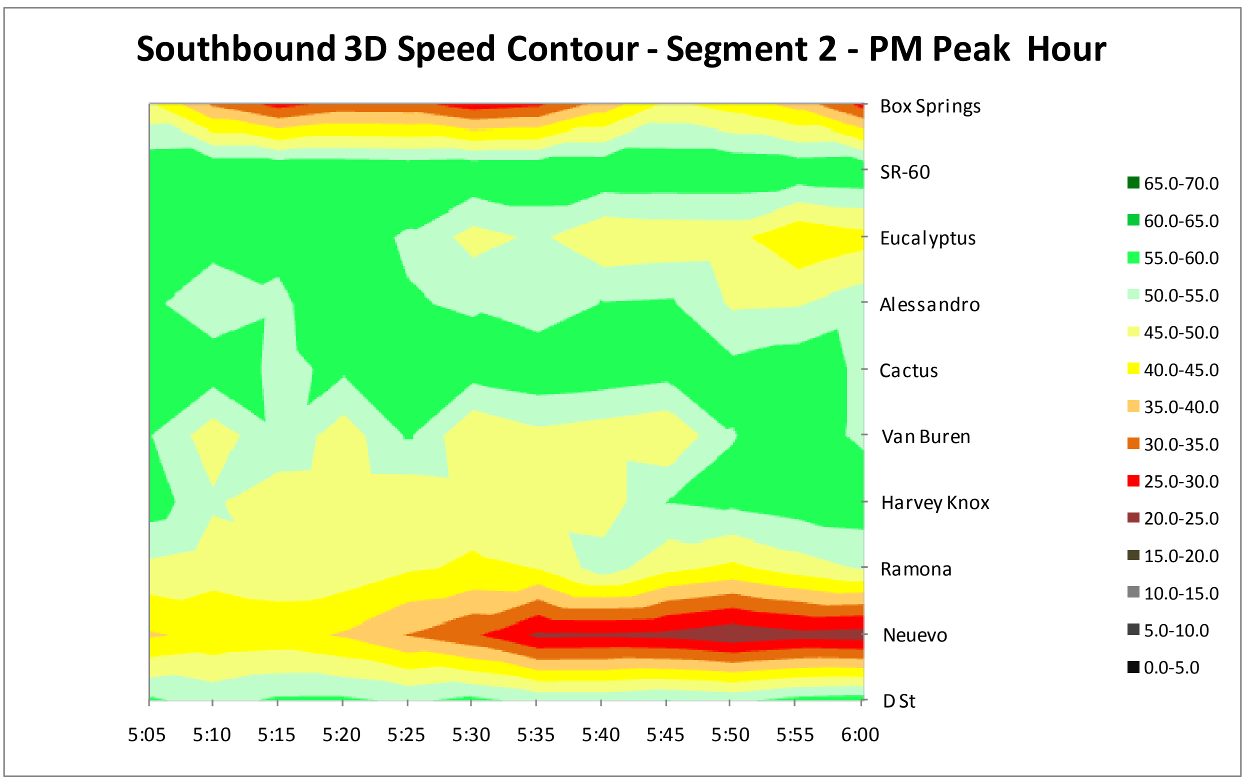
AM Peak Hour Travel Times							
Segment #	I-215 Corridor Section			Average Field Travel Time (Minutes)		Average Simulated Travel Time (Minutes)	
	Between			AM NB	AM SB	AM NB	AM SB
Segment 4	Auto Plaza Dr	AND	I-10	0.97	1.15	0.96	0.92
	I-10	AND	Washington St	1.48	2.01	1.40	2.60
	Washington St	AND	Barton Rd	1.73	5.65	1.74	4.18
	Barton Rd	AND	Iowa Ave	0.98	1.34	1.21	2.51
	Iowa Ave	AND	Center St	0.83	1.15	0.72	1.98
	Center St	AND	Columbia Ave	1.69	1.33	1.56	2.92
	Columbia Ave	AND	SR 60	3.50	0.62	4.75	0.62
				11.18	13.25	12.34	15.73
Segment 3	SR 91	AND	Blaine St	1.14	1.29	1.11	1.12
	Blaine St	AND	University Ave	0.70	0.78	0.71	0.71
	University Ave	AND	MLK Blvd	0.61	0.40	0.72	0.67
	MLK Blvd	AND	Central Ave	1.86	1.96	1.39	1.38
	Central Ave	AND	Box Springs Rd	1.84	0.98	1.94	0.91
	Box Springs Rd	AND	SR-60	2.44	0.54	3.64	0.61
				8.59	5.97	9.52	5.39
Segment 2	SR-60	AND	Eucalyptus Ave	1.06	1.11	1.96	0.95
	Eucalyptus Ave	AND	Alessandro Blvd	1.57	1.12	2.60	1.08
	Alessandro Blvd	AND	Cactus Ave	0.83	0.65	0.72	0.70
	Cactus Ave	AND	Van Buren Blvd	2.02	1.85	1.74	1.69
	Van Buren Blvd	AND	Harvey Knox	1.97	1.87	2.06	1.97
	Harvey Knox	AND	Ramona Rd	1.74	1.55	1.54	1.47
	Ramona Rd	AND	Nuevo Rd	3.15	3.00	3.46	3.23
	Nuevo Rd	AND	D St	0.77	0.74	0.86	0.63
				13.12	11.90	14.94	11.73
Segment 1	D St/Metz Rd	AND	4th St/Redlands Ave	0.97	0.99	0.95	0.93
	4th St/Redlands Ave	AND	Case Rd/SR-74	2.95	2.72	2.76	2.67
	Case Rd/SR-74	AND	Ethanac Rd	0.85	0.86	0.75	0.75
	Ethanac Rd	AND	McCall Blvd	2.01	1.93	1.86	1.85
	McCall Blvd	AND	Newport Pkwy	2.38	2.38	2.27	2.24
	Newport Pkwy	AND	Scott Rd	3.04	3.44	2.92	2.99
	Scott Rd	AND	Clinton Keith Rd	3.09	3.46	2.94	3.03
	Clinton Keith Rd	AND	Los Alamos Rd	1.91	1.91	1.80	1.95
	Los Alamos Rd	AND	Murrieta Hot Springs Rd	1.11	1.20	1.12	1.32
	Murrieta Hot Springs Rd	AND	I-15 Junct	0.87	1.44	2.15	2.25
				19.18	20.33	19.52	19.97

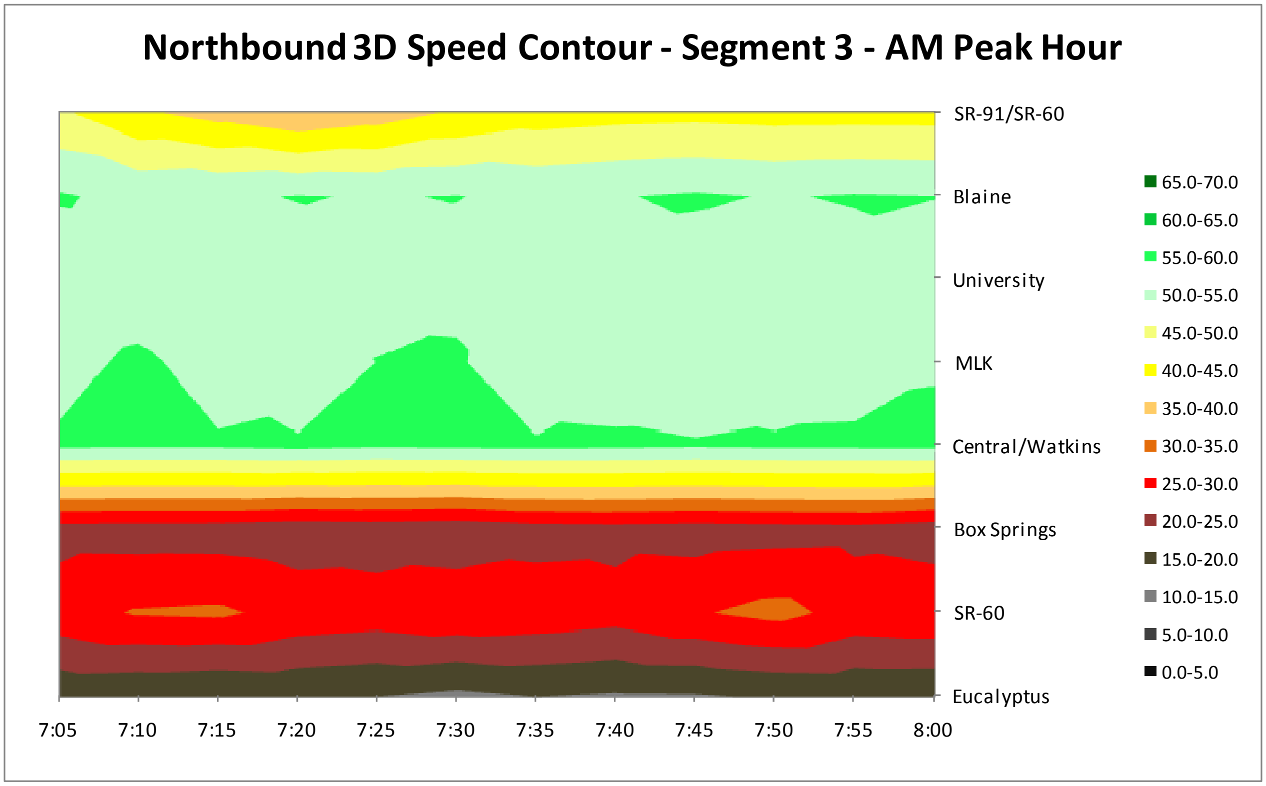
PM Peak Hour Travel Times

Segment #	I-215 Corridor Section			Average Travel Time (Minutes)		Average Simulated Travel Time (Minutes)	
	Between			PM NB	PM SB	PM NB	PM SB
Segment 4	Auto Plaza Dr	AND	I-10	1.45	1.48	2.52	2.75
	I-10	AND	Washington St	2.07	3.30	2.07	4.33
	Washington St	AND	Barton Rd	1.92	3.37	2.02	3.42
	Barton Rd	AND	Iowa Ave	1.01	2.15	0.96	2.40
	Iowa Ave	AND	Center St	0.89	1.74	0.70	2.00
	Center St	AND	Columbia Ave	1.60	2.21	1.57	2.91
	Columbia Ave	AND	SR 60	4.00	1.03	2.69	0.65
				12.95	15.29	12.53	18.47
Segment 3	SR 91	AND	Blaine St	1.28	1.85	1.14	1.77
	Blaine St	AND	University Ave	0.71	0.82	0.68	0.76
	University Ave	AND	MLK Blvd	0.54	0.42	0.66	0.71
	MLK Blvd	AND	Central Ave	1.63	1.92	1.37	1.41
	Central Ave	AND	Box Springs Rd	1.84	0.95	2.29	0.92
	Box Springs Rd	AND	SR-60	2.91	0.55	4.70	0.61
				8.90	6.51	10.84	6.18
Segment 2	SR-60	AND	Eucalyptus Ave	0.67	1.23	0.92	0.94
	Eucalyptus Ave	AND	Alessandro Blvd	1.15	1.52	1.05	1.45
	Alessandro Blvd	AND	Cactus Ave	0.68	0.86	0.68	0.74
	Cactus Ave	AND	Van Buren Blvd	1.77	2.49	1.65	1.78
	Van Buren Blvd	AND	Harvey Knox	2.00	2.51	1.88	2.13
	Harvey Knox	AND	Ramona Rd	1.68	1.68	1.41	1.85
	Ramona Rd	AND	Nuevo Rd	3.10	3.00	3.09	4.66
	Nuevo Rd	AND	D St	0.75	0.74	0.84	2.91
				11.80	14.03	11.52	16.46
Segment 1	D St/Metz Rd	AND	4th St/Redlands Ave	0.94	0.99	0.95	0.95
	4th St/Redlands Ave	AND	Case Rd/SR-74	2.99	2.72	2.76	2.81
	Case Rd/SR-74	AND	Ethanac Rd	0.86	0.86	0.75	0.76
	Ethanac Rd	AND	McCall Blvd	2.01	1.93	1.87	1.88
	McCall Blvd	AND	Newport Pkwy	2.38	2.38	2.29	2.29
	Newport Pkwy	AND	Scott Rd	3.07	3.44	2.94	2.97
	Scott Rd	AND	Clinton Keith Rd	4.03	3.46	2.96	2.98
	Clinton Keith Rd	AND	Los Alamos Rd	2.34	1.91	2.12	1.86
	Los Alamos Rd	AND	Murrieta Hot Springs Rd	1.32	1.20	1.27	1.14
	Murrieta Hot Springs Rd	AND	I-15 Junct	0.94	1.44	2.19	2.24
				20.88	20.33	20.11	19.88

Appendix B: Speed Contours






Northbound 3D Speed Contour - Segment 3 - AM Peak Hour
SR-91/SR-60
Blaine
University
MLK
Central/Watkins
Box Springs
SR-60
Eucalyptus
7:05
7:10
7:15
7:20
7:25
7:30
7:35
7:40
7:45
7:50
7:55
8:00
65.0-70.0
60.0-65.0
55.0-60.0
50.0-55.0
45.0-50.0
40.0-45.0
35.0-40.0
30.0-35.0
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10.0-15.0
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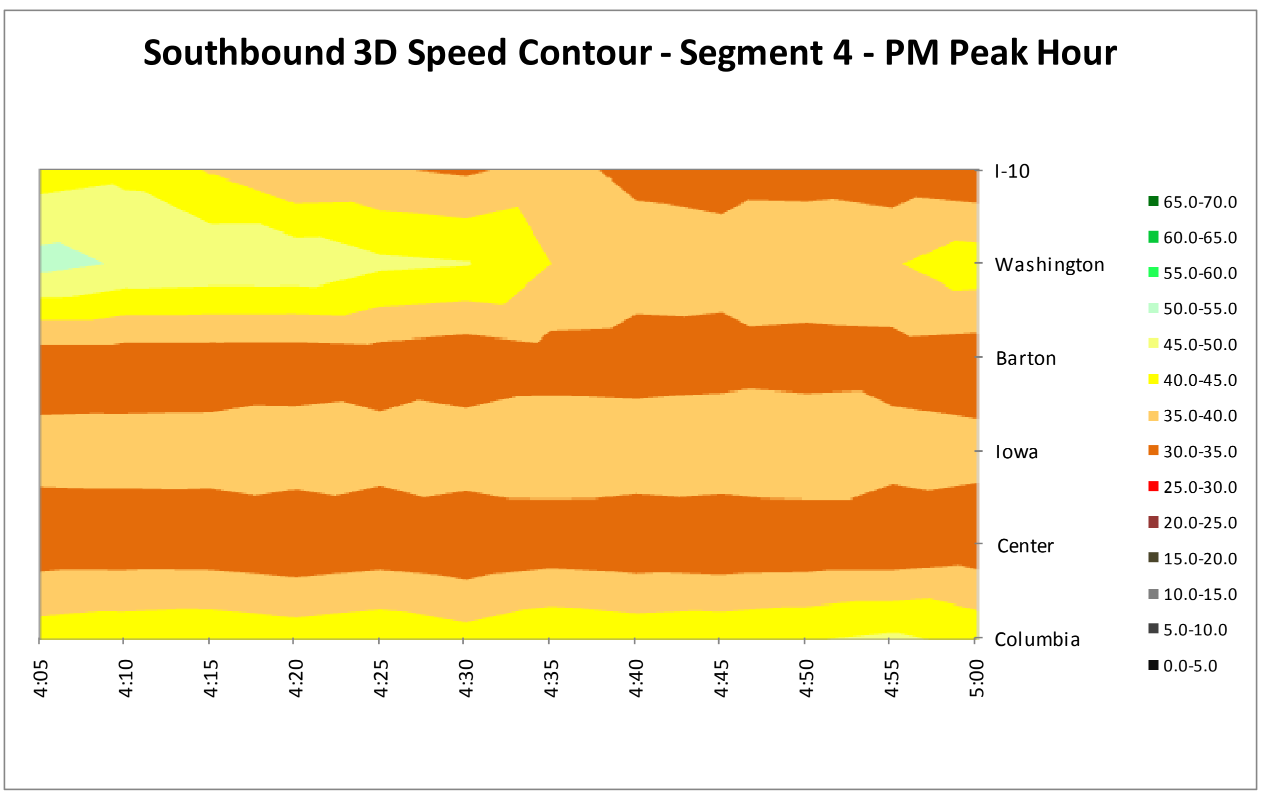
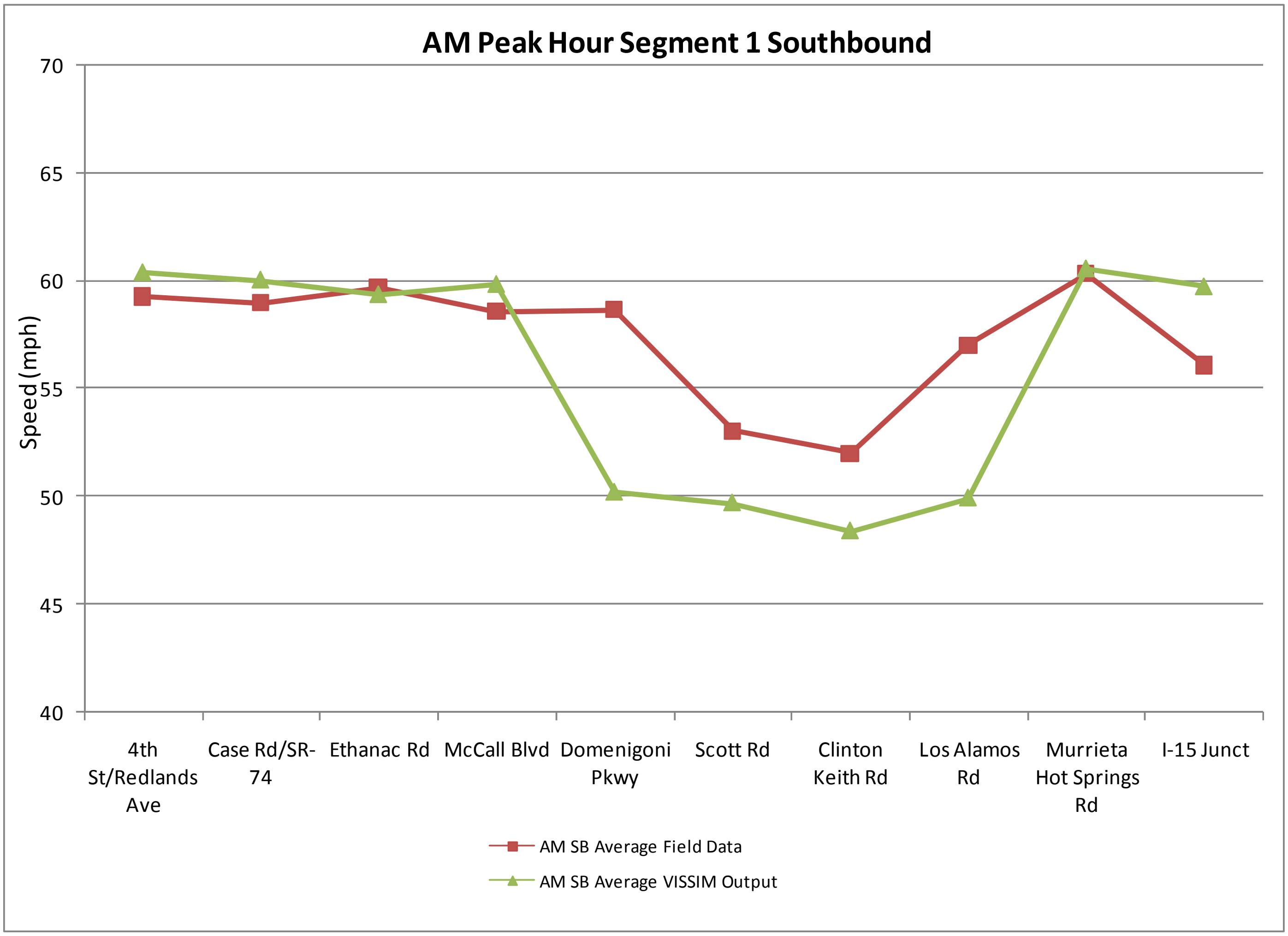
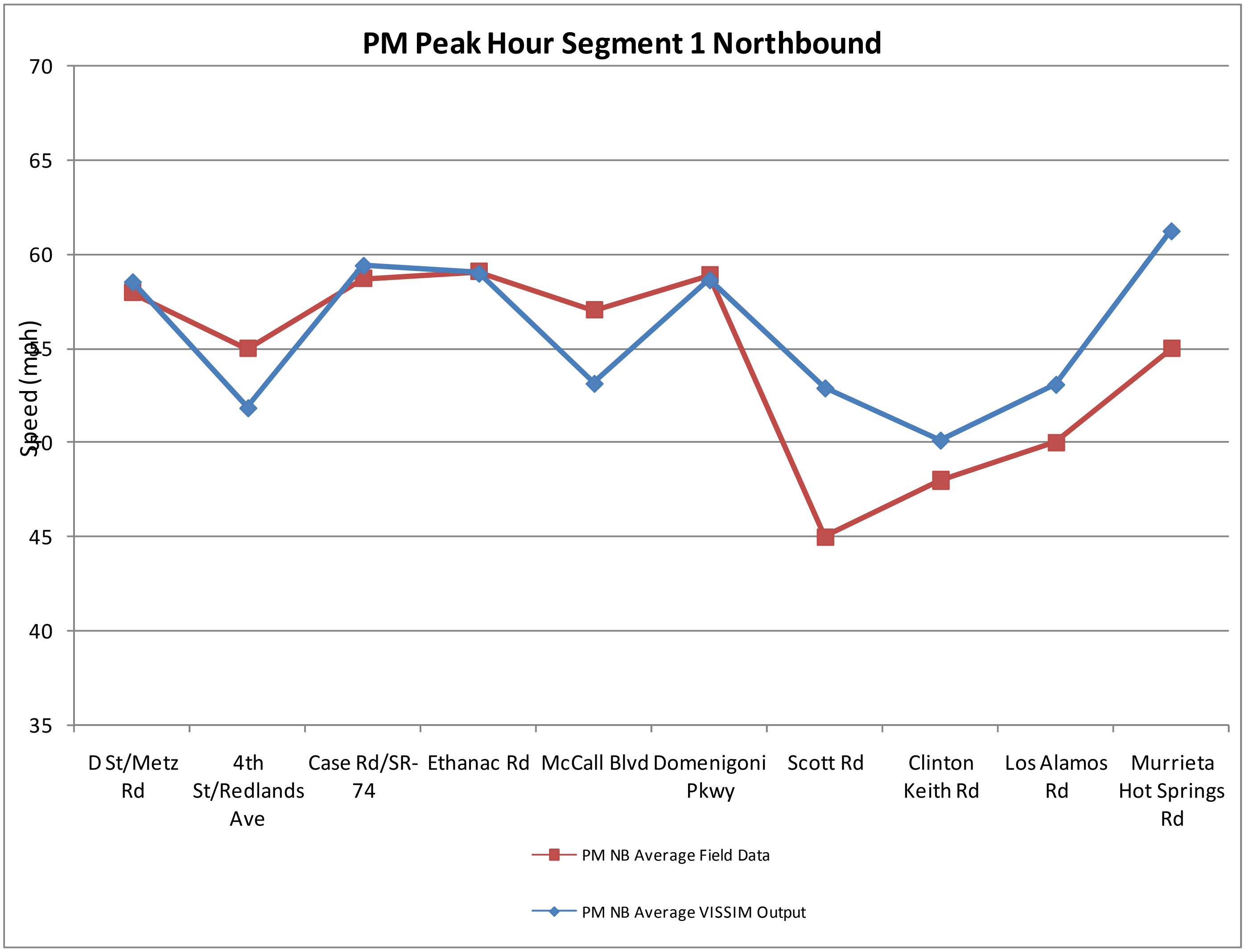
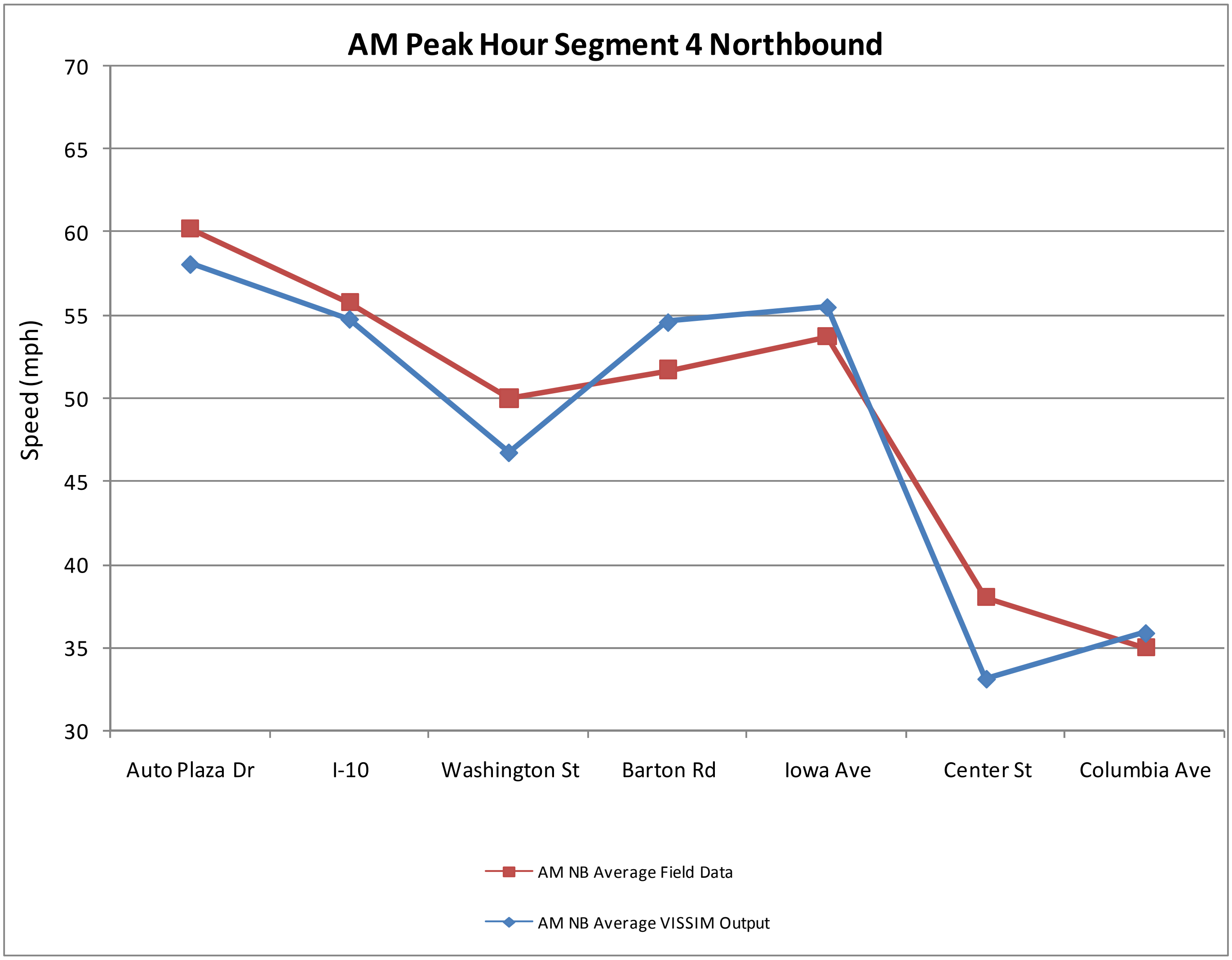

Southbound 3D Speed Contour - Segment 4 - PM Peak Hour
I-10
Washington
Barton
Iowa
Center
Columbia
4:05
4:10
4:15
4:20
4:25
4:30
4:35
4:40
4:45
4:50
4:55
5:00
65.0-70.0
60.0-65.0
55.0-60.0
50.0-55.0
45.0-50.0
40.0-45.0
35.0-40.0
30.0-35.0
25.0-30.0
20.0-25.0
15.0-20.0
10.0-15.0
5.0-10.0
0.0-5.0

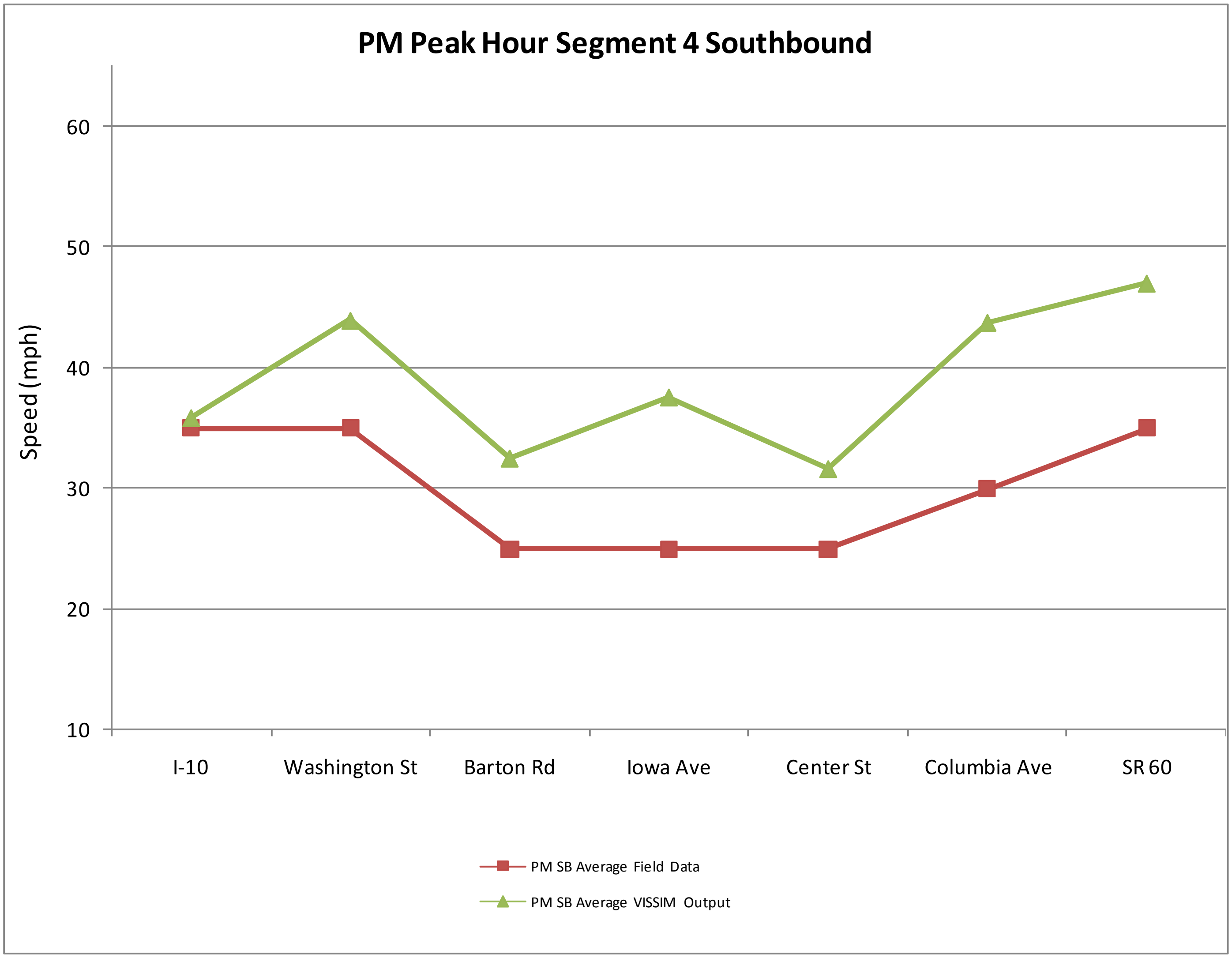
Appendix C: Speed Trendline Comparisons




PM Peak Hour Segment 1 Northbound
70
65
60
55
50
45
40
35
Speed (mph)
D St/Metz Rd
4th St/Redlands Ave
Case Rd/SR-74
Ethanac Rd
McCall Blvd
Domenigoni Pkwy
Scott Rd
Clinton Keith Rd
Los Alamos Rd
Murrieta Hot Springs Rd
PM NB Average Field Data
PM NB Average VISSIM Output



AM Peak Hour Segment 4 Northbound
Speed (mph)
70
65
60
55
50
45
40
35
30
Auto Plaza Dr
I-10
Washington St
Barton Rd
Iowa Ave
Center St
Columbia Ave
AM NB Average Field Data
AM NB Average VISSIM Output



PM Peak Hour Segment 4 Southbound
Speed (mph)
60
50
40
30
20
10
I-10
Washington St
Barton Rd
Iowa Ave
Center St
Columbia Ave
SR 60
PM SB Average Field Data
PM SB Average VISSIM Output

Appendix D: GEH Calculations

System Performance Results - Volume Comparison for AM Peak Hour Segment 2						
#	I-215 Location	Field Peak Hour Volume	Simulated Peak Hour Volume	GEH	Absolute % Difference	FHWA Acceptance Targets
1	NB, north of D St	3945	3945	0.0	0.0%	15% or less
2	SB, south of D St	2240	1902	7.4	-17.8%	15% or less
3	NB, south of Nuevo	3439	3441	0.0	0.0%	15% or less
4	NB, north of Nuevo	4129	4140	0.2	0.3%	15% or less
5	SB, north of Nuevo	2109	1916	4.3	-10.1%	15% or less
6	SB, south of Nuevo	2593	2232	7.4	-16.2%	15% or less
7	NB, south of Ramona	3372	3384	0.2	0.4%	15% or less
8	NB, north of Ramona	4571	4538	0.5	-0.7%	15% or less
9	SB, north of Ramona	2178	1867	6.9	-16.7%	15% or less
10	SB, south of Ramona	2568	2255	6.4	-13.9%	15% or less
11	NB, south of Harvey Knox	4518	4489	0.4	-0.6%	15% or less
12	NB, north of Harvey Knox	4775	4731	0.6	-0.9%	15% or less
13	SB, north of Harvey Knox	2487	2306	3.7	-7.8%	15% or less
14	SB, south of Harvey Knox	2510	2333	3.6	-7.6%	15% or less
15	NB, south of Van Buren	3882	3818	1.0	-1.7%	15% or less
16	NB, north of Van Buren	4532	4396	2.0	-3.1%	15% or less
17	SB, north of Van Buren	2564	2210	7.2	-16.0%	15% or less
18	SB, south of Van Buren	2728	2537	3.7	-7.5%	15% or less
19	NB, south of Cactus	4032	3916	1.8	-3.0%	15% or less
20	NB, north of Cactus	4491	4163	5.0	-7.9%	15% or less
21	SB, north of Cactus	2578	2367	4.2	-8.9%	15% or less
22	SB, south of Cactus	2827	2612	4.1	-8.2%	15% or less
23	NB, south of Alessandro	3747	3527	3.6	-6.2%	15% or less
24	NB, north of Alessandro	4290	4073	3.4	-5.3%	15% or less
25	SB, north of Alessandro	2305	2109	4.2	-9.3%	15% or less
26	SB, south of Alessandro	2938	2691	4.7	-9.2%	15% or less
27	NB, south of Eucalyptus	4047	3801	3.9	-6.5%	15% or less
28	NB, north of Eucalyptus	4741	4487	3.7	-5.7%	15% or less
29	SB, north of Eucalyptus	2526	2203	6.6	-14.7%	15% or less
30	SB, south of Eucalyptus	2747	2514	4.5	-9.3%	15% or less
31	NB, south of SR 60	3496	3751	4.2	6.8%	15% or less
32	SB, west of SR 60	1532	1437	2.5	-6.6%	15% or less
33	SR-60 EB, east of 215	3352	3090	4.6	-8.5%	15% or less
34	SR-60 WB, east of 215	3197	3311	2.0	3.4%	15% or less
35	SR-60 EB, west of 215	2269	2155	2.4	-5.3%	15% or less
36	SB, South of SR 60	3006	2762	4.5	-8.8%	15% or less
37	NB, south of Box Springs (before merge with SR-60)	3197	3261	1.1	2.0%	15% or less
38	NB, north of Box Springs (after merge with SR-60 before on ramp)	6693	7015	3.9	4.6%	15% or less
39	SB, north of Box Springs	3801	3590	3.5	-5.9%	15% or less
40	SR-60 EB, west of Days	3090	2865	4.1	-7.9%	15% or less
41	SR-60 WB, west of Days	4176	4244	1.0	1.6%	15% or less

System Performance Results - Volume Comparison for PM Peak Hour Segment 2

#	I-215 Location	Field Peak Hour Volume	Simulated Peak Hour Volume	GEH	Absolute % Difference	FHWA Acceptance Targets
1	NB, north of D St	3838	3797	0.7	-1.1%	15% or less
2	SB, south of D St	4043	3767	4.4	-7.3%	15% or less
3	NB, south of Nuevo	3314	3283	0.5	-0.9%	15% or less
4	NB, north of Nuevo	3705	3662	0.7	-1.2%	15% or less
5	SB, north of Nuevo	3759	3583	2.9	-4.9%	15% or less
6	SB, south of Nuevo	4092	3907	2.9	-4.7%	15% or less
7	NB, south of Ramona	3181	3145	0.6	-1.1%	15% or less
8	NB, north of Ramona	3857	3808	0.8	-1.3%	15% or less
9	SB, north of Ramona	4156	3943	3.3	-5.4%	15% or less
10	SB, south of Ramona	4463	4252	3.2	-5.0%	15% or less
11	NB, south of Harvey Knox	3841	3788	0.9	-1.4%	15% or less
12	NB, north of Harvey Knox	4053	4010	0.7	-1.1%	15% or less
13	SB, north of Harvey Knox	5004	4829	2.5	-3.6%	15% or less
14	SB, south of Harvey Knox	5031	4830	2.9	-4.2%	15% or less
15	NB, south of Van Buren	3567	3534	0.6	-0.9%	15% or less
16	NB, north of Van Buren	4144	4230	1.3	2.0%	15% or less
17	SB, north of Van Buren	4964	4591	5.4	-8.1%	15% or less
18	SB, south of Van Buren	5414	5229	2.5	-3.5%	15% or less
19	NB, south of Cactus	3733	3812	1.3	2.1%	15% or less
20	NB, north of Cactus	4073	4203	2.0	3.1%	15% or less
21	SB, north of Cactus	5085	4782	4.3	-6.3%	15% or less
22	SB, south of Cactus	5526	5134	5.4	-7.6%	15% or less
23	NB, south of Alessandro	3486	3593	1.8	3.0%	15% or less
24	NB, north of Alessandro	4118	4231	1.7	2.7%	15% or less
25	SB, north of Alessandro	5033	4741	4.2	-6.2%	15% or less
26	SB, south of Alessandro	5744	5429	4.2	-5.8%	15% or less
27	NB, south of Eucalyptus	3465	3568	1.7	2.9%	15% or less
28	NB, north of Eucalyptus	3792	3881	1.4	2.3%	15% or less
29	SB, north of Eucalyptus	5122	4890	3.3	-4.7%	15% or less
30	SB, south of Eucalyptus	5637	5337	4.0	-5.6%	15% or less
31	NB, south of SR 60	3017	2993	0.4	-0.8%	15% or less
32	SB, west of SR 60	3090	3359	4.7	8.0%	15% or less
33	SR-60 EB, east of 215	4267	4268	0.0	0.0%	15% or less
34	SR-60 WB, east of 215	3115	3385	4.7	8.0%	15% or less
35	SR-60 EB, west of 215	3283	3212	1.2	-2.2%	15% or less
36	SB, South of SR 60	5544	5477	0.9	-1.2%	15% or less
37	NB, south of Box Springs (before merge with SR-60)	3050	3323	4.8	8.2%	15% or less
38	NB, north of Box Springs (after merge with SR-60 before on ramp)	6067	6317	3.2	4.0%	15% or less
39	SB, north of Box Springs	6163	6580	5.2	6.3%	15% or less
40	SR-60 EB, west of Days	3579	3664	1.4	2.3%	15% or less
41	SR-60 WB, west of Days	4399	4779	5.6	8.0%	15% or less