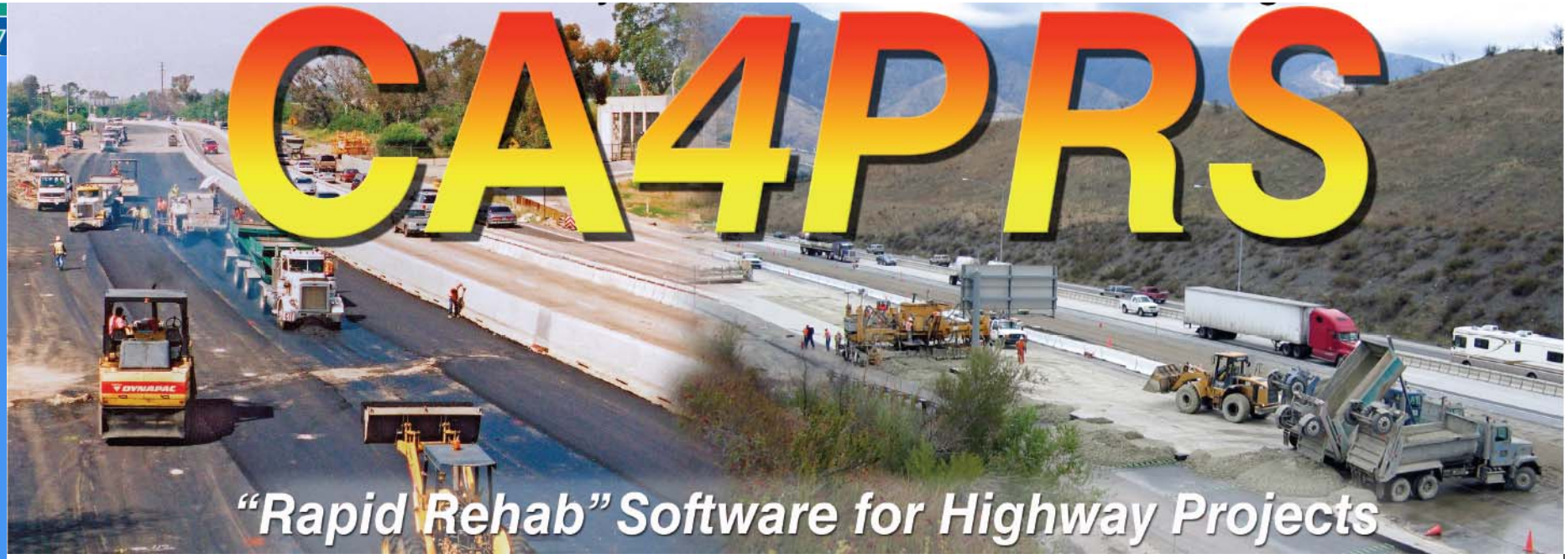


Construction Analysis for Pavement Rehabilitation Strategies

2-Day Hands-on Training for Districts

Spring, 2008

Instructor: E.B. Lee, Ph.D, PE, PMP

University of California at Berkeley

Institute of Transportation Studies - UCPRC

Course Start-up

- Sign-up sheet and Name tag
- Self-introduction
  - Name, Discipline, Career
- Package
  - CD (references), Manual (Screenshots), Brochures
- Initial assessment (Acronym Quiz)
- Projects data

Course Schedule - Day 1

8:30 – 9:00 a.m.	Course Introduction
9:00 – 10:10 a.m.	Session 1: *CA4PRS* Overview
10:10 – 10: 30 a.m.	AM Break
10:30 – 12:00 p.m.	Session 2: Concrete Rehabilitation (JPCP)
12:00 – 1:00 p.m.	Lunch
1:00 – 2:20 p.m.	Session 3: Concrete Rehabilitation (CRCP)
2:20 – 2:40 p.m.	PM Break
2:40 – 4:10 p.m.	Session 4: AC Rehabilitation (CSOL & FDAC)
4:10 – 4:30 p.m.	Fist-day Wrap-up

Course Schedule - Day 2

8:30 – 10:000 a.m.	Session 5: AC Rehabilitation (MACO)
10:00 – 10: 20 a.m.	**AM Break**
10:20 – 12:00 p.m.	Session 6: Design-Traffic Integration (WZ delay)
12:00 – 1:00 p.m.	**Lunch**
1:00 – 2:15 p.m.	Session 7: Implementation (TMP & Simulations)
2:15 – 2:30 p.m.	**PM Break**
2:30 – 3:45 p.m.	**Session 8: District Projects Analysis**
3:45 – 4:00 p.m.	**Wrap-up and Course Evaluation**

CA4PRS Introduction

- Development Background
- Modeling Alternatives
- Implementation Projects
- Outreach Promotion
- Screen Shots

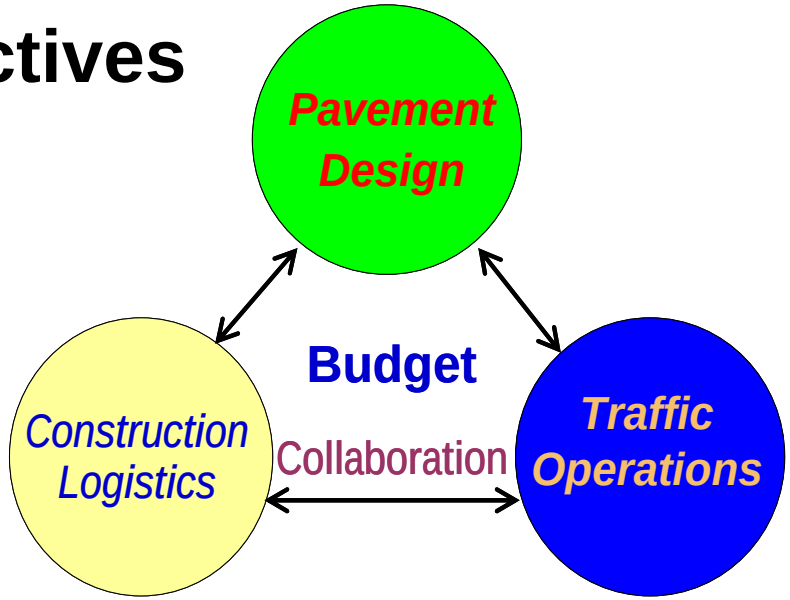
Development Background

The Challenge We Face in Highway Infrastructure Renewal

- **Highway infrastructure must be renewed**
  - Many pavements have reached their design life
  - DOTs shift their focus to highway sustainability (4-R)
  - We must rehabilitate highways under live traffic (urban)
- **Impacts of construction work-zone to public**
  - CWZ lane closures create adverse impacts to travelers, local communities, and businesses: safety & mobility

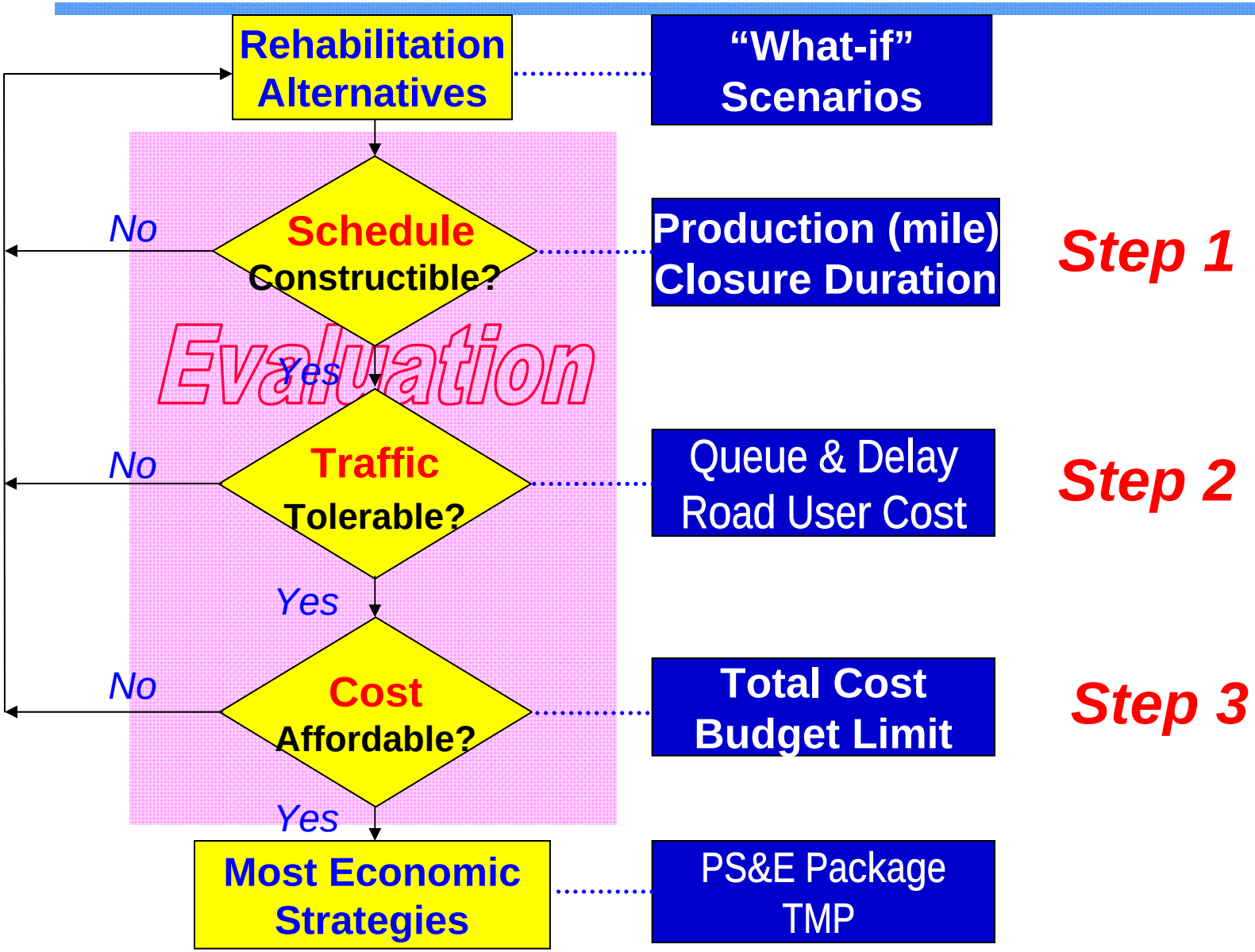
How Do We Meet This Challenge?

- **Balancing *<u>competing</u>* objectives**
  - (1) Longer-lasting design;
  - (2) Faster construction delivery;
  - (3) Tolerable traffic delays;
  - (4) Agency budget constraint
  - Needs tools for optimization and effective teamwork solution



- **CA4PRS Tool: 'Rapid Rehab' Software**
  - FHWA pooled fund for SPTC (CA, FL, MN, TX)
  - Decision-support computer model for DOT to help select the most economic rehabilitation strategies
  - Estimate **<u>construction duration</u>**, to **calculate <u>traffic delay</u>**, and **to compare <u>agency cost</u>**

CA4PRS Analysis Framework
Multi-discipline Team Solution



Modeling Alternatives

CA4PRS Comparison Alternatives
Schedule-Delay-Cost Comparison

TRAFFIC	DESIGN	CONSTRUCTION
Nighttime Weekend Daytime (shift) Continuous	PCCP (JPCP) CRCP AC Overlay Full-depth AC	Concurrently Sequentially Access Environment
Full-closure (CF) Full-closure Partial-closure	Cross-section Concrete Mix Shoulder	Trucks Plant Crew

PCC => PCC (Jointed Concrete)

Typical CA Pavement Cross-section

Existing Profile

CONCRETE	203mm (8")
CTB	102mm (4")
AB	305mm (12")
SG	

New Profile

CONCRETE	203mm (8")
CTB	102mm (4")
AB	305mm (12")
SG	

(a) 203 mm Concrete Slab

CONCRETE	205mm (8")
CTB	102mm (4")
AB	305mm (12")
SG	

CONCRETE	305mm (12")
LCB/ACB	152mm (6")
AB	152mm (6")
SG	

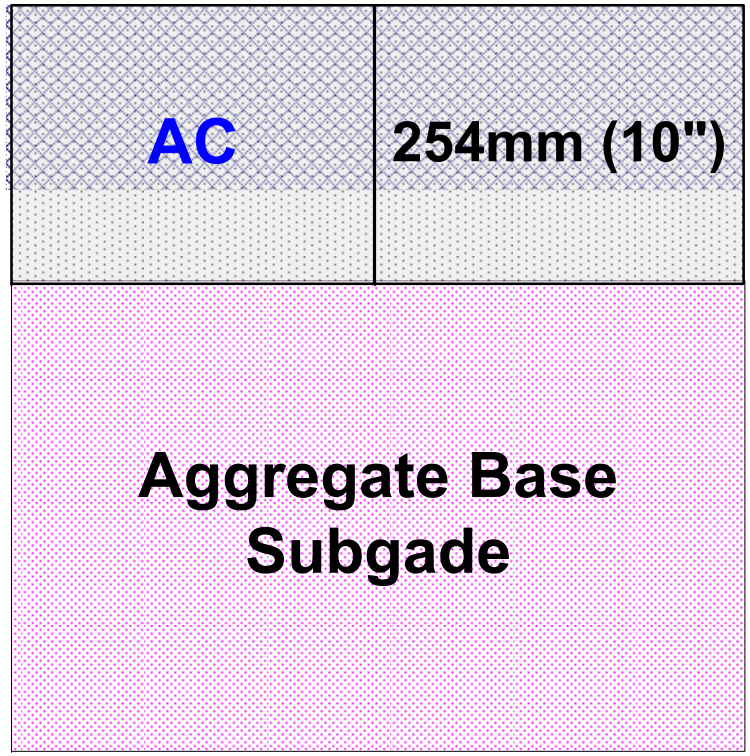
(b) 305 mm Concrete Slab

Removed | Retained | New PCC | New Base

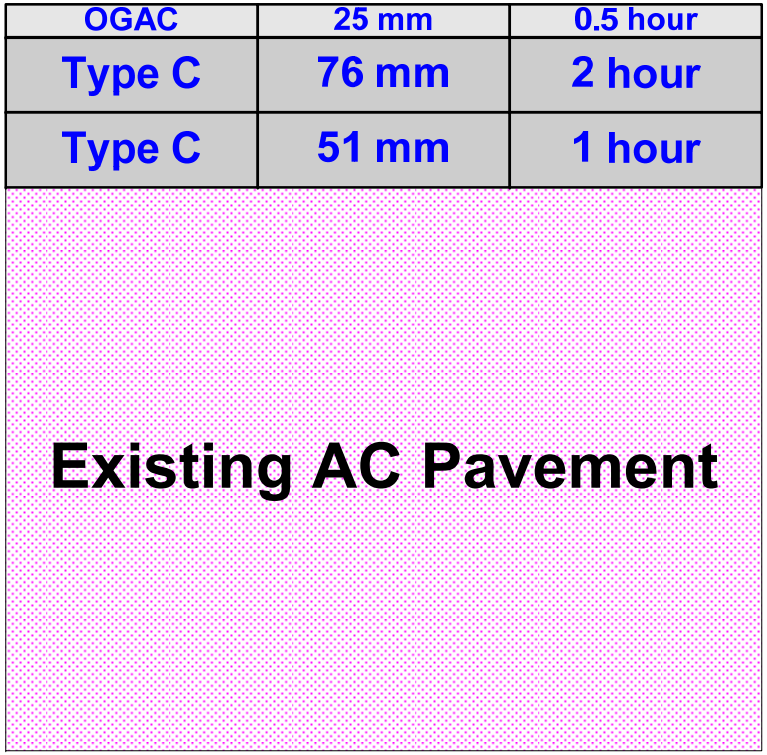
AC => AC (Milling and AC Overlay)

Typical CA Pavement Cross-section

Existing AC Pavement



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



Milling | Retained | AC

PCC => AC (Crack-seat AC Overlay and Full-depth AC Replacement) Typical CA Cross-section

Existing Pavement

PCC	203mm (8")
CTB	102mm (4")
AB	305mm (12")
SG	

CSOL

Total thick. = 230 mm (9")

Layer	Thick.	Cooling
OGFC	25 mm	0.5 hour
PBA-6a	75 mm	4 hour
AR-8000	75 mm	4 hour
AR-8000	55 mm	2 hour

PCC	203mm (8")
CTB	102mm (4")
AB	305mm (12")
SG	

Retained | Fabric | AC(CSOL)

OR

FDAC

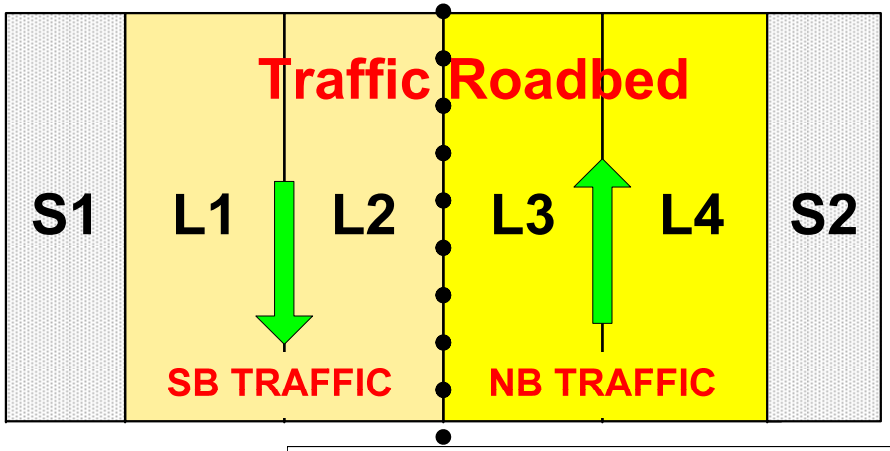
Total thick.=330mm (13")

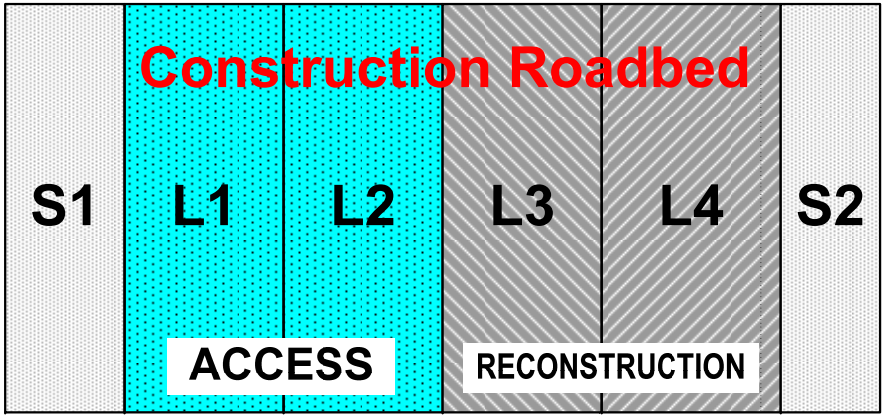
Layer	Thick.	Cooling
OGFC	25 mm	0.5 hour
PBA-6a	76 mm	1.5 hour
AR-8000	77 mm	6.5 hour
AR-8000	76 mm	2 hour
Rich-bottom	76 mm	1 hour

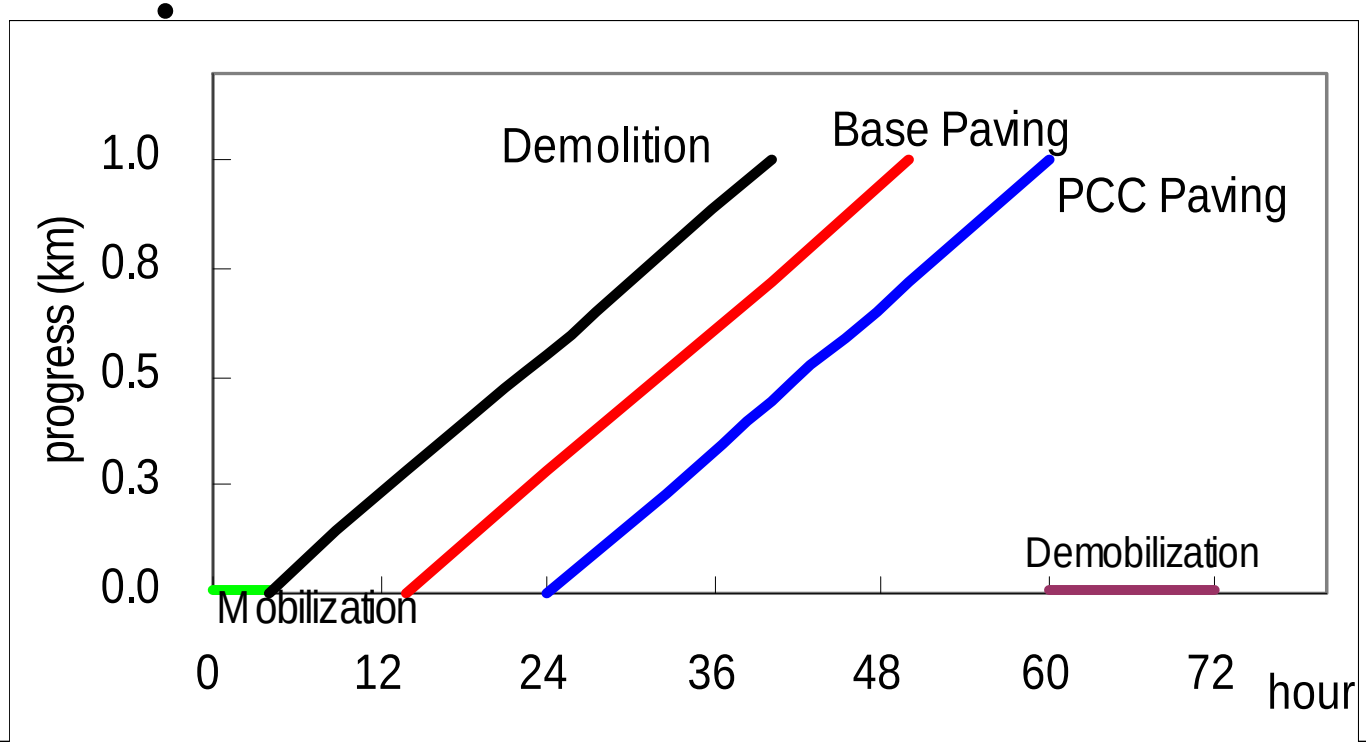
AB	279mm (11")
SG	

Removed | Retained | AC

Balance of Closure – Access – Production
Full Closure for PCC Concurrent Method

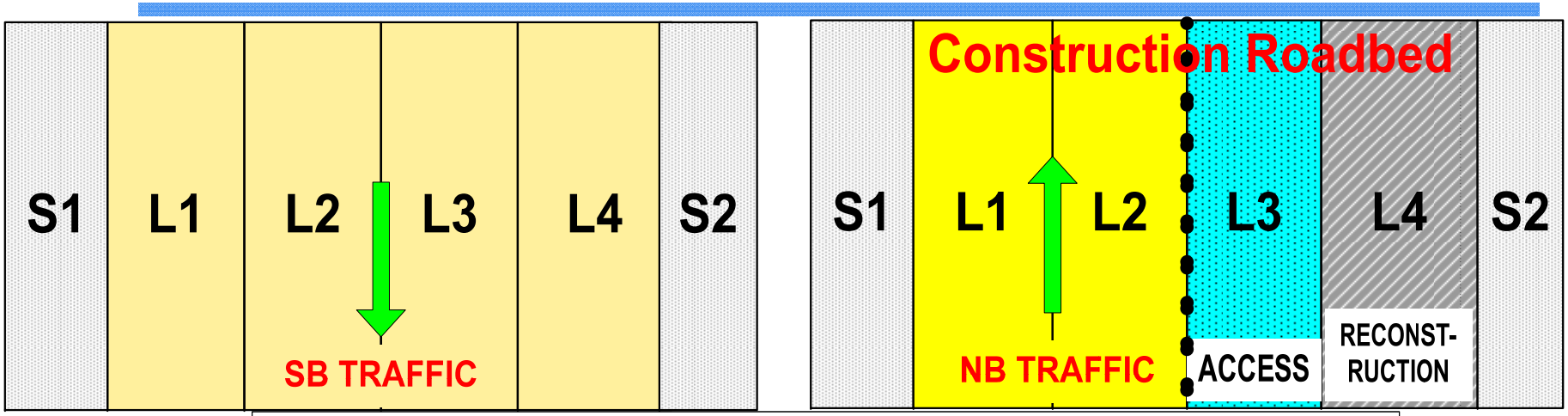


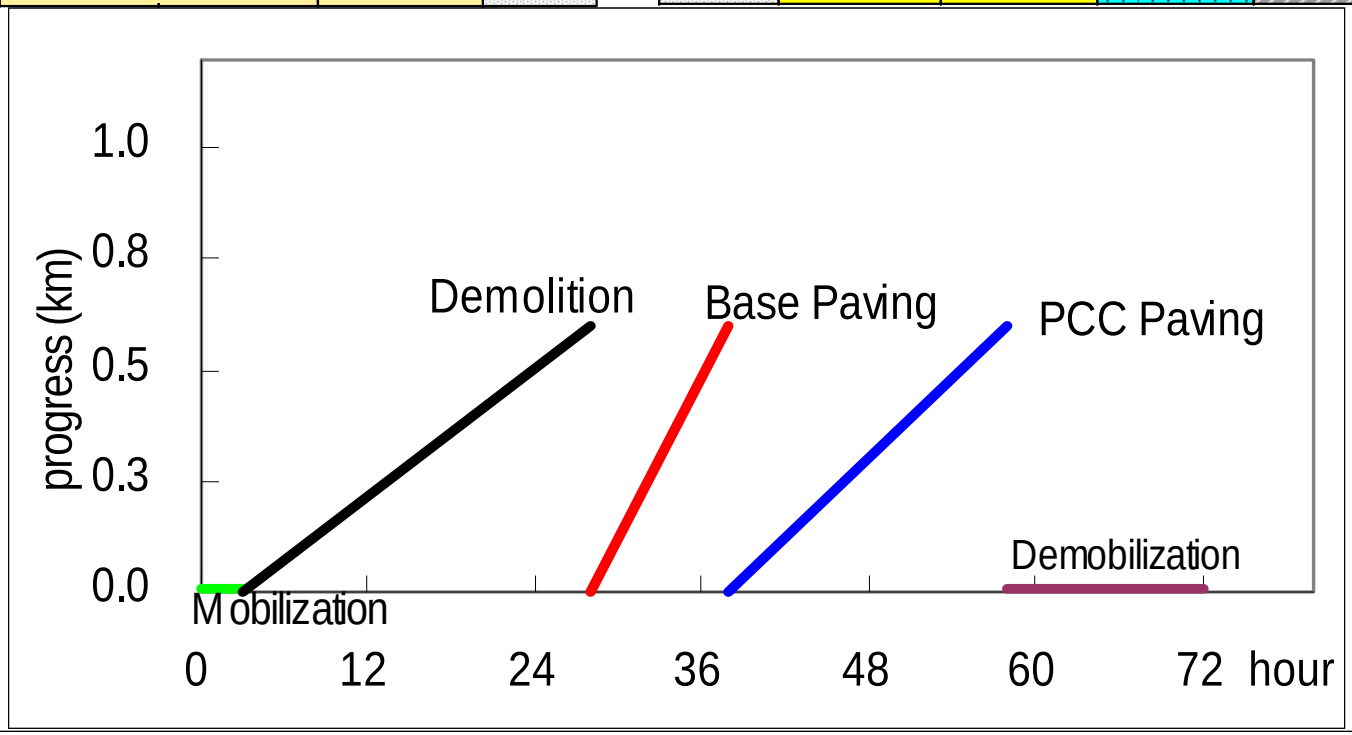




Balance of Closure – Access – Production

Half Closure for PCC Sequential Method



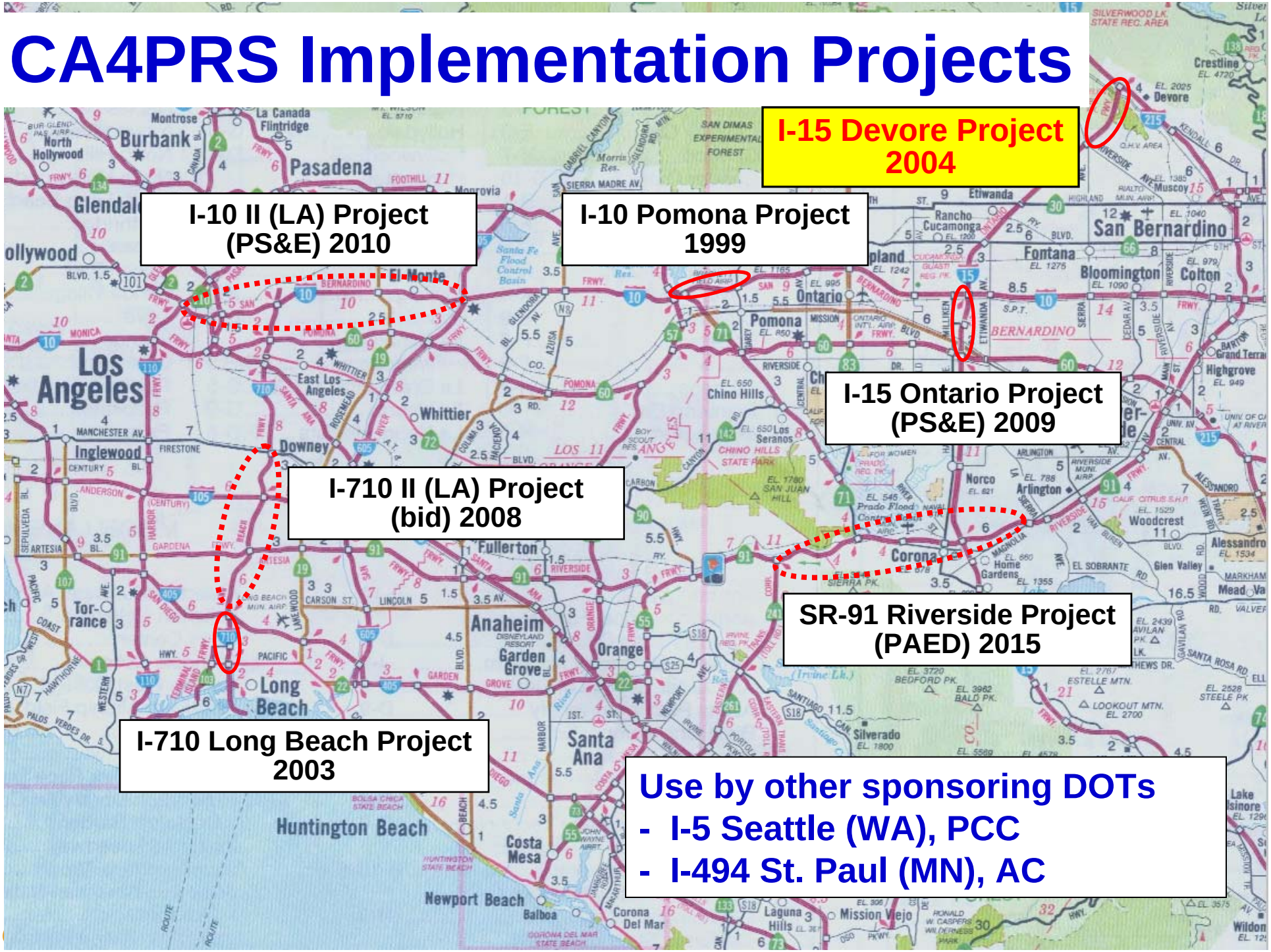


CA4PRS Analysis Inputs and Outputs Summary (for Schedule-Traffic)

- **Scheduling analysis outputs**
  - Maximum production (lane-km) per closure
  - Closure numbers and total project duration
  - Constraining resources
- **Traffic analysis Inputs**
  - Traffic demand: ADT and hourly distribution
  - Demand reduction (outreach): Detours and no-shows
  - Hourly lane closure scheme
  - Time value of traveling public
- **Traffic analysis outputs**
  - Work-zone queue and maximum Delay per Closure
  - Total Road User Cost (RUC)
  - Demand and Capacity Sensitivity

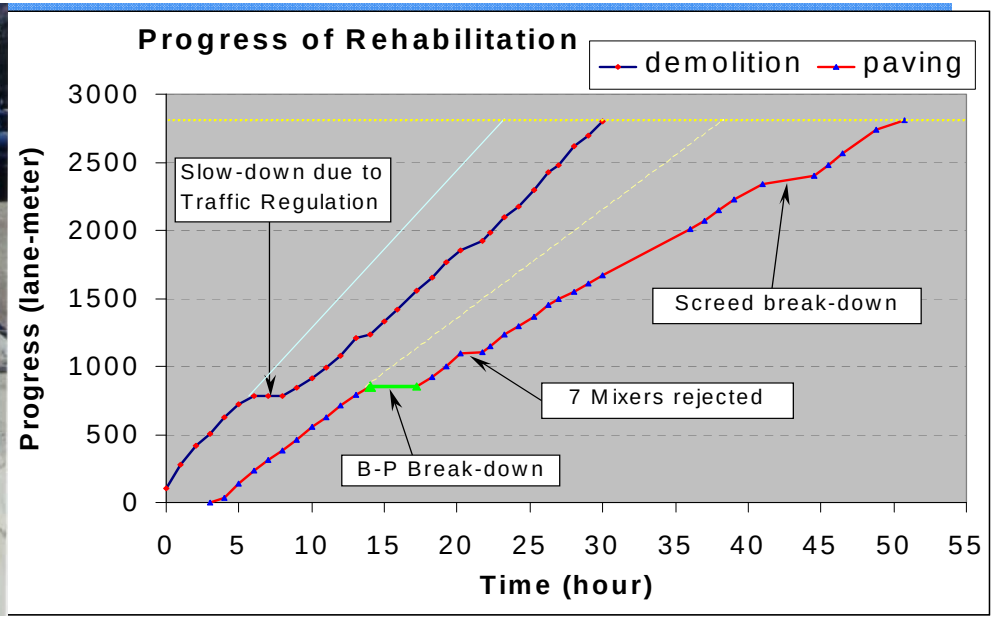
Implementation Projects

CA4PRS Implementation Projects



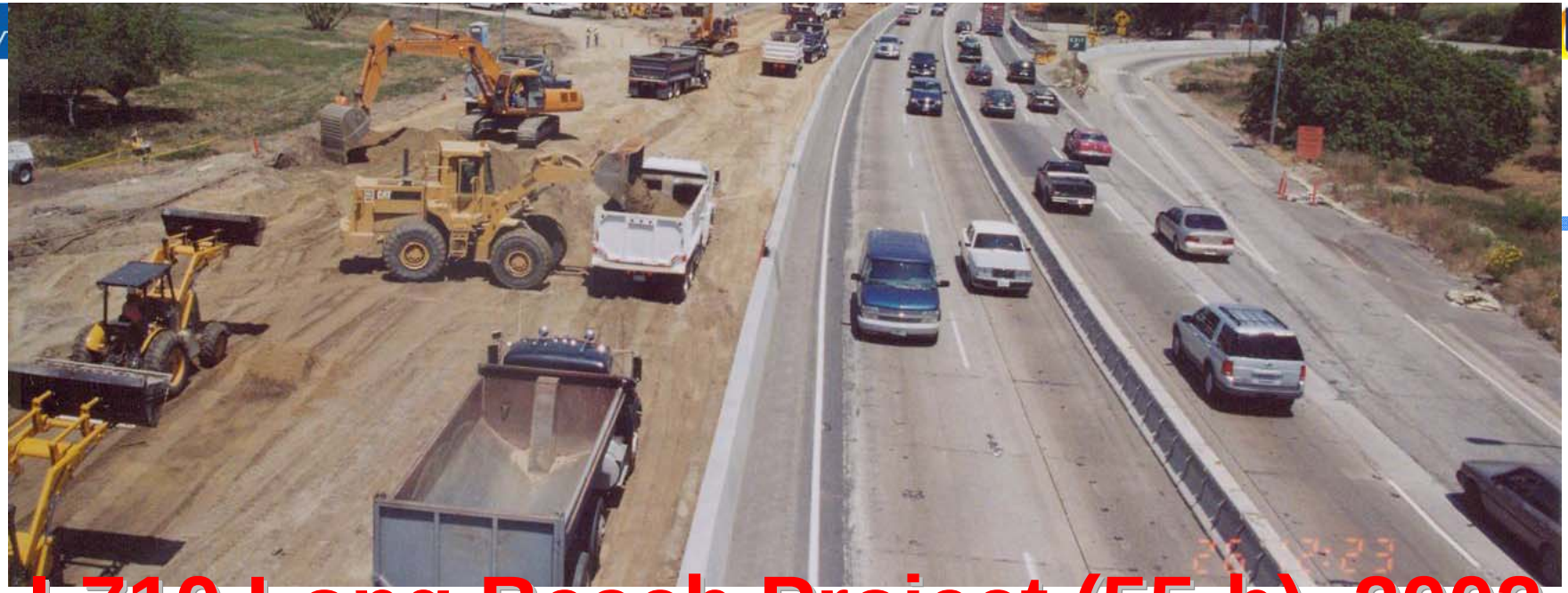
I-10 Pomona with FSHCC, 2000

I-10 Pomona Project (FSHCC)
CA4PRS Monitoring Study

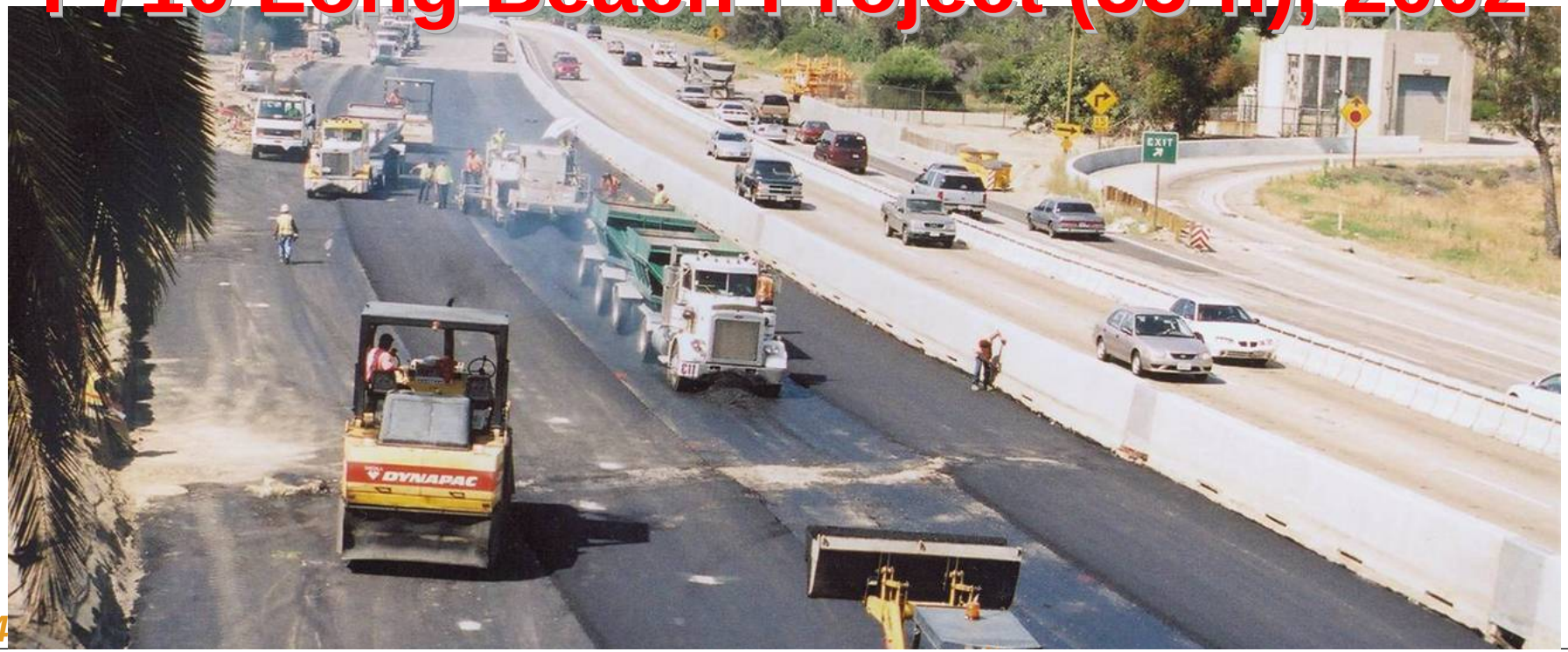


55-hour Weekend Production

- **Contractor's Plan = 3.5 lane-km**
- **CA4PRS Estimate = 2.9 lane-km (2.4-3.4)**
- **Actual Performance = 2.8 lane-km**

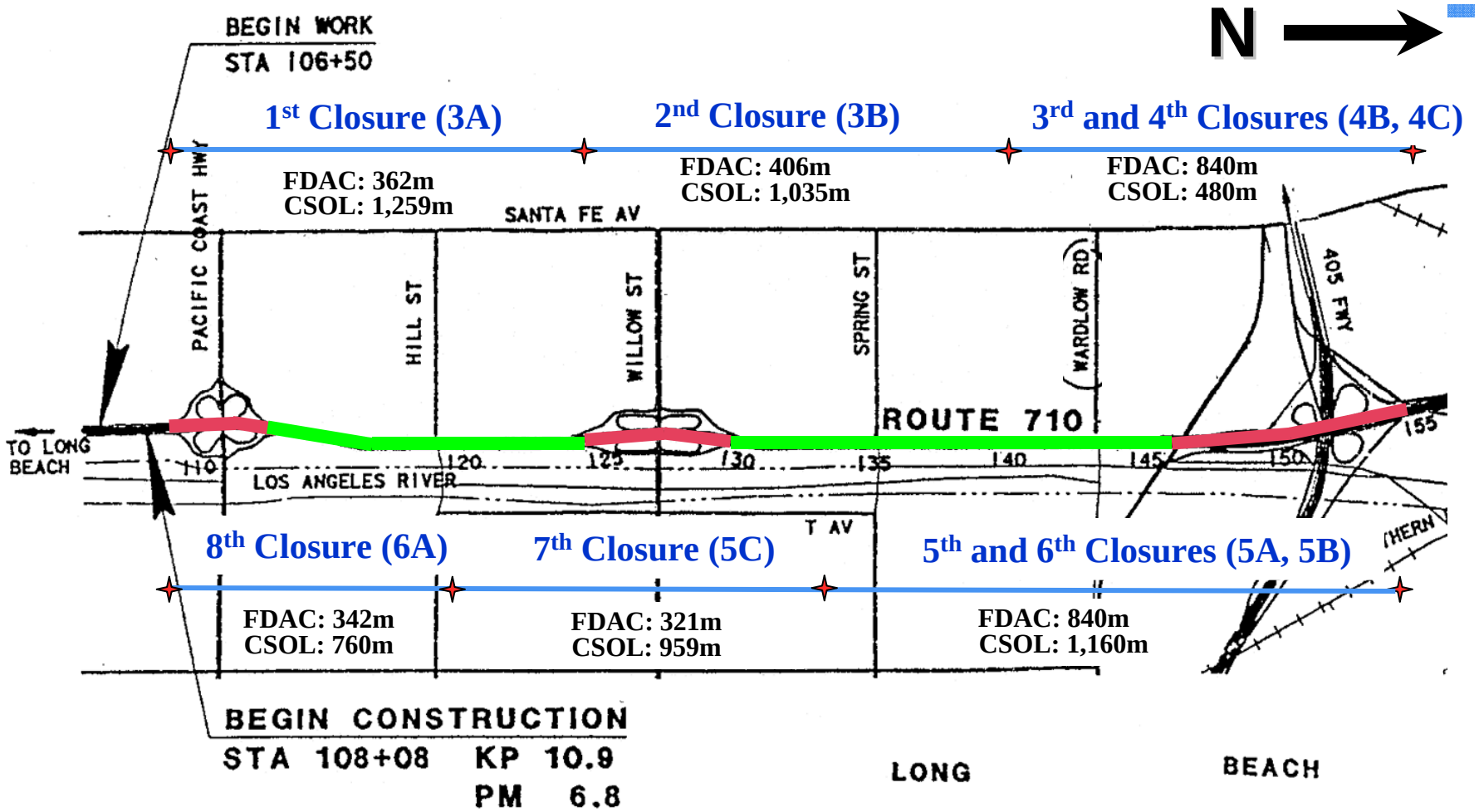


I-710 Long Beach Project (55-h), 2002



I-710 Long Beach (AC): Staging Plan

Contractor Revised Work-plan Based on CA4PRS



- Initial Caltrans Plan (10 Weekends)
- Finished with 8 Weekends (Incentives)

CSOL= 2.8 C.L.-km

FDAC= 1.6 C.L.-km

CA4PRS

I-15 Devore Project (27/7), 2004

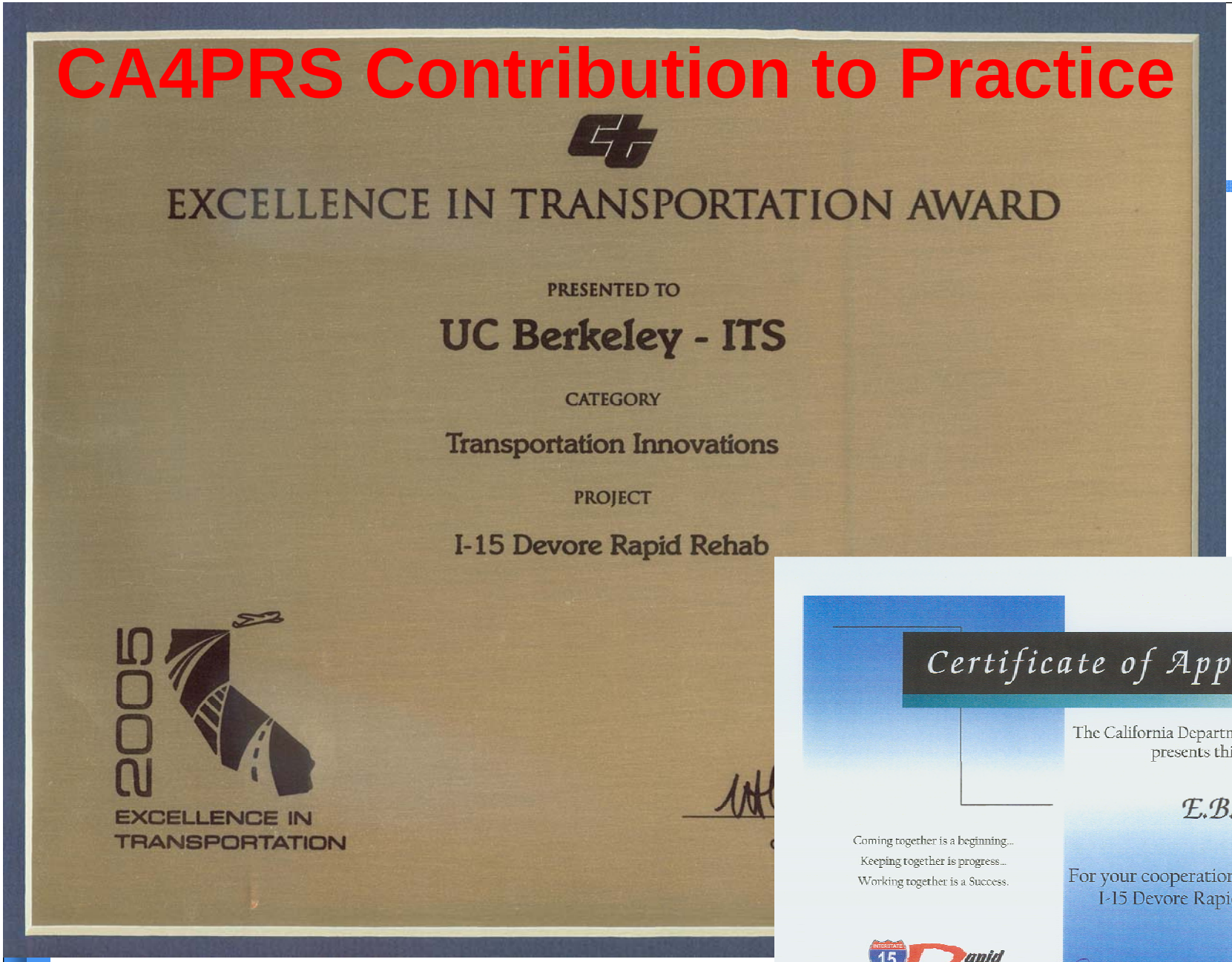
I-15 Devore (RSC) : Preconstruction CA4PRS Analysis *Schedule-Traffic-Cost*

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

Using CA4PRS on I-15 Devore, “Rapid Rehab (24/7)”, saved $6M agency cost and $2M road user cost, compared to nighttime closures.

I-15 Devore 2 Project, 2006

CA4PRS Contribution to Practice



Outreach & Deployment

Outreach for Nationwide Promotion and Deployment: FHWA-AASHTO

- FHWA nationwide deployment (in process)
  - Priory, Market-ready Technologies and Innovations
  - Group license for 50 state DOTs
  - NHI training course
- AASHTO TIG: AASHTOWare
  - CAST: Integration with traffic simulations
- International Road Federation (IRF)
  - 2007 Global Road Achievement Award: Research
- Publications: Magazine articles and papers
  - TRB TRNews, FHWA Focus, FHWA Public Roads
  - 30 Journal & conference papers (incl. case studies)

CA4PRS in Caltrans Web

Construction Analysis for Pavement Rehabilitation Strategies (CA4PRS) - Windows Internet Explorer

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

Construction Analy... | Welcome to Tabbed B...

Skip to: Content | Footer | Accessibility

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Click Here to Access CA4PRS Software (This is free for Caltrans only.)

LLPRS

Caltrans > DRI Home > Roadway > CA4PRS

Construction Analysis for Pavement Rehabilitation Strategies

A Decision-Support Tool to Integrate Design, Construction, and Traffic for Highway Projects

Development Background

State transportation agencies are increasingly shifting their focus from constructing new highways to rehabilitating and reconstructing existing facilities. Because highway rehabilitation projects often cause congestion, safety problems, and limited access for road users, agencies face a challenge in finding economical ways to rehabilitate deteriorating roadways in metropolitan areas while keeping the traveling public as safe as possible and minimizing disruptions for local communities and surrounding businesses.

One innovation in the effort to reduce highway construction time and its impact on traffic is software called CA4PRS, Construction Analysis for Pavement Rehabilitation Strategies. CA4PRS is a schedule and traffic analysis tool that helps planners and designers select effective, economical rehabilitation strategies. Funded through an FHWA (Federal Highway Administration) pooled-fund, multistate consortium (California, Minnesota, Texas, and Washington), CA4PRS was developed by the University of California Pavement Research Center (UCPRC) through the UC Berkeley Institute of Transportation Studies.

The software's scheduling module estimates highway project duration (total number of closures), incorporating alternative strategies for pavement designs, lane-closure tactics, and contractor logistics. CA4PRS's traffic module (using the Highway Capacity Manual demand capacity model) quantifies the impact of construction work zone closures on

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

Cycle of Rehab Projects with CA4PRS

Plan	Priority	Scope	Approval
	Project Initiation Documents	Project Scope Summary Report	Project Approval Environmental Documents
Design	Plans	TMP	Estimates
	Schedule Analysis	Traffic Analysis	Cost Analysis
Implement	Specifications	Contract	Implementation
	PS&E Package	Letting & Bid	Construction

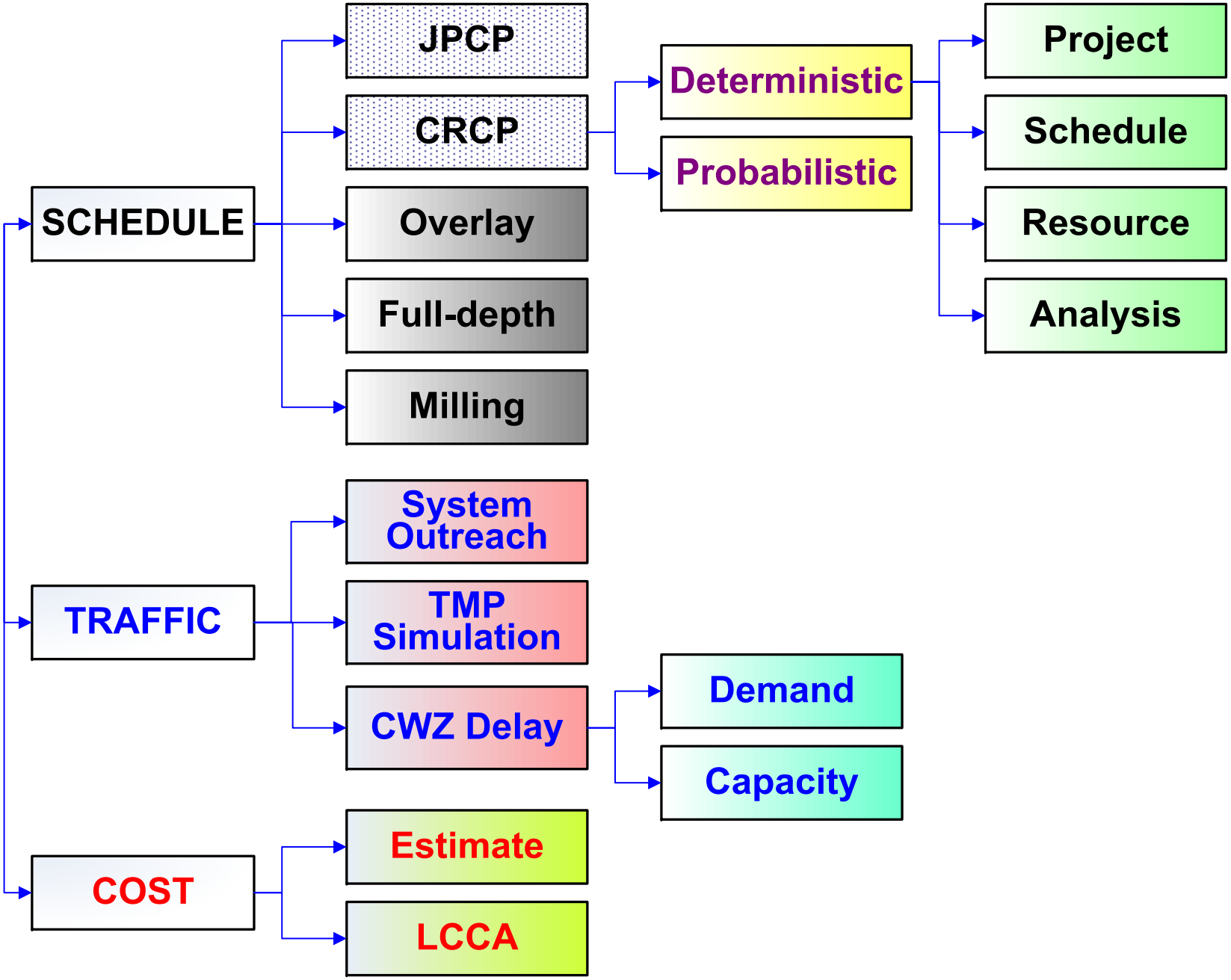
Analyses a DOT Engineers Can Perform with CA4PRS

- Planning stage: baseline to PSSR and PAED
  - Preconstruction analysis for what-if scenarios
  - Justification in project scoping and approval
- Design stage: supplementary to PS&E package
  - Construction schedule (**Working-days estimate**)
  - Traffic delay and user cost for TMP
  - Construction staging-plan
  - Constructability check
  - Contracting methods: A+B, Incentives/disincentives
- Construction stage: validate work plans
  - Seek consensus in public (media) outreach
  - Validate contractor's work plan
  - Evaluate contractor's request of change orders

Development, Training, and On-going Enhancement

- **SPTC incl. Caltrans: Free license from UCB**
- **Windows PC-based Stand-alone Application**
  - MS ACCESS database with Visual Basic interfaces
  - Store historical analysis and project data
- **2-day Hands-on user training workshops**
  - About 40 training sessions (700 engineers)
  - CA, MN, TX, WA, FL, MI, MO, UT
  - Online (self-paced) training course in development
- **Enhancement plan (current version is 2.0)**
  - Version 2.5: Roadway widening
  - Version 2.6: Precast panel (Super-slab)
  - Version 3.0: Interchange & Bridge replacements
  - Version 4.0: Interaction with LCCA (FHWA Realcost)

CA4PRS Menu - Training Outline



Screen-shots

Schedule Analysis: Project List

CA4PRS - Construction Analysis for Pavement Rehabilitation Strategies

File Options Tools Window Help

- New
- Open...
  - PCCP Rehabilitation
    - Deterministic...
    - Probabilistic...
  - CRCP Rehabilitation
  - CSOL ACP Rehabilitation
  - Full Depth ACP Rehabilitation
  - Mill And Fill ACP Rehabilitation
- Close
- Close All
- Open Database...
- Backup Database...
- Compact Database
- Page Setup...
- Exit

Saved Projects

Analysis Type	Project Identifier	Route Name	Analysis Date	Project Description
Deterministic	PCC Tutorial for I-15 Devore (Your Name)	I-15 Devore, San Berna	3/1/2005	Caltrans District 8 Concrete Demonstration Project
Deterministic	I-15 Devore Continuous Closure	I-15 Devore, San Berna	3/1/2004	Caltrans District 8 I-15 Devore Truck-lane Reconstruction-Cor
Deterministic	I-15 Ontario Weekend (Partial Closure)	I-15 Ontario, San Berna	3/1/2005	I-15 Ontario Weekend with Partial Closure
Deterministic	I-15 Devore Nighttime Closure	I-15 Devore, San Bern	3/4/2002	Caltrans District 8 Demonstration Project (9-h Nighttime Closu
Probabilistic	PCC Probablistic for I-15 Devore	I-15 Devore, San Bern	3/1/2005	Caltrans District 8 Concrete Demonstration Project
Deterministic	I-15 Baker PCC SB Trucklane Reconstructic	I-15 Ontario, San Berna	1/2/2007	I-15 Baker SB PCC Truck Lane Reconstruction with Partial Clo

Ok Copy Delete Cancel

Schedule Analysis: Project Details Inputs

PCCP Deterministic - PCC Tutorial for I-15 Devore (Your Name)

Project Identifier: PCC Tutorial for I-15 Devore (Your Name)

Unit: English / Metric

Project Details | Scheduling | Resource Profile | Analysis

Project Description: Caltrans District 8 Concrete Demonstration Project

Analyst Name: Your Name

Analysis Date: 3 / 1 /2005

Route Name: I-15 Devore, San Bernardino

Begin KM: 206.00

End KM: 211.00

Objective (lane-km): 17.00

Location: Deveore, San Bernardino, County, CA

Project Notes:
2 truck-lanes reconstruction out of 4 lanes
Total scope=17 lane-km = 4.3 (2.5 + 1.8) x 2 lanes x 2 directions

Save | Close

Schedule Analysis: Scheduling Inputs

PCCP Deterministic - PCC Tutorial for I-15 Devore (Your Name)

Project Identifier: PCC Tutorial for I-15 Devore (Your Name)

Unit: English / Metric

Project Details | Scheduling | Resource Profile | Analysis

Mobilization

Mobilization (Hours): 4.0

Demobilization (Hours): 6.0

Construction Start Date: 10/ 3 /2005

Construction Window...

Lag Times for Sequential Method (Finish to Start)

Demolition to PCCP Installtion (Hours): 3.0

Base Paving Included

Demolition to New Base Installation (Hours): 3.0

New Base Installation to PCCP Installation (Hours): 2.0

Lag Times for Concurrent Method (Start to Start)

Demolition to PCCP Installtion (Hours): 12.0

Base Paving Included

Demolition to New Base Installation (Hours): 10.0

New Base Installation to PCCP Installation (Hours): 9.0

Construction Window Settings

Weekend Closure

Start Time on Friday: 10:00 PM

End Time on Monday: 05:00 AM

Available Hours: 55.0

Nighttime Closure

Start Time on First Day: 07:00 PM

End Time on Next Day: 05:00 AM

Available Hours per Day: 10.0

Continuous Closure/Continuous Operation

Start Time on First Day: 12:00 AM

No. of Continuous Work Days: 3.0

Available Hours per Day: 24.0

Continuous Closure/Shift Operation

Daily Start Time: 06:00 AM

No. of Continuous Work Days: 6.0

Available Hours per Day: 9.0

Schedule Analysis: Resources Inputs

PCCP Probabilistic - I-15 Concurrent (Prob)

Project Identifier: I-15 Concurrent (Prob)

Project Details | Scheduling | Resource Profile | Analysis

Dump Truck (Demolition)

Rated Capacity (kg):	22000.0
Trucks per Hour:	10.0
Packing Efficiency:	0.65
Number of Team:	2.0
Team Efficiency:	0.75

Batch Plant

Capacity (cu. m):	150.0
Number of Plants:	1

End Dump Truck (PCC)

Capacity (cu. m):	6.0
Trucks per Hour:	11
Packing Efficiency:	0.90

End Dump Truck (New Base)

Capacity (cu. m):	10.0
Trucks per Hour:	4
Packing Efficiency:	1.00

Paver

Speed (m/min):	2.0
Number of Pavers:	1

Define Probability ...

Probability Function:	Normal
Mean:	10
Std. Dev.:	1

Save

Schedule Analysis: Analysis Inputs (PCC)

PCCP Deterministic - PCC Tutorial for I-15 Devore (Your Name)

Project Identifier: PCC Tutorial for I-15 Devore (Your Name)

Unit: English / Metric

Project Details | Scheduling | Resource Profile | Analysis

Construction Window
- Weekend Closure
- Nighttime Closure
- Continuous Closure/Continuous Operation
- Continuous Closure/Shift Operation

Curing Time
- 4-Hours
- 8-Hours
- 12-Hours
- User Defined 24.0 Hours

Section Profile
- 203 mm (8 inches)
- 254 mm (10 inches)
- 305 mm (12 inches)

User Defined
- User Defined
- PCCP (mm): 290.0
- Treated Base (mm): 152.4

Additional Demolition
- Additional Demolition
- Depth (mm): 100.0

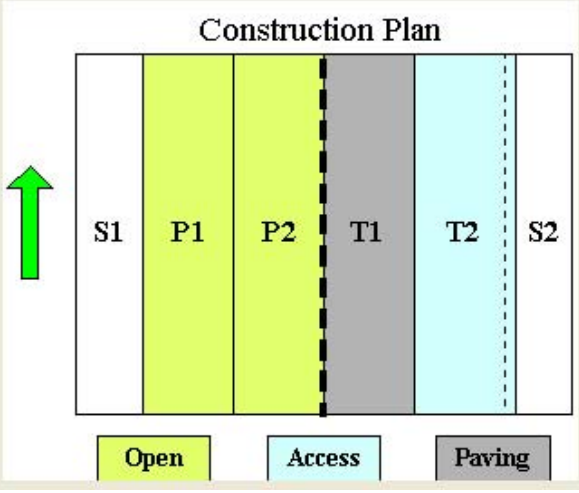
Lane Widths
- T1 Width (m): 3.7
- T2 Width (m): 3.7

Working Method
- Sequential Single Lane (T1)
- Sequential Single Lane (T2)
- Sequential Double Lane (T1+T2)
- Concurrent Single Lane (T1)
- Concurrent Single Lane (T2)

Save

Construction Plan

- Sequential Single Lane (T1)
- Sequential Single Lane (T2)
- Sequential Double Lane (T1+T2)
- Concurrent Single Lane (T1)
- Concurrent Single Lane (T2)
- Concurrent Double Lane (T1+T2)



Schedule Analysis: Scheduling Inputs (AC)

Project Identifier: 710_Full Depth_55-H Weekend

Project Details | Scheduling | Resource Profile | Analysis

Construction Window

- [x] Weekend Closure
- [ ] Nighttime Closure
- [ ] Continuous Closure/Continuous Operation
- [ ] Continuous Closure/Shift Operation

Working Method

- [x] Single Lane Paving (T1)
- [ ] Single Lane Paving (T2)
- [ ] Double Lane Paving (T1+T2)

Section Profile

Define... [x] Profile A

Define... [ ] Profile B

[x] Additional Demolition Depth 165.0

Cooling Time Analysis

(•) User Specified

( ) MultiCool Computed — MultiCool Data...

Lane Widths

T1 Width (m):

T2 Width (m):

ACP Layer Definition - Profile A

Lift Number	Lift Thickness (mm)	Lift Name	Lift Cooling Time (hour)	Paver Speed (kph)
4	76.20	PBA-6a	3.00	4.43
3	76.20	AR-8000	3.00	4.51
2	76.20	AR-8000	2.00	4.51
1	94.00	Rich Bottom	1.00	3.36
	Total: 322.60		Average: 2.25	Average: 4.20

Insert | Delete | Ok | Cancel

Schedule Outputs: Deterministic Analysis

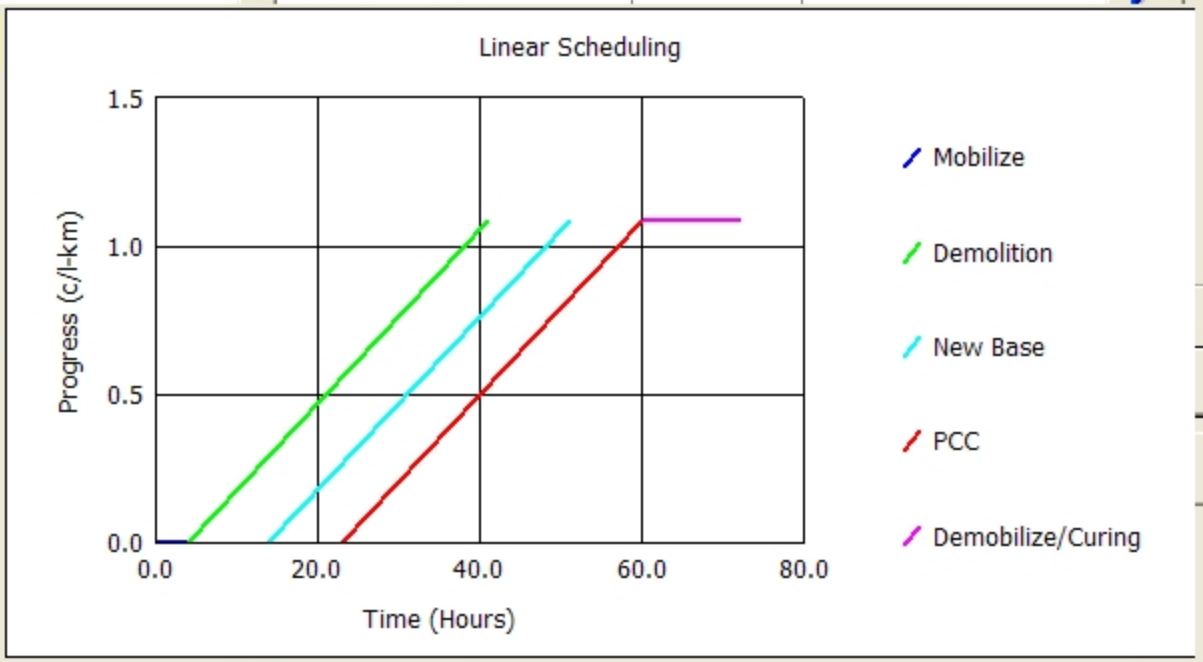
Resource Utilization - PCC Tutorial for I-15 Devore (Your Name)

Project Identifier: PCC Tutorial for I-15 Devore (Your Name)

Production Details | Production Chart | Gantt Chart

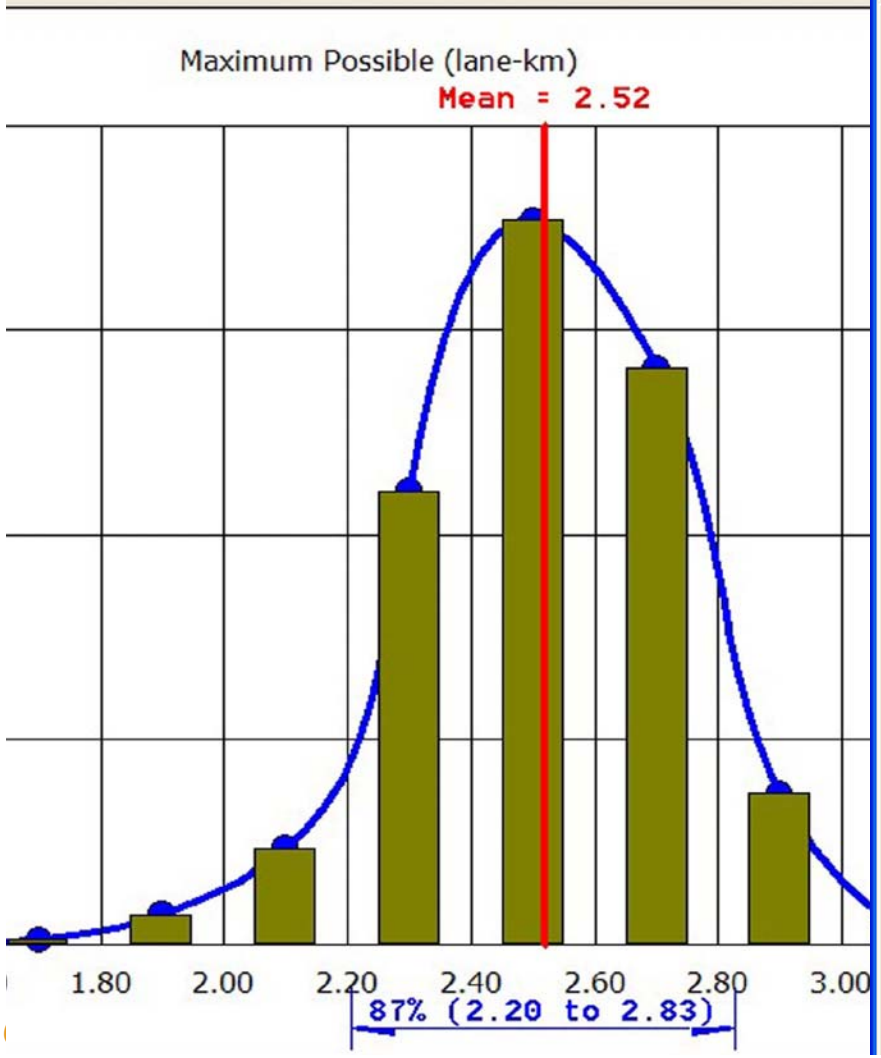
Construction Window:	**Continuous Closure/Continuous Operation**
Working Method:	**Concurrent Double Lane (T1+T2)**
Section Profile:	**305 mm (12 inches)**
Curing Time:	**12-Hours**
Objective (lane-km):	**17.00**
Maximum Possible (lane-km):	**2.16**
Maximum Possible (c/l-km):	**1.08**
Construction Windows Needed To Meet Objective:	**7.86**
Demolition Quantity (cu. m):	**3920.1**
New Base Quantity (cu. m):	**1306.7**
Concrete Quantity (cu. m):	**2613.4**
Constraint Resource:	**Demolition Hauling**
Demolition to Paving:	**N/A**
Demolition Hours:	**37.0**
Paving Hours:	**37.0**

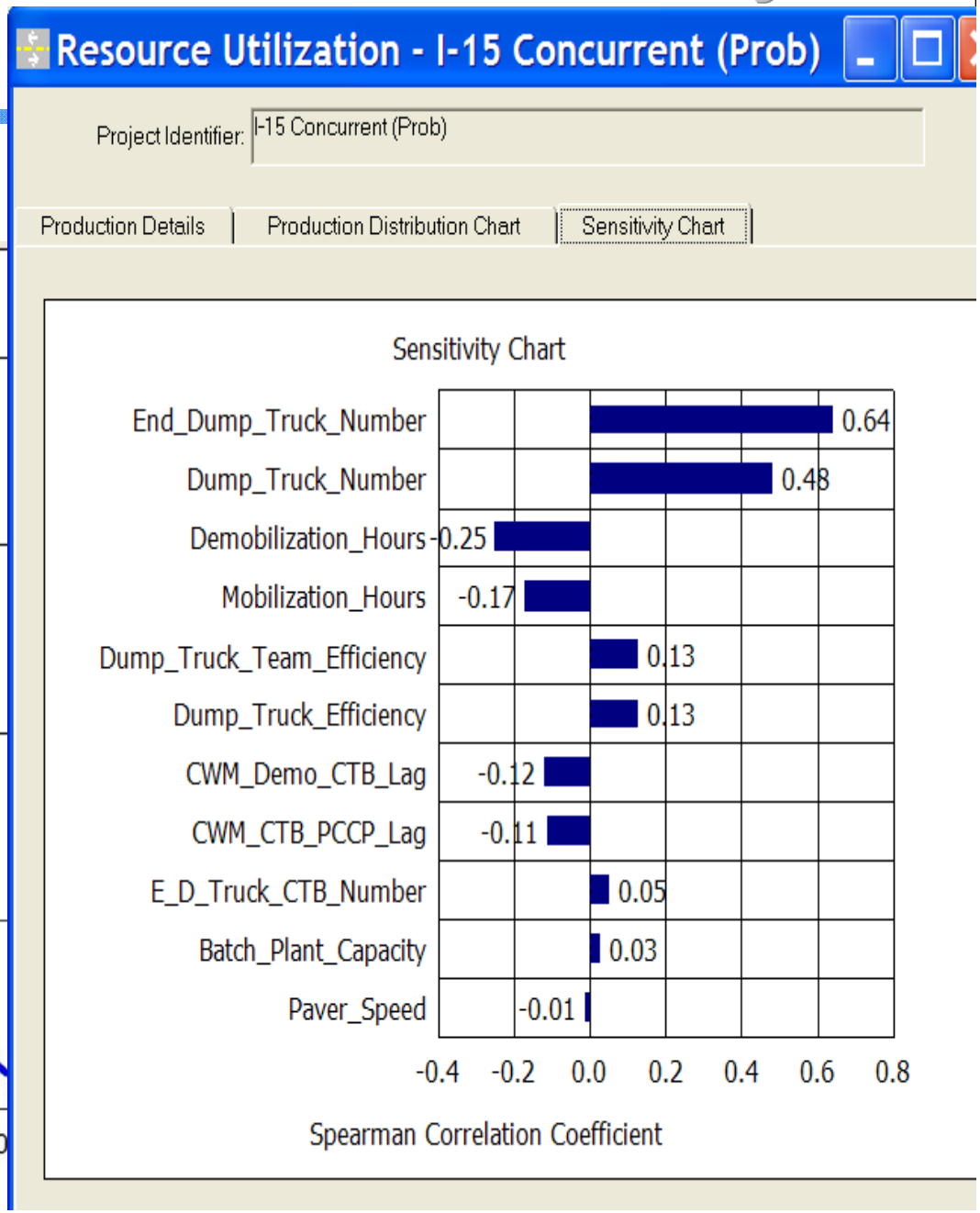
Resource	Allocated	Utilized
Demolition Hauling Truck (per hour per team)	10.0	10.0
Base Delivery Truck (per hour)	10.0	3.9
Batch Plant (cu-m/hour)	90.0	70.6
Concrete Delivery Truck (per hour)	15.0	11.8
Paver Speed (m/min)	2.0	0.5



Report... | Close

Schedule Outputs : Probabilistic Analysis





Traffic Analysis Inputs

DEMAND-CAPACITY MODEL

Before Construction

Direction 1: Northbound
Number of Lanes: 4

Direction 2: Southbound
Number of Lanes: 4

Speed Limit (MPH): 65

During Construction

Speed Limit (MPH): 55
Length(mile): 2
Closure Duration(days): 3

Number of Closures
- Direction 1: 4
- Direction 2: 4

Construction Begin: this yr

Traffic Inputs

Growth Rate (year,%): 3

Traffic Reduction on CWZ(%)
- No show up: 5
- Detour: 5

Traffic Counts
Hourly Traffic Graph
Lane Closure Chart

Vehicle Cost Input

Passenger Car($): 9
Commercial Truck($): 24
Proportion of Truck (%): 10

Capacity Information

Capacity
- Single Lane open: 1800 veh/hr/ln
- Multi Lanes open: 2100 veh/hr/ln

Capacity (Construction)
- Single Lane open: 1142 veh/hr/ln
- Multi Lanes open: 1523 veh/hr/ln

Capacity Calculation

RUN
OUTPUT
EXIT

Traffic Inputs: Hourly Counts and Lane Closures

Construction Input

Lane Closure Period

Select number of lanes for both directions during construction: 5

Select number of lanes per direction by time.

	Direction 1 (NB)	Direction 2 (SB)		Direction 1 (NB)	Direction 2 (SB)
12:00-01:00AM	3	2	12:00-01:00P	3	2
01:00-02:00AM	3	2	01:00-02:00P	3	2
02:00-03:00AM	3	2	02:00-03:00P	3	2
03:00-04:00AM	3	2	03:00-04:00P	3	2
04:00-05:00AM	3	2			
05:00-06:00AM	3	2			
06:00-07:00AM	3	2			
07:00-08:00AM	3	2			
08:00-09:00AM	3	2			
09:00-10:00AM	3	2			
10:00-11:00AM	3	2			
11:00-12:00PM	3	2			

Demand Input Window

You may type or load demands from the sheet.

Hourly Demand

	Direction 1 Northbound	Direction 2 Southbound		Direction 1 Northbound	Direction 2 Southbound
12:00-01:00AM	651	556	12:00-01:00P	2843	2932
01:00-02:00AM	389	608	01:00-02:00PM	3521	2937
02:00-03:00AM	454	935	02:00-03:00PM	4585	3041
03:00-04:00AM	699	2251	03:00-04:00P	4872	3138
04:00-05:00AM	1279	3740	04:00-05:00P	4680	2903
05:00-06:00AM	1702	4419	05:00-06:00PM	3418	2086
06:00-07:00AM	2039	4281	06:00-07:00P	2459	1454
07:00-08:00AM	2123	2985	07:00-08:00P	2059	1352
08:00-09:00AM	2134	2596	08:00-09:00P	1717	1173
09:00-10:00AM	2501	2536	09:00-10:00P	1334	1027
10:00-11:00AM	2681	2498	10:00-11:00P	1003	682
11:00-12:00PM	2676	2522	11:00-12:00A	620	651
			SUM	52439	53303

Clean demands

Load demands

If hourly counts are not availabl

CA historical data

OK

Cancel

CA4PRS

Traffic Analysis Outputs

RUC Estimation Output

Before Construction

Direction 1

Northbound

Average Queue Length: 0 miles

Max. Delay/Veh/Closure: 0 min. at 0

Total User Delay: $0.00 USD

Direction 2

Southbound

Average Queue Length: 0 miles

Max. Delay/Veh/Closure: 0 min. at 0

Total User Delay: $0.00 USD

During Construction

Direction 1

Northbound

Average Queue Length: 6 miles

Max. Delay/Veh/Closure: 73 min. at 05:00-06:00PM

Total User Delay: $2,125,055.00 USD

Direction 2

Southbound

Average Queue Length: 3 miles

Max. Delay/Veh/Closure: 42 min. at 06:00-07:00AM

Total User Delay: $948,524.00 USD

Total Differences

Direction 1

Northbound

Average Queue Length: 6 miles

Max. Delay/Veh/Closure: 73 min.

Total User Delay: $2,125,055.00 USD

Direction 2

Southbound

Average Queue Length: 3 miles

Max. Delay/Veh/Closure: 42 min.

Total User Delay: $948,524.00 USD

Graphical Output

Demand-Capacity Curve | Demand Sensitivity | Capacity Sensitivity

For printing output, please go to "FINAL OUTPUT" sheet.

Close

More Information?

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- **GOOGLE "CA4PRS"**

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