MARICOPA ASSOCIATION of GOVERNMENTS

Measuring Recurring and Non-Recurring Congestion

NATMEC Conference

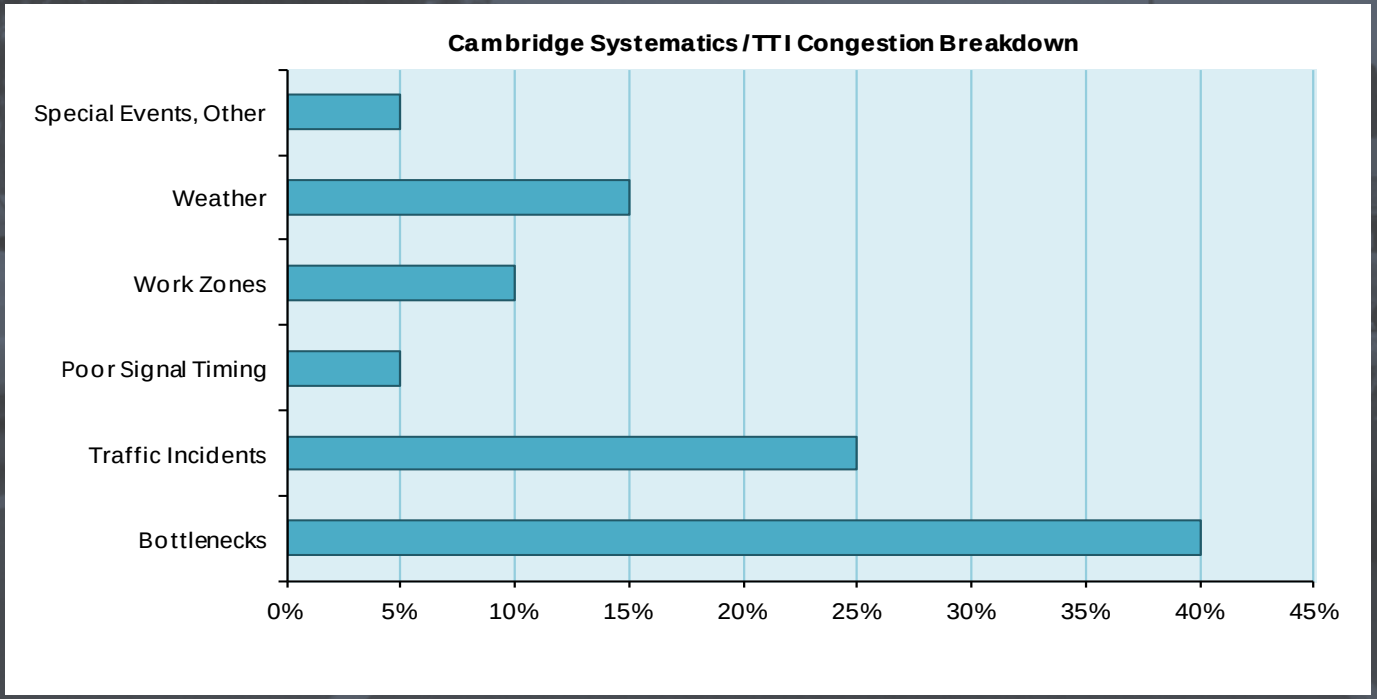
June 5, 2012

Presented by:

Jody Short

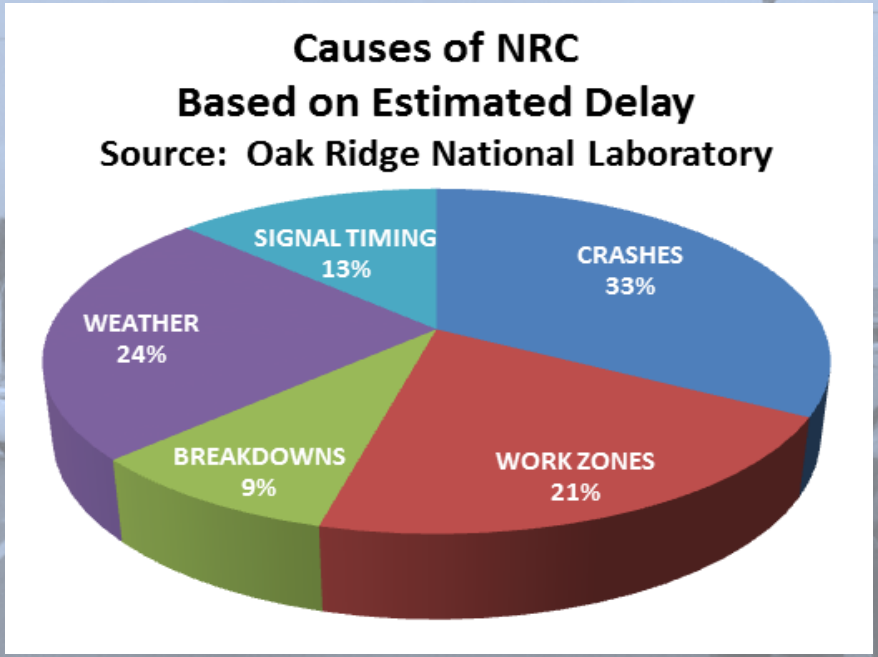
NON-RECURRING CONGESTION

Responsible for 15%-70% of total delay



CAUSES OF NON-RECURRING CONGESTION

- Incidents
  - Crashes
  - Disabled vehicles
  - Roadway debris
  - Rubbernecking
- Work zones
- Weather
- Signal timing
- Special events



STUDY OBJECTIVES

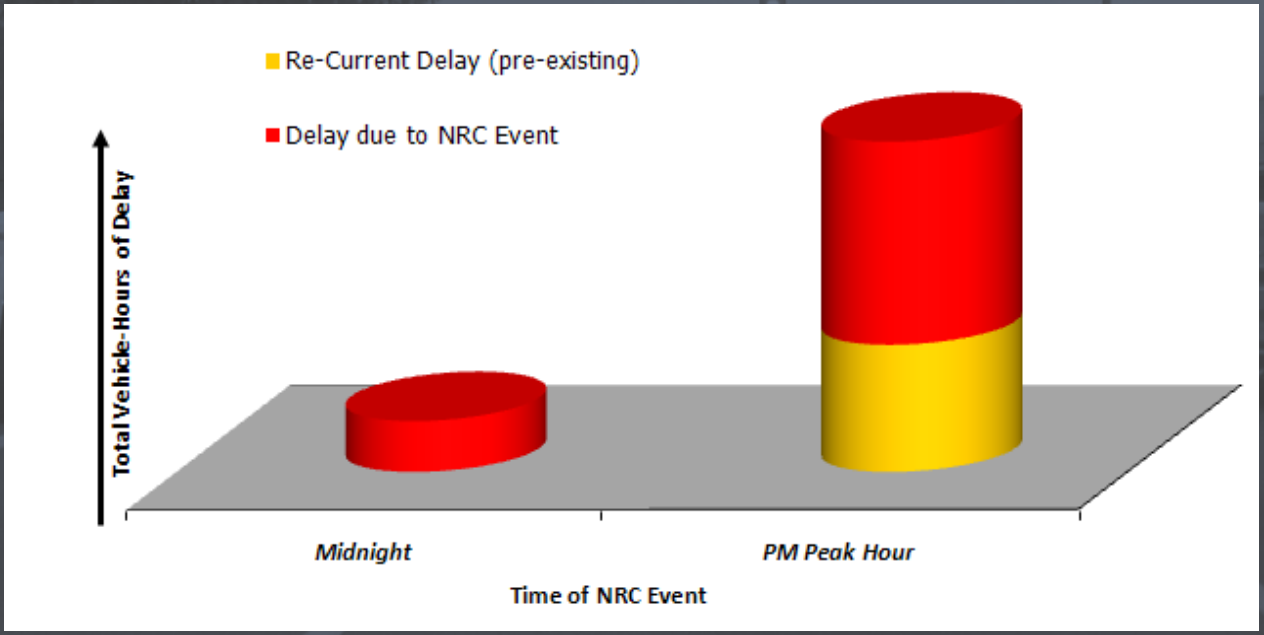
- Understand and Quantify NRC Impacts on Freeways and Arterial Streets in the Phoenix Metropolitan Area
- Identify Effective Countermeasures that will Help Regain Lost Roadway Capacity and Postpone Costly New Construction

BACKGROUND

- MAG Region has not Quantified NRC Before
- Study Will Quantify NRC on both Freeways and Arterials for an Entire Calendar Year
- 2/3 of All Vehicle Travel Uses Arterials
- First Study Nationwide to Use Field Measured NRC on Arterials
- Data Collection Efforts will help in identifying Pilot Project

HOW IS NRC MEASURED? (FREEWAY EXAMPLE)

- NRC + Recurrent Congestion (Inherent Delay) = Overall Congestion/Delay Experienced



NRC CAUSES & DATA SOURCES

- Incident/Crashes – RADS/Traffic.com
- Weather – Weather Underground
- Maintenance/Construction – TRACS & City Personnel
- Special Events – Venue Schedule Online
- Atypical Traffic Signal Operation – Controller Logs from City Personnel/TMC
- Diversions from adjacent freeway closures - HCRS

DATA COLLECTION PLAN

- Freeways
  - 2009 sensor data from ADOT
- Arterials
  - AWAM (Bluetooth) on rotating schedule
  - Trade off one area for long period of time vs. several areas for shorter durations

INITIAL CORRIDOR SCREENING

- Select Corridors with High Travel Time Variability
  - Freeways: 2007-2009 TTI Urban Mobility Report
    - Top 5 Freeway Segments with Highest Variability
    - 2 of 5 also had high HOV lane variability
  - Arterials: MAG Top 100 Crash Intersections
    - Local Knowledge from SAG
    - Proximity to Special Event Venues

BLUETOOTH TRAVEL TIME MONITOR - MATCHES

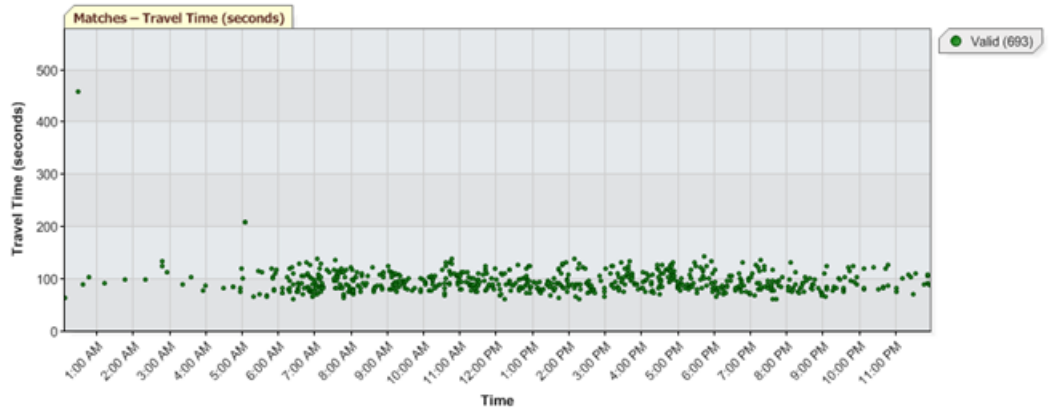
Roadway: W Bell Rd | Direction: Eastbound | Roadway Segment: All Segments

Date: 5/24/2010 | Data Type: Daily 15 Minute Averages / Individual Matches | Y-Axis: Speed / Travel Time | Show Invalid Matches: Yes / No

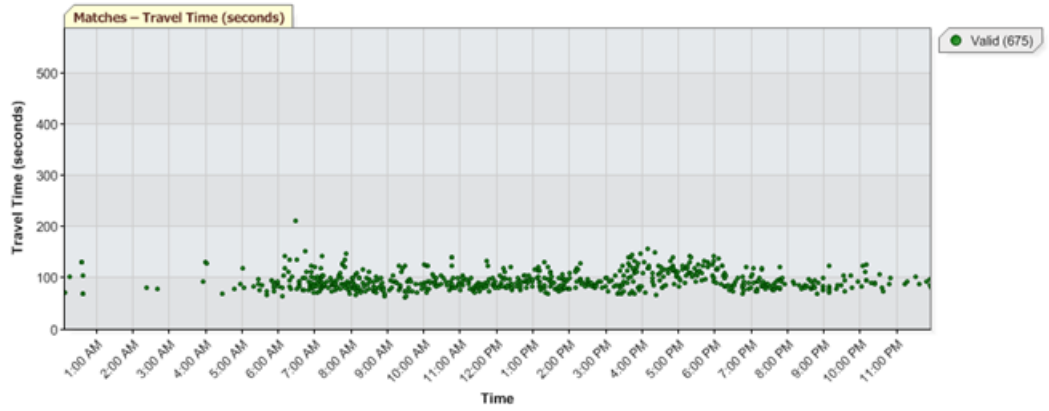
Get Chart

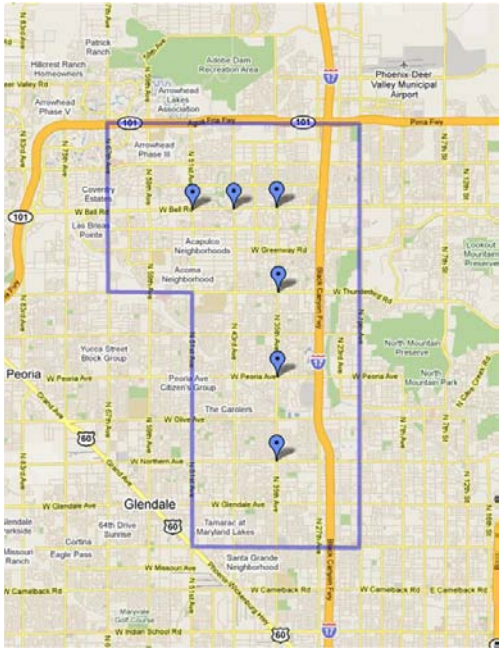
W Bell Rd Eastbound

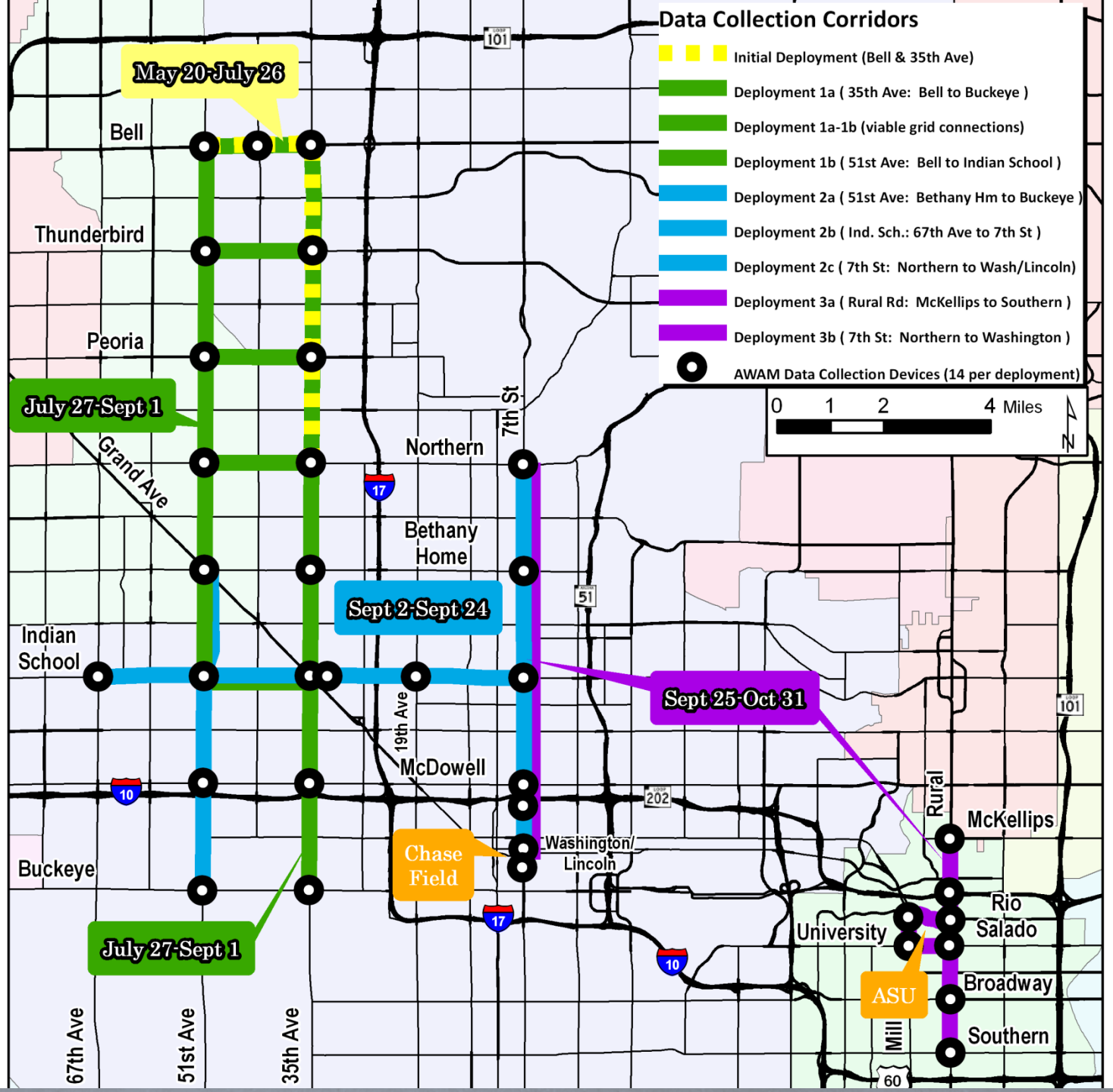
From 51st Ave to 43rd Ave (1 miles) - Individual MAC Address Matches - 5/24/2010

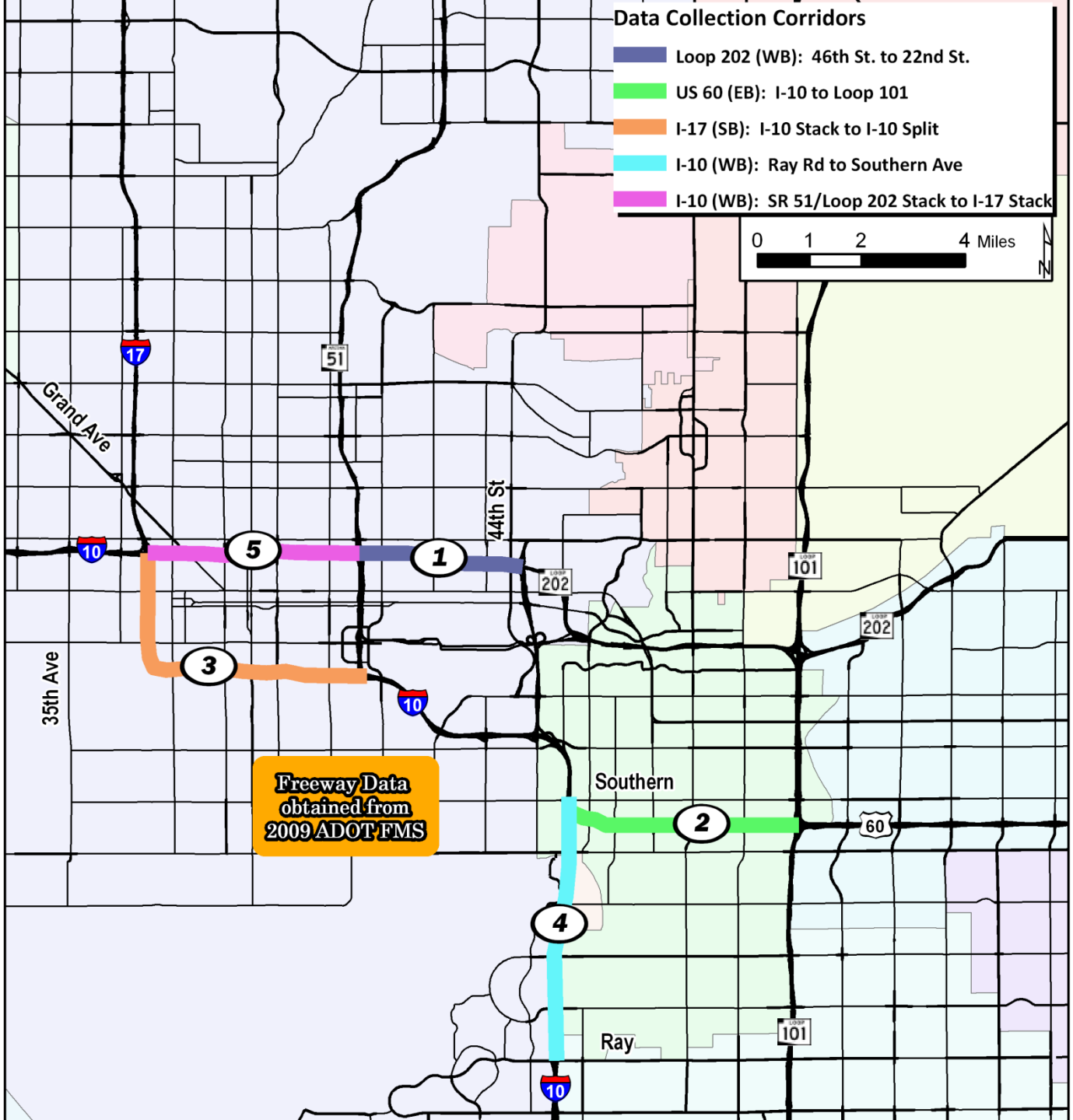


From 43rd Ave to 35th Ave (1 miles) - Individual MAC Address Matches - 5/24/2010






Data Collection Corridors
Initial Deployment (Bell & 35th Ave)
Deployment 1a (35th Ave: Bell to Buckeye)
Deployment 1a-1b (viable grid connections)
Deployment 1b (51st Ave: Bell to Indian School)
Deployment 2a (51st Ave: Bethany Hm to Buckeye)
Deployment 2b (Ind. Sch.: 67th Ave to 7th St)
Deployment 2c (7th St: Northern to Wash/Lincoln)
Deployment 3a (Rural Rd: McKellips to Southern)
Deployment 3b (7th St: Northern to Washington)
AWAM Data Collection Devices (14 per deployment)
0 1 2 4 Miles
N
May 20-July 26
July 27-Sept 1
Sept 2-Sept 24
Sept 25-Oct 31
July 27-Sept 1
Bell
Thunderbird
Peoria
Northern
Bethany Home
Indian School
Buckeye
McDowell
Chase Field
Washington/ Lincoln
McKellips
Rio Salado
University
ASU
Broadway
Southern
Grand Ave
7th St
19th Ave
Rural
Mill
67th Ave
51st Ave
35th Ave
101
17
10
51
202
60



AWAM DATA COLLECTED

Table 3-2. Number of 10-Min Intervals for the Data Collection Period

	10-MINUTE INTERVALS COLLECTED	10-MINUTE INTERVALS WITH 1 OR MORE VEHICLE MATCH	INDIVIDUAL VEHICLE MATCHES
WEEKDAY	309,445	214,666	777,400
WEEKEND	150,999	107,033	328,952
TOTAL	460,444	321,699	1,106,352

Table 3-3. Number of 10-Min Intervals for the Following Events

	10-MIN INTERVALS FOR:						
	ALL NRC EVENTS	VEHICULAR INCIDENTS	FREEWAY DIVERSION	WEATHER	CONSTRUC -TION	SPECIAL EVENTS	ATYPICAL TRAFFIC SIGNAL
WEEKDAY	50,221	2,150	112	1,025	41,988	758	4,188
	100%	4%	0%	2%	84%	2%	8%
WEEKEND	23,235	704	60	654	16,576	3,364	1,877
	100%	3%	0%	3%	71%	14%	8%

AWAM MATCH RATES

Summary

			Hourly Valid Matched Samples		Hourly Valid Match Rates	
# links	AADT Range	Length Range	Average	Daytime Avg.	Average	Daytime Avg.
76	6,200-30,800	0.4-2.2 miles	17	23	2.9%	2.6%

Different Spacing

			Hourly Valid Matched Samples		Hourly Valid Match Rates	
# links	AADT Range	Length Range	Average	Daytime Avg.	Average	Daytime Avg.
16	6,900-21,000	0.4-0.8	19	26	3.5%	3.0%
10	16,200-23,200	1.0-1.8	21	28	3.0%	2.6%
50	6,200-30,800	2.0-2.2	15	21	2.8%	2.4%
*4	13,200-14,700	4.0	6	8	1.2%	1.0%
* Not Used in Analysis						

Notes:

1. Daytime averages were weekdays from 6 a.m. to 7 p.m.
2. Hourly Valid Match Rates were hourly average valid matches divided by hourly directional traffic volumes

LEE ENGINEERING

Texas Transportation Institute

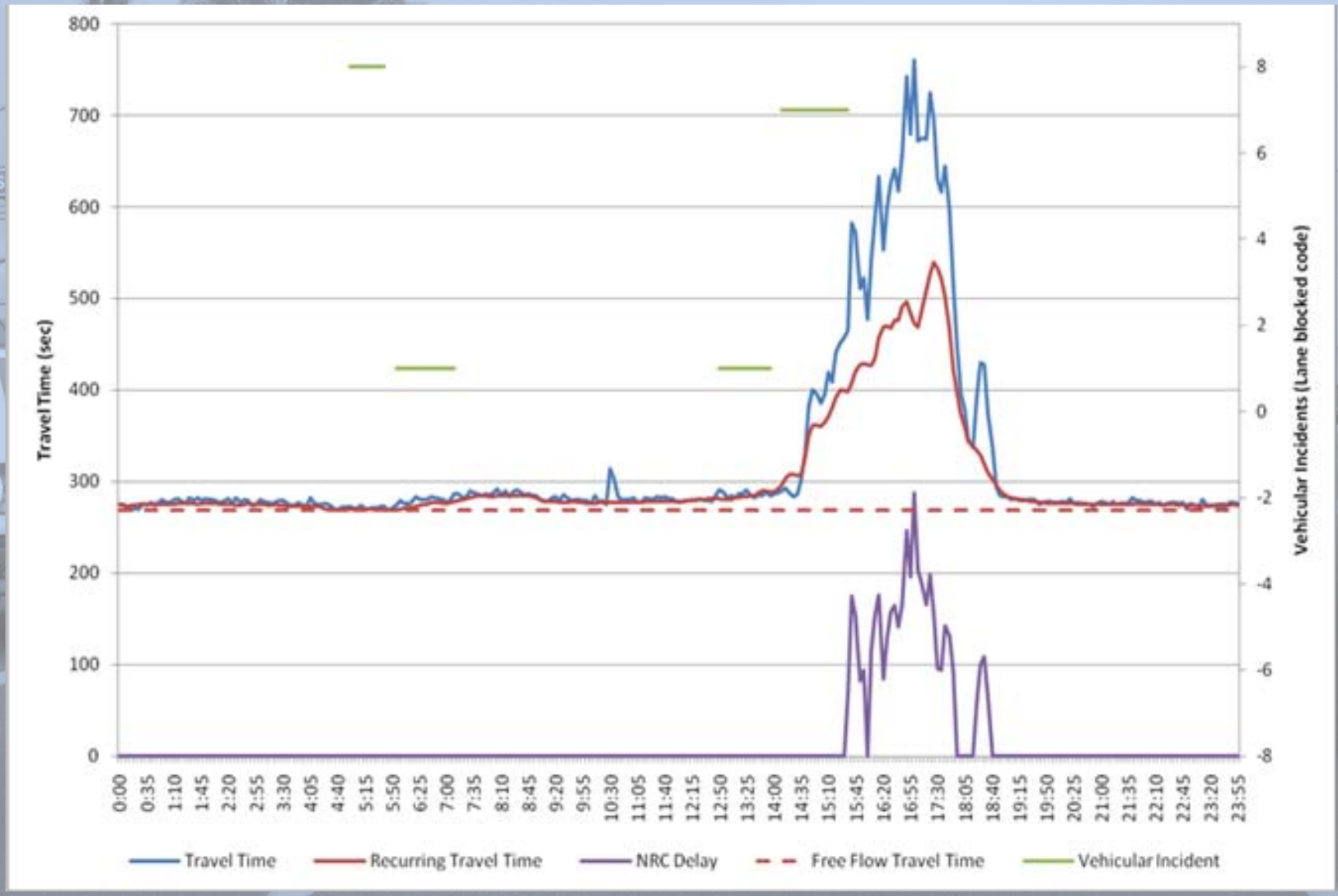
AWAM CHALLENGES

- Vandalism/Theft (modem then BT reader)
- Proximity to bridges/overpass affected signal strength/reception
- Coordination with Traffic Signal Tech

ANALYSIS

- Incident Data Reduction
- Match Incident data with Travel Time data for same time intervals
- Calculate Recurring Travel Time, TT_R ($TT_{without\ incident}$ - $TT_{Free\ Flow}$)
  - Weekday vs. Weekends
- Calculate Non-Recurring Delay ($TT_{with\ incident}$-TT_R)
  - $\geq$ 15% TT_R on Freeways
  - $\geq$ 30% TT_R on Arterials

FREEWAY DATA SAMPLE

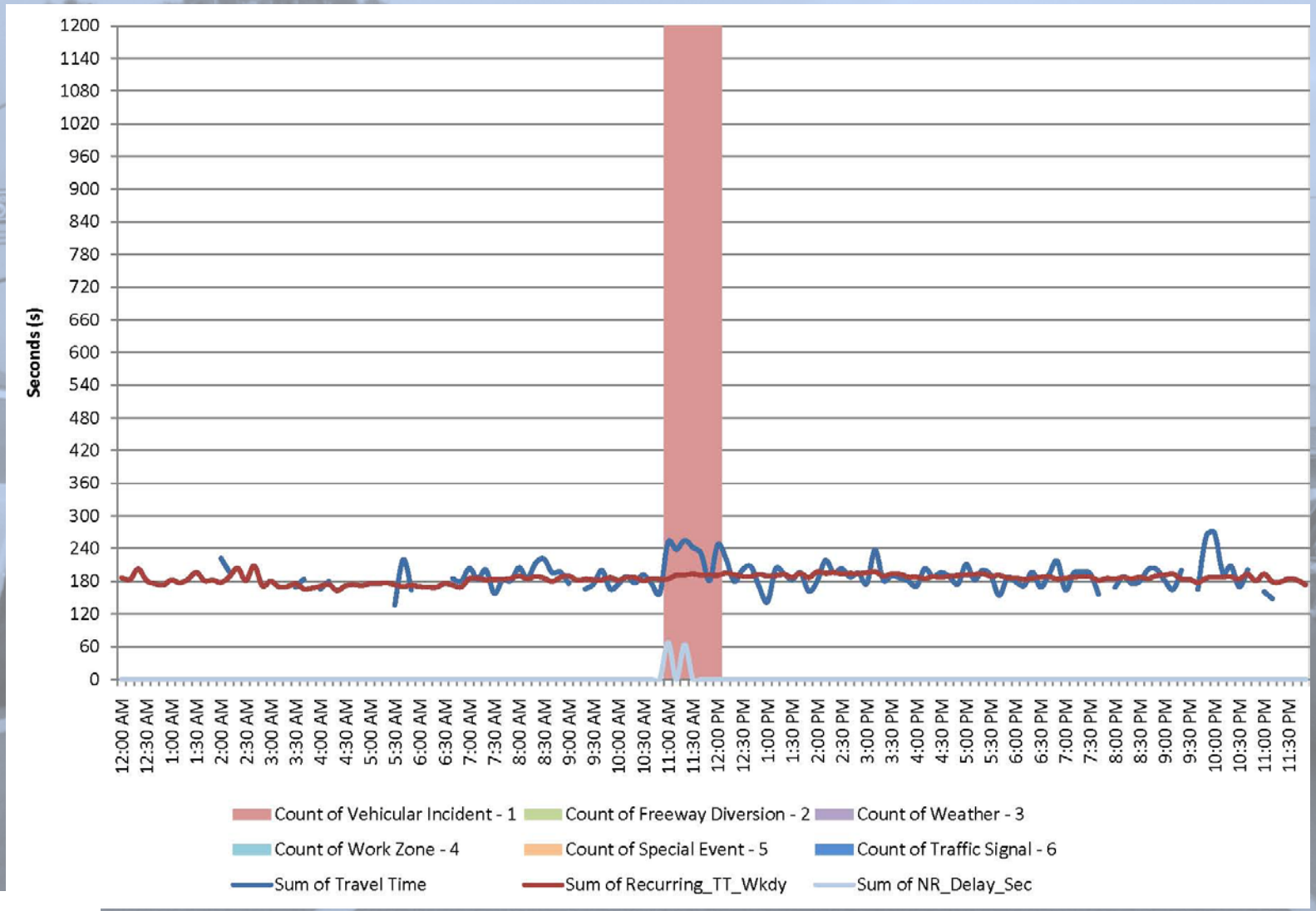


ANALYSIS (CONT'D)

- Hypothesis: full effects of NRC due to crashes may have occurred outside of the start/end time intervals
- NRC was adjusted to include delay that occurred:
  - 10 minutes before start time and
  - 3 hours after end time

  But still needed to meet buffer requirement and no other NRC event present

ARTERIAL DATA SAMPLE



MARICOPA ASSOCIATION of GOVERNMENTS

LEE ENGINEERING

Texas Transportation Institute

ANALYSIS (CONT'D)

- Summed up NRC by primary causes
  - Vehicular incidents
  - Weather
  - Construction
  - Special events
- Proportioned NRC delay when multiple NRC events occurred simultaneously

CRASH DATA CHALLENGES

35th Avenue RADS vs. NAVTEQ

Incident Type	Number from *Traffic.com*	Number from RADS	Match Rate
Injury Crash	40	64	63%
Motorcycle	1	5	20%
Pedestrian	1	5	20%
Bicycle	1	8	13%
Total	**43**	**82**	**52%**

I-10 WB RADS vs. NAVTEQ

Data Source	Incident Type	Number during Jan '09	Number during Feb '09	Sum of Jan & Feb '09
Traffic.com	Crash	35	31	66
	Disable Vehicle	7	5	12
	Miscellaneous	1	0	1
	Total	**43**	**36**	**79**
RADS	Pedestrian-involved	1	2	3
	Hazardous materials	1	0	1
	Incident	0	1	1
	Injury Crash	13	8	21
	Vehicle on Fire	3	2	5
	Medical Emergency	4	4	8
	Total	**22**	**17**	**39**
Percentage of RADS Matching *Traffic.com*		**51%**	**47%**	**49%**

FREEWAY RECURRING AND NON-RECURRING CONGESTION (VEHICLE-HOURS) TEST SECTIONS

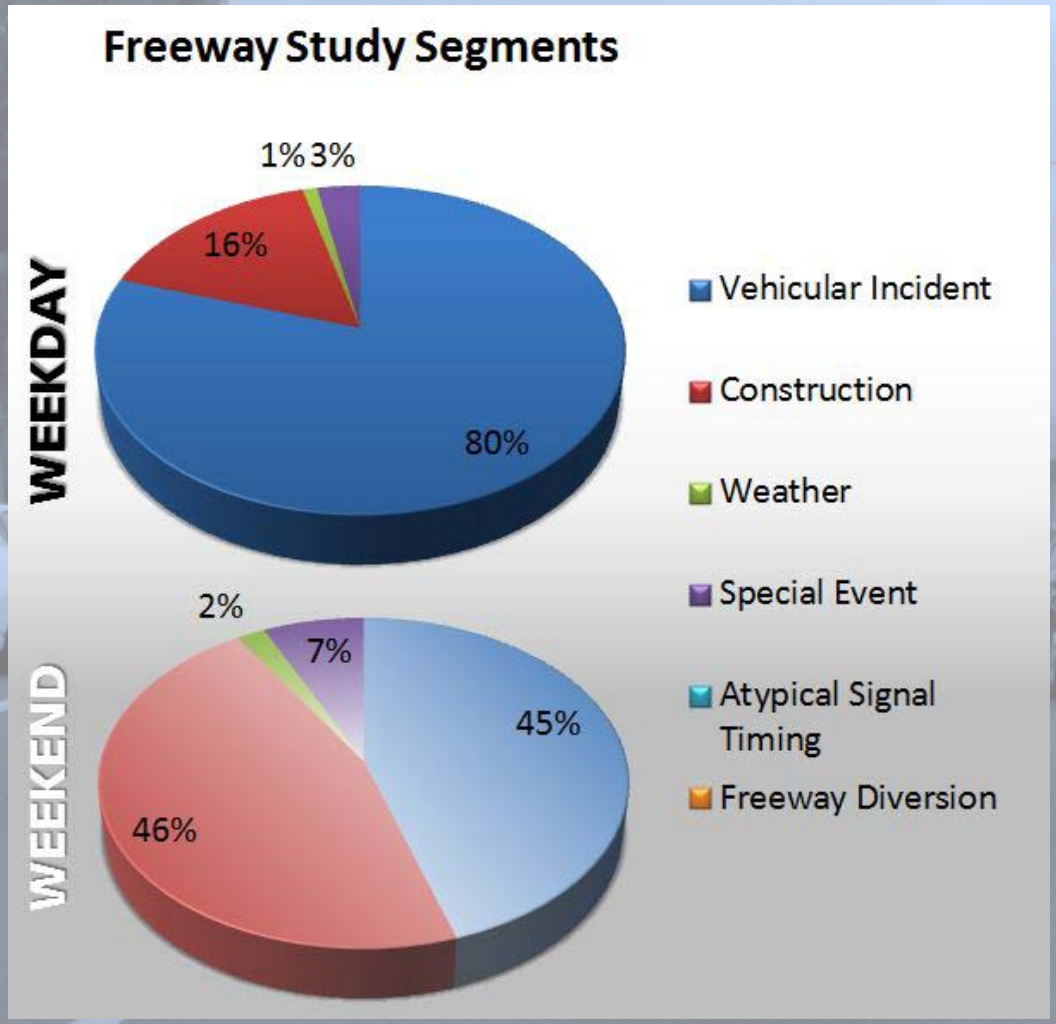
WEEKDAY

Section	Recurring	NonRecurring	Total	% Recurring	% NonRecurring
US 60 EB I-10 to Loop 101	23,299	82,017	**105,316**	22%	78%
I-10 WB Gold Poppy to Southern	140,080	39,324	**179,404**	78%	22%
I-17 SB I-10 to I-10	2,874	13,822	**16,696**	17%	83%
I-10 WB SR 51 to I-17	89,167	97,491	**186,658**	48%	52%
Loop 202 WB 46th St to 22nd St	68,514	40,407	**108,921**	63%	37%
Total	**323,933**	**273,062**	**596,994**	**54%**	**46%**

WEEKEND

Section	Recurring	NonRecurring	Total	% Recurring	% NonRecurring
US 60 EB I-10 to Loop 101	0	18,167	**18,167**	0%	100%
I-10 WB Ray to Southern	0	74	**74**	0%	100%
I-17 SB I-10 to I-10	0	2,567	**2,567**	0%	100%
I-10 WB SR 51 to I-17	0	2,097	**2,097**	0%	100%
Loop 202 WB 46th St to 22nd St	0	2,741	**2,741**	0%	100%
Total	**0**	**4,838**	**4,838**	**0%**	**100%**

NON-RECURRING CONGESTION CAUSES ON FREEWAY STUDY SEGMENTS



MARICOPA ASSOCIATION of GOVERNMENTS

LEE ENGINEERING

Texas Transportation Institute

ARTERIAL RECURRING AND NON-RECURRING CONGESTION (VEHICLE-HOURS) TEST SECTIONS

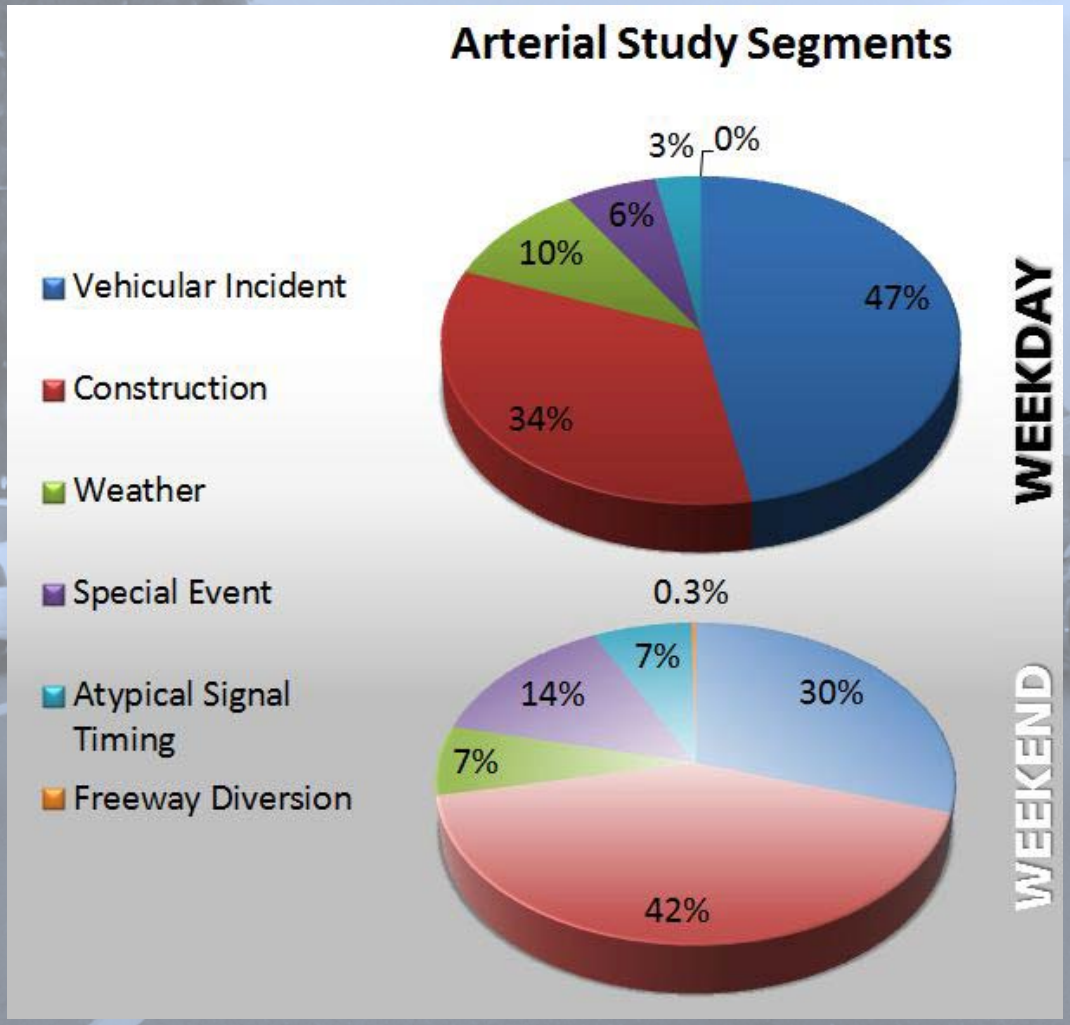
WEEKDAY

AWAM Equipped Segments	Recurring Delay (vehicle hours)	Non-Recurring Delay (vehicle hours)	Total Delay	% Recurring	% Non-Recurring
35th Ave Corridor (with Bell)	87,914	10,393	98,306	89%	11%
51st Ave Corridor (with Thunderbird, Peoria, & Northern)	84,024	3,250	87,274	96%	4%
Indian School Rd Corridor	48,526	11,951	60,477	80%	20%
7th St Corridor	53,701	6,087	59,789	90%	10%
Rural Rd Corridor (with Rio Salado, Mill, and University)	72,882	1,404	74,286	98%	2%
Grand Total	**347,047**	**33,084**	**380,131**	**91%**	**9%**

WEEKEND

AWAM Equipped Segments	Recurring Delay (vehicle hours)	Non-Recurring Delay (vehicle hours)	Total Delay	% Recurring	% Non-Recurring
35th Ave Corridor (with Bell)	25,144	4,620	29,764	84%	16%
51st Ave Corridor (with Thunderbird, Peoria, & Northern)	27,618	2,133	29,751	93%	7%
Indian School Rd Corridor	26,164	4,969	31,133	84%	16%
7th St Corridor	15,901	5,906	21,807	73%	27%
Rural Rd Corridor (with Rio Salado, Mill, and University)	30,167	4,397	34,564	87%	13%
Grand Total	**124,993**	**22,025**	**147,018**	**85%**	**15%**

NON-RECURRING CONGESTION CAUSES ON ARTERIAL STUDY SEGMENTS



MARICOPA ASSOCIATION of GOVERNMENTS

LEE ENGINEERING

Texas Transportation Institute

NRC EXTRAPOLATION

- System-wide NRC (Veh-hrs/year) was estimated based on NRC on study sections

System	Recurring	Non-Recurring	Total	% of Total	% of NRC Total
Freeway	5,506,858	5,078,017	10,584,875	12%	38%
Arterials	69,606,012	8,340,250	77,946,262	88%	62%
Total	**75,112,870**	**13,418,267**	**88,531,137**		

Note: Estimate may be high due to selected study sections

SUMMARY

- Verified that NRC is a significant issue in the MAG region on both freeways and arterial streets
- Identified potential countermeasures and a framework for a pilot project

CONTACT INFORMATION

Jody Short– Lee Engineering
jshort@lee-eng.com

Minh Le – Texas Transportation Institute
m-le@tamu.edu

MARICOPA ASSOCIATION of GOVERNMENTS

LEE ENGINEERING

Texas Transportation Institute