EA 08-472214

Jonathan den Hartog, P.E.

Project Overview

- Purpose & Need: Rehabilitate over 12 lane-miles of deteriorated PCC pavement.
- Accelerated construction and contracting innovations used:
  - CA4PRS, Dynameq, Extended Weekend Closures, Incentives/Disincentives, Precast Pavement
- Goal: Minimize disruptions to traffic, without sacrificing quality and pavement life
  - Get in, get out, stay out

Project Location

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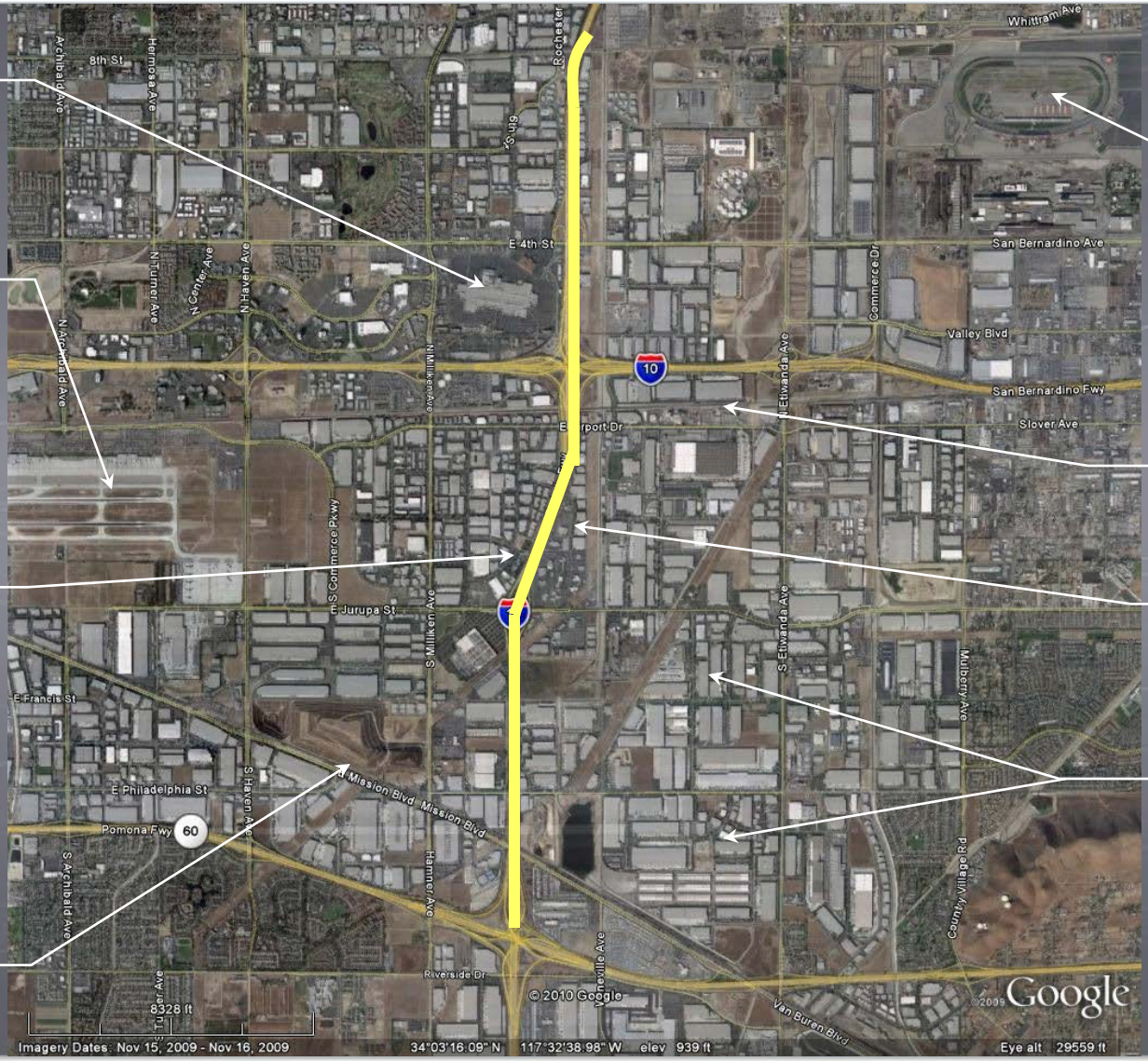

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Project Location

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Project Features

- Median Paving & Barrier
- Bridge Widening
- AC Shoulder/Ramp Rehab
- Pavement Rehabilitation
  - 12 ln-mi lane replacement
  - Random slab replacements
  - Includes 12 freeway-to-freeway connectors
  - Precast Pavement (Super-Slab)

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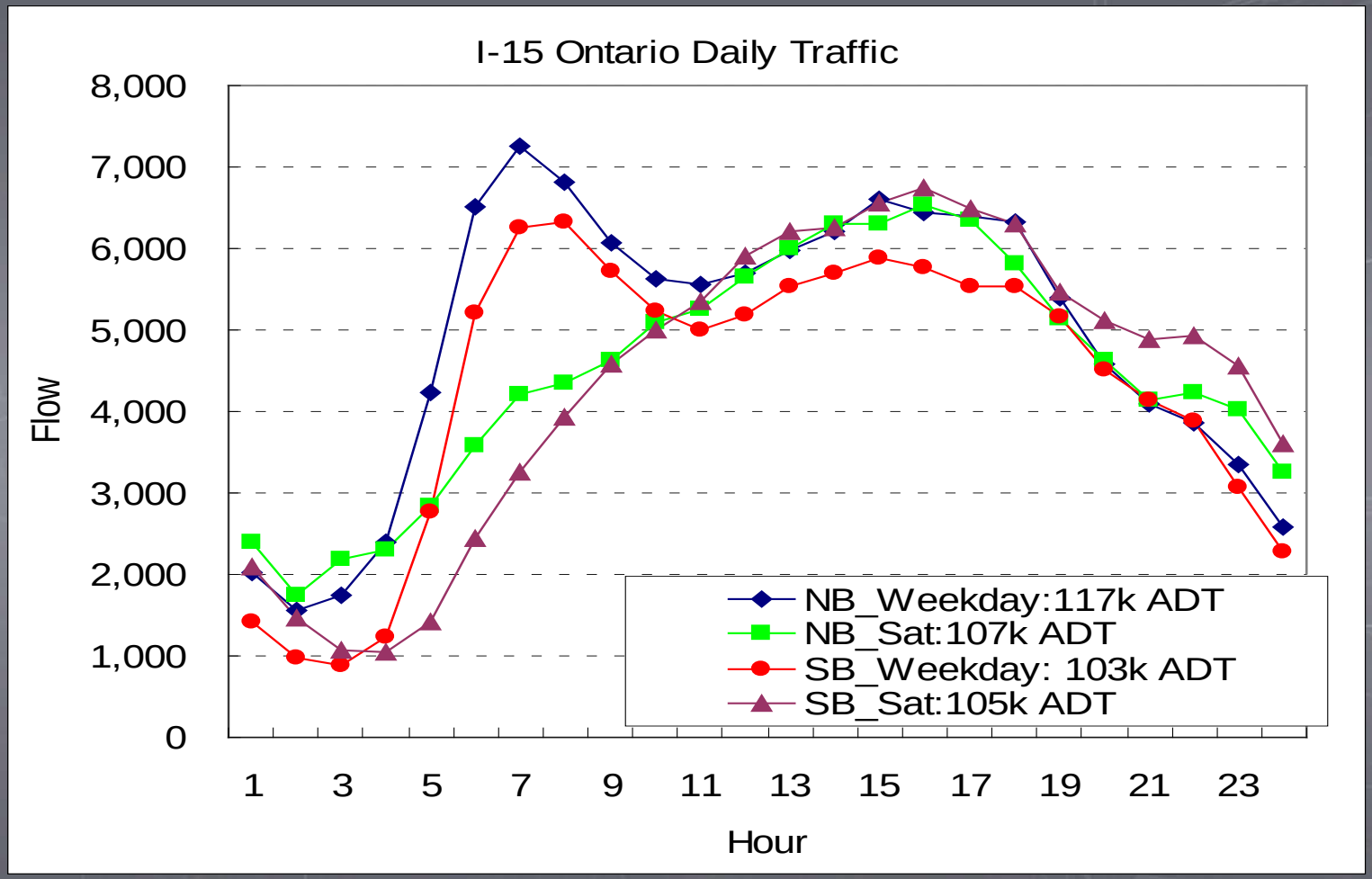
Traffic Volumes

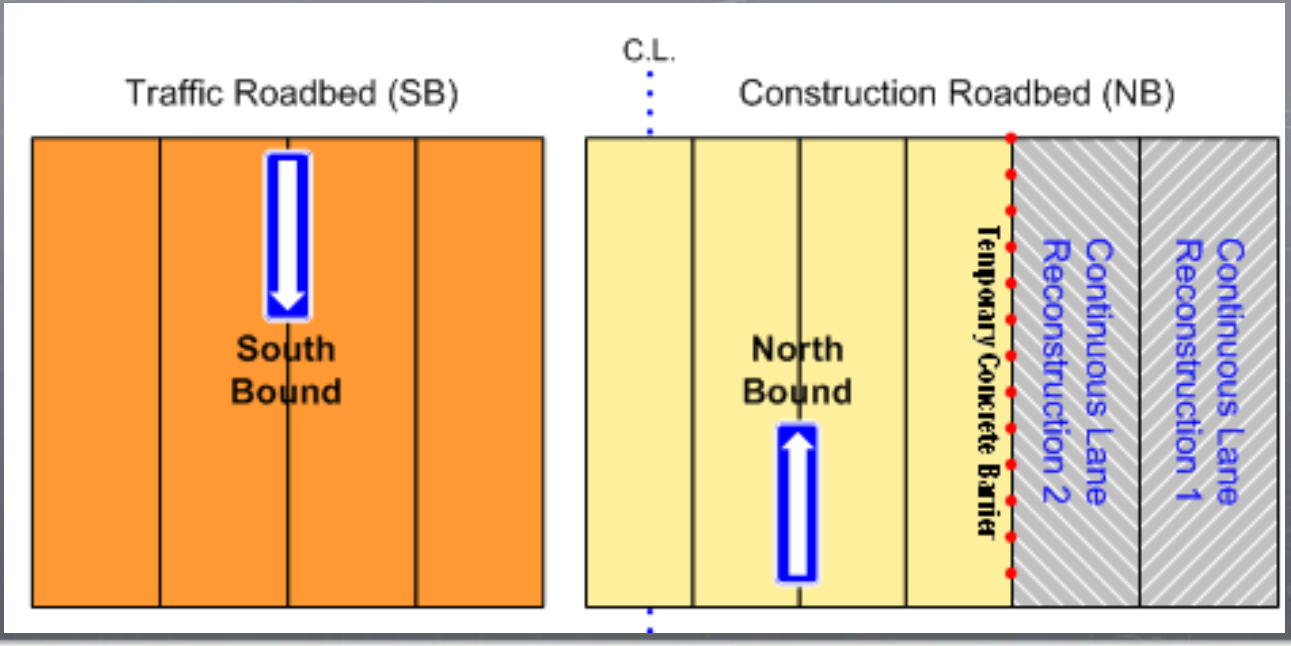


Traffic Impact Mitigation Strategies

- CA4PRS
- Dynameq
- Incentives / Disincentives
- PCMS usage
- Media Outreach

Construction Sequence

- Pave median, widen bridges
- Shift southbound I-15 two lanes toward the CL
- Rehab pavement weekday and weekend
- Repeat for northbound I-15



Typical Closure

Rapid Weekends

- 5 Major Stages,
  25 sub-stages
- 410 Working Days (~2 yrs)
- 55-Hour Weekend Closures
  - Beginning late Friday evening
  - Ending early Monday morning
- Approximately 30 weekends
- ~8 full roadbed closures

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Traffic/Staging Analysis

- CA4PRS
  - 2 Phase Study
    - Alternative Analysis And Comparison
    - Detailed Study of Preferred Alternative
  - Performed by consultant sub
- Construction Traffic Modeling (Dynameq)

Alternatives Analysis

Scenario		Closure Duration	Traffic*		Cost ($millions)		Cost Ratio
			RUC ($M)	Delay (min)	Agency	Total**	
1	Original	35 weekends	3	16	78	79	100%
3	Contraflow 55-hr Weekend	35 weekends	119	363	83	123	156%
4	Progressive Continuous	8 weeks	123	363	77	118	149%
5	Traditional Nighttime	1,220 nights	133	22	88	133	168%
6	CSOL 55-hour weekend	20 weekends	69	363	60	83	105%

** Total Cost = 1/3 RUC + Agency Cost

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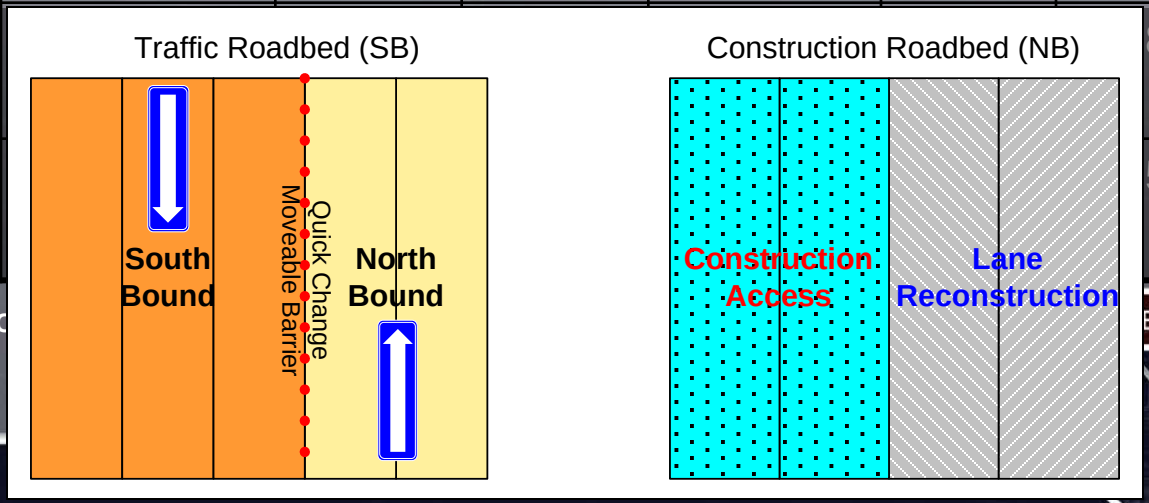
5	Traditional Nighttime						8%
6	CSOL 55-hour weekend						5%

** Total Cost = 1/3 RUC + Agency C



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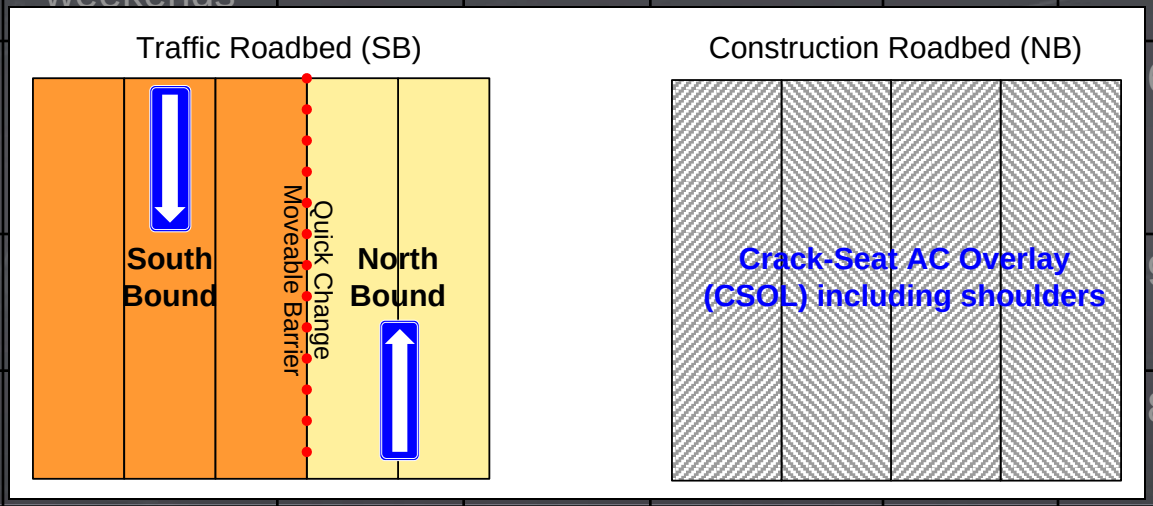

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Road User Costs/Delay

Scenario			1,500 vphpl* capacity			1,700 vphpl* capacity		
		Demand Reduction	Queue	Delay	RUC**	Queue	Delay	RUC**
			Miles	Minutes	$(Millions)	Mile	Minute	$(Millions)
1	Original	20%	8	61	20	2	18	2
		30%	2	16	3	0	0	0
3	55-hour Weekend	30%	51	363	119	34	210	63
		40%	25	179	45	13	81	17
4	Progressive Continuous	30%	51	363	123	34	210	51
		40%	25	179	47	13	81	13
5	8-hour Nighttime	5%	8	57	418	-	-	-
		10%	3	22	133	-	-	-
6-1	CSOL (Weekend)	30%	51	363	69	34	210	36
		40%	25	179	25	13	81	10
6-2	CSOL (Nighttime)	5%	8	57	120	-	-	-
		10%	3	22	38	-	-	-

* vphpl: vehicle per hour per lane
** RUC: Road User Cost

Stage Analysis (Sample)

Stage	Station		No. of Lanes	Length		Rehab Type	Total	55-hour Closures
	Start	End		(m)	(lane-km)		(lane-km)	Estimate
4B, 4C	836+81	837+81	1	100.00	0.100	CLR	2.50	2
	SB I-15 Conn WB SR-60		2	773.20	1.546	CLR		
	SB I-15 Conn EB SR-60		2	1430.50	0.858	RSR		
2A	7+40	11+79	2	439.00	0.878	CLR	1.28	1
	Jurupa On-ramp SB I-15		2	500.00	0.400	ACR		
2B	20+90	22+77	2	187.00	0.374	CLR	3.01	3
	22+77	28+51	1	574.00	0.574	CLR		
	28+51	33+03	2	452.00	0.904	CLR		
	20+96	28+95	1	799.00	0.240	RSR		
	WB I-10 CONN SB I-15		1	337.70	0.338	CLR		
	SB I-15 Jurupa Off-ramp		2	500.00	0.400	ACR		
	WB I-10 Conn SB I-15		2	300.00	0.180	RSR		

Note: CLR=Continuous Lane Reconstruction; RSR=Random Slab Replacement; ACR=Asphalt Concrete Rehabilitation

Traffic Study (Dynameq)

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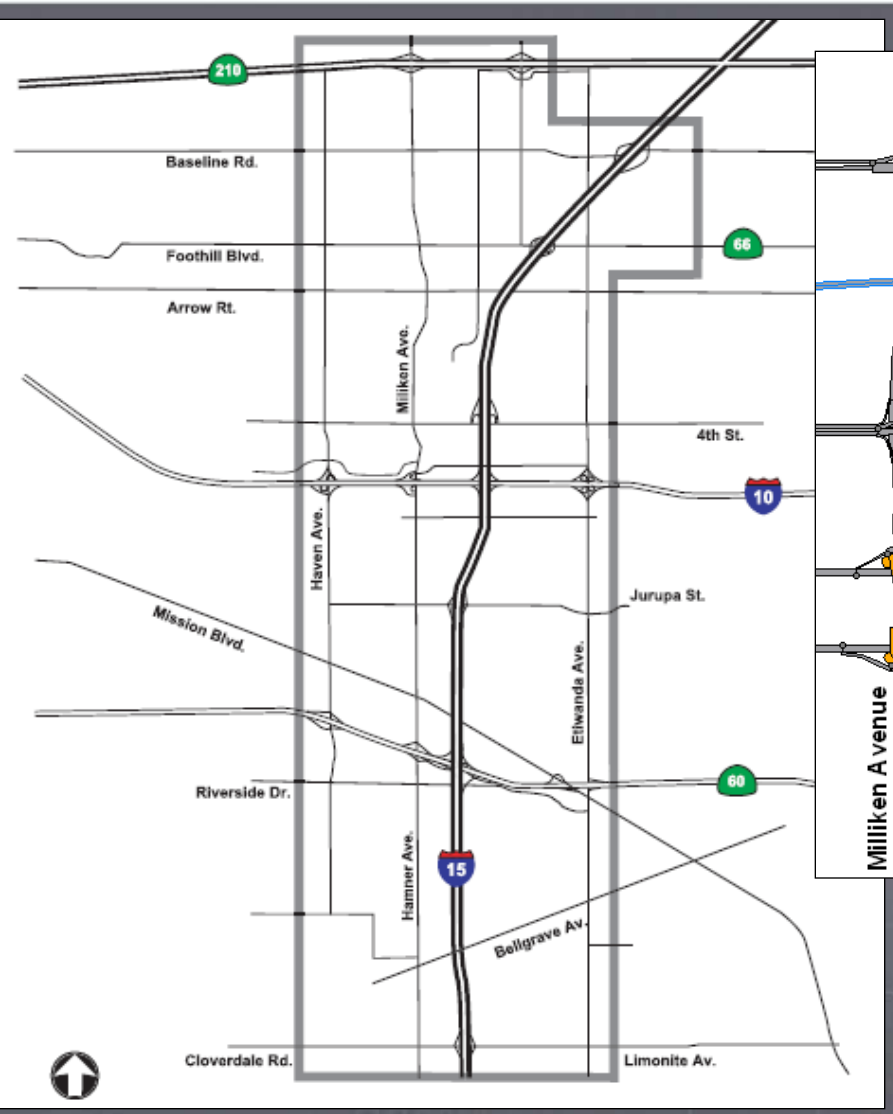

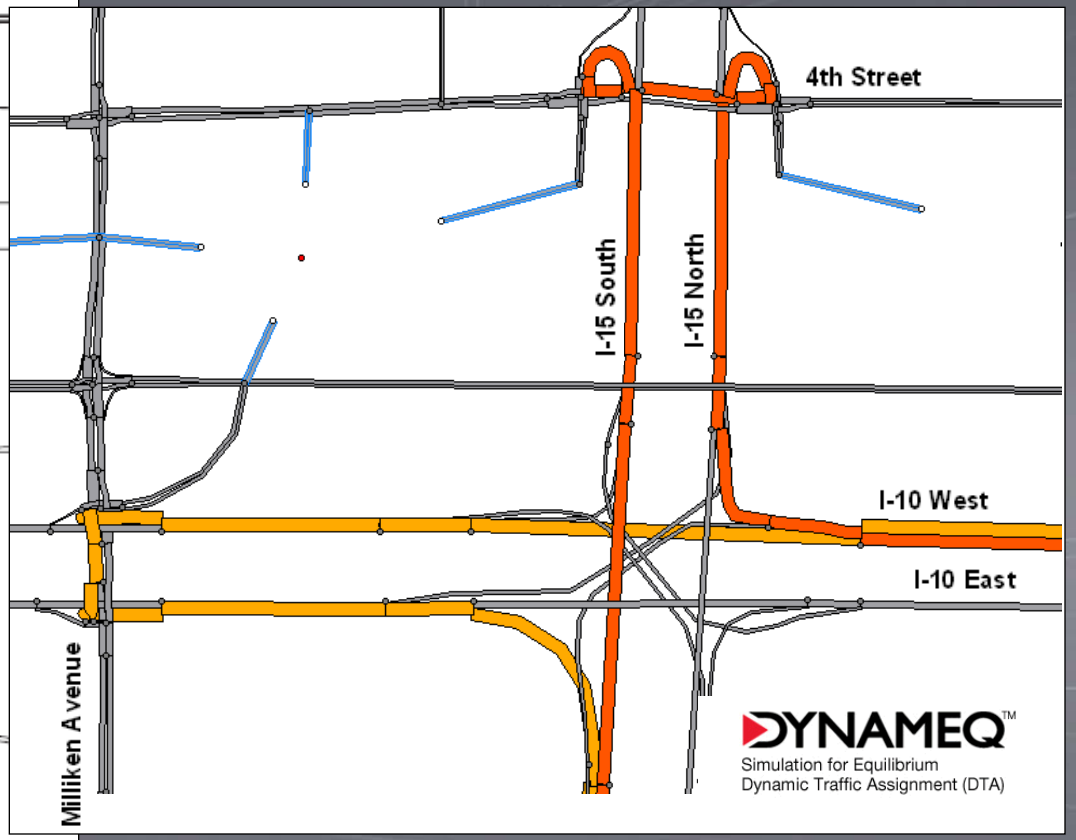

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Traffic Study (Dynameq)

	Delay (min)	
Closure	**Study 1**	**Study 2**
WB10-SB15	5.5	8.4
EB10-SB15	4.1	7.7
SB15-WB10	4.5	72.6
NB15-E/W10	5.8	58.6
EB10-NB15	5.8	8.0
Reduce SB 15	3.0	
SB15-E/W60		121.4

Actual delays: 10-30 minutes

Precast Pavement

Pros:

- Small work windows
- High quality
- Long Life

Cons:

- Precise work
- Expensive

TMP Strategies

- CA4PRS
- Dynameq
- Incentive/Disincentive **+$150,000 / saved closure (Max $900,000)** **-$175,000 / extra closure**
- Project Web Site
- Brochure/Rack Card
- Pre-construction meeting with local agencies
- Regular business meetings
- For closures:
  - Radio Ads
  - Email
  - Twitter
  - Cancellation disincentive ($25,000)
  - COZEEP

CA4PRS Validation

Inputs: Predicted Vs. Actual

	Tab	Input	Study	Actual	Unit	Default Values
	Activity Constraints	Mobilization	3	1	hrs	2-3
	Activity Constraints	Demobilization	2	Varies	hrs	4-6
	Activity Constraints	Concurrent - Demo to Base	15	11	hrs	1-2 (Sequential), 9-10 (Concurrent)
	Activity Constraints	Concurrent - Base to PCC	8	5	hrs	1-2 (Sequential), 9-10 (Concurrent)
	Resource Profile	Demo Hauling Truck	22	22	tonne	22
*	Resource Profile	Demo Trucks per hour per team	10	10	ea	10 for cut & lift, 12 for impact methods
*	Resource Profile	Demo Packing Efficiency	0.5	0.55	%	0.5 for cut & lift, 0.6 for impact
	Resource Profile	**Demo Number of Teams**	**2**	**3**	**ea**	2
*	Resource Profile	Demo Team Efficiency	0.7	0.7	%	
	Resource Profile	Base Delivery Truck Cap.	10	6	m^3	10 for bottom dump, 6 for end dump
	Resource Profile	Base Trucks Per Hour	8	16	ea	10
	Resource Profile	Base Truck Packing Eff.	100	100	%	
*	Resource Profile	Batch Plant Capacity	90	90	m^3/hr	100
	Resource Profile	Concrete Delivery Truck Cap.	6	6	m^3	6-7
	Resource Profile	Concrete Trucks Per Hour	15	15	ea	15
	Resource Profile	Concrete Truck Packing Eff.	100	100	%	
*	Resource Profile	Paver Speed	2	2	m/min	2
	Resource Profile	Number of Pavers	1	1	ea	
	Schedule Analysis	PCC Thickness	290	315	mm	
	Schedule Analysis	Base Thickness	152.4	150	mm	

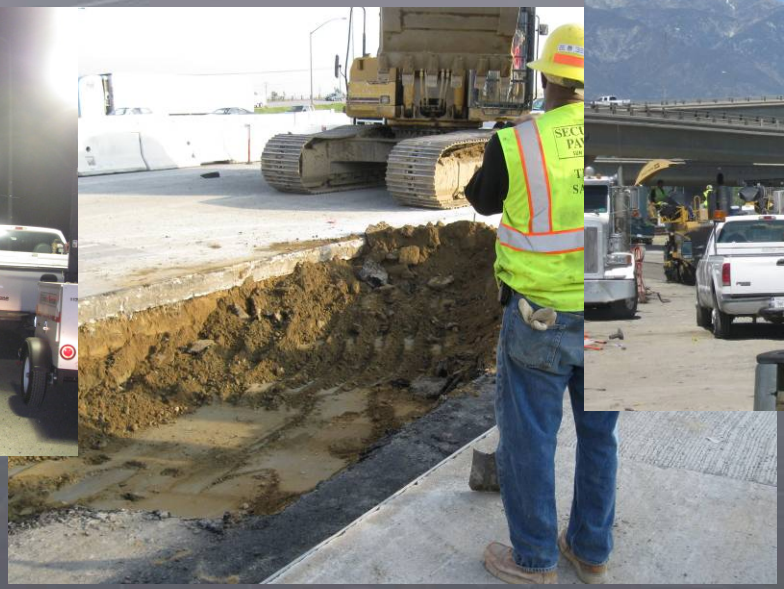
Difference speeds up actual production

Difference slows down actual production

* Unable to verify actual value in field

Predicted Vs. Actual

- Random slabs as night work
- Sometimes paving two lanes wide on connectors
- Combined stages
- Concurrent vs. Sequential



Predicted Vs. Actual (PRELIMINARY)

Stage			No. of Weekends			
Plan[1]	Study[1]	Stage Description	Study[2]	Actual[2]	Revised Inputs[3]	Notes
4B,C	5B,C	SB I-15 connectors to E/W SR-60	2	2		Contractor was restricted by width of connector, which forced him to pave one lane at a time. Only 2 demo teams used. Thus very similar to study
2B,C	2B,C	SB Jurupa offramp, W10-S15 conn, E10-S15 conn	4	2	2	Study had separate closures for 2B, 2C. Contractor chose to combine stages.
2D,E	2D,E	SB I-15 connectors to E/W I-10	5	2	2	Contractor may have included more in 2E,F combination, also need to determine how contractor handled 3-lane widths
2E,F	2E,F	Fourth St SB ramps	3	1	1	Added 2E work north of S15-E10 connector diverge

Footnotes (Column descriptions)

1. 'Plan' is the stage designation as it is called out on the project plans. 'Study' is the stage designation as it is called out in the design study. Differences exist because of changes that occurred between when the study was completed and the project design was finished.
2. 'Study' is the number of closures (weekends) estimated to be needed by the design study to complete the work for the stage. 'Actual' is the number of closures actually required to complete the work.
3. 'Revised Inputs' indicates how many closures were estimated to be needed using the revised inputs for CA4PRS shown in the previous slide.

CA4PRS Lessons Learned

- Construction experience is IMPORTANT
- Design input important for efficiency
- Breadth of knowledge required
  - Traffic
  - Pavement
  - Construction
  - Estimating
- Team approach may be best

User Survey

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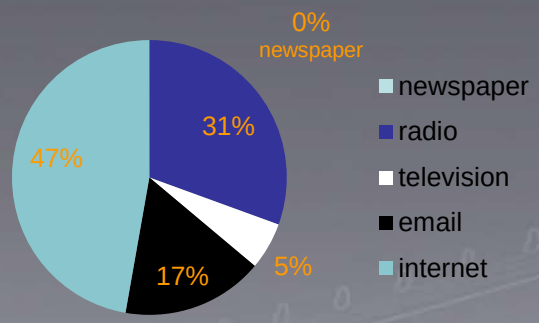
Preferred Info Source



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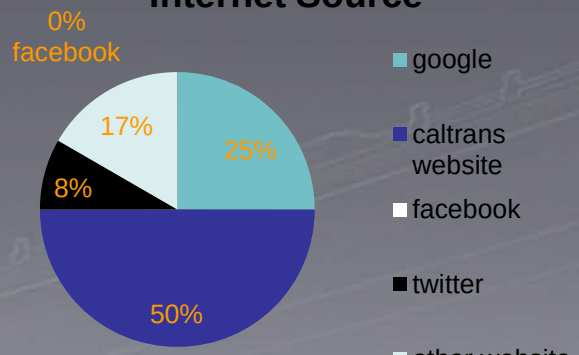
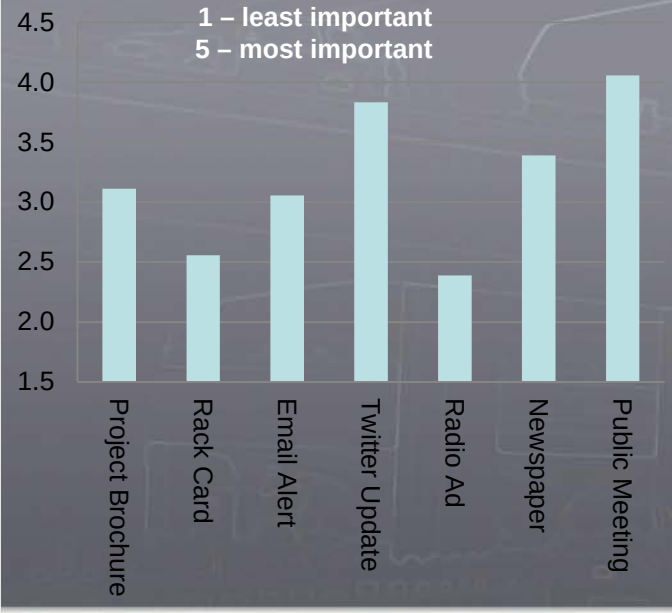


Importance of Info Source



Likert Scale Questions

1 – Strongly disagree .... 5 – Strongly agree

	Average	Std. Dev.
* Prefer extended weekend closures?	**3.75**	1.32
* Worth it to widen bridges (20% more cost)?	**3.64**	1.27
* Super-Slab worth it?	**4.08**	1.14
* Support measures taken to minimize traffic impacts?	**3.78**	1.08
* Satisfied with pavement rehabilitation?	**3.53**	1.28

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Future Directions

- Continue training on CA4PRS and promote its use on high-impact projects.
- Statewide Standards group for Precast Pavement Systems (PCPS) to make it easier to use.
- Multi-disciplinary team to use CA4PRS.

Contact Info

Jonathan den Hartog
(909) 383-5998
jdenhart@dot.ca.gov

More info:

http://www.dot.ca.gov/hq/research/roadway/ca4prs/index.htm

http://www.fhwa.dot.gov/research/deployment/ca4prs.cfm