CA4PRS and Traffic Modeling Integration for Highway Rehabilitation

- Case Study on I-15 Devore Reconstruction -

CWZ Traffic Modeling Workshop
March 20-21, 2007

Eulbum (E.B.) Lee, UC Berkeley
David Thomas, PB Americas inc.

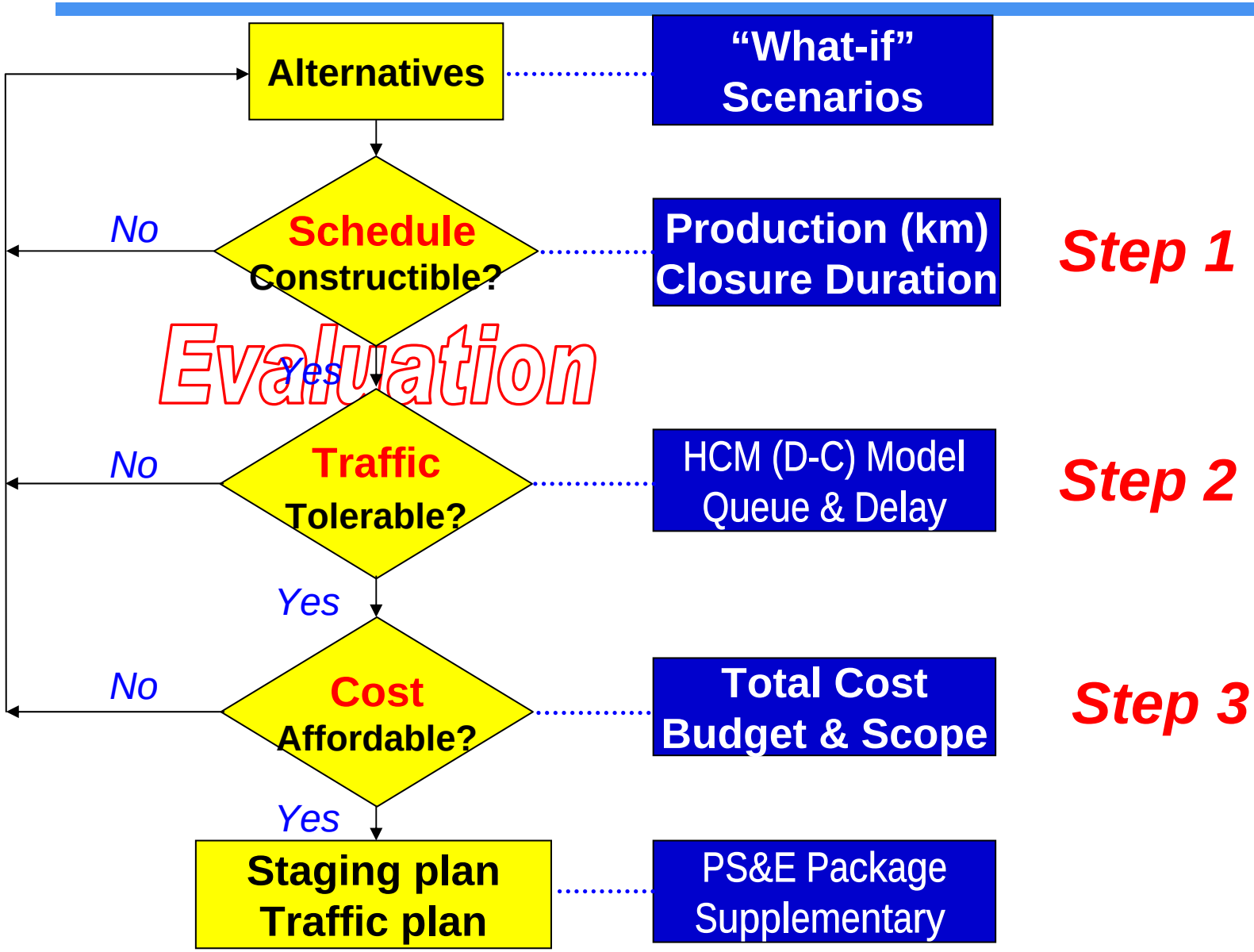
CA4PRS

(Construction Analysis for Pavement Rehabilitation Strategies)

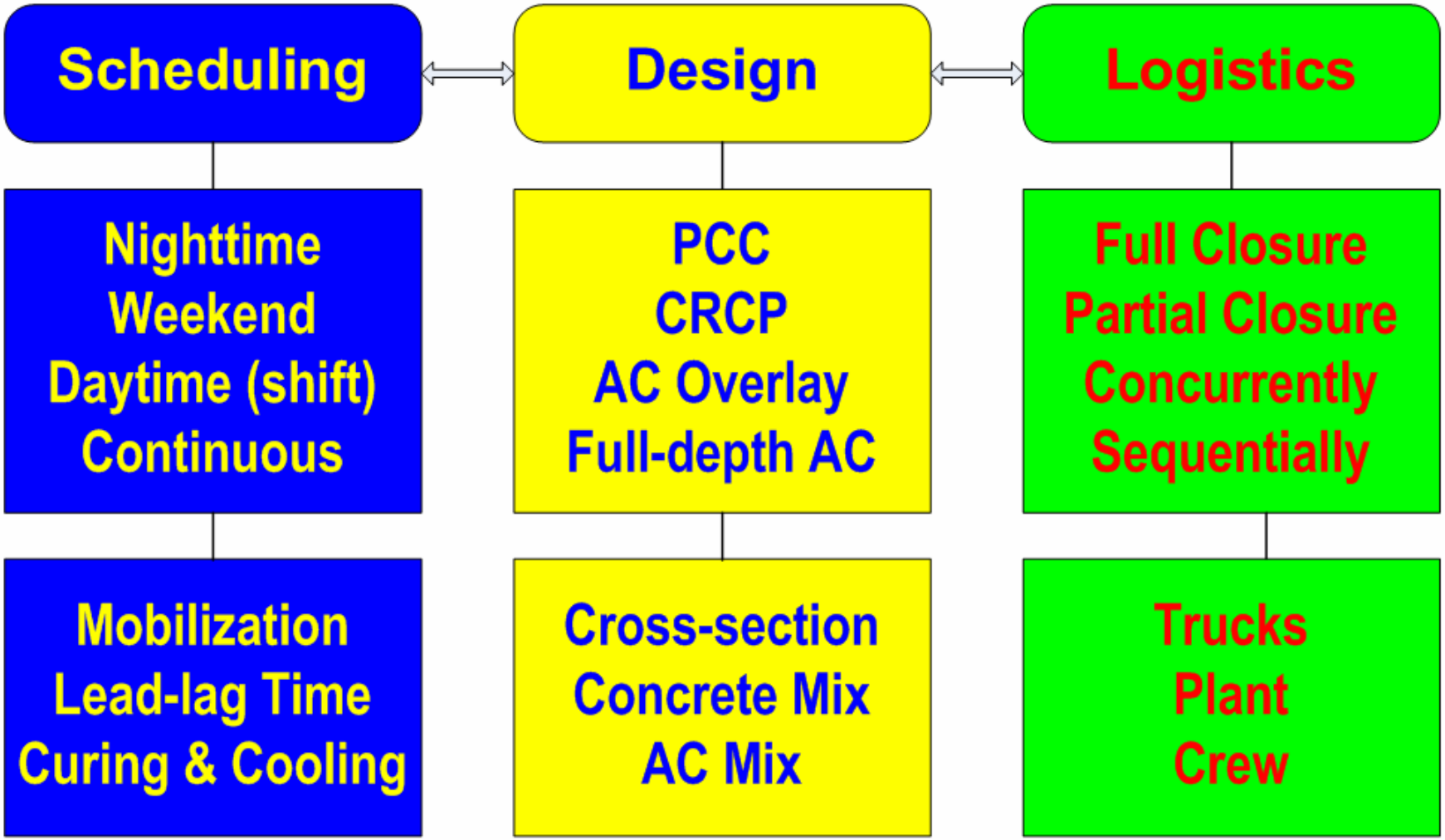
FHWA pooled fund study (CA, MN, TX, WA)

AASHTO/TIG CAST Promotion

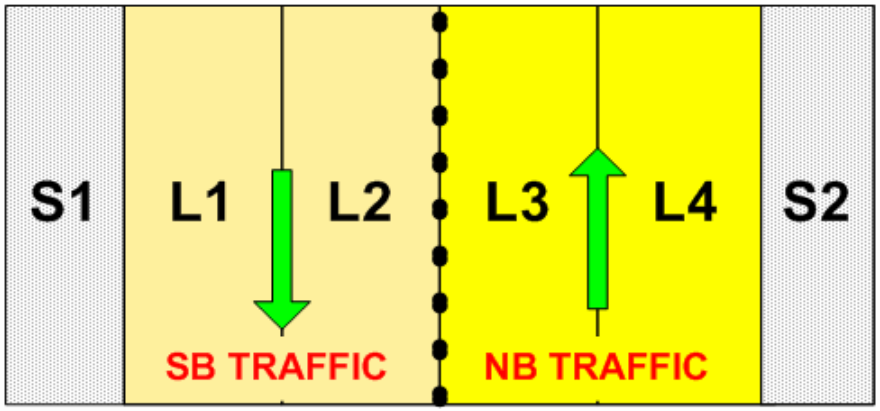
CA4PRS Analysis Framework *and* Modules



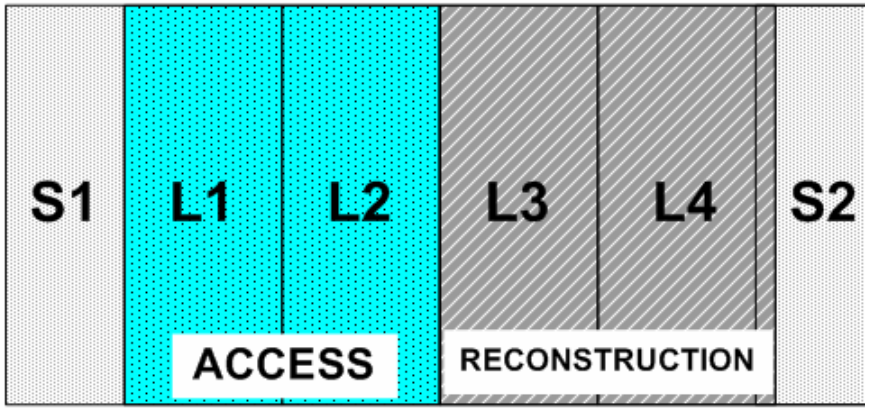
Analysis Parameters Comparing Alternatives



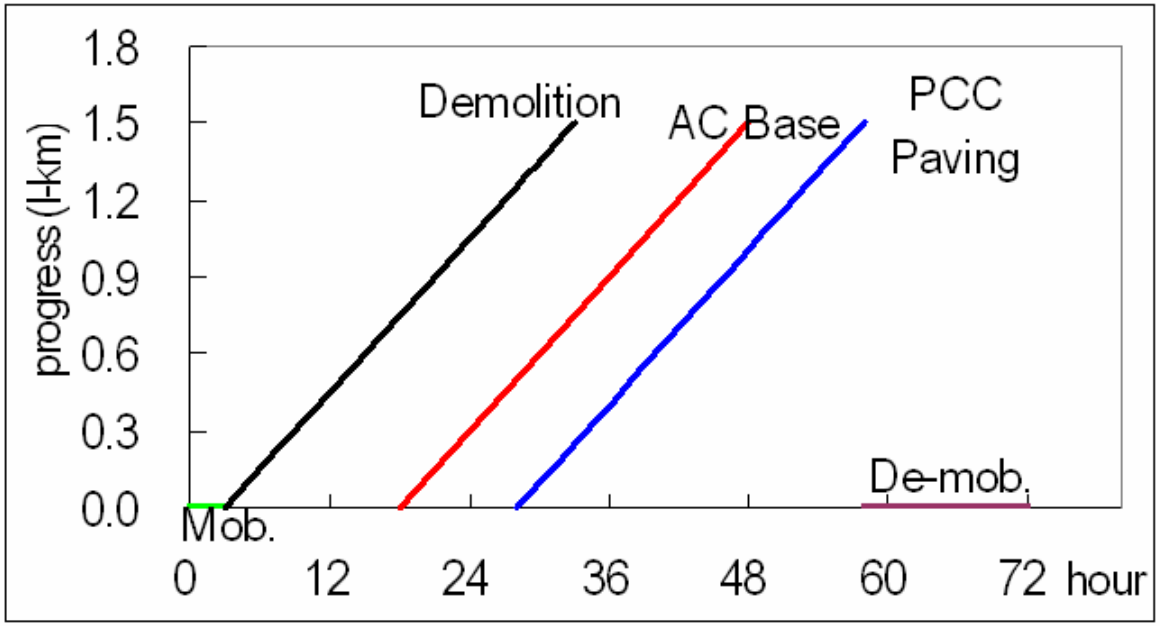
PCC Concurrent Work Method
Full Closure of Construction Roadbed



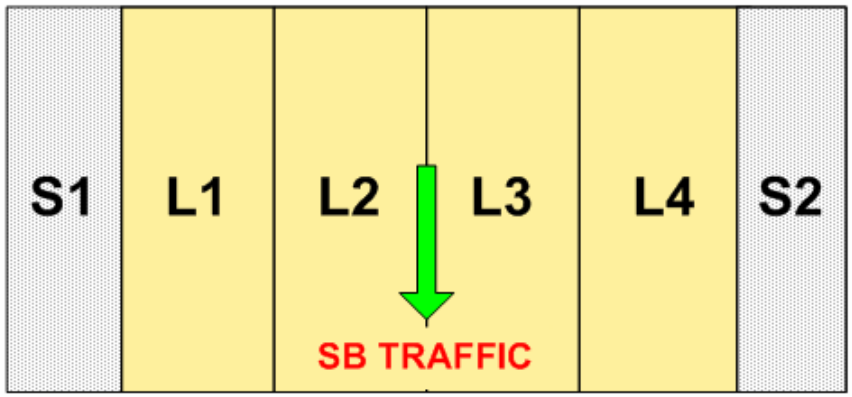
Traffic Roadbed



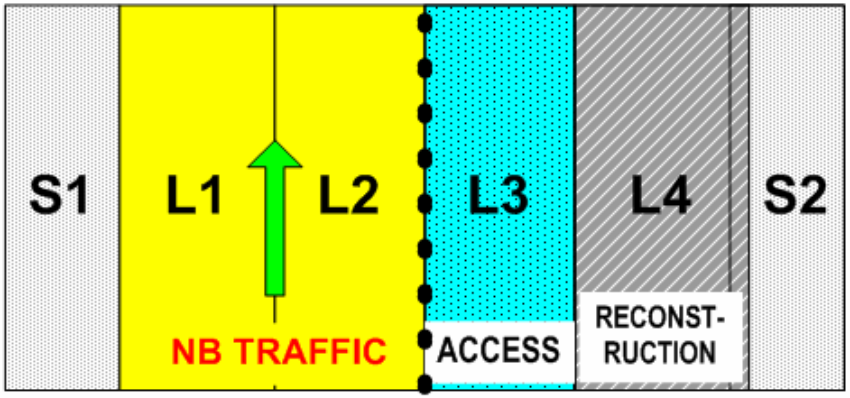
Construction Roadbed



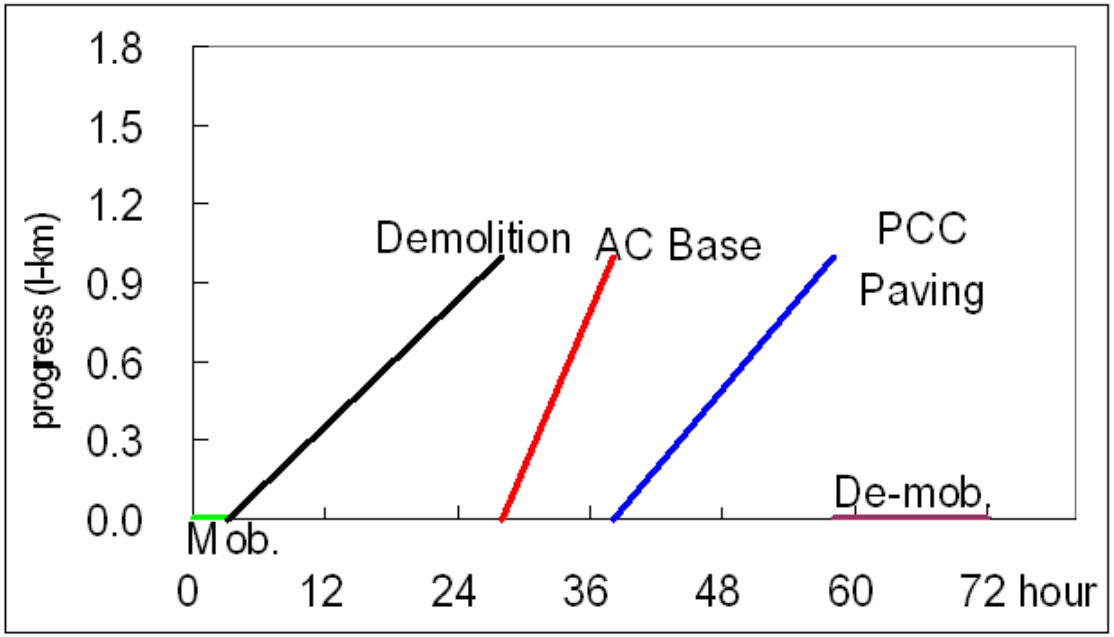
PCC Sequential Work Method
Half Closure of Construction Roadbed



Traffic Roadbed

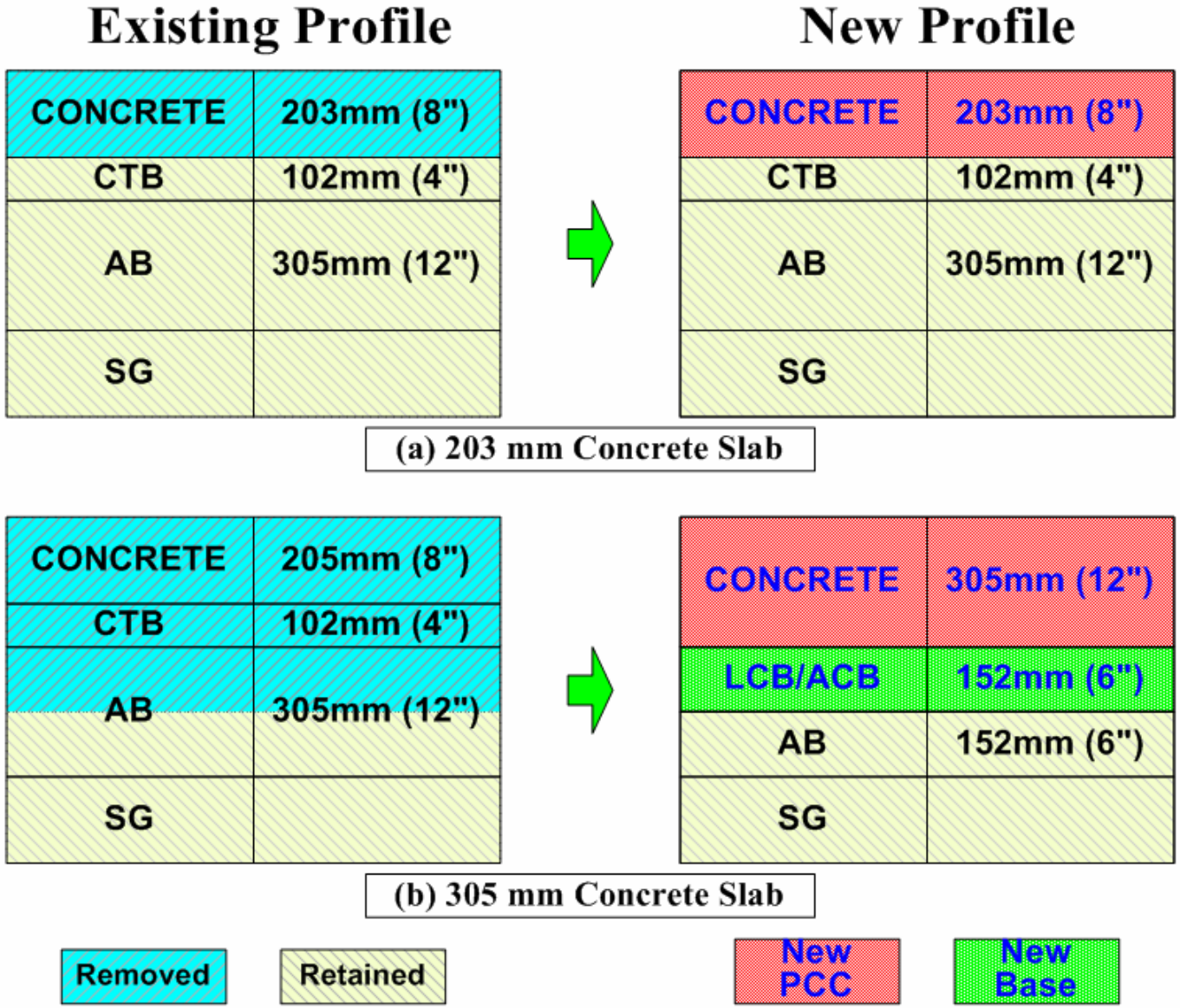


Construction Roadbed



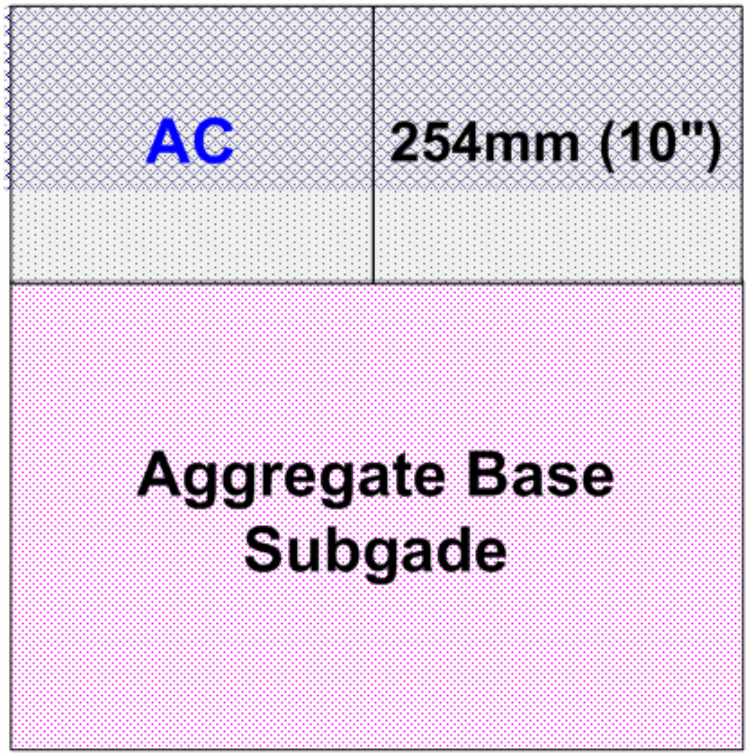
Portland Cement Concrete (JCPC)

Typical Caltrans Pavement Cross-section

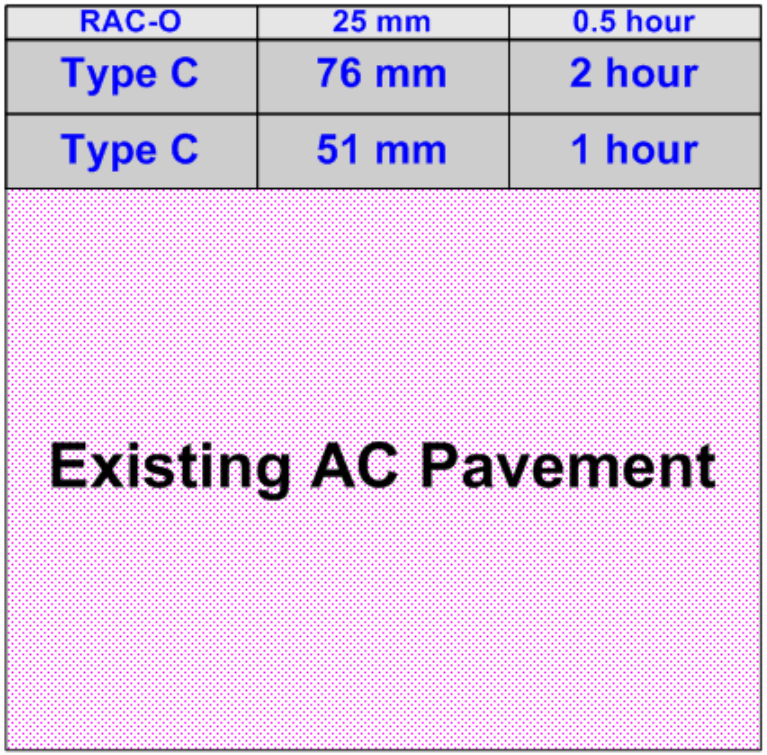


Milling and AC Overlay
Typical Caltrans Pavement Cross-section

Existing AC Pavement



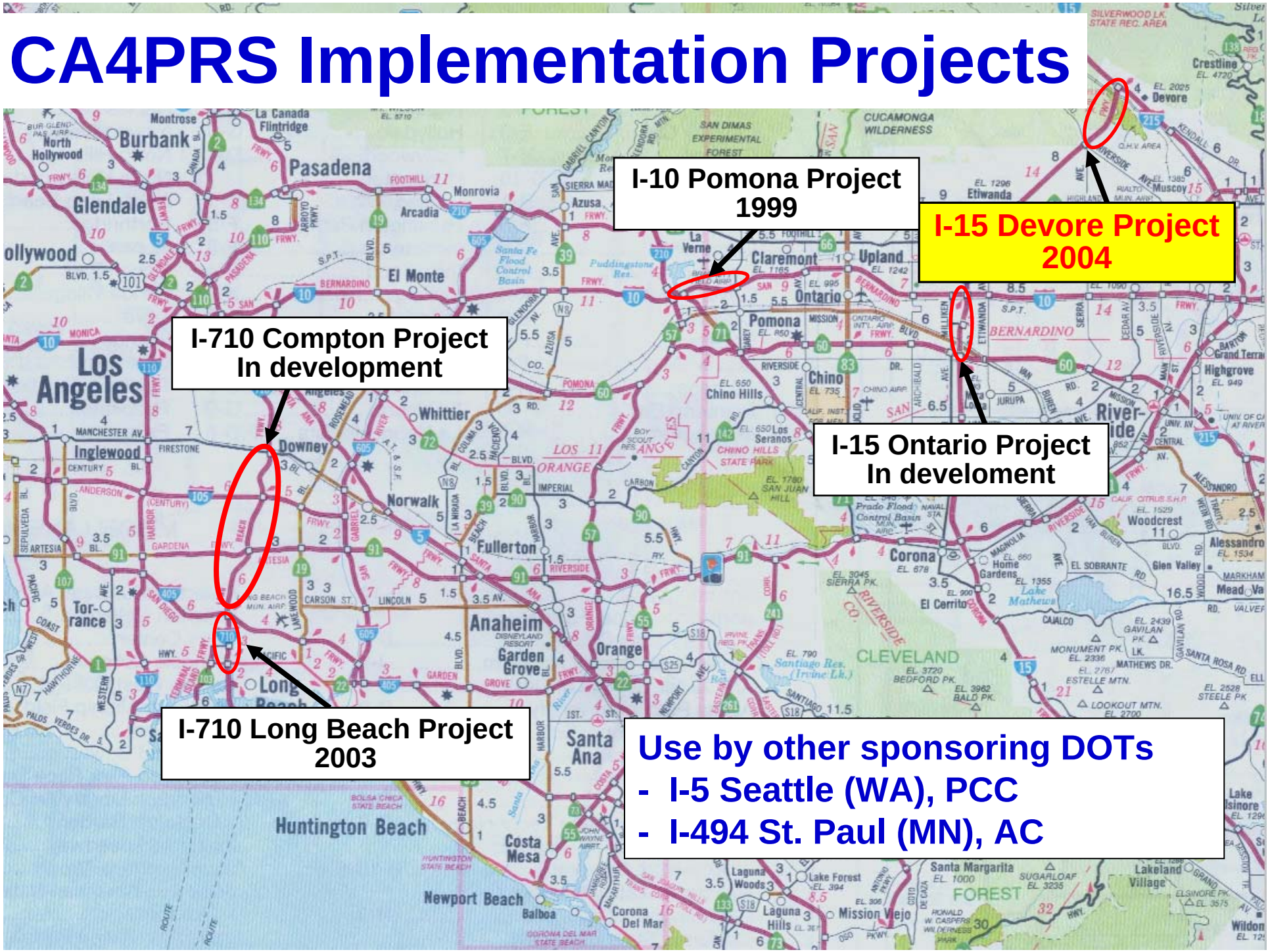
Total thick.=152mm (6")		
Layer	**Thick.**	**Cooling**
RAC-O	25 mm	0.5 hour
Type C	76 mm	2 hour
Type C	51 mm	1 hour



Milling | Retained | AC

Implementation Projects

CA4PRS Implementation Projects



I-10 Pomona (CA) Project, 2000

I-710 Long Beach (CA) Project, 2002

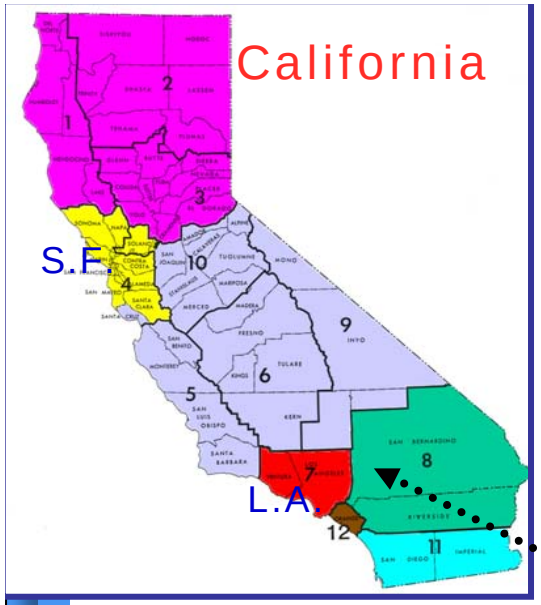
I-15 Devore 1 (CA) Project, 2004

I-15 Devore 2 Project, 2006

I-15 Devore Experience

(CA4PRS Demonstration)

I-15 Devore Reconstruction Project
(6-8 lanes PCC pavement built in 1969 -1975)



To Victorville/Barstow

CONSTRUCTION ZONE

Devore

Glen Helen Prkwy

Glen Helen Regional Park

Sierra Ave

Lytle Creek Wash

Riverside Ave

Highland Ave

Rancho Cucamonga

Foothill Blvd

Highland

Ontario

Fontana

Rialto

Colton

San Bernardino

To Palm Springs

To Los Angeles

Riverside

Norco

Corona

To San Diego

To Newport Beach

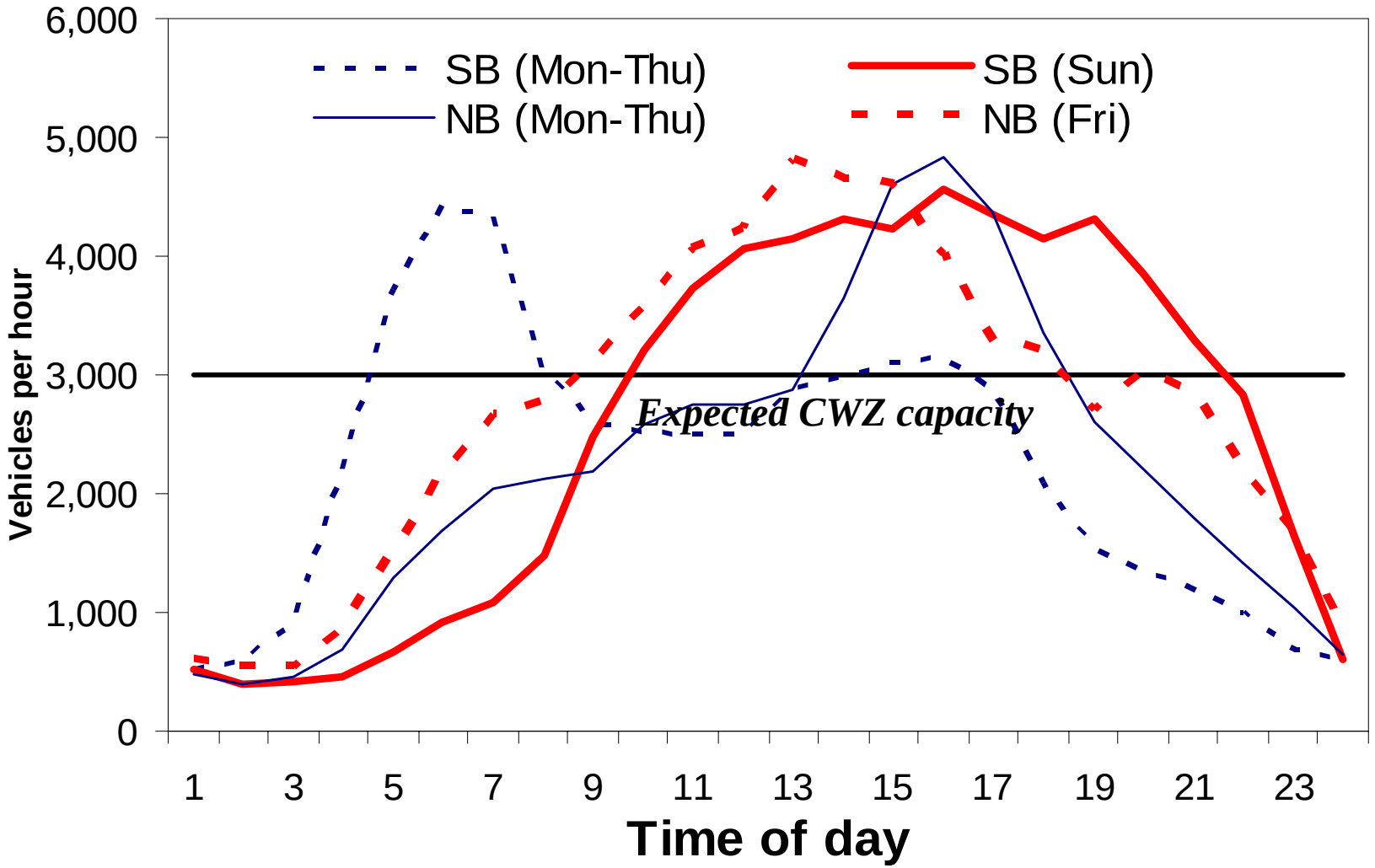
LEGEND

SUGGESTED ALTERNATE ROUTES

WORK AREA

I-15 Devore Daily Traffic Patterns

- Approximately 130,000 ADT (15% trucks)
- Weekdays Commuters + Weekend Leisure



I-15 Devore Project Summary Southern California (San Bernardino)

- **About 130,000 ADT (15% heavy trucks)**
  - Unique traffic pattern: weekday commuter and weekend leisure (to and from Las Vegas)
- **Two truck lane reconstruction: 3 miles long**
  - for each direction outside truck lane reconstructed, slab replacements in second truck lane
  - Rebuilt with 12” PCC (12-hour mix) with 6” AC base
  - One roadbed full closure with counter-flow traffic
  - Two 9-days continuous closures (24/7 operations)
  - Completed in October and November, 2004
- **Saved $6M agency and $2M RUC compared with traditional nighttime closures**

I-15 Devore Pre-Construction Analysis with *CA4PRS: Schedule-Traffic-Cost*

Construction Scenario	*Schedule Comparison*		Cost Comparison ($M)			Max. Peak Delay (Min)
	Total Closures	Closure Hours	User Delay	Agency Cost	Total Cost	
One Roadbed Continuous (24/7)	2	400	5.0	15.0	20.0	80
72-Hour Weekday Continuous	8	512	5.0	16.0	21.0	50
55-Hour Weekend Continuous	14	770	14.0	17.0	31.0	80
10-Hour Night-time Closures	220	2,200	7.0	21.0	28.0	30

Public reactions has changed 72-hour closures to one-roadbed continuous closures

CA4PRS Demonstration (PCC and AC)
Schedule and Traffic Module (PeMS)

I-15 Devore Project
(Construction Work-zone)

FHWA Public Roads: Jan/Feb 2007

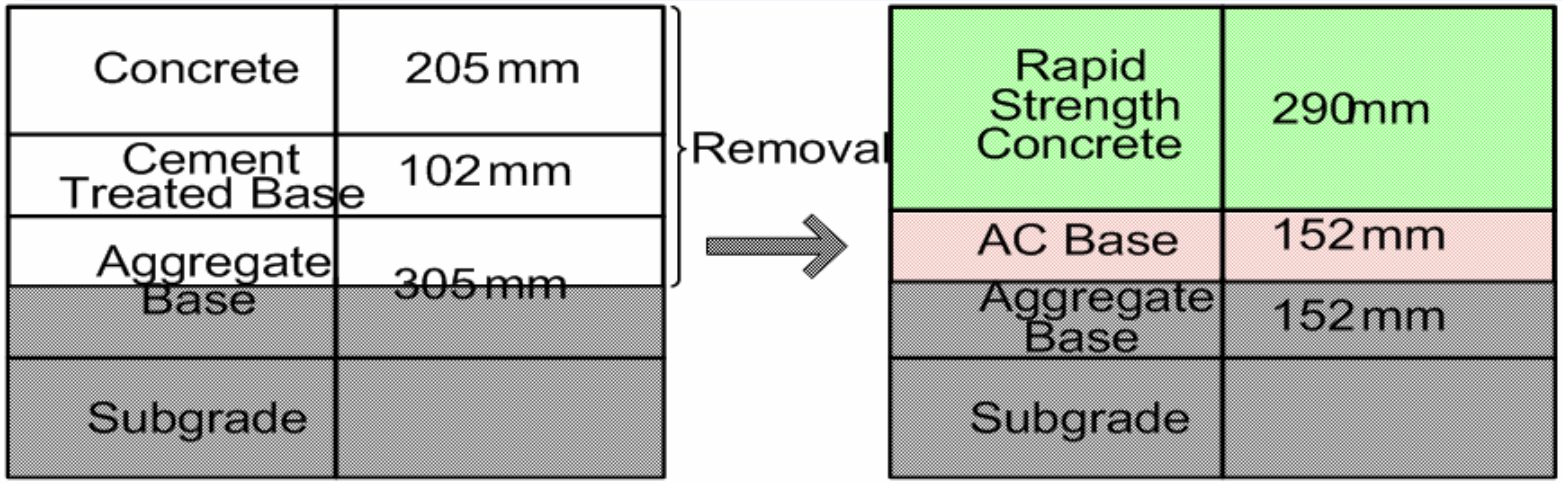
http://www.tfhrc.gov/pubrds/07jan/05.htm

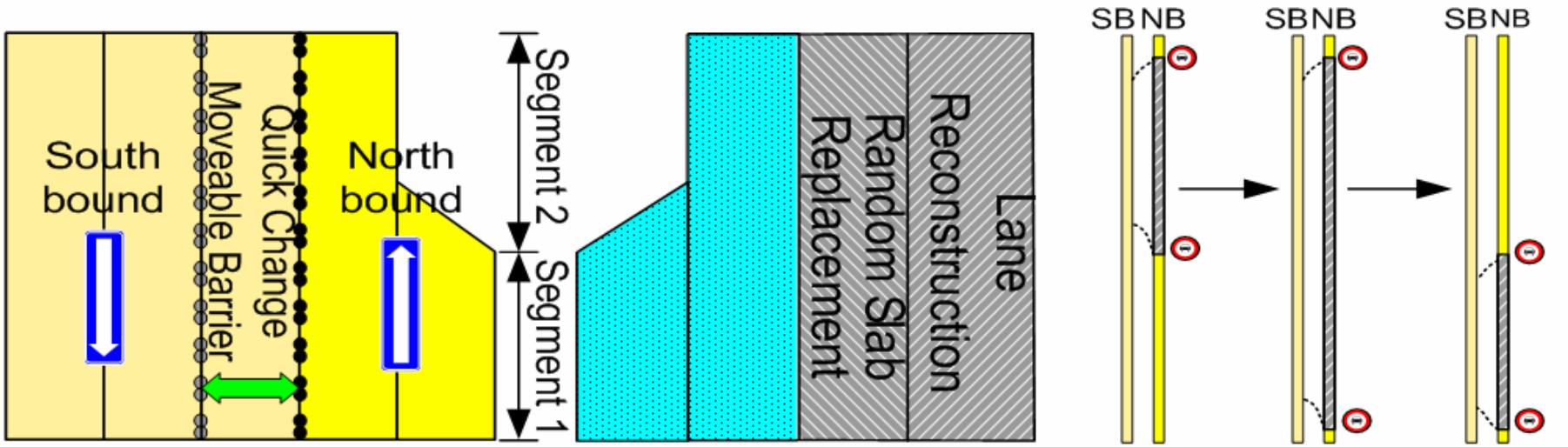
Continuous construction around the clock (24/9)

NB Construction: Oct. 3'rd – 13'th (9 days), 2004

SB Construction: Oct. 23'rd – Nov. 3'rd (9 days), 2004

I-15 Devore Pavement Cross-section and Lane-closure Scheme





Median Cross-over (South end)

Slab Removal (Non-impact Demolition)

Excavation (10” Milling) of Cement Treated Base and Aggregate Base

AC (AR-8000)Base (3” x 2 lifts) Paving

Shuttle Buggy Feeds Concrete for Paving

PCC Paving: Outer & Inner Truck Lanes

Dynamic (3/2) Lane Closure with QCMB

QCMB Operation Video

I-15 Devore Command Center

Roadmap for D8 Traffic Cameras and Signs

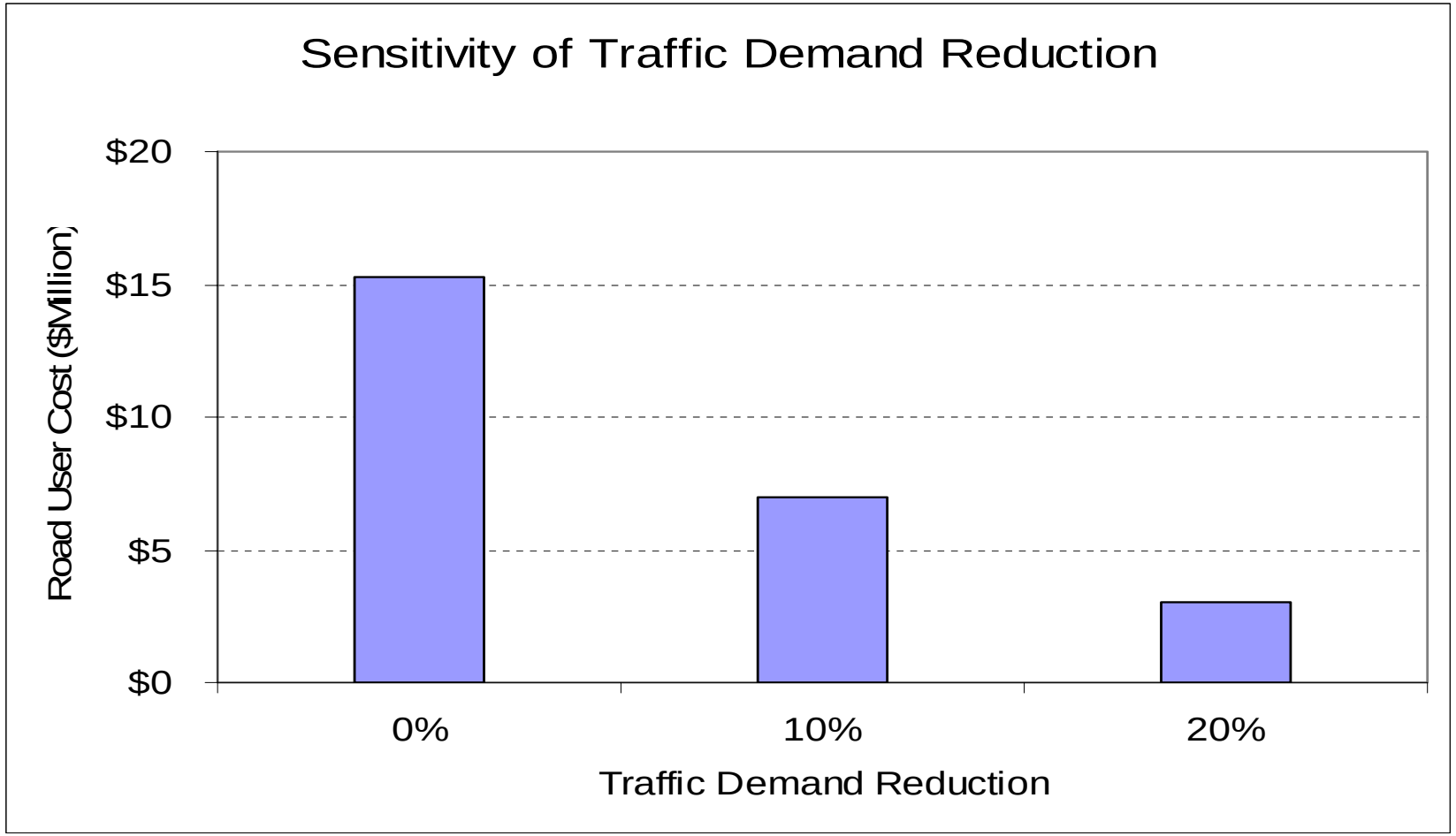
Traffic Camera on TV Screen

I-15 Devore Project
(Traffic Modeling Experience)

I-15 Devore: Traffic Analysis Models Integrated with CA4PRS

- **Step 1: Demand-Capacity Model (HCM)**
  - Road user cost: Compare all scenarios
  - Select the most economical scenario: Total cost
  - Sensitivity for TMP (Demand reduction, CWZ capacity)
- **Step 2: Macro Traffic Simulation (FREQ)**
  - Focus on the Selected Construction Scenario
  - Baseline for Incentives/disincentives and A+B contract
  - Develop lane closure charts
- **Step 3: Microscopic Simulation (PARAMICS)**
  - Blocking Freeway Connector: I-210 to I-15 NB
  - Truck restriction during peak hours through CWZ
  - Relocate the junction split location

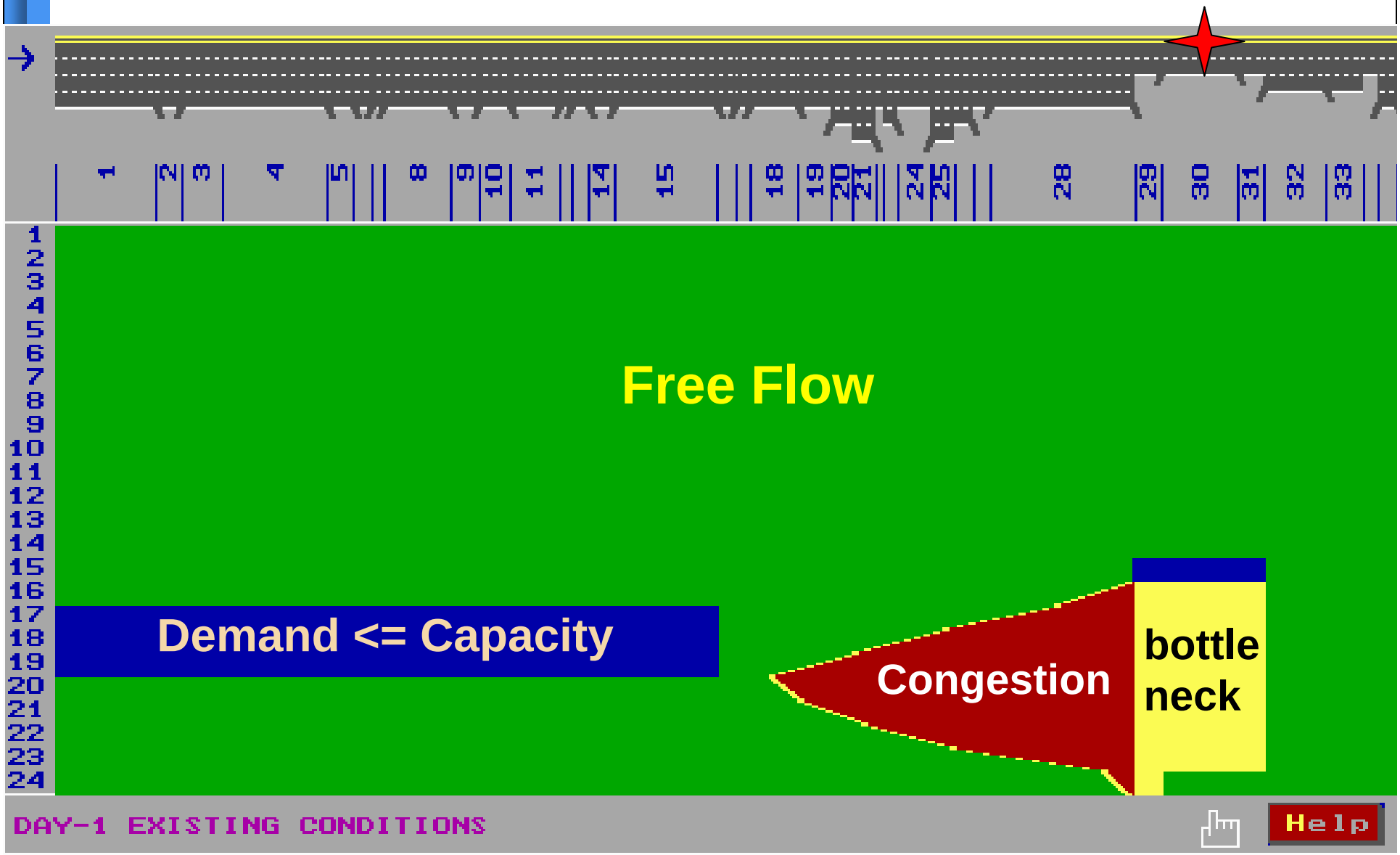
Sensitivity Analysis (1): emand Reduction: Road User Cost Demand-Capacity



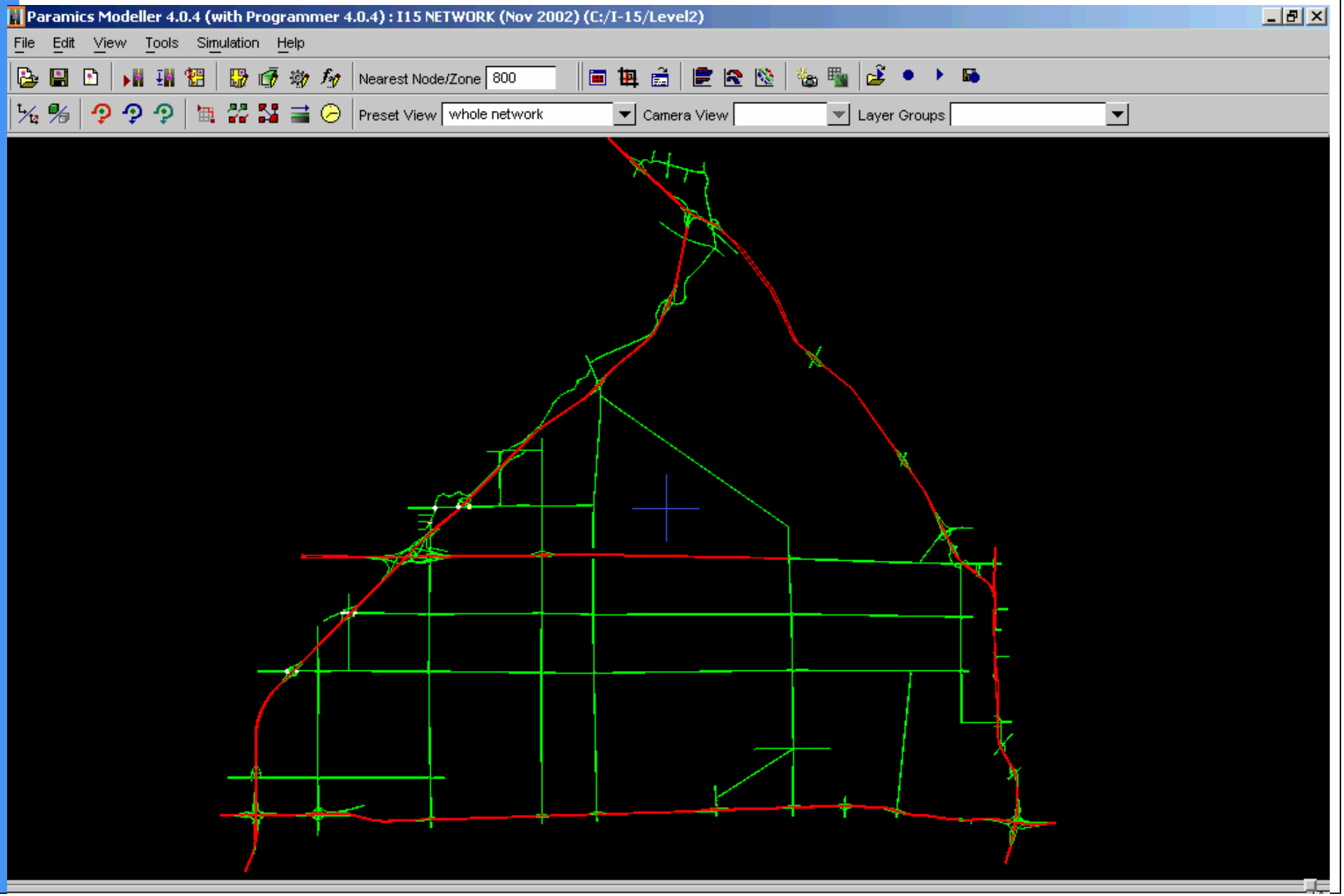
- Estimated by D-C model

FREQ Macro-simulation

Segment 1 Northbound Closure (NB traffic)



Paramics: Macroscopic Simulation Model



Simulation Sensitivity Analysis (1)
Truck Restriction Strategy (during Construction)

Segment 1 NB	No Restriction	Restriction	Difference (%)
Average Flow Rate (vehicle/hour)	1,738	1,598	-8.1
Total Travel Time (vehicle-hour)	2,796	2,300	-17.7
Average Travel Time (MM:SS)	24:08	21:35	-10.6
Average Speed (km/hr) on CWZ	52.0	63.7	+22.5

- Estimated in Paramics simulation.

Simulation Sensitivity Analysis (2)
I-15/I-215 SB Lane Split Strategy

Origin To Destination		No Action	Lane-split	Difference
I-15 North To I-15 South	Average Travel Time (min.)	32.0	22.8	-29 %
	Through-traffic (veh/hr)	2,492	2,948	18 %
	Max. Queue (km)	5.5	2.0	-63 %
I-15 North To I-215 South	Average Travel Time (min.)	23.1	12.0	-48 %
	Through-traffic (veh/hr)	1,752	1,993	14 %
	Max. Queue (km)	5.5	2.0	-63 %

Comparison of Traffic Models in Analysis

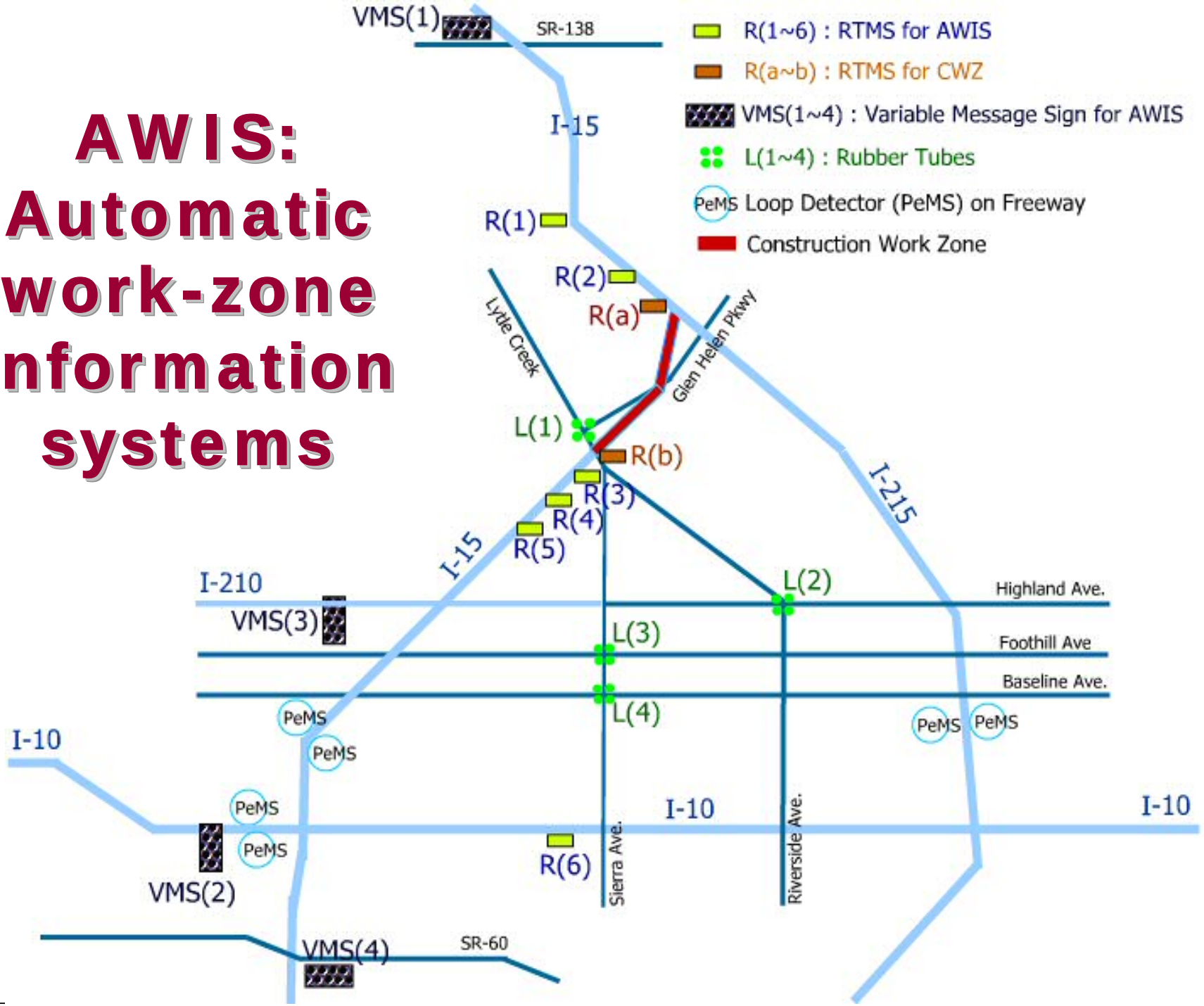
CA4PRS (Demand-Capacity), FREQ, and Paramics

Traffic Analysis Tool	Efforts (weeks)	Total Delay (vehicle-hours)	Max. Delay Per closure (min.)		Max. Queue (mile)	
			NB	SB	NB	SB
CA4PRS (HCM)	1	618,000	75	40	7.8	5.9
FREQ	3	631,000	47	35	7.1	8
PARAMICS	20	-(*)	48	26	7.2	7.3

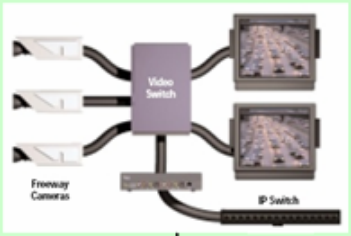
* Reference: NB peak-hour delay = 2,863 v-h for Paramics vs 3,250 v-h for FreQ

I-15 Devore Project
(Automated Work-zone Information Systems)

AWIS: Automatic work-zone information systems



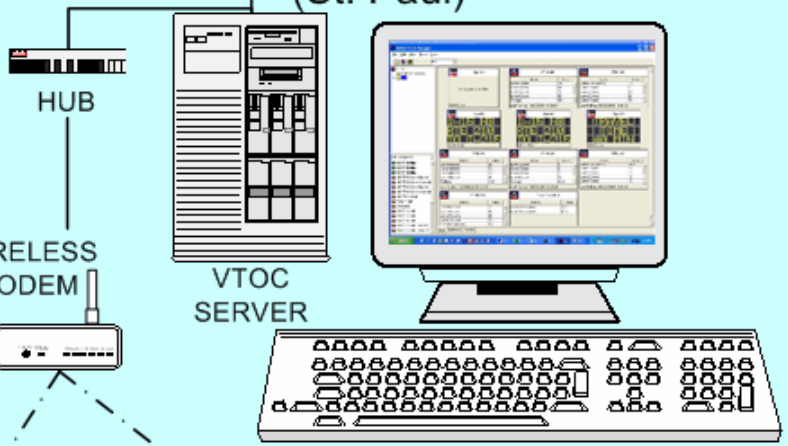
District TMC



I-15 Command Center (Caltrans)

CCTV MONITORS

Virtual Transportation Operations Center (St. Paul)



Permanent Changeable Message Signs

Traffic Monitoring Stations

(RTMS)

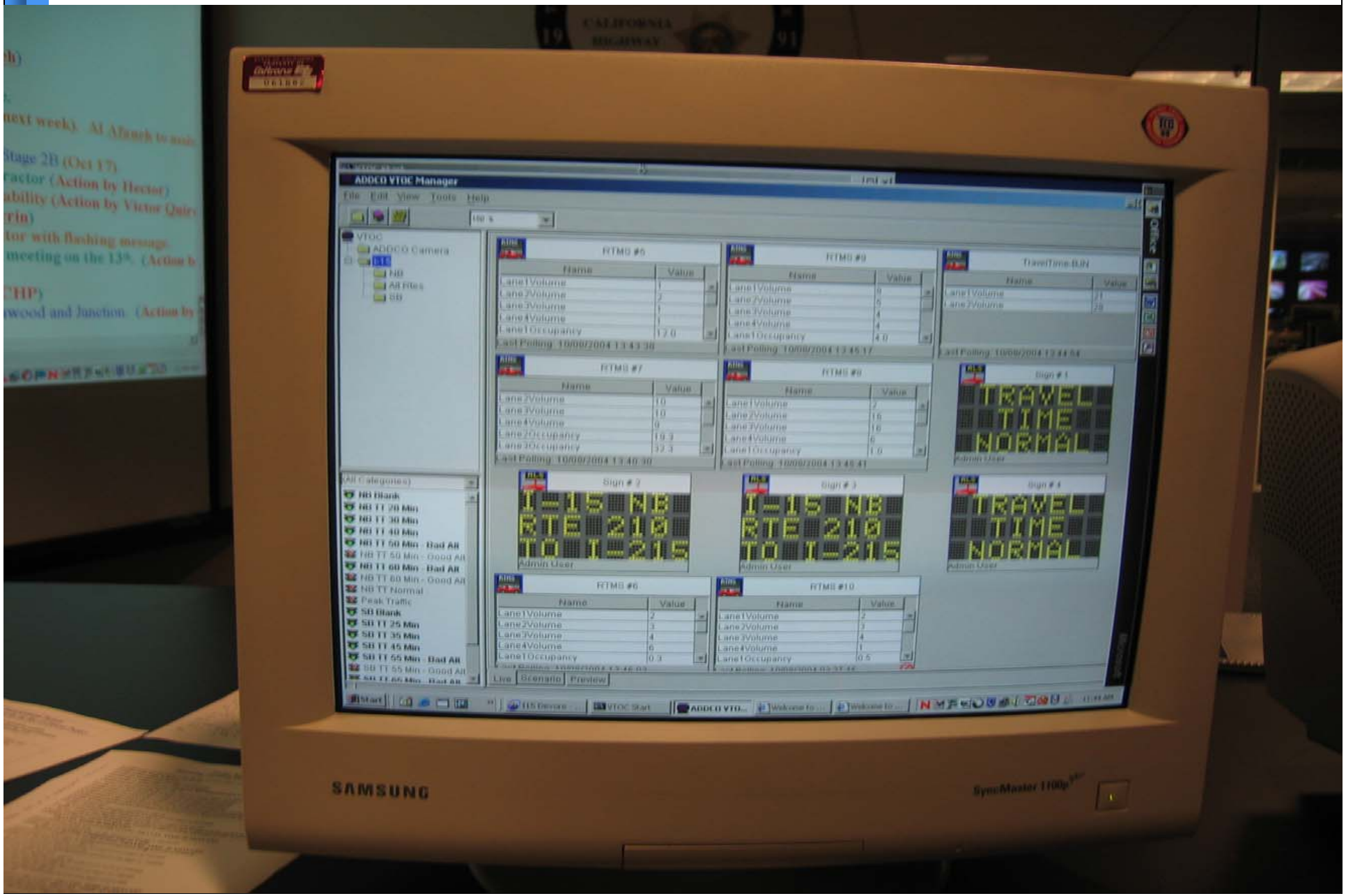
Portable Changeable Message Signs

Displayed Messages on PCMS Units

SCENARIO	N B	S B
#1	TRAVEL TIME NORMAL	TRAVEL TIME NORMAL
#2	TRAVEL TIME 20MIN	TRAVEL TIME 25MIN
#3	TRAVEL TIME 30MIN	TRAVEL TIME 35MIN
#4	TRAVEL TIME 40MIN DETOUR 10E=>215N	TRAVEL TIME 45MIN DETOUR 215S
#5	TRAVEL TIME 50MIN DETOUR 10E=>215N	TRAVEL TIME 55MIN DETOUR 215S
#6	TRAVEL TIME 60+MIN DETOUR 10E=>215N	TRAVEL TIME 65+MIN DETOUR 215S

Detour Sign toward I-10 East on Permanent CMS

AWIS Server Screen in Command Center



Edit View Favorites Tools Help

Search Favorites Media

http://www.dot.ca.gov/dist8/i15devore/realtime_trafficmap.htm

Go

- Frequently Asked Questions
- Project Photos
- Real-time Traffic Map
- Commuter Resources
- Contact Us

Navigation Links

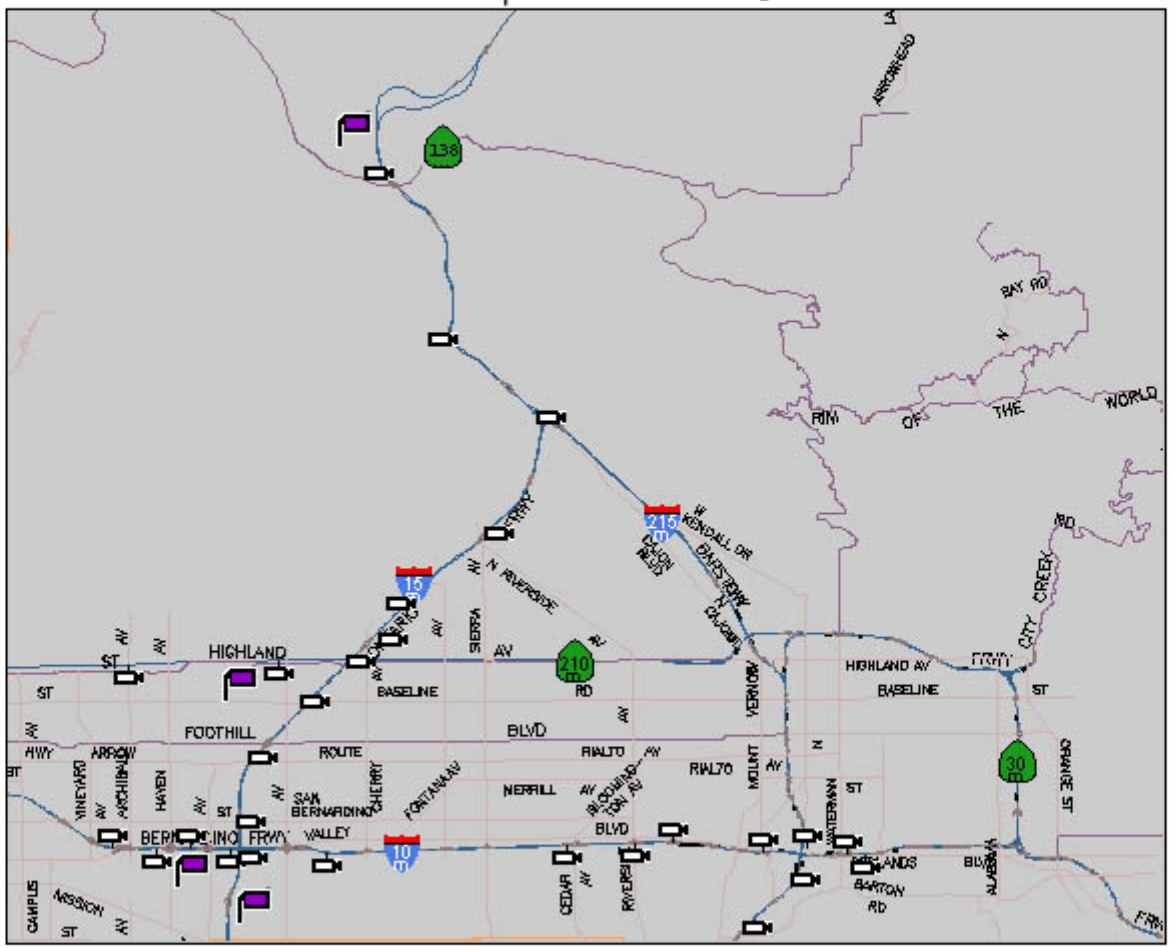
- I-15 Devore Project Home
- Caltrans District 8 Home
- California Home

Caltrans

Symbols on map that can be clicked:

= Camera

= Travel Time Message



Click here to view real-time streaming cameras

Note: To play these streaming camera feeds, you must have the Windows Media Plug-in installed properly. Click here to download the Windows Media Plug-in.

Internet

http://www.dot.ca.gov/dist8/tmc/Cam48.jpg - Microsoft...
File Edit View Favorites Tools Help
Back Search Favorites Media
Address http://www.dot.ca.gov/dist8/tmc/Cam48.jpg
Go Links
Wednesday, October 13, 2004 - 6:09:17 PM
Done
Internet

http://www.dot.ca.gov/dist8/tmc/sign3.htm - Microsoft ...
File Edit View Favorites Tools Help
Back Search Favorites Media
Address http://www.dot.ca.gov/dist8/tmc/sign3.htm Go Links
Travel Time Message Sign Display:
I-15 NB RTE 210 TO I-215
TRAVEL TIME NORMAL
(Travel time message generated on: Wed Oct 13 12:41:00 2004)
Done
Internet

Traffic Measurement Summary
(Before- versus During-construction)

	Route	ADT	Peaks
CWZ	I-15 NB	-16%	-17%
	I-15 SB	-19%	-18%
Detours	I-215 SB	+15%	+16%
	I-10 EB	+10%	+36%
	I-215 NB	+3%	+12%
Arterials	Lytle Creek& Glen Helen	+7%	+6%
	Major Intersections	+2%	+5%

I-15 Devore Project

(Public Outreach and Perception Changes)

Public Outreach to News Media

Edit View Favorites Tools Help

Search Favorites Media

http://www.dot.ca.gov/dist8/i15devore/

Go

California Home

Wednesday, September 22, 2004

Welcome to California

Translate page to:

Select language

DISTRICT 8 ONLINE

search

My CA This Site

Caltrans > District 8 > I-15 Devore Project Home

I-15 Devore Project

- Schedule
- Traffic Plan
- Suggested Alternate Routes
- Benefits Of Project
- Press Releases and Announcements
- Lane Closures (Fast Fax)
- Frequently Asked Questions
- Real-time Traffic Map
- Contact Us

Navigation Links

- I-15 Devore Project Home
- Caltrans District 8 Home
- California Home

Governor Arnold Schwarzenegger

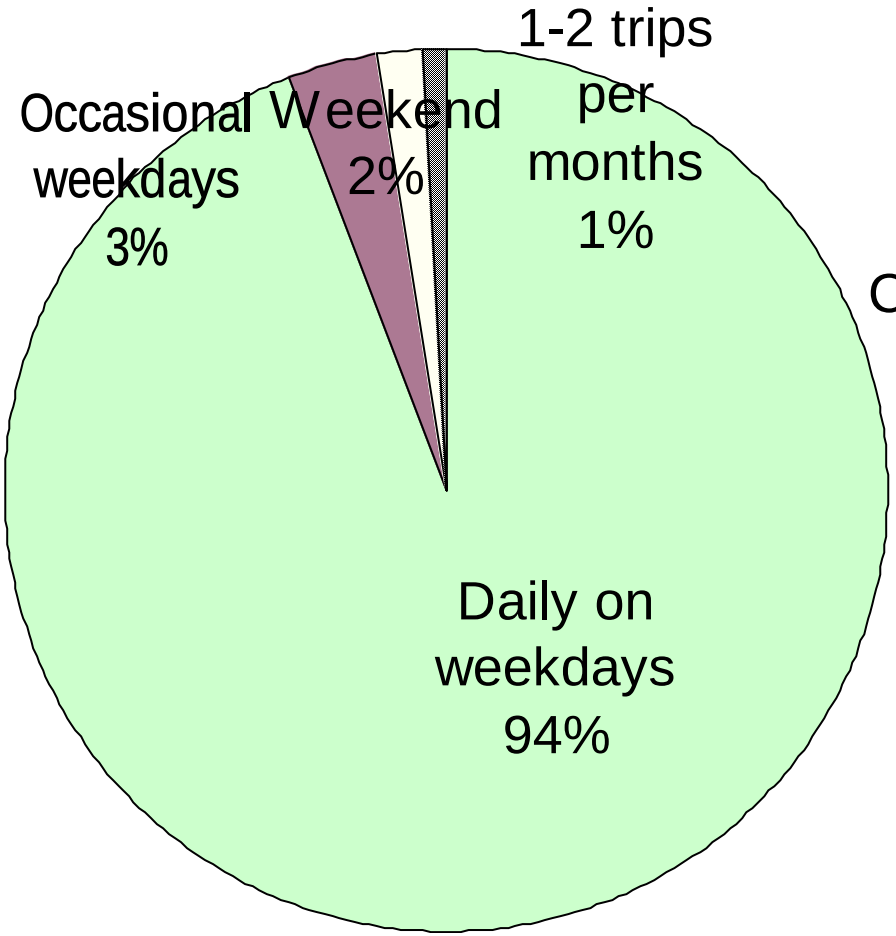
I-15 Devore Project

The I-15 Devore website has a total of about 100,000 visits (page views) from August through December, 2004.

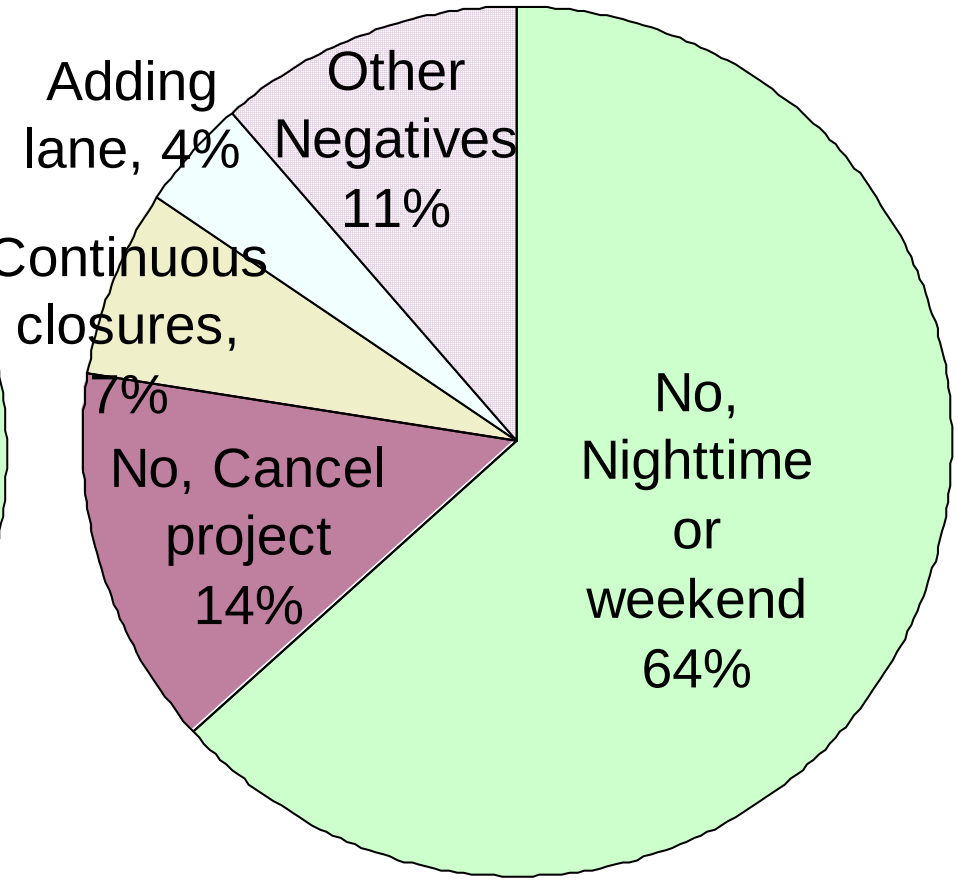
Internet

I-15 Devore Web-Surveys (400)

Initial Negative Public Reaction

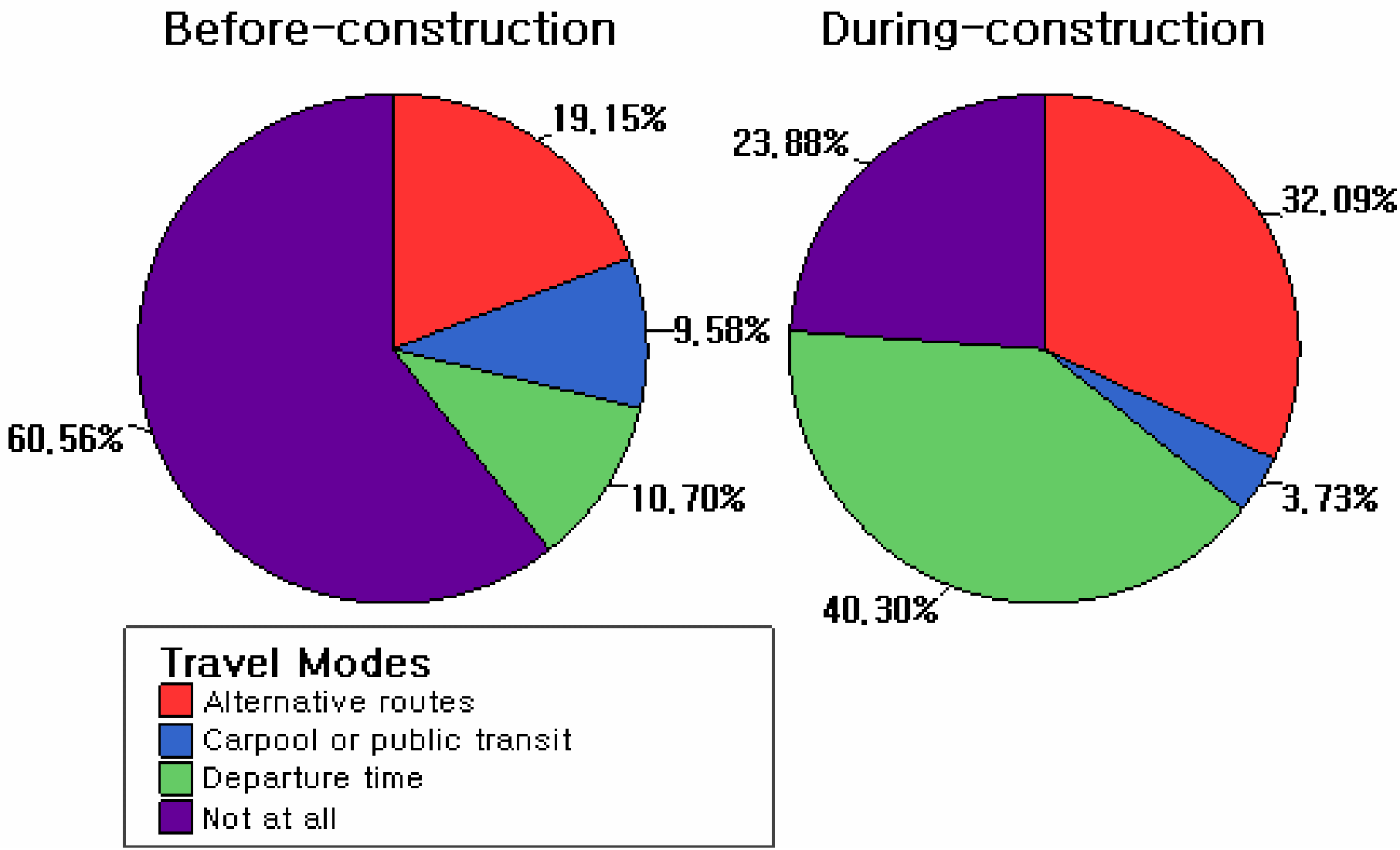


Do you typically use the I-15 Freeway through Devore?

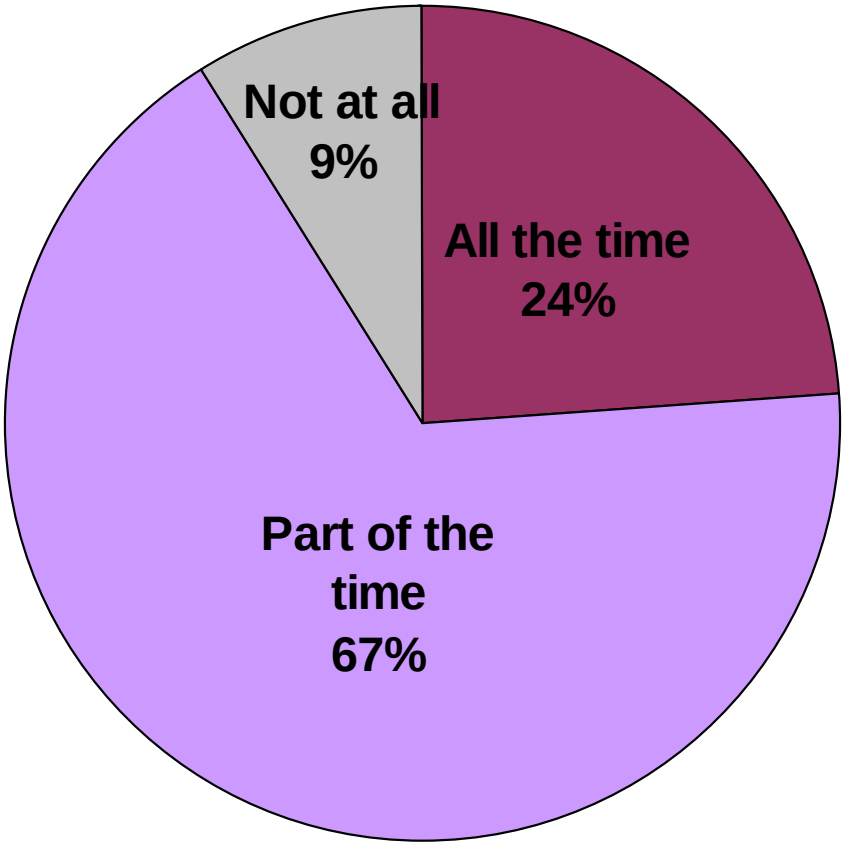


Do you support 72-hour weekday closures?

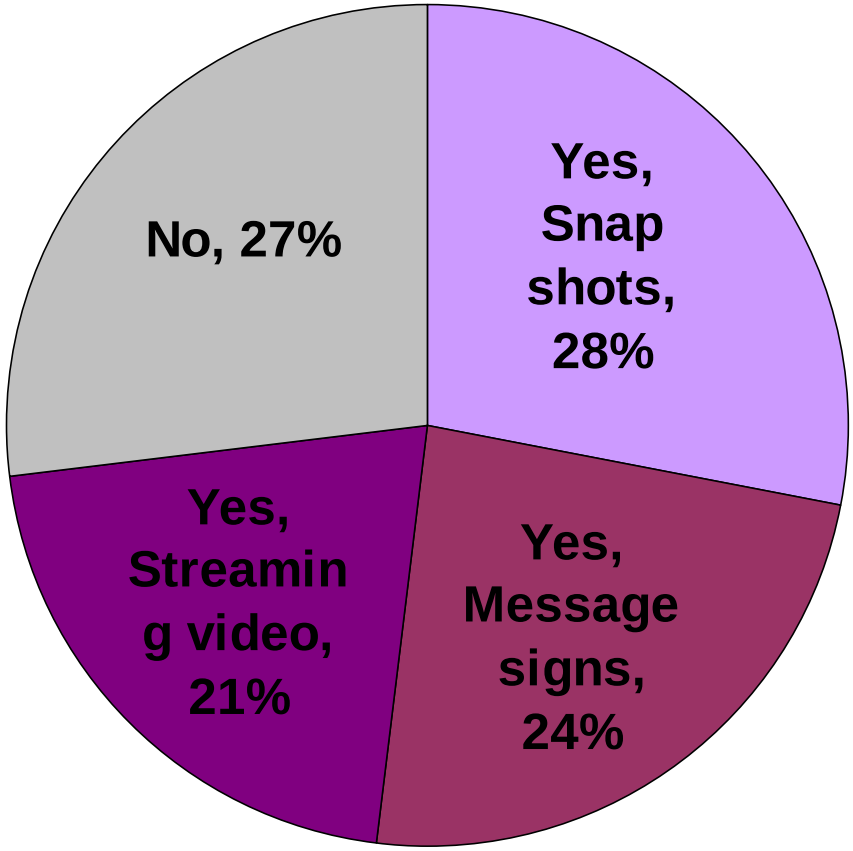
I-15 Devore Web-Surveys:
Travel Mode Changes



I-15 Devore Web-Surveys:
AWIS Utilization



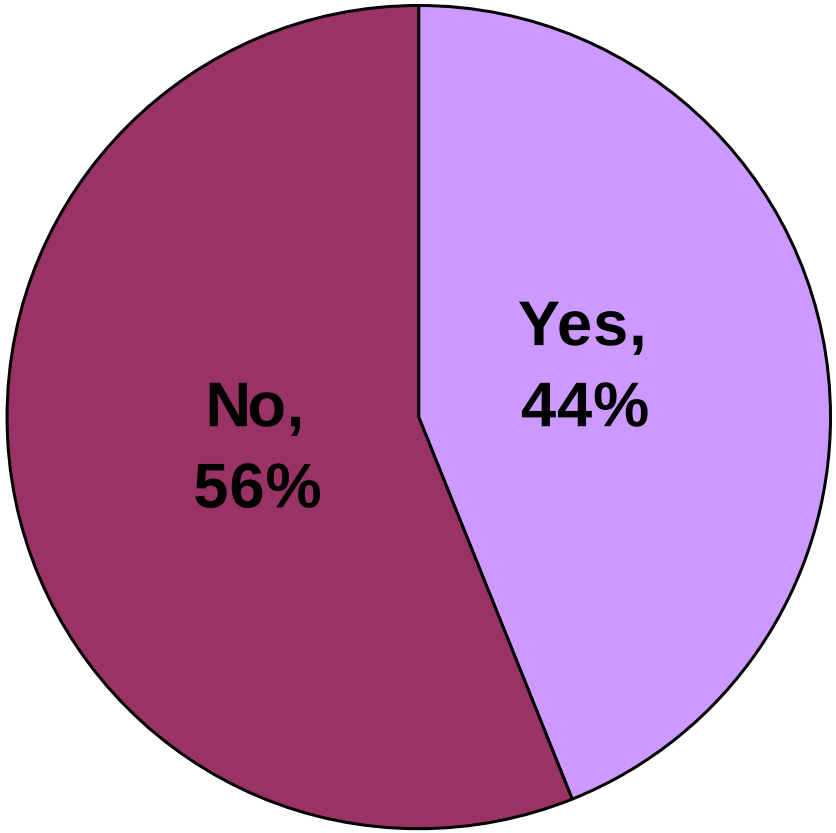
Did you find AWIS travel message signs "Accurate"?



Did you utilize Real-time Traffic Map on our website?

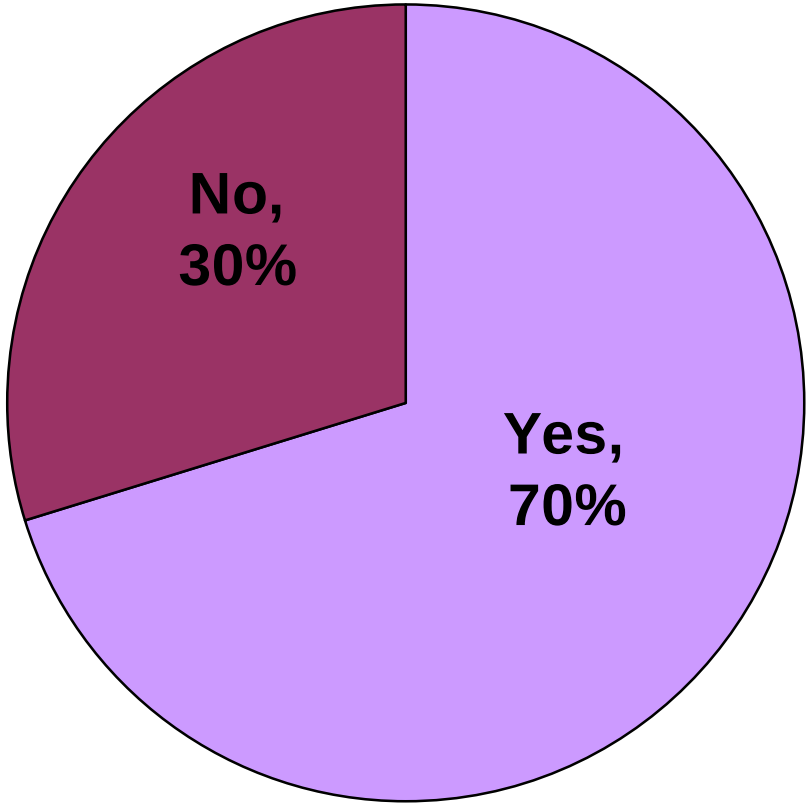
I-15 Devore Web-Surveys:
Public Perception Changes

Before- construction



Do you support I-15 Devore "Rapid Rehab" approach?

After-construction



Do you support future "Rapid-Rehab" projects?

CA4PRS Outreach & Enhancement

- Outreach: Publications
  - **Brochure**
  - **TR News (May/June 2004)**
  - **FHWA FOCUS (June 2006)**
  - **TRB and ASCE Journals**
- V2.0: Cost Module
- V2.5: Interchange and Widening
- V3.0: Bridge Replacement
- V4.0: Life Cycle Cost Analysis (Realcost)

Thank you!
More Information?

- **Contact**
  - **Keith Platte (AASHTO)**
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  - **Michael Samadian (Caltrans)**
    - *Tel: (916) 324-2048; E**mail:** Michael_M_Samadian@dot.ca.gov*
  - **Dr. E.B. Lee (UC Berkeley)**
    - *(510) 665-3637;* ***Email:*** *eblee@berkeley.edu*
  - **Dr. Nadarajah Sivaneswaran (Siva)** (FHWA)
    - ***(202) 493-3147; Email:*** *n.sivaneswaran@dot.gov*

- **CA4PRS Web (Caltrans) or "CA4PRS" in Google**

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

Paramics: LINK HEADWAY FACTOR SENSITIVITY ANALYSIS

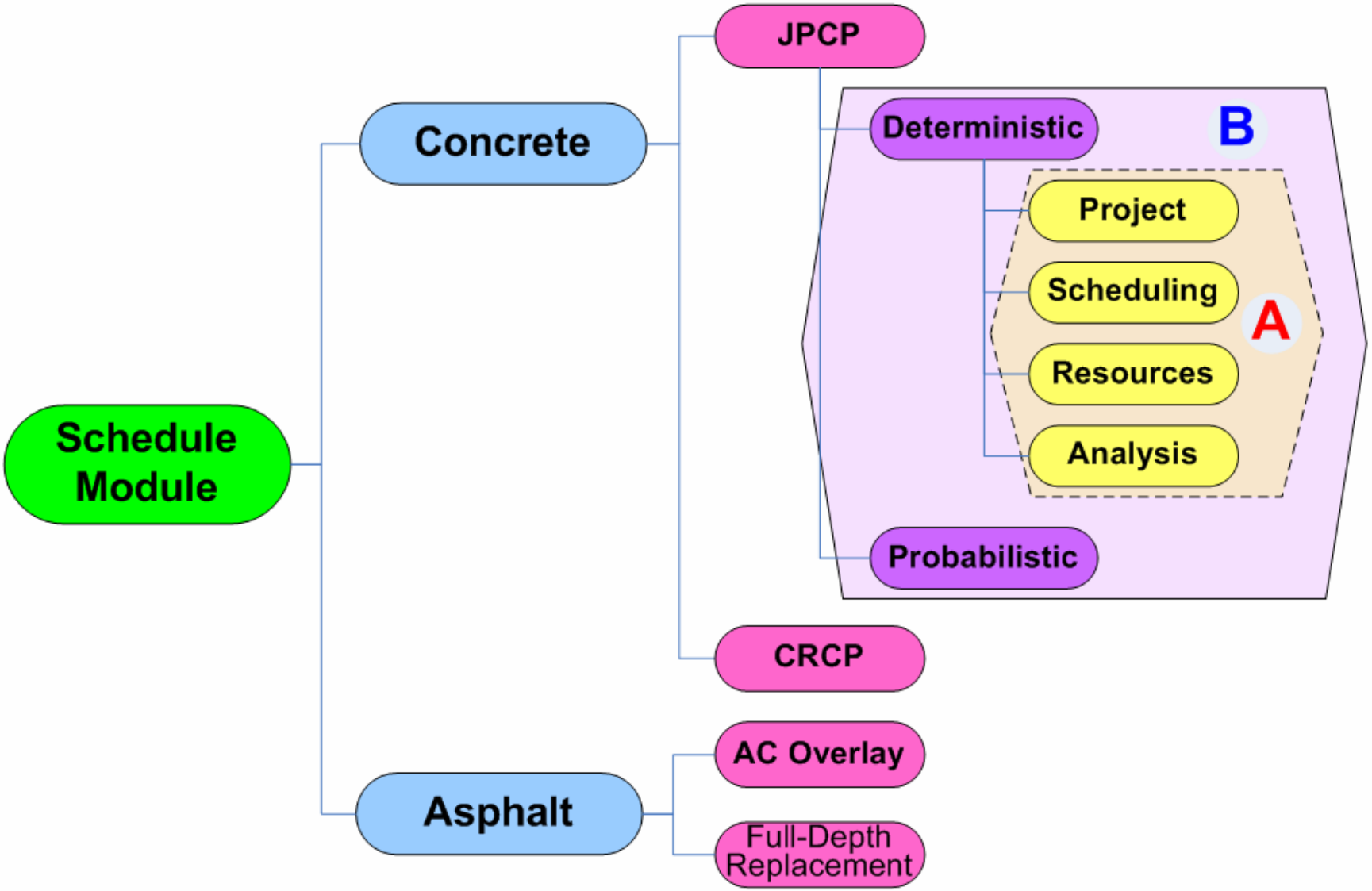
Link Headway Factor	Resulting Capacity (in veh/hr/ln)
1.0	2,500
1.2	2,350
1.5	2,000
1.8	1,600
2.0	**1,500**
2.5	1,300

Deteriorated Pavement: I-10 Pomona (LA)

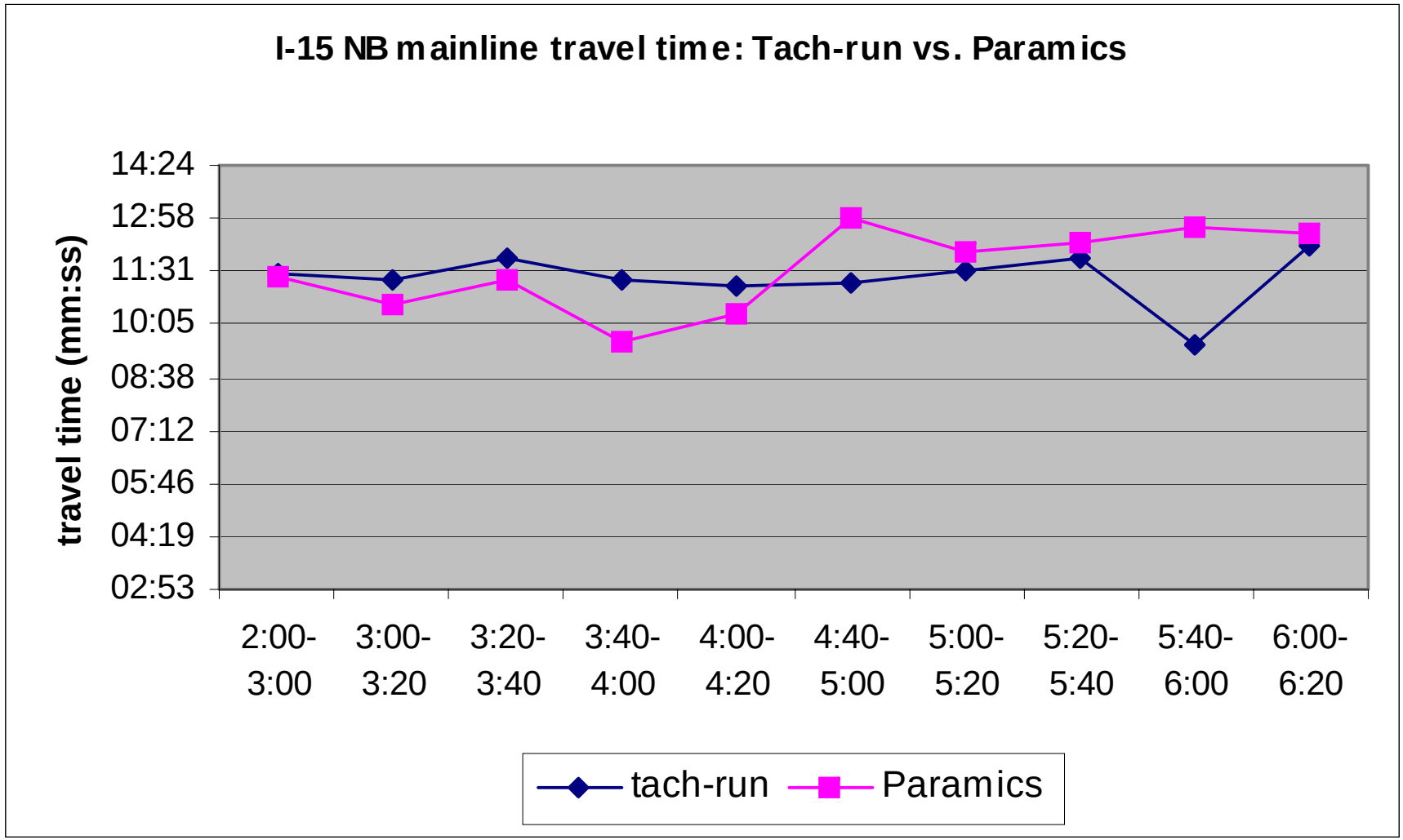
Caltrans LLPRS and CA4PRS

- **LLPRS: Long-life Pavement Rehabilitation Strategies**
  - Rebuild 2,500 lane-km of deteriorated roadways
  - Criteria: High traffic volume (ex. 150,000 ADT) or heavy trucks
  - Candidate projects are mostly PCC pavements in the LA & SF
- **LLPRS Objectives and Approach**
  - Provide 30-40 years of design-life with minimum maintenance
  - Get-in Get-out & Stay-out: FHWA AASHTO TRB collaboration
  - Minimizing closure impact on traffic delay and local business
- **CA4PRS: A tool for Decision-making Process**
  - FHWA pooled fund study (CA, MN, TX, WA)
  - Software tool to calculate construction duration and traffic delay for different strategies
  - Team-building, Department approval, and Public justification

CA4PRS Schedule Analysis Menu Tree



Simulation calibration: Travel-time before-closure: Simulation vs. Tech-run



Simulation Estimated Speed (before vs. during-construction)

I-15 NB	PARAMICS SPEED CONTOUR - Base Run														(Monday)	
	Section number															
Interval Start	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
15:00		58.0	70.0	68.5	71.1	69.4	65.4	68.2	67.5	61.8	68.6	65.5	76.2	65.0	68.7	67.5
15:20		59.3	75.1	69.3	53.2	65.3	65.4	66.6	66.9	61.9	67.7	66.1	68.4	65.0	68.7	59.1
15:40		68.1	68.7	60.3	55.8	62.2	56.1	68.9	68.7	60.6	65.7	71.2	75.1	67.3	70.1	61.7
16:00		56.9	69.4	68.5	56.5	62.9	61.6	71.1	68.2	64.7	65.3	72.0	68.5	65.7	69.1	62.8
16:20		57.1	68.7	56.6	57.1	64.7	61.2	69.3	68.6	61.7	71.8	65.5	60.7	70.0	66.0	58.0
16:40		60.0	64.3	69.7	59.2	66.7	63.9	67.7	68.5	65.1	69.1	73.1	60.4	70.4	65.2	56.5
17:00		57.4	70.7	69.3	64.3	65.6	63.1	66.6	68.4	65.5	67.1	60.5	68.1	68.1	73.1	62.8
17:20		58.9	69.1	68.5	63.8	63.2	58.7	66.1	60.4	67.6	60.2	66.7	71.1	66.6	67.8	58.4
17:40		56.3	65.5	62.7	65.5	63.0	66.1	68.5	67.5	60.7	65.3	71.5	68.4	67.9	65.0	59.4
18:00		66.6	76.6	64.4	66.2	55.8	53.1	66.8	67.1	60.1	67.9	70.9	67.3	68.3	69.9	57.7
18:20		65.1	76.0	62.1	68.8	64.1	60.7	69.0	66.0	60.4	68.1	64.5	64.1	68.8	70.1	64.6
18:40		57.8	75.8	47.0	61.0	60.0	63.3	67.7	69.0	61.7	69.1	70.0	63.2	68.9	69.0	65.1

I-15 NB	CONSTRUCTION (SEG1NB) SPEED CONTOUR														(Monday)	
	Section number															
Interval Start	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
15:00	66.8	74.5	54.4	64.7	44.8	44.8	42.6	44.9	44.7	51.9	50.6	63.3	52.7	64.1	69.0	42.0
15:20	68.0	75.0	57.6	67.5	44.2	44.2	45.8	34.9	40.3	54.8	51.2	57.1	52.6	63.6	68.5	44.7
15:40	68.8	76.5	57.6	69.1	45.2	45.2	44.0	33.8	36.1	59.2	52.5	58.1	54.9	62.5	68.5	42.0
16:00	66.5	74.5	56.2	68.5	46.0	46.0	45.7	35.7	37.3	53.8	51.9	58.1	54.2	64.1	68.7	41.0
16:20	67.2	74.5	56.5	68.4	45.0	45.0	45.1	37.0	41.7	51.9	50.4	57.2	54.8	61.1	69.5	38.3
16:40	68.2	74.5	56.6	67.4	44.9	44.9	44.9	36.1	39.7	54.4	51.3	57.5	54.2	64.7	69.8	36.3
17:00	67.1	74.5	57.0	67.7	45.0	45.0	44.7	33.9	36.6	55.8	51.9	58.3	55.1	64.6	69.6	38.0
17:20	68.0	74.5	56.2	68.2	44.1	44.1	45.7	34.8	41.2	58.3	51.1	56.9	52.9	63.5	68.7	40.0
17:40	67.5	74.5	55.9	68.1	42.7	42.7	44.8	36.3	33.7	56.1	52.5	58.4	53.8	64.2	68.1	41.3
18:00	67.3	75.0	55.7	65.9	44.3	44.3	45.2	35.0	38.1	54.2	51.0	57.4	52.4	61.2	69.5	46.0
18:20	68.2	75.0	56.5	67.9	42.4	42.4	45.3	35.6	42.3	50.0	51.0	57.7	54.8	64.9	68.1	33.7
18:40	66.7	74.0	56.7	67.7	43.5	43.5	45.6	36.0	45.4	54.1	51.8	58.8	55.8	65.0	69.5	41.0