

District: **TxDOT Houston**

PROJECT: **IH 45 S from N of FM 519 to N of FM 1764**

EA:

Freeway

PPNO:

0500-04-105

3

INVESTMENT ANALYSIS SUMMARY RESULTS

Life-Cycle Costs (mil. \$)	\$138.5	ITEMIZED BENEFITS (mil. \$)	Average Annual	Total Over 20 Years
Life-Cycle Benefits (mil. \$)	\$370.0	Travel Time Savings	\$12.3	\$245.4
Net Present Value (mil. \$)	\$231.5	Veh. Op. Cost Savings	-\$2.7	-\$53.3
Benefit / Cost Ratio:	2.7	Accident Cost Savings	\$9.2	\$184.0
Rate of Return on Investment:	12.4%	Emission Cost Savings	-\$0.3	-\$6.1
Payback Period:	9 years	TOTAL BENEFITS	\$18.5	\$370.0
		Person-Hours of Time Saved	1,008,881	20,177,620
		CO₂ Emissions Saved (tons)	-11,751	-235,020
		CO₂ Emissions Saved (mil. \$)	-\$0.2	-\$5.0

Should benefit-cost results include:

1) Induced Travel? (y/n)

Default = Y

2) Vehicle Operating Costs? (y/n)

Default = Y

3) Accident Costs? (y/n)

Default = Y

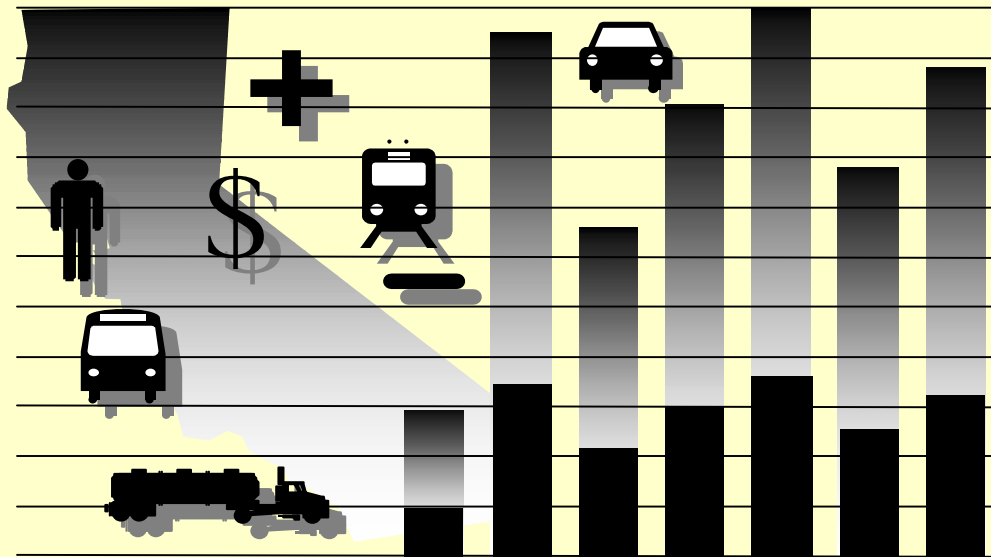
4) Vehicle Emissions? (y/n)

Default = Y

includes value for CO₂e



California Life-Cycle Benefit/Cost Analysis Model (Version 5.0) TIGER Benefit-Cost Analysis



Office of Transportation Economics
Division of Transportation Planning
2014 TIGER Grant Applications

For questions and comments, please contact:

Barry Padilla

(916) 653-9248 barry_padilla@dot.ca.gov

District: **TxDOT Houston**

PROJECT: **IH 45 S from N of FM 519 to N of FM 1764**

Facility Type: **Freeway**
 CSJ #: **0500-04-105**

1A PROJECT DATA

Type of Project
 Select project type from list: **General Highway**

Project Location (enter 1 for So. Cal., 2 for No. Cal., or 3 for rural): **1**

Length of Construction Period: **2** years
 One- or Two-Way Data: **2** enter 1 or 2

Length of Peak Period(s) (up to 24 hrs): **7** hours

1C HIGHWAY ACCIDENT DATA

Actual 3-Year Accident Data (from Table B)

	Count (No.)	Rate
Total Accidents (Tot)	299	0.92
Fatal Accidents (Fat)	3	0.009
Injury Accidents (Inj)	97	0.30
Property Damage Only (PDO) Accidents	199	0.61

Statewide Basic Average Accident Rate

Rate Group	No Build	Build
Accident Rate (per million vehicle-miles)	0.22	0.16
Percent Fatal Accidents (Pct Fat)	1.3%	0.9%
Percent Injury Accidents (Pct Inj)	64.9%	46.7%

1B HIGHWAY DESIGN AND TRAFFIC DATA

Highway Design

	No Build	Build
Roadway Type (Fwy, Exp, Conv Hwy)	F	F
Number of General Traffic Lanes	6	8
Number of HOV/HOT Lanes		
HOV Restriction (2 or 3)		
Exclusive ROW for Buses (y/n)	N	
Highway Free-Flow Speed	65	75
Ramp Design Speed (if aux. lane/off-ramp proj.)	35	35
Length (in miles) Highway Segment	4.4	4.4
Impacted Length	4.4	4.4

Average Daily Traffic

	No Build	Build
Current	94,420	
Base (Year 1)	102,658	102,658
Forecast (Year 20)	180,919	180,919

Average Hourly HOV/HOT Lane Traffic

	No Build	Build
Percent of Induced Trips in HOV (if HOT or 2-to-3 conv.)		100%

Percent Traffic in Weave: 0.0%

Percent Trucks (include RVs, if applicable): 6%

Truck Speed

On-Ramp Volume

	Peak	Non-Peak
Hourly Ramp Volume (if aux. lane/on-ramp proj.)	0	0
Metering Strategy (1, 2, 3, or D, if on-ramp proj.)		

Queue Formation (if queuing or grade crossing project)

	Year 1	Year 20
Arrival Rate (in vehicles per hour)	0	0
Departure Rate (in vehicles per hour)	0	0

Pavement Condition (if pavement project)

	No Build	Build
IRI (inches/mile) Base (Year 1)		
Forecast (Year 20)		

Average Vehicle Occupancy (AVO)

	No Build	Build
General Traffic Non-Peak	1.32	1.32
Peak	1.25	1.25
High Occupancy Vehicle (if HOV/HOT lanes)	2.15	2.15

1D RAIL AND TRANSIT DATA

Annual Person-Trips

	No Build	Build
Base (Year 1)		
Forecast (Year 20)		

Percent Trips during Peak Period: 54%

Percent New Trips from Parallel Highway: 100%

Annual Vehicle-Miles

	No Build	Build
Base (Year 1)		
Forecast (Year 20)		

Average Vehicles/Train (if rail project)

Reduction in Transit Accidents

Percent Reduction (if safety project)

Average Transit Travel Time

	No Build	Build
In-Vehicle Non-Peak (in minutes)		0.0
Peak (in minutes)		0.0
Out-of-Vehicle Non-Peak (in minutes)	0.0	0.0
Peak (in minutes)	0.0	0.0

Highway Grade Crossing

	Current	Year 1	Year 20
Annual Number of Trains		0	
Avg. Gate Down Time (in min.)		0.0	

Transit Agency Costs (if TMS project)

	No Build	Build
Annual Capital Expenditure		\$0
Annual Ops. and Maintenance Expenditure		\$0

Model should be run for both roads for intersection or bypass highway projects, and may be run twice for connectors. Press button below to prepare model to enter data for second road. After data are entered, results reflect total project benefits.

Prepare Model for Second Road

Enter all project costs (in today's dollars) in columns 1 to 7. Costs during construction should be entered in the first eight rows.
 Project costs (including maintenance and operating costs) should be net of costs without project.

1E PROJECT COSTS (enter costs in thousands of dollars)									
Col. no.	(1)	(2)	(3)	(4)	(5)	(6)	(7)		
Year	DIRECT PROJECT COSTS					Mitigation	Transit Agency Cost Savings	TOTAL COSTS (in dollars)	
	Project Support	R / W	Construction	Maint./ Op.	Rehab.			Constant Dollars	Present Value
Construction Period									
1			\$70,250					\$70,250,000	\$70,250,000
2			70,250					70,250,000	68,203,883
3								0	0
4								0	0
5								0	0
6								0	0
7								0	0
8								0	0
Project Open									
1								\$0	\$0
2								0	0
3								0	0
4								0	0
5								0	0
6								0	0
7								0	0
8								0	0
9								0	0
10								0	0
11								0	0
12								0	0
13								0	0
14								0	0
15								0	0
16								0	0
17								0	0
18								0	0
19								0	0
20								0	0
Total	\$0	\$0	\$140,500	\$0	\$0	\$0	\$0	\$140,500,000	\$138,453,883

$$\text{Present Value} = \frac{\text{Future Value (in Constant Dollars)}}{(1 + \text{Real Discount Rate})^{\text{Year}}}$$

HIGHWAY SPEED AND VOLUME INPUTS

Calculated by Model Changed by User Used for Proj. Eval. Reason for Change

No Build

Year 1

Peak Period

HOV Volume	0		0	
Non-HOV Volume	51,627		51,627	
Weaving Volume	0		0	
Truck Volume	3,295		3,295	
HOV Speed	55.0		55.0	
Non-HOV Speed	64.8		64.8	
Weaving Speed	55.0		55.0	
Truck Speed	64.8		64.8	

Non-Peak Period

Non-HOV Volume	44,872		44,872	
Weaving Volume	0		0	
Truck Volume	2,864		2,864	
Non-HOV Speed	65.0		65.0	
Weaving Speed	55.0		55.0	
Truck Speed	65.0		65.0	

Year 20

Peak Period

HOV Volume	0		0	
Non-HOV Volume	90,984		90,984	
Weaving Volume	0		0	
Truck Volume	5,807		5,807	
HOV Speed	55.0		55.0	
Non-HOV Speed	35.6		35.6	
Weaving Speed	55.0		55.0	
Truck Speed	35.6		35.6	

Non-Peak Period

Non-HOV Volume	79,080		79,080	
Weaving Volume	0		0	
Truck Volume	5,048		5,048	
Non-HOV Speed	65.0		65.0	
Weaving Speed	55.0		55.0	
Truck Speed	65.0		65.0	

Build

Year 1

Peak Period

HOV Volume	0		0	
Non-HOV Volume	51,627		51,627	
Weaving Volume	0		0	
Truck Volume	3,295		3,295	
HOV Speed	55.0		55.0	
Non-HOV Speed	75.0		75.0	
Weaving Speed	55.0		55.0	
Truck Speed	75.0		75.0	

Non-Peak Period

Non-HOV Volume	44,872		44,872	
Weaving Volume	0		0	
Truck Volume	2,864		2,864	
Non-HOV Speed	75.0		75.0	
Weaving Speed	55.0		55.0	
Truck Speed	75.0		75.0	

Year 20

Peak Period

HOV Volume	0		0	
Non-HOV Volume	90,984		90,984	
Weaving Volume	0		0	
Truck Volume	5,807		5,807	
HOV Speed	55.0		55.0	
Non-HOV Speed	71.7		71.7	
Weaving Speed	55.0		55.0	
Truck Speed	71.7		71.7	

Non-Peak Period

Non-HOV Volume	79,080		79,080	
Weaving Volume	0		0	
Truck Volume	5,048		5,048	
Non-HOV Speed	75.0		75.0	
Weaving Speed	55.0		55.0	
Truck Speed	75.0		75.0	

Model speed estimates based on Highway Capacity Manual, pavement research, and research on weaving impacts

2B

HIGHWAY ACCIDENT RATES

	Calculated by Model	Changed by User	Used for Proj. Eval.	Reason for Change
No Build				
Fatal Accidents	0.009		0.009	
Injury Accidents	0.30		0.30	
PDO Accidents	0.61		0.61	
Total Accidents	0.919			
Hwy Safety or Weaving Improvement <input type="text" value="0%"/> collision reduction factor (per HSIP Guidelines)				
Adjustment Factor (Actual/Statewide Avg. Existing)				
Fatal Accidents	3.1152		3.1152	
Injury Accidents	2.0640		2.0640	
PDO Accidents	8.0559		8.0559	
Build				
Fatal Accidents	0.005		0.005	
Injury Accidents	0.16		0.16	
PDO Accidents	0.68		0.68	
Total Accidents	0.840			

2C

RAMP AND ARTERIAL INPUTS

(if detailed information is available for a TMS or an arterial signal management project)

Detailed Information Available? (y/n)

Aggregate Segment Length (estimate as VMT/total volume)

All Ramps miles

Arterials miles

	Entered by User	Used for Proj. Eval.	Source/Notes
No Build (Peak Period Only)			
Year 1			
Aggregate Ramp Volume		0	
Aggregate Arterial Volume		0	
Average Ramp Speed		5.0	
Average Arterial Speed		5.0	
Year 20			
Aggregate Ramp Volume		0	
Aggregate Arterial Volume		0	
Average Ramp Speed		5.0	
Average Arterial Speed		5.0	
Build (Peak Period Only)			
Year 1			
Aggregate Ramp Volume		0	
Aggregate Arterial Volume		0	
Average Ramp Speed		5.0	
Average Arterial Speed		5.0	
Year 20			
Aggregate Ramp Volume		0	
Aggregate Arterial Volume		0	
Average Ramp Speed		5.0	
Average Arterial Speed		5.0	

2D

ANNUAL PERSON-TRIPS

(for HOV and HOT lane projects that affect average vehicle occupancy)

	No Build	Build	Induced
Year 1			
Peak Period			
HOV Trips	0	0	
Non-HOV Trips	16,778,680	16,778,680	0
Truck Trips	856,784	856,784	0
Non-Peak Period			
Non-HOV Trips	15,400,006	15,400,006	0
Truck Trips	744,681	744,681	0
Total Trips	33,780,151	33,780,151	0
Year 20			
Peak Period			
HOV Trips	0	0	
Non-HOV Trips	29,569,854	29,569,854	0
Truck Trips	1,509,950	1,509,950	0
Non-Peak Period			
Non-HOV Trips	27,140,151	27,140,151	0
Truck Trips	1,312,386	1,312,386	0
Total Trips	59,532,341	59,532,341	0

SUMMARY OF TRAVEL TIME BENEFITS

Year	HIGHWAY								
	Peak HOV	Peak Non-HOV	Peak Weaving	Peak Truck	Peak Ramp	Peak Arterial	Non-Peak Non-HOV	Non-Peak Weaving	Non-Peak Truck
1	\$0	\$2,263,080	\$0	\$201,412	\$0	\$0	\$2,030,133	\$0	\$171,098
20	\$0	\$19,225,953	\$0	\$1,711,088	\$0	\$0	\$2,559,401	\$0	\$215,704
2	\$0	\$2,691,754	\$0	\$239,563	\$0	\$0	\$2,074,687	\$0	\$174,853
3	\$0	\$3,154,314	\$0	\$280,730	\$0	\$0	\$2,117,065	\$0	\$178,425
4	\$0	\$3,652,495	\$0	\$325,068	\$0	\$0	\$2,157,327	\$0	\$181,818
5	\$0	\$4,188,247	\$0	\$372,749	\$0	\$0	\$2,195,536	\$0	\$185,038
6	\$0	\$4,763,759	\$0	\$423,969	\$0	\$0	\$2,231,750	\$0	\$188,090
7	\$0	\$5,381,491	\$0	\$478,947	\$0	\$0	\$2,266,028	\$0	\$190,979
8	\$0	\$6,044,216	\$0	\$537,929	\$0	\$0	\$2,298,427	\$0	\$193,710
9	\$0	\$6,755,060	\$0	\$601,193	\$0	\$0	\$2,329,001	\$0	\$196,286
10	\$0	\$7,517,556	\$0	\$669,054	\$0	\$0	\$2,357,804	\$0	\$198,714
11	\$0	\$8,335,710	\$0	\$741,869	\$0	\$0	\$2,384,890	\$0	\$200,997
12	\$0	\$9,214,068	\$0	\$820,042	\$0	\$0	\$2,410,309	\$0	\$203,139
13	\$0	\$10,157,813	\$0	\$904,034	\$0	\$0	\$2,434,111	\$0	\$205,145
14	\$0	\$11,172,869	\$0	\$994,373	\$0	\$0	\$2,456,345	\$0	\$207,019
15	\$0	\$12,266,032	\$0	\$1,091,663	\$0	\$0	\$2,477,058	\$0	\$208,765
16	\$0	\$13,445,129	\$0	\$1,196,602	\$0	\$0	\$2,496,298	\$0	\$210,386
17	\$0	\$14,719,217	\$0	\$1,309,994	\$0	\$0	\$2,514,108	\$0	\$211,887
18	\$0	\$16,098,822	\$0	\$1,432,777	\$0	\$0	\$2,530,534	\$0	\$213,271
19	\$0	\$17,596,248	\$0	\$1,566,047	\$0	\$0	\$2,545,617	\$0	\$214,543
Total	\$0	\$178,643,835	\$0	\$15,899,103	\$0	\$0	\$46,866,428	\$0	\$3,949,867

C

SUMMARY OF TRAVEL TIME BENEFITS (continued)

Year	TRANSIT				Present Value of Travel Time Benefits	Constant Dollars	Total Per-Hrs of Time Saved
	Peak In-Vehicle	Peak Out-of-Veh	Non-Peak In-Vehicle	Non-Peak Out-of-Veh			
1	\$0	\$0	\$0	\$0	\$4,665,722	\$4,949,865	308,572
20	\$0	\$0	\$0	\$0	\$23,712,146	\$44,111,577	2,190,858
2	\$0	\$0	\$0	\$0	\$5,180,858	\$5,661,263	348,712
3	\$0	\$0	\$0	\$0	\$5,730,534	\$6,449,766	392,547
4	\$0	\$0	\$0	\$0	\$6,316,708	\$7,322,796	440,373
5	\$0	\$0	\$0	\$0	\$6,941,571	\$8,288,598	492,520
6	\$0	\$0	\$0	\$0	\$7,607,569	\$9,356,350	549,350
7	\$0	\$0	\$0	\$0	\$8,317,446	\$10,536,291	611,270
8	\$0	\$0	\$0	\$0	\$9,074,281	\$11,839,879	678,728
9	\$0	\$0	\$0	\$0	\$9,881,540	\$13,279,964	752,229
10	\$0	\$0	\$0	\$0	\$10,743,129	\$14,871,003	832,338
11	\$0	\$0	\$0	\$0	\$11,663,465	\$16,629,313	919,689
12	\$0	\$0	\$0	\$0	\$12,647,558	\$18,573,365	1,014,998
13	\$0	\$0	\$0	\$0	\$13,701,103	\$20,724,148	1,119,077
14	\$0	\$0	\$0	\$0	\$14,830,606	\$23,105,601	1,232,849
15	\$0	\$0	\$0	\$0	\$16,043,518	\$25,745,137	1,357,369
16	\$0	\$0	\$0	\$0	\$17,348,414	\$28,674,285	1,493,847
17	\$0	\$0	\$0	\$0	\$18,755,206	\$31,929,482	1,643,678
18	\$0	\$0	\$0	\$0	\$20,275,405	\$35,553,045	1,808,479
19	\$0	\$0	\$0	\$0	\$21,922,454	\$39,594,391	1,990,136
Total	\$0	\$0	\$0	\$0	\$245,359,233	\$377,196,119	20,177,620

SUMMARY OF VEHICLE OPERATING COST BENEFITS

Year	HIGHWAY						TRANSIT		Present Value of Veh Op Cost Benefits	Constant Dollars		
	Peak HOV	Peak Non-HOV	Peak Weaving	Peak Truck	Peak Arterial	Non-Peak Non-HOV	Non-Peak Weaving	Non-Peak Truck			Peak Period	Non-Peak Period
1	\$0	(\$751,553)	\$0	(\$166,514)	\$0	(\$508,059)	\$0	(\$129,439)	-	-	(\$1,555,566)	(\$1,650,300)
20	\$0	(\$1,359,616)	\$0	(\$186,211)	\$0	(\$510,621)	\$0	(\$130,092)	-	-	(\$2,186,540)	(\$4,067,608)
2	\$0	(\$927,593)	\$0	(\$172,888)	\$0	(\$513,053)	\$0	(\$130,712)	-	-	(\$1,744,245)	(\$1,905,984)
3	\$0	(\$1,258,426)	\$0	(\$211,342)	\$0	(\$517,325)	\$0	(\$131,800)	-	-	(\$2,118,892)	(\$2,384,832)
4	\$0	(\$1,438,390)	\$0	(\$230,842)	\$0	(\$520,912)	\$0	(\$132,714)	-	-	(\$2,322,858)	(\$2,692,829)
5	\$0	(\$1,635,931)	\$0	(\$253,908)	\$0	(\$523,852)	\$0	(\$133,463)	-	-	(\$2,547,154)	(\$3,041,435)
6	\$0	(\$1,746,977)	\$0	(\$265,966)	\$0	(\$526,178)	\$0	(\$134,056)	-	-	(\$2,673,177)	(\$3,287,671)
7	\$0	(\$1,943,673)	\$0	(\$274,160)	\$0	(\$527,925)	\$0	(\$134,501)	-	-	(\$2,880,258)	(\$3,648,625)
8	\$0	(\$2,000,266)	\$0	(\$280,888)	\$0	(\$529,124)	\$0	(\$134,806)	-	-	(\$2,945,084)	(\$3,842,667)
9	\$0	(\$2,089,920)	\$0	(\$291,032)	\$0	(\$529,804)	\$0	(\$134,979)	-	-	(\$3,045,736)	(\$4,093,215)
10	\$0	(\$2,195,212)	\$0	(\$300,924)	\$0	(\$529,997)	\$0	(\$135,028)	-	-	(\$3,161,162)	(\$4,375,787)
11	\$0	(\$2,176,687)	\$0	(\$300,772)	\$0	(\$529,728)	\$0	(\$134,960)	-	-	(\$3,142,148)	(\$4,479,951)
12	\$0	(\$2,173,801)	\$0	(\$300,373)	\$0	(\$529,026)	\$0	(\$134,781)	-	-	(\$3,137,982)	(\$4,608,232)
13	\$0	(\$2,169,237)	\$0	(\$286,339)	\$0	(\$527,915)	\$0	(\$134,498)	-	-	(\$3,117,990)	(\$4,716,239)
14	\$0	(\$2,111,180)	\$0	(\$280,668)	\$0	(\$526,420)	\$0	(\$134,117)	-	-	(\$3,052,386)	(\$4,755,518)
15	\$0	(\$2,052,007)	\$0	(\$274,836)	\$0	(\$524,565)	\$0	(\$133,644)	-	-	(\$2,985,052)	(\$4,790,132)
16	\$0	(\$1,957,566)	\$0	(\$262,836)	\$0	(\$522,371)	\$0	(\$133,085)	-	-	(\$2,875,857)	(\$4,753,354)
17	\$0	(\$1,896,887)	\$0	(\$256,772)	\$0	(\$519,859)	\$0	(\$132,446)	-	-	(\$2,805,965)	(\$4,776,967)
18	\$0	(\$1,682,679)	\$0	(\$233,904)	\$0	(\$517,051)	\$0	(\$131,730)	-	-	(\$2,565,365)	(\$4,498,383)
19	\$0	(\$1,571,266)	\$0	(\$208,783)	\$0	(\$513,965)	\$0	(\$130,944)	-	-	(\$2,424,958)	(\$4,379,744)
Total	\$0	(\$35,138,868)	\$0	(\$5,039,960)	\$0	(\$10,447,751)	\$0	(\$2,661,795)	-	-	(\$53,288,374)	(\$76,749,472)

SUMMARY OF ACCIDENT REDUCTION BENEFITS

Year	HIGHWAY						TRANSIT	Present Value of Accident Benefits	Constant Dollars		
	Peak HOV	Peak Non-HOV	Peak Weaving	Peak Truck	Peak Arterial	Non-Peak Non-HOV	Non-Peak Weaving			Non-Peak Truck	All Periods
1	\$0	\$4,499,473	\$0	\$287,200	\$0	\$3,910,757	\$0	\$249,623	\$0	\$8,947,053	\$9,491,929
20	\$0	\$4,522,158	\$0	\$288,648	\$0	\$3,930,474	\$0	\$250,881	\$0	\$8,992,162	\$16,728,071
2	\$0	\$4,543,697	\$0	\$290,023	\$0	\$3,949,195	\$0	\$252,076	\$0	\$9,034,991	\$9,872,779
3	\$0	\$4,581,528	\$0	\$292,438	\$0	\$3,982,075	\$0	\$254,175	\$0	\$9,110,216	\$10,253,628
4	\$0	\$4,613,300	\$0	\$294,466	\$0	\$4,009,690	\$0	\$255,938	\$0	\$9,173,394	\$10,634,478
5	\$0	\$4,639,335	\$0	\$296,128	\$0	\$4,032,319	\$0	\$257,382	\$0	\$9,225,163	\$11,015,327
6	\$0	\$4,659,939	\$0	\$297,443	\$0	\$4,050,227	\$0	\$258,525	\$0	\$9,266,135	\$11,396,177
7	\$0	\$4,675,408	\$0	\$298,430	\$0	\$4,063,672	\$0	\$259,383	\$0	\$9,296,893	\$11,777,026
8	\$0	\$4,686,022	\$0	\$299,108	\$0	\$4,072,898	\$0	\$259,972	\$0	\$9,318,000	\$12,157,876
9	\$0	\$4,692,052	\$0	\$299,493	\$0	\$4,078,138	\$0	\$260,307	\$0	\$9,329,989	\$12,538,726
10	\$0	\$4,693,755	\$0	\$299,601	\$0	\$4,079,619	\$0	\$260,401	\$0	\$9,333,376	\$12,919,575
11	\$0	\$4,691,378	\$0	\$299,450	\$0	\$4,077,553	\$0	\$260,269	\$0	\$9,328,650	\$13,300,425
12	\$0	\$4,685,158	\$0	\$299,053	\$0	\$4,072,147	\$0	\$259,924	\$0	\$9,316,282	\$13,681,274
13	\$0	\$4,675,321	\$0	\$298,425	\$0	\$4,063,597	\$0	\$259,379	\$0	\$9,296,720	\$14,062,124
14	\$0	\$4,662,082	\$0	\$297,580	\$0	\$4,052,090	\$0	\$258,644	\$0	\$9,270,395	\$14,442,973
15	\$0	\$4,645,648	\$0	\$296,531	\$0	\$4,037,806	\$0	\$257,732	\$0	\$9,237,716	\$14,823,823
16	\$0	\$4,626,216	\$0	\$295,290	\$0	\$4,020,917	\$0	\$256,654	\$0	\$9,199,077	\$15,204,673
17	\$0	\$4,603,975	\$0	\$293,871	\$0	\$4,001,586	\$0	\$255,420	\$0	\$9,154,852	\$15,585,522
18	\$0	\$4,579,105	\$0	\$292,283	\$0	\$3,979,970	\$0	\$254,041	\$0	\$9,105,399	\$15,966,372
19	\$0	\$4,551,778	\$0	\$290,539	\$0	\$3,956,218	\$0	\$252,525	\$0	\$9,051,060	\$16,347,221
Total	\$0	\$92,527,326	\$0	\$5,906,000	\$0	\$80,420,947	\$0	\$5,133,252	\$0	\$183,987,525	\$262,199,999

SUMMARY OF EMISSION REDUCTION BENEFITS

Year	HIGHWAY								
	Peak HOV	Peak Non-HOV	Peak Weaving	Peak Truck	Peak Ramp	Peak Arterial	Non-Peak Non-HOV	Non-Peak Weaving	Non-Peak Truck
1	\$0	(\$79,593)	\$0	(\$28,929)	\$0	\$0	(\$54,443)	\$0	(\$23,030)
20	\$0	(\$161,950)	\$0	(\$23,757)	\$0	\$0	(\$65,400)	\$0	(\$17,308)
2	\$0	(\$95,758)	\$0	(\$29,029)	\$0	\$0	(\$55,745)	\$0	(\$23,438)
3	\$0	(\$133,284)	\$0	(\$34,412)	\$0	\$0	(\$56,997)	\$0	(\$23,819)
4	\$0	(\$152,080)	\$0	(\$37,370)	\$0	\$0	(\$58,202)	\$0	(\$24,176)
5	\$0	(\$177,364)	\$0	(\$41,058)	\$0	\$0	(\$59,360)	\$0	(\$24,509)
6	\$0	(\$191,129)	\$0	(\$43,219)	\$0	\$0	(\$60,475)	\$0	(\$24,820)
7	\$0	(\$216,796)	\$0	(\$43,918)	\$0	\$0	(\$61,546)	\$0	(\$25,108)
8	\$0	(\$202,566)	\$0	(\$29,204)	\$0	\$0	(\$55,100)	\$0	(\$14,971)
9	\$0	(\$215,455)	\$0	(\$30,822)	\$0	\$0	(\$56,117)	\$0	(\$15,212)
10	\$0	(\$228,885)	\$0	(\$32,311)	\$0	\$0	(\$57,102)	\$0	(\$15,443)
11	\$0	(\$232,741)	\$0	(\$32,877)	\$0	\$0	(\$58,057)	\$0	(\$15,665)
12	\$0	(\$236,420)	\$0	(\$33,493)	\$0	\$0	(\$58,982)	\$0	(\$15,879)
13	\$0	(\$238,999)	\$0	(\$32,174)	\$0	\$0	(\$59,879)	\$0	(\$16,084)
14	\$0	(\$235,106)	\$0	(\$32,069)	\$0	\$0	(\$60,747)	\$0	(\$16,282)
15	\$0	(\$233,005)	\$0	(\$31,999)	\$0	\$0	(\$61,587)	\$0	(\$16,471)
16	\$0	(\$223,342)	\$0	(\$31,281)	\$0	\$0	(\$62,401)	\$0	(\$16,653)
17	\$0	(\$221,011)	\$0	(\$31,020)	\$0	\$0	(\$63,188)	\$0	(\$16,827)
18	\$0	(\$198,412)	\$0	(\$28,998)	\$0	\$0	(\$63,950)	\$0	(\$16,995)
19	\$0	(\$187,945)	\$0	(\$26,074)	\$0	\$0	(\$64,687)	\$0	(\$17,155)
Total	\$0	(\$3,861,842)	\$0	(\$654,015)	\$0	\$0	(\$1,193,964)	\$0	(\$379,845)

C

SUMMARY OF EMISSION REDUCTION BENEFITS (continued)

Year	TRANSIT				Present Value of Emission Benefits	Constant Dollars	CO ₂ EMISSIONS SAVED	
	Peak Bus	Non-Peak Bus	Passenger Rail	Light Rail			tons/yr	PV \$/yr
1	\$0	\$0	\$0	\$0	(\$185,995)	(\$197,322)	(4,869)	(\$114,591)
20	\$0	\$0	\$0	\$0	(\$268,416)	(\$499,332)	(12,508)	(\$244,576)
2	\$0	\$0	\$0	\$0	(\$203,969)	(\$222,883)	(5,623)	(\$131,061)
3	\$0	\$0	\$0	\$0	(\$248,513)	(\$279,703)	(7,097)	(\$163,798)
4	\$0	\$0	\$0	\$0	(\$271,828)	(\$315,123)	(8,012)	(\$183,126)
5	\$0	\$0	\$0	\$0	(\$302,292)	(\$360,952)	(9,115)	(\$206,316)
6	\$0	\$0	\$0	\$0	(\$319,642)	(\$393,119)	(9,852)	(\$220,841)
7	\$0	\$0	\$0	\$0	(\$347,368)	(\$440,036)	(10,999)	(\$244,159)
8	\$0	\$0	\$0	\$0	(\$301,841)	(\$393,834)	(11,835)	(\$260,165)
9	\$0	\$0	\$0	\$0	(\$317,605)	(\$426,834)	(12,647)	(\$275,315)
10	\$0	\$0	\$0	\$0	(\$333,741)	(\$461,975)	(13,486)	(\$290,725)
11	\$0	\$0	\$0	\$0	(\$339,341)	(\$483,819)	(13,879)	(\$296,294)
12	\$0	\$0	\$0	\$0	(\$344,775)	(\$506,314)	(14,267)	(\$301,624)
13	\$0	\$0	\$0	\$0	(\$347,137)	(\$525,075)	(14,580)	(\$305,251)
14	\$0	\$0	\$0	\$0	(\$344,203)	(\$536,258)	(14,706)	(\$304,903)
15	\$0	\$0	\$0	\$0	(\$343,063)	(\$550,515)	(14,823)	(\$304,344)
16	\$0	\$0	\$0	\$0	(\$333,677)	(\$551,518)	(14,649)	(\$297,837)
17	\$0	\$0	\$0	\$0	(\$332,047)	(\$565,287)	(14,731)	(\$296,600)
18	\$0	\$0	\$0	\$0	(\$308,354)	(\$540,701)	(13,866)	(\$276,472)
19	\$0	\$0	\$0	\$0	(\$295,861)	(\$534,358)	(13,477)	(\$266,116)
Total	\$0	\$0	\$0	\$0	(\$6,089,667)	(\$8,784,959)	(235,020)	(\$4,984,115)

NET PRESENT VALUE CALCULATION

Year	PRESENT VALUE OF USER BENEFITS				PRESENT VALUE OF USER BENEFITS (road 2)			
	Travel Time Savings	Vehicle Op. Cost Savings	Accident Reductions	Vehicle Emission Reductions	Travel Time Savings	Vehicle Op. Cost Savings	Accident Reductions	Vehicle Emission Reductions
Construction Period								
1								
2								
3								
4								
5								
6								
7								
8								
Project Open								
1	\$4,665,722	(\$1,555,566)	\$8,947,053	(\$185,995)				
2	\$5,180,858	(\$1,744,245)	\$9,034,991	(\$203,969)				
3	\$5,730,534	(\$2,118,892)	\$9,110,216	(\$248,513)				
4	\$6,316,708	(\$2,322,858)	\$9,173,394	(\$271,828)				
5	\$6,941,571	(\$2,547,154)	\$9,225,163	(\$302,292)				
6	\$7,607,569	(\$2,673,177)	\$9,266,135	(\$319,642)				
7	\$8,317,446	(\$2,880,258)	\$9,296,893	(\$347,368)				
8	\$9,074,281	(\$2,945,084)	\$9,318,000	(\$301,841)				
9	\$9,881,540	(\$3,045,736)	\$9,329,989	(\$317,605)				
10	\$10,743,129	(\$3,161,162)	\$9,333,376	(\$333,741)				
11	\$11,663,465	(\$3,142,148)	\$9,328,650	(\$339,341)				
12	\$12,647,558	(\$3,137,982)	\$9,316,282	(\$344,775)				
13	\$13,701,103	(\$3,117,990)	\$9,296,720	(\$347,137)				
14	\$14,830,606	(\$3,052,386)	\$9,270,395	(\$344,203)				
15	\$16,043,518	(\$2,985,052)	\$9,237,716	(\$343,063)				
16	\$17,348,414	(\$2,875,857)	\$9,199,077	(\$333,677)				
17	\$18,755,206	(\$2,805,965)	\$9,154,852	(\$332,047)				
18	\$20,275,405	(\$2,565,365)	\$9,105,399	(\$308,354)				
19	\$21,922,454	(\$2,424,958)	\$9,051,060	(\$295,861)				
20	\$23,712,146	(\$2,186,540)	\$8,992,162	(\$268,416)				
Total	\$245,359,233	(\$53,288,374)	\$183,987,525	(\$6,089,667)	\$0	\$0	\$0	\$0

20,177,620	Person-Hours of Time Saved
(235,020)	CO ₂ Emissions Saved (tons)
(\$4,984,115)	CO ₂ Emissions Saved (\$ PV)

	Person-Hours of Time Saved
	CO ₂ Emissions Saved (tons)
	CO ₂ Emissions Saved (\$ PV)

PRESENT VALUE OF USER BENEFITS (road 3)				Present Value of Total User Benefits	Present Value of Total Project Costs	NET PRESENT VALUE
Travel Time Savings	Vehicle Op. Cost Savings	Accident Reductions	Vehicle Emission Reductions			
				\$0	\$70,250,000	(\$70,250,000)
				\$0	\$68,203,883	(\$68,203,883)
				\$0	\$0	\$0
				\$0	\$0	\$0
				\$0	\$0	\$0
				\$0	\$0	\$0
				\$0	\$0	\$0
				\$0	\$0	\$0
				\$11,871,214	\$0	\$11,871,214
				\$12,267,634	\$0	\$12,267,634
				\$12,473,345	\$0	\$12,473,345
				\$12,895,417	\$0	\$12,895,417
				\$13,317,289	\$0	\$13,317,289
				\$13,880,884	\$0	\$13,880,884
				\$14,386,713	\$0	\$14,386,713
				\$15,145,356	\$0	\$15,145,356
				\$15,848,189	\$0	\$15,848,189
				\$16,581,603	\$0	\$16,581,603
				\$17,510,627	\$0	\$17,510,627
				\$18,481,083	\$0	\$18,481,083
				\$19,532,697	\$0	\$19,532,697
				\$20,704,411	\$0	\$20,704,411
				\$21,953,119	\$0	\$21,953,119
				\$23,337,957	\$0	\$23,337,957
				\$24,772,046	\$0	\$24,772,046
				\$26,507,084	\$0	\$26,507,084
				\$28,252,695	\$0	\$28,252,695
				\$30,249,353	\$0	\$30,249,353
\$0	\$0	\$0	\$0	\$369,968,717	\$138,453,883	\$231,514,833

	Person-Hours of Time Saved
	CO ₂ Emissions Saved (tons)
	CO ₂ Emissions Saved (\$ PV)

B

INTERNAL RATE OF RETURN ON INVESTMENT AND PAYBACK PERIOD

Year	USER BENEFITS IN CONSTANT DOLLARS				USER BENEFITS IN CONSTANT DOLLARS (road 2)			
	Travel Time Savings	Vehicle Op. Cost Savings	Accident Reductions	Vehicle Emission Reductions	Travel Time Savings	Vehicle Op. Cost Savings	Accident Reductions	Vehicle Emission Reductions
Construction Period								
1								
2								
3								
4								
5								
6								
7								
8								
Project Open								
1	\$4,949,865	(\$1,650,300)	\$9,491,929	(\$197,322)				
2	\$5,661,263	(\$1,905,984)	\$9,872,779	(\$222,883)				
3	\$6,449,766	(\$2,384,832)	\$10,253,628	(\$279,703)				
4	\$7,322,796	(\$2,692,829)	\$10,634,478	(\$315,123)				
5	\$8,288,598	(\$3,041,435)	\$11,015,327	(\$360,952)				
6	\$9,356,350	(\$3,287,671)	\$11,396,177	(\$393,119)				
7	\$10,536,291	(\$3,648,625)	\$11,777,026	(\$440,036)				
8	\$11,839,879	(\$3,842,667)	\$12,157,876	(\$393,834)				
9	\$13,279,964	(\$4,093,215)	\$12,538,726	(\$426,834)				
10	\$14,871,003	(\$4,375,787)	\$12,919,575	(\$461,975)				
11	\$16,629,313	(\$4,479,951)	\$13,300,425	(\$483,819)				
12	\$18,573,365	(\$4,608,232)	\$13,681,274	(\$506,314)				
13	\$20,724,148	(\$4,716,239)	\$14,062,124	(\$525,075)				
14	\$23,105,601	(\$4,755,518)	\$14,442,973	(\$536,258)				
15	\$25,745,137	(\$4,790,132)	\$14,823,823	(\$550,515)				
16	\$28,674,285	(\$4,753,354)	\$15,204,673	(\$551,518)				
17	\$31,929,482	(\$4,776,967)	\$15,585,522	(\$565,287)				
18	\$35,553,045	(\$4,498,383)	\$15,966,372	(\$540,701)				
19	\$39,594,391	(\$4,379,744)	\$16,347,221	(\$534,358)				
20	\$44,111,577	(\$4,067,608)	\$16,728,071	(\$499,332)				
Total	\$377,196,119	(\$76,749,472)	\$262,199,999	(\$8,784,959)	\$0	\$0	\$0	\$0

USER BENEFITS IN CONSTANT DOLLARS (road 3)				Total User Benefits in Constant Dollars	Total Project Costs in Constant Dollars	ANNUAL RETURNS ON INVESTMENT	CUMULATIVE RETURNS AFTER PROJ OPENS
Travel Time Savings	Vehicle Op. Cost Savings	Accident Reductions	Vehicle Emission Reductions				
				\$0	\$70,250,000	(\$70,250,000)	
				\$0	\$70,250,000	(\$70,250,000)	
				\$0	\$0	\$0	
				\$0	\$0	\$0	
				\$0	\$0	\$0	
				\$0	\$0	\$0	
				\$0	\$0	\$0	
				\$0	\$0	\$0	
				\$12,594,171	\$0	\$12,594,171	\$12,594,171
				\$13,405,175	\$0	\$13,405,175	\$25,999,346
				\$14,038,859	\$0	\$14,038,859	\$40,038,205
				\$14,949,322	\$0	\$14,949,322	\$54,987,527
				\$15,901,539	\$0	\$15,901,539	\$70,889,066
				\$17,071,737	\$0	\$17,071,737	\$87,960,803
				\$18,224,658	\$0	\$18,224,658	\$106,185,461
				\$19,761,254	\$0	\$19,761,254	\$125,946,715
				\$21,298,641	\$0	\$21,298,641	\$147,245,356
				\$22,952,816	\$0	\$22,952,816	\$170,198,172
				\$24,965,968	\$0	\$24,965,968	\$195,164,139
				\$27,140,093	\$0	\$27,140,093	\$222,304,232
				\$29,544,957	\$0	\$29,544,957	\$251,849,190
				\$32,256,798	\$0	\$32,256,798	\$284,105,988
				\$35,228,312	\$0	\$35,228,312	\$319,334,300
				\$38,574,086	\$0	\$38,574,086	\$357,908,386
				\$42,172,750	\$0	\$42,172,750	\$400,081,137
				\$46,480,333	\$0	\$46,480,333	\$446,561,470
				\$51,027,510	\$0	\$51,027,510	\$497,588,980
				\$56,272,708	\$0	\$56,272,708	\$553,861,688
\$0	\$0	\$0	\$0	\$553,861,688	\$140,500,000	\$413,361,688	

Total Construction Costs

\$140,500,000

Years After Construction Begins	ANNUAL RETURNS ON INVESTMENT
1	(\$70,250,000)
2	(\$70,250,000)
3	\$12,594,171
4	\$13,405,175
5	\$14,038,859
6	\$14,949,322
7	\$15,901,539
8	\$17,071,737
9	\$18,224,658
10	\$19,761,254
11	\$21,298,641
12	\$22,952,816
13	\$24,965,968
14	\$27,140,093
15	\$29,544,957
16	\$32,256,798
17	\$35,228,312
18	\$38,574,086
19	\$42,172,750
20	\$46,480,333
21	\$51,027,510
22	\$56,272,708
23	\$0
24	\$0
25	\$0
26	\$0
27	\$0
28	\$0

Internal Rate of Return 12.43%

Payback Period 9 years

The INTERNAL RATE OF RETURN (IRR) is the discount rate at which benefits and costs break even (are equal). For a project with an IRR greater than the Discount Rate, benefits are greater than costs, and the project has a positive economic value. The IRR allows projects with different costs, different benefit flows, and different time periods to be compared.

The PAYBACK PERIOD is the number of years it takes for the net benefits (benefits minus costs) to equal, or payback, the initial construction costs. For a project with a Payback Period longer than the life-cycle of the project, initial construction costs are not recovered. The Payback Period varies inversely with the Benefit-Cost Ratio: shorter Payback Period yields higher Benefit-Cost.

Parameters

This page contains all economic values and rate tables.
To update economic values automatically, change "Economic Update Factor."

General Economic Parameters	
Year of Current Dollars for Model	2015
Economic Update Factor (Using GDP Deflator)	1.02
Real Discount Rate	3.0%

Travel Time Parameters		
	Value	Units
Statewide Average Hourly Wage	\$ 30.26	\$/hr
Heavy and Light Truck Drivers		
Average Hourly Wage	\$ 17.69	\$/hr
Benefits and Costs	\$ 8.68	\$/hr
Value of Time		
Automobile	\$ 15.13	\$/hr/per
Truck	\$ 26.37	\$/hr/veh
Auto & Truck Composite	\$ 20.27	\$/hr/veh
Transit	\$ 15.13	\$/hr/per
Out-of-Vehicle Travel	2	times
Incident-Related Travel	3	times
Travel Time Uprater	1.2%	annual incr
Vehicle Operating Cost Parameters		
Average Fuel Price		
Automobile (regular unleaded)	\$ 3.37	\$/gal
Truck (diesel)	\$ 3.74	\$/gal
Sales and Fuel Taxes		
State Sales Tax (gasoline)	0.00%	%
State Sales Tax (diesel)	0.00%	%
Average Local Sales Tax	0.00%	%
Federal Fuel Excise Tax (gasoline)	\$ 0.184	\$/gal
Federal Fuel Excise Tax (diesel)	\$ 0.244	\$/gal
State Fuel Excise Tax (gasoline)	\$ 0.200	\$/gal
State Fuel Excise Tax (diesel)	\$ 0.200	\$/gal
Fuel Cost Per Gallon (Exclude Taxes)		
Automobile	\$ 3.00	\$/gal
Truck	\$ 3.30	\$/gal
Non-Fuel Cost Per Mile		
Automobile	\$ 0.324	\$/mi
Truck	\$ 0.447	\$/mi
Idling Speed for Op. Costs and Emissions	5	mph
Accident Cost Parameters		
Cost of a Fatality	\$ 9,200,000	\$/event
Cost of an Injury		
Level A (Severe)	\$ 966,000	\$/event
Level B (Moderate)	\$ 432,400	\$/event
Level C (Minor)	\$ 27,600	\$/event
Cost of Property Damage	\$ 3,927	\$/event
Cost of Highway Accident		
Fatal Accident	\$ 10,200,000	\$/accident
Injury Accident	\$ 261,100	\$/accident
PDO Accident	\$ 15,900	\$/accident
Average Cost	\$ 145,400	\$/accident
Statewide Highway Accident Rates		
Fatal Accident	0.007	per mil veh-mi
Injury Accident	0.27	per mil veh-mi
PDO Accident	0.53	per mil veh-mi
Non-Freeway	1.05	per mil veh-mi

Sources: 1) Office of Management and Budget (OMB), 2) Review of OMB and State Treasurer's Office data, 3) Bureau of Labor Statistics (BLS) OES, 4) BLS Employment Cost Index, 5) USDOT Department Guidance, 6) California Department of Transportation TSI and Traffic Operations, 7) IDAS model, 8) AAA Daily Fuel Gauge Report, 9) California Board of Equalization, 10) AAA Your Driving Costs, 11) American Transportation Research Institute, 12) National Safety Council, 13) TASAS summary 2009

TIGER Sources: 1) OMB GDP and Deflators Used in Historical Tables 1940-2019 (Table 10.1), 2) TIC

Highway Operations Parameters				
	Value	Units		
Maximum V/C Ratio	1.56	-		
Percent ADT in Peak Period	53.5%	%		
Percent ADT in Average Peak Hour	7.6%	%		
Annualization Factor	260	days/yr		
Freeway				
	Alpha	Beta	Capacity (vp/hpl)	Dep. Rate (vp/hpl)
Freeway	0.20	10	2,000	1,800
Expressway	0.20	10	2,000	1,800
Conventional Highway	0.05	10	800	1,400
HOV Lanes	0.55	8	1,600	
Non-HOV Lanes				
	Alpha	Beta	Capacity (vp/hpl)	
No Build	0.20	10	2,000	
Build	0.20	10	2,000	

Sources: 15) Highway Capacity Manual, 16) NCHRP 387, 17) PeMS data

Travel Demand Tables

Project Types		
Highway Capacity Expansion		
Please select a type of highway project		
General Highway	<input type="checkbox"/> TRUE	GenHwy
HOV Lane Addition	<input type="checkbox"/> FALSE	HOV
HOT Lane Addition	<input type="checkbox"/> FALSE	HOT
Passing Lane	<input type="checkbox"/> FALSE	Passing
Intersection	<input type="checkbox"/> FALSE	Intersect
Bypass	<input type="checkbox"/> FALSE	Bypass
Queuing	<input type="checkbox"/> FALSE	Queuing
Pavement	<input type="checkbox"/> FALSE	Pavement
Rail or Transit Cap Expansion		
Please select a type of rail or transit project		
Passenger Rail	<input type="checkbox"/> FALSE	PassRail
Light-Rail (LRT)	<input type="checkbox"/> FALSE	LRT
Bus	<input type="checkbox"/> FALSE	Bus
Hwy-Rail Grade Crossing	<input type="checkbox"/> FALSE	HwyRail
Hwy Operational Improvement		
Please select a type of op. improvement		
Auxiliary Lane	<input type="checkbox"/> FALSE	AuxLane
Freeway Connector	<input type="checkbox"/> FALSE	FreeConn
HOV Connector	<input type="checkbox"/> FALSE	HOVConn
HOV Drop Ramp	<input type="checkbox"/> FALSE	HOVDrop
Off-Ramp Widening	<input type="checkbox"/> FALSE	OffRamp
On-Ramp Widening	<input type="checkbox"/> FALSE	OnRamp
HOV-2 to HOV-3 Conv	<input type="checkbox"/> FALSE	HOV2to3
HOT Lane Conversion	<input type="checkbox"/> FALSE	HOTConv
Transp Mgmt Systems (TMS)		
Please select a type of TMS project		
Ramp Metering	<input type="checkbox"/> FALSE	RM
Ramp Metering Signal Coord	<input type="checkbox"/> FALSE	AM
Incident Management	<input type="checkbox"/> FALSE	IM
Traveler Information	<input type="checkbox"/> FALSE	TI
Arterial Signal Management	<input type="checkbox"/> FALSE	ASM
Transit Vehicle Location (AVL)	<input type="checkbox"/> FALSE	AVL
Transit Vehicle Signal Priority	<input type="checkbox"/> FALSE	SigPriority
Bus Rapid Transit (BRT)	<input type="checkbox"/> FALSE	BRT
TMS Lookup Code	<input type="checkbox"/> NoAdj	TMSLookup
User Modified Inputs	<input type="checkbox"/> FALSE	UserAdjInputs

DEMAND FOR TRAVEL IN PEAK PERIOD (percent of total daily travel)						
Number of Hours in Peak Period	Urban				Rural	
	So. California		No. California		Fwy/Exp	Other
	Fwy/Exp	Other	Fwy/Exp	Other	Fwy/Exp	Other
1	8.6%	8.6%	8.6%	8.6%	8.6%	8.6%
2	17.2%	17.2%	17.2%	17.2%	17.2%	17.2%
3	25.8%	25.8%	25.8%	25.8%	25.8%	25.8%
4	34.1%	34.1%	34.1%	34.1%	34.1%	34.1%
5	41.0%	41.0%	41.0%	41.0%	41.0%	41.0%
6	47.3%	47.3%	47.3%	47.3%	47.3%	47.3%
7	53.5%	53.5%	53.5%	53.5%	53.5%	53.5%
8	59.6%	59.6%	59.6%	59.6%	59.6%	59.6%
9	65.6%	65.6%	65.6%	65.6%	65.6%	65.6%
10	71.1%	71.1%	71.1%	71.1%	71.1%	71.1%
11	76.5%	76.5%	76.5%	76.5%	76.5%	76.5%
12	81.7%	81.7%	81.7%	81.7%	81.7%	81.7%
13	86.9%	86.9%	86.9%	86.9%	86.9%	86.9%
14	89.9%	89.9%	89.9%	89.9%	89.9%	89.9%
15	92.7%	92.7%	92.7%	92.7%	92.7%	92.7%
16	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%
17	96.7%	96.7%	96.7%	96.7%	96.7%	96.7%
18	97.9%	97.9%	97.9%	97.9%	97.9%	97.9%
19	98.9%	98.9%	98.9%	98.9%	98.9%	98.9%
20	99.5%	99.5%	99.5%	99.5%	99.5%	99.5%
21	99.7%	99.7%	99.7%	99.7%	99.7%	99.7%
22	99.8%	99.8%	99.8%	99.8%	99.8%	99.8%
23	99.9%	99.9%	99.9%	99.9%	99.9%	99.9%
24	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: California Department of Transportation, 2000-2001 California Statewide Travel Survey
Weekday Travel Report, June 2003

Operating Cost Tables

FUEL CONSUMPTION RATES		
<i>(gal/veh-mi)</i>		
Speed	Auto*	Truck
5	0.1439	0.2234
6	0.1366	0.2130
7	0.1293	0.2026
8	0.1220	0.1922
9	0.1147	0.1818
10	0.1074	0.1714
11	0.1025	0.1631
12	0.0977	0.1548
13	0.0929	0.1466
14	0.0880	0.1383
15	0.0832	0.1300
16	0.0800	0.1247
17	0.0767	0.1193
18	0.0735	0.1139
19	0.0702	0.1086
20	0.0670	0.1032
21	0.0648	0.0997
22	0.0626	0.0962
23	0.0603	0.0926
24	0.0581	0.0891
25	0.0559	0.0856
26	0.0544	0.0832
27	0.0529	0.0809
28	0.0515	0.0785
29	0.0500	0.0762
30	0.0485	0.0738
31	0.0475	0.0723
32	0.0465	0.0708
33	0.0455	0.0693
34	0.0445	0.0678
35	0.0435	0.0663
36	0.0429	0.0654
37	0.0423	0.0645
38	0.0417	0.0635
39	0.0411	0.0626
40	0.0405	0.0617
41	0.0402	0.0613
42	0.0400	0.0609
43	0.0397	0.0604
44	0.0394	0.0600
45	0.0391	0.0596
46	0.0391	0.0596
47	0.0391	0.0596
48	0.0391	0.0596
49	0.0391	0.0596
50	0.0390	0.0596
51	0.0393	0.0600
52	0.0396	0.0604
53	0.0399	0.0608
54	0.0401	0.0612
55	0.0404	0.0617
56	0.0410	0.0626
57	0.0416	0.0635
58	0.0422	0.0644
59	0.0428	0.0653
60	0.0433	0.0662
61	0.0443	0.0677
62	0.0453	0.0692
63	0.0462	0.0708
64	0.0472	0.0723
65	0.0482	0.0738
66	0.0488	0.0752
67	0.0495	0.0767
68	0.0502	0.0781
69	0.0509	0.0796
70	0.0515	0.0810
71	0.0516	0.0821
72	0.0516	0.0831
73	0.0516	0.0842
74	0.0517	0.0854
75	0.0517	0.0865
76	0.0518	0.0882
77	0.0518	0.0900
78	0.0519	0.0918
79	0.0519	0.0936
80	0.0520	0.0953

*Includes motorcycles & motorhomes
 Note: Five mph is best estimate for idling

Source: California Air Resources Board,
 EMFAC2011, 2011 & 2031 average

Accident Tables

HIGHWAY INJURY SEVERITY FREQUENCY
(percent of injuries)

Event	Urban	Suburban	Rural	Average
Severe Injury (A)	4.70%	4.70%	4.70%	4.70%
Other Visible Injury (B)	26.28%	26.28%	26.28%	26.28%
Complaint of Pain (C)	69.02%	69.02%	69.02%	69.02%

Source: 2009 SWITRS Annual Report, Table 8C

RATES FOR TRANSIT ACCIDENT EVENTS
(events/million veh-mi)

Event	Pass Train	Light Rail	Bus
Fatality	0.0428	0.1897	0.0351
Injury	0.2517	3.6283	3.8909
All Accidents	0.2519	7.4952	3.8924

Source: USDOT, Transportation Statistics Annual Report, Table 2-33, 2002 to 2008 average

NUMBER OF FATALITIES
(events/accident)

Accident Type	Urban	Suburban	Rural	Average
Fatal Accident	1.09	1.11	1.16	1.13

NUMBER OF INJURIES
(events/accident)

Accident Type	Urban	Suburban	Rural	Average
Fatal Accident	0.84	1.02	1.26	1.06
Injury Accident	1.42	1.43	1.51	1.44

NUMBER OF VEHICLES INVOLVED
(events/accident)

Accident Type	Urban	Suburban	Rural	Average
Fatal Accident	1.69	1.63	1.61	1.65
Injury Accident	2.08	1.97	1.58	1.96
PDO Accident	2.03	1.94	1.62	1.95

DISTRIBUTION OF ACCIDENT TYPES
(percent of accidents)

Accident Type	Urban	Suburban	Rural	Average
Fatal Accident	0.50%	0.74%	2.11%	0.83%
Injury Accident	32.08%	32.90%	37.91%	33.27%
PDO Accident	67.42%	66.37%	59.98%	65.90%

Source: California Department of Transportation, TASAS Unit, 2007 to 2009 average

COST OF TRANSIT ACCIDENT EVENTS
(\$/event)

Event	Pass Train	Light Rail	Bus
Fatality	\$9,200,000	\$9,200,000	\$9,200,000
Injury	\$513,400	\$513,400	\$513,400
Prop Damage	\$82,000	\$5,800	\$2,800

Source: FTA, Transit Safety & Security Statistics, 2002 to 2007 average

COSTS OF TRANSIT ACCIDENTS
(\$/million veh-mi)

Value	Pass Train	Light Rail	Bus
Cost	\$543,600	\$3,651,500	\$2,331,400

Source: Combination of above two tables

HIGHWAY-RAIL GRADE CROSSING INCIDENTS
(units in table)

Value	Incident	Fatality	Injury
Total Events	1,500	332	608
Avg per Incident		0.2213	0.4053
Cost per Event		\$9,200,000	\$513,400

Source: FRA, Office of Safety Analysis, 5.11 - Hwy/Rail Incidents Summary Tables, California, Jan 2001 to Dec 2010

COST OF HIGHWAY ACCIDENTS
(\$/accident)

Accident Type	Urban	Suburban	Rural	Average
Fatal Accident	\$10,200,000	\$10,400,000	\$10,900,000	\$10,600,000
Injury Accident	\$261,100	\$262,400	\$275,100	\$264,100
PDO Accident	\$15,900	\$15,200	\$12,700	\$15,300
All Types	\$145,400	\$172,900	\$342,100	\$185,700

Source: Combination of above four tables

PASSING LANE ACCIDENT REDUCTION FACTORS
(rate with passing lane/rate without passing lane)

Minimum ADT	Fatality	Injury	PDO
0	25.0%	69.4%	92.6%
5,000	19.2%	80.3%	96.5%
10,000	84.0%	57.7%	97.8%

Source: Taylor and Jain, 1991

Emissions Tables

HIGHWAY EMISSIONS FACTORS (g/mi)
Model Year 2011

Mode	Speed	CO	CO ₂	NO _x	PM ₁₀	SO _x	VOC
Auto	0	5.2339	79.62	0.3731	0.0044	0.0000	0.7131
	5	5.7109	1200.44	0.4530	0.0640	0.0122	0.6503
	6	5.5208	1138.67	0.4412	0.0627	0.0116	0.6153
	7	5.3908	1076.91	0.4294	0.0614	0.0110	0.5802
	8	5.1407	1015.14	0.4176	0.0601	0.0104	0.5452
	9	4.9507	953.38	0.4058	0.0588	0.0098	0.5102
	10	4.7606	891.61	0.3940	0.0575	0.0091	0.4751
	11	4.6222	850.74	0.3852	0.0567	0.0087	0.4539
	12	4.4838	809.87	0.3764	0.0559	0.0083	0.4326
	13	4.3453	769.00	0.3677	0.0551	0.0079	0.4114
	14	4.2069	728.13	0.3589	0.0543	0.0075	0.3901
	15	4.0685	687.26	0.3502	0.0535	0.0071	0.3689
	16	3.9674	659.79	0.3438	0.0531	0.0068	0.3558
	17	3.8664	632.31	0.3373	0.0526	0.0065	0.3428
	18	3.7653	604.84	0.3309	0.0521	0.0063	0.3298
	19	3.6643	577.36	0.3245	0.0516	0.0060	0.3168
	20	3.5632	549.88	0.3181	0.0512	0.0057	0.3038
	21	3.4877	531.23	0.3134	0.0509	0.0055	0.2958
	22	3.4122	512.58	0.3087	0.0506	0.0053	0.2878
	23	3.3367	493.93	0.3040	0.0503	0.0051	0.2798
	24	3.2612	475.28	0.2993	0.0500	0.0050	0.2718
	25	3.1857	456.63	0.2947	0.0497	0.0048	0.2638
	26	3.1288	444.02	0.2914	0.0495	0.0046	0.2588
	27	3.0718	431.40	0.2881	0.0493	0.0045	0.2538
	28	3.0149	418.78	0.2847	0.0491	0.0044	0.2488
	29	2.9579	406.16	0.2814	0.0489	0.0043	0.2437
	30	2.9010	393.55	0.2781	0.0487	0.0041	0.2387
	31	2.8584	385.23	0.2759	0.0486	0.0040	0.2356
	32	2.8159	376.92	0.2738	0.0485	0.0040	0.2325
	33	2.7734	368.60	0.2716	0.0483	0.0039	0.2294
	34	2.7309	360.29	0.2694	0.0482	0.0038	0.2263
	35	2.6883	351.97	0.2672	0.0481	0.0037	0.2231
	36	2.6580	346.91	0.2659	0.0480	0.0037	0.2214
	37	2.6277	341.84	0.2647	0.0479	0.0036	0.2196
	38	2.5974	336.77	0.2634	0.0479	0.0036	0.2178
	39	2.5671	331.70	0.2622	0.0478	0.0035	0.2160
	40	2.5368	326.63	0.2609	0.0477	0.0034	0.2142
	41	2.5180	324.21	0.2605	0.0477	0.0034	0.2134
	42	2.4992	321.78	0.2601	0.0476	0.0034	0.2127
	43	2.4804	319.36	0.2597	0.0476	0.0034	0.2119
	44	2.4615	316.93	0.2593	0.0475	0.0034	0.2112
	45	2.4427	314.51	0.2589	0.0475	0.0033	0.2104
	46	2.4360	314.44	0.2593	0.0475	0.0033	0.2105
	47	2.4293	314.37	0.2597	0.0475	0.0033	0.2107
	48	2.4227	314.30	0.2601	0.0474	0.0033	0.2108
	49	2.4160	314.23	0.2605	0.0474	0.0033	0.2109
	50	2.4093	314.17	0.2609	0.0474	0.0033	0.2111
	51	2.4171	316.46	0.2621	0.0474	0.0033	0.2121
	52	2.4249	318.75	0.2633	0.0474	0.0034	0.2132
	53	2.4328	321.05	0.2645	0.0474	0.0034	0.2142
	54	2.4406	323.34	0.2657	0.0474	0.0034	0.2153
	55	2.4485	325.64	0.2669	0.0474	0.0034	0.2163
	56	2.4758	330.54	0.2690	0.0475	0.0035	0.2184
	57	2.5031	335.45	0.2711	0.0475	0.0035	0.2206
	58	2.5304	340.36	0.2732	0.0475	0.0036	0.2227
	59	2.5577	345.27	0.2753	0.0476	0.0036	0.2248
	60	2.5851	350.18	0.2774	0.0476	0.0037	0.2270
	61	2.6411	358.30	0.2805	0.0476	0.0038	0.2305
	62	2.6972	366.41	0.2836	0.0477	0.0039	0.2341
	63	2.7533	374.53	0.2868	0.0478	0.0039	0.2377
	64	2.8094	382.64	0.2899	0.0478	0.0040	0.2413
	65	2.8654	390.76	0.2930	0.0479	0.0041	0.2449
	66	2.9386	396.35	0.2952	0.0479	0.0042	0.2489
	67	3.0117	401.95	0.2973	0.0480	0.0042	0.2528
	68	3.0848	407.55	0.2995	0.0480	0.0043	0.2568
	69	3.1580	413.15	0.3016	0.0481	0.0043	0.2608
	70	3.2311	418.75	0.3038	0.0481	0.0044	0.2647
	71	3.3211	418.85	0.3042	0.0481	0.0044	0.2688
	72	3.4111	418.95	0.3045	0.0482	0.0044	0.2729
	73	3.5012	419.04	0.3049	0.0482	0.0044	0.2770
	74	3.5912	419.14	0.3052	0.0482	0.0044	0.2811
	75	3.6812	419.24	0.3056	0.0482	0.0044	0.2852
	76	3.8430	419.40	0.3060	0.0482	0.0044	0.2919
	77	4.0048	419.55	0.3065	0.0482	0.0044	0.2986
	78	4.1666	419.70	0.3070	0.0482	0.0044	0.3053
	79	4.3284	419.86	0.3075	0.0482	0.0044	0.3119
	80	4.4902	420.01	0.3079	0.0482	0.0044	0.3186

HIGHWAY EMISSIONS FACTORS (g/mi)
Model Year 2031

Mode	Speed	CO	CO ₂	NO _x	PM ₁₀	SO _x	VOC
Auto	0	1.3628	80.38	0.0771	0.0049	0.0000	0.2019
	5	1.3760	1208.90	0.1323	0.0584	0.0122	0.1693
	6	1.3510	1146.73	0.1290	0.0574	0.0116	0.1612
	7	1.3260	1084.55	0.1258	0.0564	0.0110	0.1530
	8	1.3011	1022.37	0.1225	0.0554	0.0104	0.1449
	9	1.2761	960.19	0.1193	0.0544	0.0097	0.1367
	10	1.2511	898.02	0.1160	0.0534	0.0091	0.1286
	11	1.2273	856.86	0.1135	0.0528	0.0087	0.1235
	12	1.2034	815.71	0.1109	0.0523	0.0083	0.1185
	13	1.1796	774.55	0.1084	0.0517	0.0079	0.1135
	14	1.1558	733.40	0.1058	0.0511	0.0075	0.1085
	15	1.1320	692.24	0.1033	0.0505	0.0071	0.1035
	16	1.1120	664.57	0.1014	0.0502	0.0068	0.1005
	17	1.0920	636.90	0.0994	0.0499	0.0065	0.0975
	18	1.0721	609.23	0.0975	0.0495	0.0062	0.0944
	19	1.0521	581.56	0.0955	0.0492	0.0060	0.0914
	20	1.0322	553.89	0.0936	0.0488	0.0057	0.0884
	21	1.0154	535.11	0.0921	0.0486	0.0055	0.0865
	22	0.9985	516.34	0.0906	0.0484	0.0053	0.0847
	23	0.9817	497.56	0.0891	0.0482	0.0051	0.0828
	24	0.9649	478.79	0.0876	0.0480	0.0049	0.0809
	25	0.9481	460.01	0.0862	0.0478	0.0048	0.0791
	26	0.9340	447.31	0.0850	0.0477	0.0046	0.0779
	27	0.9198	434.61	0.0839	0.0475	0.0045	0.0768
	28	0.9057	421.90	0.0828	0.0474	0.0044	0.0757
	29	0.8916	409.20	0.0817	0.0473	0.0042	0.0745
	30	0.8774	396.50	0.0806	0.0472	0.0041	0.0734
	31	0.8657	388.13	0.0798	0.0471	0.0040	0.0727
	32	0.8540	379.77	0.0791	0.0470	0.0039	0.0721
	33	0.8422	371.40	0.0783	0.0469	0.0039	0.0714
	34	0.8305	363.04	0.0775	0.0468	0.0038	0.0708
	35	0.8188	354.67	0.0767	0.0468	0.0037	0.0701
	36	0.8093	349.58	0.0762	0.0467	0.0036	0.0698
	37	0.7999	344.48	0.0756	0.0466	0.0036	0.0695
	38	0.7904	339.39	0.0751	0.0466	0.0035	0.0692
	39	0.7810	334.29	0.0746	0.0465	0.0035	0.0689
	40	0.7716	329.19	0.0740	0.0465	0.0034	0.0686
	41	0.7645	326.76	0.0738	0.0465	0.0034	0.0686
	42	0.7574	324.33	0.0735	0.0464	0.0034	0.0685
	43	0.7504	321.90	0.0732	0.0464	0.0034	0.0685
	44	0.7433	319.47	0.0729	0.0464	0.0033	0.0685
	45	0.7362	317.03	0.0726	0.0464	0.0033	0.0685
	46	0.7319	316.98	0.0726	0.0463	0.0033	0.0688
	47	0.7275	316.94	0.0725	0.0463	0.0033	0.0690
	48	0.7232	316.89	0.0724	0.0463	0.0033	0.0693
	49	0.7188	316.84	0.0724	0.0463	0.0033	0.0696
	50	0.7144	316.79	0.0723	0.0463	0.0033	0.0699
	51	0.7135	319.12	0.0725	0.0463	0.0033	0.0705
	52	0.7126	321.45	0.0726	0.0463	0.0034	0.0711
	53	0.7116	323.78	0.0728	0.0463	0.0034	0.0717
	54	0.7107	326.11	0.0729	0.0463	0.0034	0.0723
	55	0.7098	328.45	0.0731	0.0463	0.0034	0.0729
	56	0.7137	333.43	0.0735	0.0464	0.0035	0.0739
	57	0.7176	338.41	0.0738	0.0464	0.0035	0.0749
	58	0.7215	343.39	0.0742	0.0464	0.0036	0.0760
	59	0.7254	348.37	0.0746	0.0464	0.0036	0.0770
	60	0.7293	353.35	0.0750	0.0464	0.0037	0.0780
	61	0.7407	361.57	0.0756	0.0465	0.0038	0.0797
	62	0.7520	369.78	0.0762	0.0465	0.0038	0.0813
	63	0.7634	378.00	0.0769	0.0466	0.0039	0.0830
	64	0.7747	386.22	0.0775	0.0466	0.0040	0.0847
	65	0.7861	394.44	0.0781	0.0467	0.0041	0.0863
	66	0.8123	400.15	0.0786	0.0467	0.0042	0.0888
	67	0.8386	405.86	0.0791	0.0467	0.0042	0.0912
	68	0.8648	411.57	0.0796	0.0468	0.0043	0.0936
	69	0.8911	417.28	0.0801	0.0468	0.0043	0.0960
	70	0.9173	422.99	0.0806	0.0468	0.0044	0.0984
	71	0.9675	423.21	0.0808	0.0468	0.0044	0.1020
	72	1.0177	423.43	0.0810	0.0468	0.0044	

Emissions Tables

Truck	0	7.7807	88.95	0.9968	0.0033	0.0000	0.8010
	5	8.2113	1871.17	1.4852	0.0764	0.0190	0.8648
	6	7.9348	1783.22	1.4539	0.0752	0.0181	0.8200
	7	7.6582	1695.27	1.4225	0.0739	0.0172	0.7751
	8	7.3817	1607.32	1.3912	0.0727	0.0164	0.7303
	9	7.1052	1519.37	1.3599	0.0714	0.0155	0.6854
	10	6.8287	1431.43	1.3286	0.0702	0.0146	0.6406
	11	6.5519	1361.83	1.2955	0.0691	0.0139	0.6068
	12	6.2751	1292.24	1.2625	0.0680	0.0132	0.5731
	13	5.9984	1222.65	1.2294	0.0669	0.0125	0.5394
	14	5.7216	1153.05	1.1964	0.0658	0.0118	0.5056
	15	5.4448	1083.46	1.1633	0.0647	0.0111	0.4719
	16	5.2607	1038.29	1.1404	0.0640	0.0106	0.4514
	17	5.0765	993.12	1.1176	0.0633	0.0102	0.4310
	18	4.8924	947.96	1.0947	0.0626	0.0097	0.4105
	19	4.7082	902.79	1.0719	0.0619	0.0093	0.3901
	20	4.5241	857.62	1.0490	0.0612	0.0088	0.3696
	21	4.3967	827.81	1.0337	0.0607	0.0085	0.3568
	22	4.2692	797.99	1.0184	0.0602	0.0082	0.3440
	23	4.1418	768.18	1.0032	0.0597	0.0079	0.3311
	24	4.0144	738.36	0.9879	0.0592	0.0076	0.3183
	25	3.8870	708.54	0.9726	0.0588	0.0073	0.3055
	26	3.7963	688.82	0.9631	0.0584	0.0071	0.2973
	27	3.7057	669.09	0.9537	0.0581	0.0070	0.2890
	28	3.6150	649.37	0.9442	0.0578	0.0068	0.2808
	29	3.5243	629.64	0.9348	0.0574	0.0066	0.2725
	30	3.4337	609.92	0.9253	0.0571	0.0064	0.2643
	31	3.3683	597.14	0.9207	0.0569	0.0062	0.2589
	32	3.3030	584.37	0.9162	0.0567	0.0061	0.2535
	33	3.2377	571.59	0.9116	0.0565	0.0060	0.2481
	34	3.1723	558.81	0.9070	0.0562	0.0058	0.2427
	35	3.1070	546.04	0.9024	0.0560	0.0057	0.2373
	36	3.0606	538.35	0.9022	0.0559	0.0056	0.2339
	37	3.0141	530.65	0.9020	0.0557	0.0055	0.2304
	38	2.9676	522.96	0.9018	0.0555	0.0054	0.2269
	39	2.9212	515.26	0.9015	0.0553	0.0054	0.2235
	40	2.8747	507.57	0.9013	0.0552	0.0053	0.2200
	41	2.8437	503.97	0.9054	0.0551	0.0052	0.2180
	42	2.8126	500.38	0.9094	0.0549	0.0052	0.2159
	43	2.7815	496.79	0.9135	0.0548	0.0052	0.2139
	44	2.7504	493.20	0.9175	0.0547	0.0051	0.2118
	45	2.7193	489.60	0.9216	0.0546	0.0051	0.2098
	46	2.7023	489.59	0.9303	0.0545	0.0051	0.2087
	47	2.6853	489.58	0.9390	0.0545	0.0051	0.2076
	48	2.6683	489.58	0.9477	0.0544	0.0051	0.2065
	49	2.6513	489.57	0.9564	0.0543	0.0051	0.2055
	50	2.6343	489.56	0.9651	0.0543	0.0051	0.2044
	51	2.6320	493.15	0.9792	0.0542	0.0051	0.2041
	52	2.6296	496.74	0.9934	0.0542	0.0052	0.2039
	53	2.6273	500.34	1.0076	0.0542	0.0052	0.2037
	54	2.6250	503.93	1.0218	0.0542	0.0052	0.2034
	55	2.6226	507.52	1.0360	0.0541	0.0053	0.2032
	56	2.6377	515.24	1.0571	0.0541	0.0053	0.2038
	57	2.6528	522.95	1.0783	0.0541	0.0054	0.2043
	58	2.6679	530.66	1.0995	0.0541	0.0055	0.2049
	59	2.6830	538.37	1.1207	0.0541	0.0056	0.2054
	60	2.6981	546.08	1.1418	0.0541	0.0057	0.2060
	61	2.7365	558.91	1.1726	0.0541	0.0058	0.2075
	62	2.7748	571.73	1.2033	0.0542	0.0059	0.2091
	63	2.8132	584.55	1.2340	0.0542	0.0061	0.2107
	64	2.8516	597.37	1.2647	0.0542	0.0062	0.2122
	65	2.8899	610.19	1.2954	0.0543	0.0064	0.2138
	66	2.9429	622.24	1.3362	0.0543	0.0065	0.2152
	67	2.9958	634.29	1.3770	0.0543	0.0066	0.2167
	68	3.0488	646.34	1.4178	0.0543	0.0067	0.2181
	69	3.1017	658.39	1.4586	0.0544	0.0068	0.2195
	70	3.1547	670.44	1.4994	0.0544	0.0069	0.2210
	71	3.2177	679.52	1.5549	0.0544	0.0070	0.2215
	72	3.2807	688.60	1.6103	0.0545	0.0071	0.2221
	73	3.3436	697.68	1.6658	0.0545	0.0072	0.2226
	74	3.4066	706.77	1.7213	0.0546	0.0073	0.2231
	75	3.4696	715.85	1.7767	0.0546	0.0074	0.2237
	76	3.5719	730.65	1.8592	0.0547	0.0076	0.2245
	77	3.6741	745.45	1.9417	0.0547	0.0077	0.2253
	78	3.7764	760.25	2.0243	0.0547	0.0079	0.2262
	79	3.8787	775.04	2.1068	0.0548	0.0080	0.2270
	80	3.9809	789.84	2.1893	0.0548	0.0082	0.2278

Truck	0	2.4976	90.05	0.4876	0.0028	0.0000	0.2977
	5	2.1294	1891.53	0.3786	0.0651	0.0191	0.2464
	6	2.0765	1802.78	0.3708	0.0642	0.0182	0.2360
	7	2.0236	1714.03	0.3631	0.0633	0.0173	0.2256
	8	1.9707	1625.28	0.3553	0.0625	0.0164	0.2151
	9	1.9178	1536.53	0.3475	0.0616	0.0156	0.2047
	10	1.8650	1447.78	0.3397	0.0608	0.0147	0.1942
	11	1.8056	1377.21	0.3314	0.0601	0.0140	0.1876
	12	1.7462	1306.63	0.3231	0.0595	0.0133	0.1810
	13	1.6868	1236.06	0.3148	0.0589	0.0126	0.1745
	14	1.6275	1165.48	0.3065	0.0582	0.0118	0.1679
	15	1.5681	1094.91	0.2981	0.0576	0.0111	0.1613
	16	1.5259	1049.14	0.2923	0.0572	0.0107	0.1573
	17	1.4836	1003.38	0.2865	0.0568	0.0102	0.1534
	18	1.4414	957.61	0.2806	0.0564	0.0098	0.1494
	19	1.3992	911.84	0.2748	0.0560	0.0093	0.1455
	20	1.3570	866.08	0.2690	0.0556	0.0089	0.1415
	21	1.3255	835.90	0.2650	0.0553	0.0086	0.1391
	22	1.2941	805.73	0.2611	0.0551	0.0083	0.1366
	23	1.2627	775.56	0.2571	0.0548	0.0080	0.1341
	24	1.2312	745.39	0.2531	0.0546	0.0077	0.1317
	25	1.1998	715.21	0.2492	0.0543	0.0074	0.1292
	26	1.1756	695.24	0.2467	0.0541	0.0071	0.1276
	27	1.1513	675.26	0.2442	0.0539	0.0069	0.1260
	28	1.1271	655.29	0.2416	0.0537	0.0067	0.1244
	29	1.1029	635.31	0.2391	0.0536	0.0065	0.1229
	30	1.0786	615.34	0.2366	0.0534	0.0063	0.1213
	31	1.0595	602.42	0.2353	0.0532	0.0062	0.1202
	32	1.0403	589.49	0.2340	0.0531	0.0060	0.1192
	33	1.0211	576.57	0.2327	0.0530	0.0059	0.1181
	34	1.0019	563.65	0.2314	0.0529	0.0058	0.1171
	35	0.9828	550.73	0.2301	0.0528	0.0057	0.1160
	36	0.9674	542.95	0.2299	0.0527	0.0056	0.1153
	37	0.9520	535.17	0.2297	0.0526	0.0055	0.1146
	38	0.9367	527.39	0.2295	0.0525	0.0054	0.1140
	39	0.9213	519.62	0.2292	0.0524	0.0054	0.1133
	40	0.9060	511.84	0.2290	0.0524	0.0053	0.1126
	41	0.8937	508.20	0.2299	0.0523	0.0053	0.1122
	42	0.8814	504.57	0.2307	0.0523	0.0052	0.1118
	43	0.8690	500.94	0.2315	0.0522	0.0052	0.1113
	44	0.8567	497.30	0.2324	0.0522	0.0051	0.1109
	45	0.8444	493.67	0.2332	0.0521	0.0051	0.1105
	46	0.8347	493.67	0.2352	0.0521	0.0051	0.1103
	47	0.8251	493.67	0.2372	0.0520	0.0051	0.1100
	48	0.8154	493.67	0.2393	0.0520	0.0051	0.1098
	49	0.8057	493.67	0.2413	0.0520	0.0051	0.1096
	50	0.7960	493.67	0.2433	0.0520	0.0051	0.1094
	51	0.7888	497.33	0.2466	0.0519	0.0051	0.1093
	52	0.7816	501.00	0.2500	0.0519	0.0052	0.1093
	53	0.7743	504.66	0.2533	0.0519	0.0052	0.1092
	54	0.7671	508.32	0.2567	0.0519	0.0053	0.1091
	55	0.7599	511.99	0.2600	0.0518	0.0053	0.1091
	56	0.7552	519.76	0.2651	0.0518	0.0054	0.1092
	57	0.7505	527.54	0.2702	0.0519	0.0054	0.1093
	58	0.7459	535.32	0.2752	0.0519	0.0055	0.1094
	59	0.7412	543.10	0.2803	0.0519	0.0056	0.1094
	60	0.7365	550.88	0.2854	0.0519	0.0057	0.1095
	61	0.7348	563.87	0.2928	0.0519	0.0058	0.1098
	62	0.7331	576.87	0.3002	0.0519	0.0059	0.1101
	63	0.7313	589.86	0.3076	0.0520	0.0061	0.1104
	64	0.7296	602.86	0.3150	0.0520	0.0062	0.1107
	65	0.7279	615.86	0.3224	0.0520	0.0063	0.1110
	66	0.7328	628.14	0.3324	0.0520	0.0065	0.1112
	67	0.7378	640.43	0.3424	0.0521	0.0066	0.1115
	68	0.7427	652.71	0.3525	0.0521	0.0067	0.1118
	69	0.7476	665.00	0.3625	0.0521	0.0069	0.1120
	70	0.7526	677.28	0.3725	0.0521	0.0070	0.1123
	71	0.7563	686.73	0.3863	0.0521	0.0071	0.1123
	72	0.7779	696.18	0.4001	0.0522	0.0072	0.1124
	73	0.7906	705.64	0.4140	0.0522	0.0073	0.1125
	74	0.8033	715.09	0.4278	0.0522	0.0073	0.1126
	75	0.8160	724.54	0.4416	0.0522	0.0074	0.1126
	76	0.8364	739.92				

Emissions Tables

Bus	0	16.2307	31.60	1.9169	0.0000	0.0000	1.1480
	5	28.2802	2573.44	19.0484	0.9433	0.0248	3.0451
	6	27.1830	2530.41	18.5778	0.9295	0.0243	2.9403
	7	26.0858	2487.38	18.1073	0.9157	0.0237	2.8355
	8	24.9885	2444.35	17.6367	0.9019	0.0232	2.7307
	9	23.8913	2401.32	17.1662	0.8882	0.0226	2.6258
	10	22.7941	2358.29	16.6956	0.8744	0.0221	2.5210
	11	21.3267	2300.37	16.0232	0.8534	0.0215	2.3743
	12	19.8593	2242.45	15.3507	0.8324	0.0210	2.2276
	13	18.3919	2184.53	14.6782	0.8115	0.0204	2.0808
	14	16.9246	2126.60	14.0058	0.7905	0.0199	1.9341
	15	15.4572	2068.68	13.3333	0.7695	0.0193	1.7873
	16	14.5867	2033.37	12.9075	0.7558	0.0188	1.6952
	17	13.7162	1998.07	12.4816	0.7420	0.0182	1.6031
	18	12.8457	1962.76	12.0557	0.7282	0.0177	1.5110
	19	11.9752	1927.46	11.6298	0.7144	0.0171	1.4188
	20	11.1047	1892.15	11.2040	0.7006	0.0165	1.3267
	21	10.5723	1870.09	10.9408	0.6918	0.0165	1.2671
	22	10.0400	1848.02	10.6777	0.6829	0.0165	1.2076
	23	9.5076	1825.95	10.4146	0.6741	0.0165	1.1480
	24	8.9753	1803.89	10.1514	0.6653	0.0165	1.0884
	25	8.4430	1781.82	9.8883	0.6565	0.0165	1.0288
	26	8.1131	1768.58	9.7399	0.6504	0.0165	0.9897
	27	7.7832	1755.34	9.5915	0.6443	0.0165	0.9505
	28	7.4533	1742.10	9.4431	0.6383	0.0165	0.9113
	29	7.1234	1728.86	9.2947	0.6322	0.0165	0.8722
	30	6.7935	1715.62	9.1463	0.6261	0.0165	0.8330
	31	6.5905	1707.35	9.0884	0.6217	0.0165	0.8071
	32	6.3875	1699.08	9.0305	0.6173	0.0165	0.7811
	33	6.1845	1690.80	8.9726	0.6129	0.0165	0.7552
	34	5.9815	1682.53	8.9146	0.6085	0.0165	0.7293
	35	5.7785	1674.25	8.8567	0.6041	0.0165	0.7034
	36	5.6621	1669.29	8.8760	0.6013	0.0165	0.6857
	37	5.5457	1664.32	8.8953	0.5985	0.0165	0.6680
	38	5.4293	1659.36	8.9146	0.5958	0.0165	0.6504
	39	5.3129	1654.39	8.9339	0.5930	0.0165	0.6327
	40	5.1965	1649.43	8.9532	0.5903	0.0165	0.6151
	41	5.1430	1647.77	9.0531	0.5886	0.0160	0.6041
	42	5.0895	1646.12	9.1529	0.5870	0.0154	0.5930
	43	5.0360	1644.46	9.2528	0.5853	0.0149	0.5820
	44	4.9825	1642.81	9.3526	0.5836	0.0143	0.5710
	45	4.9290	1641.15	9.4525	0.5820	0.0138	0.5599
	46	4.9306	1641.15	9.6478	0.5809	0.0143	0.5528
	47	4.9323	1641.15	9.8431	0.5798	0.0149	0.5456
	48	4.9339	1641.15	10.0383	0.5787	0.0154	0.5384
	49	4.9356	1641.15	10.2336	0.5776	0.0160	0.5312
	50	4.9372	1641.15	10.4289	0.5765	0.0165	0.5241
	51	4.9395	1643.91	10.7489	0.5759	0.0165	0.5202
	52	5.0498	1646.67	11.0688	0.5754	0.0165	0.5163
	53	5.1061	1649.43	11.3888	0.5748	0.0165	0.5125
	54	5.1623	1652.19	11.7087	0.5743	0.0165	0.5086
	55	5.2186	1654.94	12.0287	0.5737	0.0165	0.5048
	56	5.3400	1660.46	12.5312	0.5737	0.0165	0.5048
	57	5.4613	1665.98	13.0338	0.5737	0.0165	0.5048
	58	5.5827	1671.49	13.5363	0.5737	0.0165	0.5048
	59	5.7040	1677.01	14.0389	0.5737	0.0165	0.5048
	60	5.8254	1682.53	14.5414	0.5737	0.0165	0.5048
	61	6.0334	1691.35	15.3237	0.5748	0.0165	0.5070
	62	6.2413	1700.18	16.1059	0.5759	0.0165	0.5092
	63	6.4493	1709.00	16.8881	0.5770	0.0165	0.5114
	64	6.6573	1717.83	17.6704	0.5781	0.0165	0.5136
	65	6.8653	1726.66	18.4526	0.5792	0.0165	0.5158
	66	7.2029	1741.55	19.6861	0.5809	0.0165	0.5213
	67	7.5405	1756.45	20.9196	0.5825	0.0165	0.5268
	68	7.8781	1771.34	22.1531	0.5842	0.0165	0.5323
	69	8.2157	1786.24	23.3866	0.5858	0.0165	0.5379
	70	8.5533	1801.13	24.6200	0.5875	0.0165	0.5434
	71	9.0967	1824.30	26.6181	0.5897	0.0165	0.5533
	72	9.6400	1847.47	28.6162	0.5919	0.0165	0.5632
	73	10.1834	1870.64	30.6142	0.5941	0.0165	0.5732
	74	10.7268	1893.81	32.6123	0.5963	0.0165	0.5831
	75	11.2702	1916.98	34.6104	0.5985	0.0165	0.5930
	76	12.1600	1955.59	37.9467	0.6024	0.0171	0.6074
	77	13.0498	1994.21	41.2831	0.6063	0.0177	0.6217
	78	13.9396	2032.82	44.6195	0.6101	0.0182	0.6360
	79	14.8294	2071.44	47.9558	0.6140	0.0188	0.6504
	80	15.7192	2110.05	51.2922	0.6178	0.0193	0.6647

Bus	0	6.7367	35.88	0.9329	0.0000	0.0000	0.4575
	5	8.5199	2438.77	9.8329	0.7659	0.0243	1.0942
	6	8.1853	2395.98	9.5863	0.7576	0.0238	1.0616
	7	7.8508	2353.19	9.3398	0.7494	0.0233	1.0290
	8	7.5162	2310.39	9.0932	0.7411	0.0229	0.9964
	9	7.1816	2267.60	8.8467	0.7328	0.0224	0.9638
	10	6.8470	2224.80	8.6001	0.7246	0.0219	0.9313
	11	6.4035	2168.39	8.2490	0.7124	0.0209	0.8846
	12	5.9600	2111.98	7.8979	0.7003	0.0199	0.8379
	13	5.5165	2055.57	7.5468	0.6881	0.0190	0.7912
	14	5.0730	1999.16	7.1957	0.6760	0.0180	0.7445
	15	4.6295	1942.75	6.8446	0.6638	0.0170	0.6978
	16	4.3689	1908.71	6.6219	0.6555	0.0170	0.6677
	17	4.1082	1874.67	6.3992	0.6473	0.0170	0.6375
	18	3.8476	1840.63	6.1764	0.6390	0.0170	0.6074
	19	3.5869	1806.59	5.9537	0.6307	0.0170	0.5772
	20	3.3263	1772.55	5.7310	0.6225	0.0170	0.5471
	21	3.1687	1751.15	5.5929	0.6171	0.0170	0.5271
	22	3.0111	1729.75	5.4548	0.6118	0.0170	0.5072
	23	2.8536	1708.36	5.3167	0.6064	0.0170	0.4873
	24	2.6960	1686.96	5.1786	0.6011	0.0170	0.4673
	25	2.5385	1665.56	5.0405	0.5957	0.0170	0.4474
	26	2.4412	1652.92	4.9617	0.5923	0.0170	0.4343
	27	2.3439	1640.28	4.8829	0.5889	0.0170	0.4211
	28	2.2467	1627.63	4.8041	0.5855	0.0170	0.4080
	29	2.1494	1614.99	4.7253	0.5821	0.0170	0.3949
	30	2.0522	1602.34	4.6466	0.5787	0.0170	0.3817
	31	1.9919	1593.59	4.6149	0.5758	0.0170	0.3730
	32	1.9316	1584.84	4.5833	0.5729	0.0170	0.3642
	33	1.8713	1576.08	4.5517	0.5699	0.0170	0.3555
	34	1.8110	1567.33	4.5201	0.5670	0.0170	0.3467
	35	1.7507	1558.58	4.4885	0.5641	0.0170	0.3380
	36	1.7166	1554.20	4.4977	0.5626	0.0165	0.3321
	37	1.6826	1549.82	4.5070	0.5612	0.0160	0.3263
	38	1.6485	1545.45	4.5162	0.5597	0.0156	0.3205
	39	1.6145	1541.07	4.5255	0.5583	0.0151	0.3146
	40	1.5805	1536.69	4.5347	0.5568	0.0146	0.3088
	41	1.5639	1534.75	4.5863	0.5558	0.0141	0.3049
	42	1.5474	1532.80	4.6378	0.5549	0.0136	0.3010
	43	1.5309	1530.86	4.6894	0.5539	0.0131	0.2971
	44	1.5143	1528.91	4.7409	0.5529	0.0126	0.2932
	45	1.4978	1526.97	4.7924	0.5519	0.0122	0.2893
	46	1.4973	1526.97	4.8926	0.5510	0.0122	0.2869
	47	1.4968	1526.97	4.9928	0.5500	0.0122	0.2845
	48	1.4963	1526.97	5.0930	0.5490	0.0122	0.2821
	49	1.4958	1526.97	5.1932	0.5481	0.0122	0.2796
	50	1.4954	1526.97	5.2933	0.5471	0.0122	0.2772
	51	1.5099	1529.40	5.4592	0.5471	0.0126	0.2762
	52	1.5245	1531.83	5.6250	0.5471	0.0131	0.2752
	53	1.5391	1534.26	5.7908	0.5471	0.0136	0.2743
	54	1.5537	1536.69	5.9566	0.5471	0.0141	0.2733
	55	1.5683	1539.13	6.1225	0.5471	0.0146	0.2723
	56	1.6019	1544.48	6.3836	0.5471	0.0151	0.2723
	57	1.6354	1549.82	6.6447	0.5471	0.0156	0.2723
	58	1.6690	1555.17	6.9059	0.5471	0.0160	0.2723
	59	1.7025	1560.52	7.1670	0.5471	0.0165	0.2723
	60	1.7361	1565.87	7.4282	0.5471	0.0170	0.2723
	61	1.7930	1574.63	7.8347	0.5476	0.0170	0.2738
	62	1.8499	1583.38	8.2413	0.5481	0.0170	0.2752
	63	1.9068	1592.13	8.6478	0.5485	0.0170	0.2767
	64	1.9637	1600.89	9.0543	0.5490	0.0170	0.2782
	65	2.0206	1609.64	9.4609	0.5495	0.0170	0.2796
	66	2.1144	1624.23	10.1038	0.5505	0.0170	0.2821
	67	2.2083	1638.82	10.7467	0.5515	0.0170	0.2845
	68	2.3021	1653.41	11.3895	0.5524	0.0170	0.2869
	69	2.3960	1667.99	12.0324	0.5534	0.0170	0.2893
	70	2.4898	1682.58	12.6753	0.5544	0.0170	0.2918
	71	2.6401	1705.44	13.7155	0.5558	0.0170	0.2957
	72	2.7904	1728.30	14.7557	0.5573	0.0170	0.2996
	73	2.9406	1751.15	15.7959	0.5588	0.0170	0.

HEALTH COST OF TRANSPORTATION EMISSIONS
(\$/ton)

Area	Proj Loc	CO	CO ₂ e	NO _x	PM ₁₀	SO _x	VOC
LA/South Coast	1	\$0	\$24	\$8,209	\$360,383	\$46,561	\$2,083
CA Urban Area	2	\$0	\$24	\$7,877	\$360,383	\$46,561	\$1,999
CA Rural Area	3	\$0	\$24	\$7,877	\$360,383	\$46,561	\$1,999

CO₂e Uprater increase in value per year

Sources: McCubbin and Delucchi, 1996 for emissions other than CO₂e
Interagency Working Group on Social Cost of Carbon, United States Government, 2010 for CO₂e

PASSENGER TRAIN EMISSIONS FACTORS
(g/train-mile)

Mode	Year	CO	CO ₂	NO _x	PM ₁₀	SO _x	VOC
Passenger Train	2002	45.67		583.58	62.02		19.73
	2022	45.67		250.11	31.01		19.73

LIGHT RAIL EMISSIONS FACTORS
(g/veh-mile)

Mode	Year	CO	CO ₂	NO _x	PM ₁₀	SO _x	VOC
Light Rail	2002	0.14		1.13	0.17		0.06
	2022	0.14		1.14	0.17		0.06

Source: California Air Resources Board

Pavement Adjustments (used only for pavement projects)

PAVEMENT DETERIORATION (IRI in inches/mile)			
Year 0	Year 20, By Loading		
	Light	Medium	Heavy
0	125	150	350
25	150	200	500
50	175	250	675
75	200	300	750
100	275	400	750
125	325	475	750
150	400	575	750
175	500	700	750
200	575	750	750
225	650	750	750
250	750	750	750
275	750	750	750
300	750	750	750
325	750	750	750
350	750	750	750
375	750	750	750
400	750	750	750
425	750	750	750
450	750	750	750

Source: Paterson, 1987

VEHICLE OPERATING SPEED (percent adjustment)		
IRI	Auto	Truck
0	1.00	1.02
25	1.00	1.02
50	1.00	1.02
75	1.00	1.02
100	1.00	1.02
125	1.00	1.02
150	1.00	1.01
175	1.00	1.00
200	1.00	0.98
225	1.00	0.95
250	1.00	0.92
275	0.99	0.89
300	0.98	0.86
325	0.97	0.83
350	0.96	0.81
375	0.95	0.78
400	0.94	0.76
425	0.93	0.73
450	0.92	0.71

Source: Botterill, 1996 and 1997

FUEL CONSUMPTION (percent adjustment)		
IRI	Auto	Truck
0	0.97	0.96
25	0.98	0.97
50	0.98	0.97
75	0.98	0.98
100	0.98	0.98
125	0.99	0.99
150	1.00	0.99
175	1.00	1.00
200	1.01	1.01
225	1.01	1.02
250	1.02	1.03
275	1.03	1.04
300	1.03	1.05
325	1.04	1.06
350	1.05	1.07
375	1.06	1.08
400	1.07	1.10
425	1.08	1.11
450	1.09	1.13

Source: Texas Transportation Institute, 1994

NON-FUEL COSTS (percent adjustment)		
IRI	Auto	Truck
0	1.00	1.00
25	1.00	1.00
50	1.00	1.00
75	1.00	1.00
100	1.00	1.00
125	1.00	1.00
150	1.02	1.02
175	1.03	1.04
200	1.05	1.06
225	1.07	1.08
250	1.09	1.10
275	1.11	1.12
300	1.12	1.14
325	1.14	1.16
350	1.16	1.18
375	1.18	1.20
400	1.19	1.22
425	1.21	1.24
450	1.23	1.26

Source: ARRB Research Board TR VOC Model

Weaving Adjustments (used only for freeway connector, HOV connector, and HOV drop ramp projects)

VEHICLE OPERATING SPEED (percent adjustment)		
Percent Weaving	Freeway Conn	HOV Project
0.000	1.00	1.00
0.002	0.98	0.99
0.004	0.96	0.98
0.006	0.95	0.96
0.008	0.93	0.95
0.010	0.91	0.94
0.012	0.89	0.93
0.014	0.87	0.92
0.016	0.85	0.90
0.018	0.84	0.89
0.020	0.79	0.88
0.022	0.75	0.87
0.024	0.71	0.85
0.026	0.66	0.84
0.028	0.62	0.82
0.030	0.58	0.79
0.032	0.54	0.76
0.034	0.50	0.73
0.036	0.48	0.71
0.038	0.47	0.68
0.040	0.47	0.65
0.042	0.47	0.62
0.044	0.47	0.60
0.046	0.46	0.57
0.048	0.46	0.54
0.050	0.46	0.51
0.052	0.46	0.48
0.054	0.45	0.48
0.056	0.45	0.47
0.058	0.45	0.47
0.060	0.45	0.47
0.062	0.45	0.47
0.064	0.45	0.47
0.066	0.45	0.47
0.068	0.45	0.46
0.070	0.45	0.46
0.072	0.45	0.46
0.074	0.45	0.46
0.076	0.45	0.46
0.078	0.45	0.46
0.080	0.45	0.45

Source: Fitzpatrick, Brewer, and Venglar, 2003

TMS Adjustments (used only for ramp metering, ramp metering signal coordination, incident management, traveler information projects, AVL, transit priority, and BRT projects)

PEAK PERIOD SPEED, VOLUME, AND NON-HIGHWAY BENEFITS (percent adjustment)								
TMS Strategy	Without		With		Non-Highway Benefits			Total Benefit
	Speed	Volume	Speed	Volume	TT	VOC	Em	
AMoth	1.02	0.95	1.02	0.95	-5.05	12.81	1.37	0.74
AMsev	1.53	0.94	1.53	0.94	1.21	1.38	-0.37	1.00
IMoth	0.88	1.18	0.98	0.96	0.51	0.15	0.06	0.74
IMsev	1.01	0.97	1.01	0.95	0.30	0.31	0.30	1.00
NoAdj	1.00	1.00	1.00	1.00	0.00	0.00	0.00	1.00
ORoth	0.98	1.03	1.00	1.00	-0.07	-0.03	-0.07	0.00
ORsev	0.95	1.03	1.00	1.00	0.00	0.00	5.67	0.00
RMoth	1.00	1.00	1.03	0.97	-0.07	-0.03	-0.07	1.00
RMsev	1.00	1.00	1.05	0.97	0.00	0.00	5.67	1.00
Tloth	1.00	1.00	1.02	0.97	-0.11	-0.12	-0.35	1.00
Tlsev	1.00	1.00	1.01	0.97	-0.39	-0.39	-0.35	1.00

Source: California Department of Transportation TMS Master Plan, 2003
18) Chaudhary and Messer, 2000

TRANSIT TRAVEL TIME AND AGENCY COST SAVINGS (percent savings)			
TMS Strategy	Travel Time	Agency Costs	
		Capital	O&M
Transit Vehicle Location (AVL)	15%	2%	8%
Transit Vehicle Signal Priority	10%	-	-
Bus Rapid Transit (BRT)	29%	-	-

Sources: FHWA ITS Deployment Analysis System (IDAS), California PATH