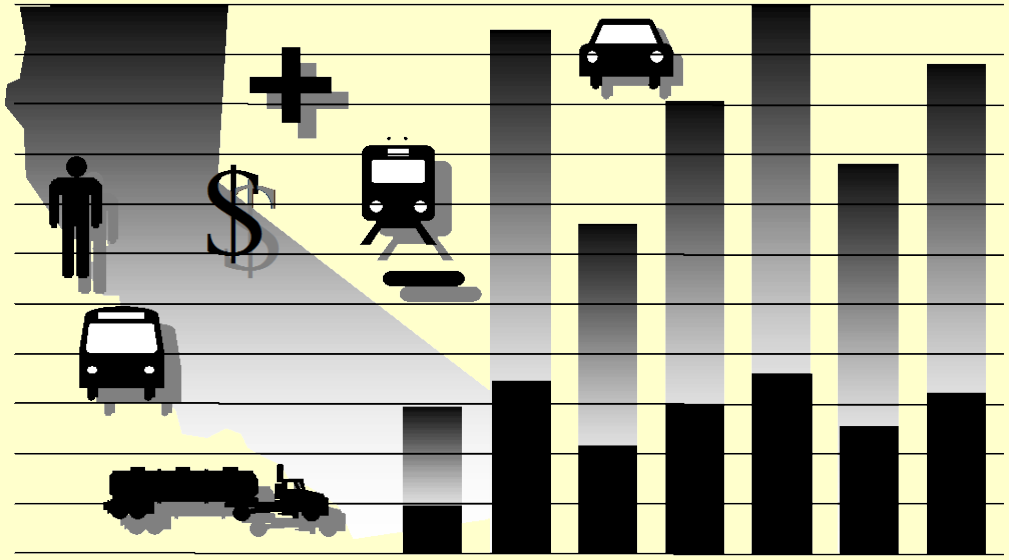
California Department Of Transportation

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

TIGER Benefit-Cost Analysis



Office of Transportation Economics
Division of Transportation Planning
2016 TIGER Grant Applications

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CALIFORNIA LIFE-CYCLE BENEFIT/COST ANALYSIS MODEL (CAL-B/C)

INTRODUCTION

This spreadsheet model provides a method for preparing a simple economic analysis of both highway and transit projects. Given certain input data for a project, the model calculates its life-cycle costs, life-cycle benefits, net present value, benefit/cost ratio, internal rate of return, and payback period. Annual benefits are also calculated.

The model is arranged by worksheets and contains the following information, data, and results:

Worksheets	Contents
Instructions	General model description and assumptions
1) Project Information	Project input data
2) Model Inputs	Highway speed, volume, accident data, and trips estimated by model
3) Results	Summary results of analysis
Travel Time	Calculation of travel time and induced demand impacts
Vehicle Operating Costs	Calculation of highway vehicle operating cost impacts
Accident Costs	Calculation of accident cost impacts
Emissions	Calculation of emission impacts
Final Calculations	Calculation of net present value, internal rate of return, and payback period
Parameters	Economic assumptions, lookup tables, and other model parameters

The model is designed so that the user generally needs to enter data only in the green boxes on the Project Information worksheet. The model estimates detailed highway speed, volume, and accident data for the user to review on the Model Inputs worksheet. Highway speeds are estimated from volumes using relationships found in the Highway Capacity Manual. Other adjustments are made for weaving and pavement conditions. An option is also available to conduct a simple queuing analysis. Accidents are estimated from statewide averages and recent data for the facility. If available, inputs from regional planning or traffic simulation models can be entered to override model calculations. Summary results are shown in Results worksheet.

The remaining worksheets are provided for the user to see, but model performs calculations automatically. Some projects (i.e., bypasses, interchanges, and connectors) require the user to enter two sets of highway data, since two roads are involved. The model calculates benefits for the first road before the user enters information about the second road. The user clicks a button and the model clears the Project Information worksheet to receive information on the other road.

In the process of economic analysis, some generally accepted economic assumptions are necessary. These assumptions include: the real and nominal discount rates, unit user costs (e.g., value of time), consumption rates (e.g., fuel consumption and vehicle emissions), and accident rates. These assumptions are given in the Parameters worksheet and should not be changed by the user.

After reading the instructions in this worksheet, the user should proceed to the Project Information worksheet and input data for the specific project in the green boxes (light gray when printed). The model provides default values in the red boxes (medium gray when printed). These values can be changed by the user, if information specific to the project is available. The model calculates some values based on relationships or assumptions, with results shown in the blue boxes (dark gray when printed). These values can be changed by the user.

INSTRUCTIONS

The user can analyze most projects simply by entering limited data on the Project Information Sheet and getting results on the Results page. The Model Inputs page allows the user to enter more detailed data adjust estimated speeds, volumes, and accidents rates, and check the number of trips estimated for projects that affect vehicle occupancy.

PROJECT DATA (Box 1A)

This section provides general information about the project and is used for highway, rail, and transit projects. At the top of the sheet, the user can enter information about the project, such as the project name, Caltrans district, and funding information.

Type of Project

1 Please select the appropriate type of highway, rail, or transit project from the pull-down menu. The menu appears if user clicks on the green box next to the project type.

For a bypass or intersection project, model reminds user that information must be entered for both roads impacted by project. After entering information for the first road, the user clicks a button at bottom of the worksheet to prepare model for data on the bypass or intersecting road. The user may also enter information for connector projects involving two roads.

Project Location

2 Insert a 1, 2, or 3 for the appropriate region of California. This information is used to estimate peak traffic and emissions benefits.

Length of Construction Period

3 Insert the number of construction years before benefits begin. This must be a whole number (round to next higher integer).

One- or Two-Way Data

4 Indicate whether Highway Design and Traffic Data to be entered in Box 1B is for a single direction or both directions of highway.

Length of Peak Period(s)

5 Insert the number of peak period hours per typical day. The model provides a default of 5 hours (statewide average). Model estimates total % daily traffic occurring during peak period using a lookup table developed from Traffic Census data. Model does not distinguish between weekdays and weekends.

To model a 24-hour HOV or HOT lane, enter 24 hours so peak is 100% of ADT. To model a ramp metering project, user should enter the number of hours per day that metering is operational.

HIGHWAY DESIGN AND TRAFFIC DATA (Box 1B)

Highway design and traffic data must be entered for highway projects. Enter data consistent with one- or two-way answer in Box 1A. Statewide default values are provided for some inputs.

Highway Design

6 **Roadway Type:** Indicate if the road is a freeway, expressway, or conventional highway in build and no build cases.

7 **Number of General Traffic Lanes:** Insert number of general purpose (not HOV or bus) lanes in both directions for build and no build cases. Enter data consistent with Box 1A.

8 **Number of HOV Lanes:** Insert number of HOV lanes in both directions for the build and no build cases. A value must be provided if an HOV restriction is entered on the next row.

9 **HOV Restriction:** If highway facility has/will have HOV lanes, enter the HOV restriction (e.g., 2 means 2 people per vehicle). Must be entered for an HOV project. Enter for a non-HOV project, if facility has HOV lanes. Changes in HOV restrictions are special project types and handled automatically by model.

10 **Exclusive ROW for Buses:** If bus project, indicate (with "Y" or "N") whether buses have exclusive right-of-way. This information is used to estimate emissions.

11 **Highway Free-Flow Speed:** Insert free-flow speed for build and no build cases. Model assumes build is same as no build, if not entered.

12 **Ramp Design Speed:** If auxiliary lane or off-ramp project, enter the design speed of the appropriate on- or off-ramp. This is used to estimate the speed of traffic affected by weaving.

13 **Highway Segment:** Insert segment length for build and no build cases. Model assumes build is same as no build, if not entered.

14 **Impacted Length:** The model estimates an area affected by the project. In most cases, this equals the segment length. For passing lane projects, the default affected area is 3 miles longer than the project area. For auxiliary lane and off-ramp projects, the default affected area is 1500 feet. For connectors and HOV drop ramps, default affected area is 3250 feet. User can change these lengths.

Average Daily Traffic (ADT)

15 **Current:** For most projects, insert current two-way ADT on facility. For operational improvements, enter only the one-way ADT applicable to the project. Enter data consistent with one-way or two-way answer in Box 1A.

16 **Forecast (Year 20):** Insert projected ADT for 20 years after construction completion for build and no build cases. Model assumes build is same as no build, if not entered.

The model uses the current and forecasted ADT to estimate annual traffic for 20 years after construction, assuming a linear trend. User can change base (Year 1) forecasts.

Average Hourly HOV/HOT Lane Traffic

17 Insert hourly HOV/HOT volumes for build and no build cases in a typical peak hour.

Percent Traffic in Weave

18 For operational improvements, insert % traffic affected by weaving. Model suggests a % based on the type of project (2 right lanes for auxiliary lanes, 3 right lanes for off-ramps, 2.5% of all traffic for freeway connectors, and 4% of HOV traffic for HOV connectors and drop ramps). Users can change values for project conditions.

Percent Trucks

19 Insert estimated % of ADT comprised of trucks in build and no build cases. Model provides a default value (statewide average).

Truck Speed

20 If passing lane project, enter estimated speed (in MPH) for slow vehicles (trucks, recreational vehicles, etc.). Values must be entered for passing lane projects.

On-Ramp Volume

21 **Hourly Ramp Volume:** If auxiliary lane or on-ramp widening project, insert average hourly ramp volume to estimate traffic affected by weaving for auxiliary lanes and metering effectiveness for on-ramp widening. No entry needed for ramp metering projects.

22 **Metering Strategy:** If on-ramp widening project, enter 1, 2, or 3 for vehicles allowed per green signal. Enter "D" for dual metering. No entry should be made for ramp metering projects.

Queue Formation

23 **Arrival Rate:** For queuing and rail grade crossing projects, enter vehicles per hour contributing to queue. Arrival rate should be estimated only for time queue grows. Model estimates queue dissipation automatically.

24 **Departure Rate:** For queuing and rail crossing projects, enter vehicles per hour leaving queue.

Pavement Condition (for Pavement Rehab. Projects)

25 If pavement rehabilitation project, enter base (Year 1) International Roughness Index (IRI) for build and no build. Model will calculate Year 20 values using standard parameters unless entered by user.

Average Vehicle Occupancy (AVO)

26 Model provides default values. The figures change automatically, depending on presence of HOV lanes. Adjust if project-specific data are available.

HIGHWAY ACCIDENT DATA (Box 1C)

Statewide default values are provided for transit projects. The model uses information provided to calculate accident rates for each accident type in the Model Inputs worksheet.

Actual 3-Year Accident Data (from Table B)

27 Insert the total number of fatal, injury, and property damage only accidents on the segment over the 3 most recent years. For rail grade crossing projects, enter 10-year accident data from FRA WBAPS in fatal and injury rows and collision prediction in total accident row.

Statewide Basic Average Accident Rate

28 Insert statewide average accident rates per million vehicle-miles (or million vehicles, as appropriate) for build and no build highway rate groups. Include Base Rate and ADT Factor where applicable.

29 Insert statewide % of accidents that are fatal and injury accidents for road classifications similar to build and no build facilities.

The model uses adjustment factors (the ratio of actual rates to statewide rates for existing facility) to estimate accident rates by accident type for the new road classification. Additional adjustments (accident savings) are made for highway TMS projects. Results are presented in the Model Inputs worksheet and can be changed by the user.

RAIL AND TRANSIT DATA (Box 1D)

This section is used for rail and transit projects only.

Annual Person-Trips

30 **Base (Year 1):** Insert estimated annual transit person-trips for first year after construction completion in build and no build cases. For a transit TMS project, enter only person-trips on routes affected. If the routes are substantially different, the benefits analysis should be split into pieces.

31 **Forecast (Year 20):** Insert forecasted annual transit person-trips for 20 years after construction completion in build and no build cases.

Percent Trips during Peak Period

32 Insert % annual person-trips that occur during peak period.

Percent New Trips from Parallel Highway

33 Insert % new transit person-trips originating on parallel highway.

Annual Vehicle-Miles

34 **Base (Year 1):** Insert estimated annual vehicle-miles for first year after construction completion in build and no build cases. For passenger rail projects, multiply the number of train-miles by the average number of rail cars per train consist.

35 **Forecast (Year 20):** Insert forecasted annual vehicle-miles for 20 years after construction completion in build and no build cases.

Average Vehicles per Train

36 If passenger rail project, insert the average number of rail cars per train consist. This is used to calculate emissions.

Reduction in Transit Accidents

37 If project affects transit/rail safety, insert estimated percent accident reduction due to project. Increases should be entered as negative %.

Average Transit Travel Time

38 **In-Vehicle:** Insert average in-vehicle transit travel time in minutes during peak and non-peak periods in build and no build cases. For TMS Projects, insert the average for all transit routes impacted. Model assumes build is same as no build for most projects. Signal priority and bus rapid transit projects reduce time. User can adjust build travel times.

39 **Out-of-Vehicle:** Insert average out-of-vehicle transit travel time in minutes during peak and non-peak periods. Model monetizes out-of-vehicle travel time at a higher value.

Highway Grade Crossing

40 **Annual Number of Trains:** Insert annual number of passenger and freight trains entering highway-rail crossing.

41 **Average Gate Down Time:** Insert average time per train that crossing gate is down for passenger and freight trains.

Transit Agency Costs (for Transit TMS Projects)

42 **Annual Capital Expenditure:** If transit TMS project, insert annual agency capital expenditures for routes impacted by project. Model calculates cost reductions for expenditures in build case due to transit TMS. Agency cost savings are entered automatically as a negative cost in Box 1E.

43 **Annual Ops. and Maintenance Expenditure:** If transit TMS project, insert the annual average operating and maintenance costs for routes impacted by project. Model calculates cost reductions for expenditures in build case due to transit TMS. Agency cost savings are entered automatically as a negative cost in Box 1E.

PROJECT COSTS (Box 1E)

Net project costs should be entered in the years they are expected to occur. Costs should be entered for construction period and for twenty years after construction completion. Construction Year 1 is the first year that costs are incurred. All costs should be entered in thousands of dollars.

44 Insert project's initial costs in constant (Year 2007) dollars for project development, right-of-way, and construction. The number of construction years with costs should equal the length of the construction period (Box 1A, Input 5).

45 Insert estimated future incremental maintenance/operating and rehabilitation costs in constant (Year 2007) dollars. These figures should be entered in the years after the project opens.

46 Insert estimated mitigation costs (e.g., wetlands, community, and sound walls) in constant (Year 2007) dollars during construction and for 20 years after construction completion.
47 Model adds agency cost savings due to transit TMS automatically.
48 Insert any other costs not already included.

HIGHWAY SPEED AND VOLUME INPUTS (Box 2A)

This section allows user to review detailed speed and volume data estimated by the model. These values are estimated from the inputs provided in the Project Information sheet.

49 User may enter new speed and volume data for the highway in the green boxes to override model calculations, if detailed data are available from a travel demand or micro-simulation model. The model estimates speeds and volumes on highway for HOVs, non-HOVs, weaving vehicles, and trucks during the peak and non-peak periods in Year 1 and Year 20 in build and no build cases. Speeds are estimated using a BPR curve (or queuing analysis). Adjustments are made to speed and volumes to account for weaving, transit mode shifts, pavement condition, and TMS.
50 If TMS project and detailed simulation data are available, the highway results should be inputted in the green cells. Model will use the data in place of figures estimated by the model.

HIGHWAY ACCIDENT RATES (Box 2B)

User may adjust accident rates calculated by the model. User may also enter TASAS highway accident data for rail grade crossing projects in this box.

51 **No Build:** Fatality, injury and PDO accident rates for no build facility are estimated using inputs from Box 1C of the Project Information sheet. User may change these rates in green boxes.
52 **Highway Safety or Weaving Improvement:** Model assumes an overall safety improvement for off-ramp and ramp metering projects. User may adjust this percentage. For safety projects, user should enter collision reduction factor from HSIP Guidelines.
53 **Adjustment Factor:** User may change the ratios of facility accident rates to statewide averages used in calculating rates for the build facility. These factors are also adjusted by the collision reduction factor.
54 **Build Facility:** User may modify the fatality, injury, and PDO accident rates for build facility. Model estimates these accident rates using statewide average rates and the adjustment factors.

RAMP AND ARTERIAL INPUTS (Box 2C)

This section allows users to enter detailed arterial information for an arterial signal management project or detailed ramp and arterial data for a highway TMS project.

55 **Detailed Information Available:** Input "Y" if detailed arterial and/or ramp data are available. Model automatically selects "Y" if other data are inputted. User should enter detailed ramp and arterial data for TMS highway project if detailed highway data are entered in Box 2A.
56 **Aggregate Segment Length:** Input the total segment lengths for the ramps and arterials. These can be estimated from travel demand or micro-simulation model data as VMT/total trips.
57 User may enter speeds and volumes on ramps and arterials during peak and non-peak periods in Year 1 and Year 20 in build and no build cases. If arterial signal management project, user must enter arterial data. Benefits are estimated assuming all vehicles are automobiles.

ANNUAL PERSON-TRIPS (Box 2D)

This section is for information purposes only. It allows user to examine number trips estimated for projects that affect AVO (e.g., HOT lane and HOV conversions).

NEXT STEPS

58 For bypass, interchange, and connector projects, click button on Project Information page after data are verified for the first road. Enter data for the second road in Boxes 1B and 1C. As with the first road, detailed data may be verified on Model Inputs page. Model prompts user to save interim version of analysis before proceeding.
59 Summary results are available immediately in the Results worksheet.

District: SC

PROJECT: Broad River Road

EA:
PPNO:

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)	2	
Length of Construction Period	6	years
One- or Two-Way Data	2	enter 1 or 2
	Current	
Length of Peak Period(s) (up to 24 hrs)	5	hours

1B HIGHWAY DESIGN AND TRAFFIC DATA

Highway Design		No Build	Build
Roadway Type (Fwy, Exp, Conv Hwy)		C	C
Number of General Traffic Lanes		4	4
Number of HOV/HOT Lanes			
HOV Restriction (2 or 3)			
Exclusive ROW for Buses (y/n)		N	
Highway Free-Flow Speed		35	35
Ramp Design Speed (if aux. lane/off-ramp proj.)		35	35
Length (in miles)	Highway Segment	4.6	4.6
	Impacted Length	4.6	4.6

Average Daily Traffic			
	Current	24,300	
		No Build	Build
	Base (Year 1)	24,700	29,120
	Forecast (Year 20)	34,000	34,000
Average Hourly HOV/HOT Lane Traffic			0
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)		9%	9%
Truck Speed		35	

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)	121	85
	Forecast (Year 20)	241	169

Average Vehicle Occupancy (AVO)		No Build	Build
General Traffic	Non-Peak	1.30	1.30
	Peak	1.15	1.15
High Occupancy Vehicle (if HOV/HOT lanes)		2.15	2.15

1C HIGHWAY ACCIDENT DATA

Actual 3-Year Accident Data (from Table B)	Count (No.)	Rate
Total Accidents (Tot)	1320	10.78
Fatal Accidents (Fat)	0	0.000
Injury Accidents (Inj)	342	2.79
Property Damage Only (PDO) Accidents	978	7.99

Statewide Basic Average Accident Rate	No Build	Build
Rate Group	1.00	1.00
Accident Rate (per million vehicle-miles)	2.386	2.219
Percent Fatal Accidents (Pct Fat)	0.63%	0.63%
Percent Injury Accidents (Pct Inj)	28.52%	28.52%

1D RAIL AND TRANSIT DATA

Annual Person-Trips		No Build	Build
	Base (Year 1)		
	Forecast (Year 20)		
Percent Trips during Peak Period		41%	
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)	
	INITIAL COSTS			SUBSEQUENT COSTS					
	Project Support	R / W	Construction	Maint./ Op.	Rehab.			Constant Dollars	Present Value
Construction Period									
1	$1,553							$1,553,000	$1,553,000
2	$1,553							$1,553,000	$1,451,402
3	$1,553							$1,553,000	$1,356,450
4			$11,214					$11,214,000	$9,153,964
5			$11,214					$11,214,000	$8,555,107
6			$11,214					$11,214,000	$7,995,427
7								0	0
8								0	0
Project Open									
1				$50				$50,000	$33,317.11
2				$50				$50,000	$31,137.49
3				$50				$50,000	$29,100.46
4				$50				$50,000	$27,196.69
5				$50				$50,000	$25,417.46
6				$50				$50,000	$23,754.64
7				$50				$50,000	$22,200.60
8				$50				$50,000	$20,748.22
9				$50				$50,000	$19,390.86
10				$50				$50,000	$18,122.30
11				$50				$50,000	$16,936.73
12				$50				$50,000	$15,828.72
13				$50				$50,000	$14,793.20
14				$50				$50,000	$13,825.42
15				$50				$50,000	$12,920.95
16				$50				$50,000	$12,075.65
17				$50				$50,000	$11,285.66
18				$50				$50,000	$10,547.34
19				$50				$50,000	$9,857.33
20				$50				$50,000	$9,212.46
Total	$4,659	$0	$33,642	$1,000	$0	$0	$0	$39,301,000	$30,443,020

Present Value = Future Value (in Constant Dollars) / (1 + Real Discount Rate) ^ Year

2A

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	9,216	10,078	10,078	
Weaving Volume	0		0	
Truck Volume	911	997	997	
HOV Speed	55.0		55.0	
Non-HOV Speed	35.0	15.0	15.0	
Weaving Speed	55.0		55.0	
Truck Speed	15.0	15.0	15.0	
Non-Peak Period				
Non-HOV Volume	13,261	23,514	23,514	
Weaving Volume	0		0	
Truck Volume	1,312	2,326	2,326	
Non-HOV Speed	35.0	35.0	35.0	
Weaving Speed	55.0		55.0	
Truck Speed	35.0	35.0	35.0	
Year 20				
Peak Period				
HOV Volume	0		0	
Non-HOV Volume	12,685	13,372	13,372	
Weaving Volume	0		0	
Truck Volume	1,255	1,322	1,322	
HOV Speed	55.0		55.0	
Non-HOV Speed	34.3	10.0	10.0	
Weaving Speed	55.0		55.0	
Truck Speed	10.0	10.0	10.0	
Non-Peak Period				
Non-HOV Volume	18,255	31,202	31,202	
Weaving Volume	0		0	
Truck Volume	1,805	3,086	3,086	
Non-HOV Speed	35.0	35.0	35.0	
Weaving Speed	55.0		55.0	
Truck Speed	35.0	35.0	35.0	
Build				
Year 1				
Peak Period				
HOV Volume	0		0	
Non-HOV Volume	10,865	10,078	10,078	
Weaving Volume	0		0	
Truck Volume	1,075	997	997	
HOV Speed	55.0		55.0	
Non-HOV Speed	35.0	20.0	20.0	
Weaving Speed	55.0		55.0	
Truck Speed	20.0	20.0	20.0	
Non-Peak Period				
Non-HOV Volume	15,635	23,514	23,514	
Weaving Volume	0		0	
Truck Volume	1,546	2,326	2,326	
Non-HOV Speed	35.0	35.0	35.0	
Weaving Speed	55.0		55.0	
Truck Speed	35.0	35.0	35.0	
Year 20				
Peak Period				
HOV Volume	0		0	
Non-HOV Volume	12,685	13,372	13,372	
Weaving Volume	0		0	
Truck Volume	1,255	1,322	1,322	
HOV Speed	55.0		55.0	
Non-HOV Speed	34.3	15.0	15.0	
Weaving Speed	55.0		55.0	
Truck Speed	15.0	15.0	15.0	
Non-Peak Period				
Non-HOV Volume	18,255	31,202	31,202	
Weaving Volume	0		0	
Truck Volume	1,805	3,086	3,086	
Non-HOV Speed	35.0	35.0	35.0	
Weaving Speed	55.0		55.0	
Truck Speed	35.0	35.0	35.0	

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	0.000	0.000	0.000	
Injury Accidents	2.79	11.64	11.64	Used local data rates
PDO Accidents	7.99	33.29	33.29	Used local data rates
Total Accidents	10.780			
Hwy Safety or Weaving Improvement		0%	collision reduction factor (per HSIP Guidelines)	
Adjustment Factor (Actual/Statewide Avg. Existing)				
Fatal Accidents	0.0000		0.0000	
Injury Accidents	17.1065		17.1065	
PDO Accidents	19.6950		19.6950	
Build				
Fatal Accidents	0.000	0.000	0.000	
Injury Accidents	10.83	10.48	10.48	Introduction of medians and reduction of intersection accidents
PDO Accidents	30.96	29.96	29.96	Introduction of medians and reduction of intersection accidents
Total Accidents	41.785			

2C

RAMP AND ARTERIAL INPUTS

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

Detailed Information Available? (y/n)	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	3,600,000	3,600,000	0
Truck Trips	300,000	300,000	0
Non-Peak Period			
Non-HOV Trips	3,600,000	3,600,000	0
Truck Trips	300,000	300,000	0
Total Trips	7,800,000	7,800,000	0
Year 20			
Peak Period			
HOV Trips	0	0	
Non-HOV Trips	6,120	6,120	0
Truck Trips	510	510	0
Non-Peak Period			
Non-HOV Trips	6,120	6,120	0
Truck Trips	510	510	0
Total Trips	13,260	13,260	0

District: SC

PROJECT: Broad River Road

EA:
PPNO:

3

INVESTMENT ANALYSIS

SUMMARY RESULTS

Life-Cycle Costs (mil. $)	$30.4
Life-Cycle Benefits (mil. $)	$273.3
Net Present Value (mil. $)	$242.8
Benefit / Cost Ratio:	9.0
Rate of Return on Investment:	43.7%
Payback Period:	2 years

ITEMIZED BENEFITS (mil. $)	Average Annual	Total Over 20 Years
Travel Time Savings	$3.3	$66.2
Veh. Op. Cost Savings	$0.4	$8.5
Accident Cost Savings	$9.8	$196.5
Emission Cost Savings	$0.1	$2.0
TOTAL BENEFITS	$13.7	$273.3
Person-Hours of Time Saved	591,424	11,828,470
CO_2 Emissions Saved (tons)	4,547	90,944
CO_2 Emissions Saved (mil. $)	$0.1	$1.7

Should benefit-cost results include:

1) Induced Travel? (y/n)	Y (Default = Y)
2) Vehicle Operating Costs? (y/n)	Y (Default = Y)
3) Accident Costs? (y/n)	Y (Default = Y)
4) Vehicle Emissions? (y/n) includes value for CO_2e	Y (Default = Y)

C

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	$2,998,175	$0	$497,697	$0	$0	$0	$0	$0
20	$0	$2,759,605	$0	$458,094	$0	$0	$0	$0	$0
2	$0	$2,975,092	$0	$493,865	$0	$0	$0	$0	$0
3	$0	$2,952,808	$0	$490,166	$0	$0	$0	$0	$0
4	$0	$2,931,385	$0	$486,610	$0	$0	$0	$0	$0
5	$0	$2,910,883	$0	$483,207	$0	$0	$0	$0	$0
6	$0	$2,891,362	$0	$479,966	$0	$0	$0	$0	$0
7	$0	$2,872,884	$0	$476,899	$0	$0	$0	$0	$0
8	$0	$2,855,511	$0	$474,015	$0	$0	$0	$0	$0
9	$0	$2,839,305	$0	$471,325	$0	$0	$0	$0	$0
10	$0	$2,824,332	$0	$468,839	$0	$0	$0	$0	$0
11	$0	$2,810,661	$0	$466,570	$0	$0	$0	$0	$0
12	$0	$2,798,362	$0	$464,528	$0	$0	$0	$0	$0
13	$0	$2,787,511	$0	$462,727	$0	$0	$0	$0	$0
14	$0	$2,778,187	$0	$461,179	$0	$0	$0	$0	$0
15	$0	$2,770,476	$0	$459,899	$0	$0	$0	$0	$0
16	$0	$2,764,469	$0	$458,902	$0	$0	$0	$0	$0
17	$0	$2,760,265	$0	$458,204	$0	$0	$0	$0	$0
18	$0	$2,757,973	$0	$457,824	$0	$0	$0	$0	$0
19	$0	$2,757,710	$0	$457,780	$0	$0	$0	$0	$0
Total	**$0**	**$56,796,955**	**$0**	**$9,428,295**	**$0**	**$0**	**$0**	**$0**	**$0**

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	$3,495,872	$5,246,361	352,210
20	$0	$0	$0	$0	$3,217,699	$17,463,847	934,660
2	$0	$0	$0	$0	$3,468,957	$5,570,386	369,529
3	$0	$0	$0	$0	$3,442,974	$5,915,671	387,781
4	$0	$0	$0	$0	$3,417,995	$6,283,844	407,031
5	$0	$0	$0	$0	$3,394,090	$6,676,688	427,349
6	$0	$0	$0	$0	$3,371,329	$7,096,147	448,811
7	$0	$0	$0	$0	$3,349,783	$7,544,353	471,501
8	$0	$0	$0	$0	$3,329,525	$8,023,640	495,509
9	$0	$0	$0	$0	$3,310,629	$8,536,571	520,934
10	$0	$0	$0	$0	$3,293,171	$9,085,963	547,885
11	$0	$0	$0	$0	$3,277,230	$9,674,921	576,482
12	$0	$0	$0	$0	$3,262,890	$10,306,867	606,854
13	$0	$0	$0	$0	$3,250,238	$10,985,583	639,146
14	$0	$0	$0	$0	$3,239,366	$11,715,256	673,517
15	$0	$0	$0	$0	$3,230,375	$12,500,531	710,141
16	$0	$0	$0	$0	$3,223,371	$13,346,568	749,213
17	$0	$0	$0	$0	$3,218,470	$14,259,113	790,947
18	$0	$0	$0	$0	$3,215,797	$15,244,580	835,584
19	$0	$0	$0	$0	$3,215,490	$16,310,144	883,389
Total	**$0**	**$0**	**$0**	**$0**	**$66,225,249**	**$201,787,034**	**11,828,470**

C

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	$456,644	$0	$77,701	$0	$0	$0	$0	-	-	$534,345	$801,907
20	$0	$250,270	$0	$44,037	$0	$0	$0	$0	-	-	$294,307	$1,597,332
2	$0	$476,987	$0	$81,860	$0	$0	$0	$0	-	-	$558,847	$897,386
3	$0	$453,321	$0	$77,799	$0	$0	$0	$0	-	-	$531,119	$912,562
4	$0	$430,710	$0	$73,918	$0	$0	$0	$0	-	-	$504,628	$927,738
5	$0	$445,892	$0	$77,305	$0	$0	$0	$0	-	-	$523,197	$1,029,207
6	$0	$423,429	$0	$73,410	$0	$0	$0	$0	-	-	$496,839	$1,045,772
7	$0	$401,996	$0	$69,694	$0	$0	$0	$0	-	-	$471,691	$1,062,338
8	$0	$381,556	$0	$66,151	$0	$0	$0	$0	-	-	$447,706	$1,078,903
9	$0	$391,931	$0	$68,147	$0	$0	$0	$0	-	-	$460,078	$1,186,326
10	$0	$371,829	$0	$64,652	$0	$0	$0	$0	-	-	$436,481	$1,204,265
11	$0	$352,680	$0	$61,323	$0	$0	$0	$0	-	-	$414,003	$1,222,205
12	$0	$334,446	$0	$58,152	$0	$0	$0	$0	-	-	$392,598	$1,240,144
13	$0	$339,737	$0	$59,638	$0	$0	$0	$0	-	-	$399,374	$1,349,858
14	$0	$322,038	$0	$56,531	$0	$0	$0	$0	-	-	$378,569	$1,369,106
15	$0	$305,202	$0	$53,575	$0	$0	$0	$0	-	-	$358,777	$1,388,354
16	$0	$289,190	$0	$50,765	$0	$0	$0	$0	-	-	$339,954	$1,407,602
17	$0	$294,666	$0	$51,850	$0	$0	$0	$0	-	-	$346,516	$1,535,203
18	$0	$279,104	$0	$49,111	$0	$0	$0	$0	-	-	$328,215	$1,555,913
19	$0	$264,317	$0	$46,509	$0	$0	$0	$0	-	-	$310,826	$1,576,622
Total	**$0**	**$7,265,942**	**$0**	**$1,262,127**	**$0**	**$0**	**$0**	**$0**	**-**	**-**	**$8,528,069**	**$24,388,742**

C

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	$4,203,670	$0	$415,743	$0	$9,808,006	$0	$970,012	$0	$15,397,431	$23,107,392
20	$0	$1,542,264	$0	$152,530	$0	$3,598,694	$0	$355,911	$0	$5,649,399	$30,661,731
2	$0	$3,996,247	$0	$395,229	$0	$9,324,097	$0	$922,153	$0	$14,637,725	$23,504,988
3	$0	$3,797,972	$0	$375,619	$0	$8,861,526	$0	$876,405	$0	$13,911,522	$23,902,585
4	$0	$3,608,537	$0	$356,884	$0	$8,419,572	$0	$832,696	$0	$13,217,689	$24,300,182
5	$0	$3,427,632	$0	$338,993	$0	$7,997,519	$0	$790,955	$0	$12,555,098	$24,697,779
6	$0	$3,254,954	$0	$321,915	$0	$7,594,652	$0	$751,111	$0	$11,922,632	$25,095,376
7	$0	$3,090,199	$0	$305,621	$0	$7,210,269	$0	$713,096	$0	$11,319,185	$25,492,972
8	$0	$2,933,070	$0	$290,081	$0	$6,843,675	$0	$676,840	$0	$10,743,666	$25,890,569
9	$0	$2,783,275	$0	$275,266	$0	$6,494,188	$0	$642,275	$0	$10,195,004	$26,288,166
10	$0	$2,640,525	$0	$261,148	$0	$6,161,139	$0	$609,337	$0	$9,672,149	$26,685,763
11	$0	$2,504,542	$0	$247,699	$0	$5,843,871	$0	$577,959	$0	$9,174,071	$27,083,360
12	$0	$2,375,049	$0	$234,892	$0	$5,541,747	$0	$548,079	$0	$8,699,767	$27,480,956
13	$0	$2,251,781	$0	$222,701	$0	$5,254,142	$0	$519,635	$0	$8,248,258	$27,878,553
14	$0	$2,134,476	$0	$211,100	$0	$4,980,449	$0	$492,566	$0	$7,818,591	$28,276,150
15	$0	$2,022,882	$0	$200,063	$0	$4,720,080	$0	$466,816	$0	$7,409,841	$28,673,747
16	$0	$1,916,754	$0	$189,567	$0	$4,472,463	$0	$442,327	$0	$7,021,110	$29,071,344
17	$0	$1,815,854	$0	$179,588	$0	$4,237,042	$0	$419,043	$0	$6,651,528	$29,468,941
18	$0	$1,719,953	$0	$170,103	$0	$4,013,283	$0	$396,914	$0	$6,300,253	$29,866,537
19	$0	$1,628,828	$0	$161,091	$0	$3,800,667	$0	$375,886	$0	$5,966,472	$30,264,134
Total	**$0**	**$53,648,462**	**$0**	**$5,305,833**	**$0**	**$125,177,082**	**$0**	**$12,380,013**	**$0**	**$196,511,390**	**$537,691,225**

C

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	$94,974	$0	$15,909	$0	$0	$0	$0	$0
20	$0	$69,089	$0	$11,490	$0	$0	$0	$0	$0
2	$0	$101,443	$0	$17,021	$0	$0	$0	$0	$0
3	$0	$98,004	$0	$16,438	$0	$0	$0	$0	$0
4	$0	$94,661	$0	$15,872	$0	$0	$0	$0	$0
5	$0	$99,726	$0	$16,816	$0	$0	$0	$0	$0
6	$0	$96,281	$0	$16,230	$0	$0	$0	$0	$0
7	$0	$92,937	$0	$15,662	$0	$0	$0	$0	$0
8	$0	$84,822	$0	$13,844	$0	$0	$0	$0	$0
9	$0	$88,650	$0	$14,561	$0	$0	$0	$0	$0
10	$0	$85,613	$0	$14,067	$0	$0	$0	$0	$0
11	$0	$82,666	$0	$13,588	$0	$0	$0	$0	$0
12	$0	$79,805	$0	$13,123	$0	$0	$0	$0	$0
13	$0	$82,865	$0	$13,699	$0	$0	$0	$0	$0
14	$0	$79,970	$0	$13,225	$0	$0	$0	$0	$0
15	$0	$77,163	$0	$12,765	$0	$0	$0	$0	$0
16	$0	$74,442	$0	$12,319	$0	$0	$0	$0	$0
17	$0	$77,059	$0	$12,802	$0	$0	$0	$0	$0
18	$0	$74,316	$0	$12,351	$0	$0	$0	$0	$0
19	$0	$71,660	$0	$11,914	$0	$0	$0	$0	$0
Total	**$0**	**$1,706,146**	**$0**	**$283,694**	**$0**	**$0**	**$0**	**$0**	**$0**

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	$110,882	$166,405	2,979	$91,653
20	$0	$0	$0	$0	$80,580	$437,341	5,956	$73,820
2	$0	$0	$0	$0	$118,463	$190,226	3,330	$97,672
3	$0	$0	$0	$0	$114,442	$196,633	3,387	$94,682
4	$0	$0	$0	$0	$110,533	$203,211	3,443	$91,759
5	$0	$0	$0	$0	$116,541	$229,255	3,814	$96,910
6	$0	$0	$0	$0	$112,511	$236,819	3,876	$93,869
7	$0	$0	$0	$0	$108,598	$244,584	3,937	$90,900
8	$0	$0	$0	$0	$98,667	$237,771	4,030	$88,706
9	$0	$0	$0	$0	$103,210	$266,132	4,431	$92,955
10	$0	$0	$0	$0	$99,681	$275,022	4,498	$89,951
11	$0	$0	$0	$0	$96,254	$284,156	4,565	$87,025
12	$0	$0	$0	$0	$92,928	$293,541	4,632	$84,176
13	$0	$0	$0	$0	$96,564	$326,379	5,057	$87,616
14	$0	$0	$0	$0	$93,194	$337,040	5,129	$84,713
15	$0	$0	$0	$0	$89,928	$347,992	5,201	$81,890
16	$0	$0	$0	$0	$86,762	$359,242	5,273	$79,146
17	$0	$0	$0	$0	$89,861	$398,121	5,725	$81,902
18	$0	$0	$0	$0	$86,667	$410,846	5,802	$79,128
19	$0	$0	$0	$0	$83,574	$423,917	5,879	$76,435
Total	**$0**	**$0**	**$0**	**$0**	**$1,989,839**	**$5,864,632**	**90,944**	**$1,744,908**

A

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	$3,495,872	$534,345	$15,397,431	$110,882				
2	$3,468,957	$558,847	$14,637,725	$118,463				
3	$3,442,974	$531,119	$13,911,522	$114,442				
4	$3,417,995	$504,628	$13,217,689	$110,533				
5	$3,394,090	$523,197	$12,555,098	$116,541				
6	$3,371,329	$496,839	$11,922,632	$112,511				
7	$3,349,783	$471,691	$11,319,185	$108,598				
8	$3,329,525	$447,706	$10,743,666	$98,667				
9	$3,310,629	$460,078	$10,195,004	$103,210				
10	$3,293,171	$436,481	$9,672,149	$99,681				
11	$3,277,230	$414,003	$9,174,071	$96,254				
12	$3,262,890	$392,598	$8,699,767	$92,928				
13	$3,250,238	$399,374	$8,248,258	$96,564				
14	$3,239,366	$378,569	$7,818,591	$93,194				
15	$3,230,375	$358,777	$7,409,841	$89,928				
16	$3,223,371	$339,954	$7,021,110	$86,762				
17	$3,218,470	$346,516	$6,651,528	$89,861				
18	$3,215,797	$328,215	$6,300,253	$86,667				
19	$3,215,490	$310,826	$5,966,472	$83,574				
20	$3,217,699	$294,307	$5,649,399	$80,580				
Total	$66,225,249	$8,528,069	$196,511,390	$1,989,839	$0	$0	$0	$0

11,828,470	Person-Hours of Time Saved		Person-Hours of Time Saved
90,944	CO_2 Emissions Saved (tons)		CO_2 Emissions Saved (tons)
$1,744,908	CO_2 Emissions Saved ($ PV)		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	$1,553,000	($1,553,000)
				$0	$1,451,402	($1,451,402)
				$0	$1,356,450	($1,356,450)
				$0	$9,153,964	($9,153,964)
				$0	$8,555,107	($8,555,107)
				$0	$7,995,427	($7,995,427)
				$0	$0	$0
				$0	$0	$0
				$19,538,530	$33,317	$19,505,212
				$18,783,992	$31,137	$18,752,855
				$18,000,058	$29,100	$17,970,957
				$17,250,845	$27,197	$17,223,649
				$16,588,926	$25,417	$16,563,509
				$15,903,311	$23,755	$15,879,556
				$15,249,257	$22,201	$15,227,056
				$14,619,564	$20,748	$14,598,816
				$14,068,921	$19,391	$14,049,531
				$13,501,482	$18,122	$13,483,359
				$12,961,558	$16,937	$12,944,621
				$12,448,182	$15,829	$12,432,354
				$11,994,434	$14,793	$11,979,640
				$11,529,721	$13,825	$11,515,895
				$11,088,921	$12,921	$11,076,000
				$10,671,197	$12,076	$10,659,121
				$10,306,374	$11,286	$10,295,088
				$9,930,931	$10,547	$9,920,384
				$9,576,361	$9,857	$9,566,504
				$9,241,985	$9,212	$9,232,772
$0	$0	$0	$0	**$273,254,548**	**$30,443,020**	**$242,811,528**

	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	$5,246,361	$801,907	$23,107,392	$166,405				
2	$5,570,386	$897,386	$23,504,988	$190,226				
3	$5,915,671	$912,562	$23,902,585	$196,633				
4	$6,283,844	$927,738	$24,300,182	$203,211				
5	$6,676,688	$1,029,207	$24,697,779	$229,255				
6	$7,096,147	$1,045,772	$25,095,376	$236,819				
7	$7,544,353	$1,062,338	$25,492,972	$244,584				
8	$8,023,640	$1,078,903	$25,890,569	$237,771				
9	$8,536,571	$1,186,326	$26,288,166	$266,132				
10	$9,085,963	$1,204,265	$26,685,763	$275,022				
11	$9,674,921	$1,222,205	$27,083,360	$284,156				
12	$10,306,867	$1,240,144	$27,480,956	$293,541				
13	$10,985,583	$1,349,858	$27,878,553	$326,379				
14	$11,715,256	$1,369,106	$28,276,150	$337,040				
15	$12,500,531	$1,388,354	$28,673,747	$347,992				
16	$13,346,568	$1,407,602	$29,071,344	$359,242				
17	$14,259,113	$1,535,203	$29,468,941	$398,121				
18	$15,244,580	$1,555,913	$29,866,537	$410,846				
19	$16,310,144	$1,576,622	$30,264,134	$423,917				
20	$17,463,847	$1,597,332	$30,661,731	$437,341				
Total	$201,787,034	$24,388,742	$537,691,225	$5,864,632	$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	$1,553,000	($1,553,000)	
				$0	$1,553,000	($1,553,000)	
				$0	$1,553,000	($1,553,000)	
				$0	$11,214,000	($11,214,000)	
				$0	$11,214,000	($11,214,000)	
				$0	$11,214,000	($11,214,000)	
				$0	$0	$0	
				$0	$0	$0	
				$29,322,064	$50,000	$29,272,064	$29,272,064
				$30,162,987	$50,000	$30,112,987	$59,385,051
				$30,927,451	$50,000	$30,877,451	$90,262,502
				$31,714,975	$50,000	$31,664,975	$121,927,477
				$32,632,928	$50,000	$32,582,928	$154,510,405
				$33,474,114	$50,000	$33,424,114	$187,934,520
				$34,344,247	$50,000	$34,294,247	$222,228,767
				$35,230,883	$50,000	$35,180,883	$257,409,650
				$36,277,194	$50,000	$36,227,194	$293,636,844
				$37,251,014	$50,000	$37,201,014	$330,837,858
				$38,264,642	$50,000	$38,214,642	$369,052,500
				$39,321,508	$50,000	$39,271,508	$408,324,007
				$40,540,373	$50,000	$40,490,373	$448,814,380
				$41,697,552	$50,000	$41,647,552	$490,461,932
				$42,910,624	$50,000	$42,860,624	$533,322,556
				$44,184,755	$50,000	$44,134,755	$577,457,311
				$45,661,378	$50,000	$45,611,378	$623,068,689
				$47,077,877	$50,000	$47,027,877	$670,096,566
				$48,574,817	$50,000	$48,524,817	$718,621,383
				$50,160,251	$50,000	$50,110,251	$768,731,634
$0	$0	$0	$0	**$769,731,634**	**$39,301,000**	**$730,430,634**	

Total Construction Costs **$38,301,000**

Years After Construction Begins	ANNUAL RETURNS ON INVESTMENT
1	($1,553,000)
2	($1,553,000)
3	($1,553,000)
4	($11,214,000)
5	($11,214,000)
6	($11,214,000)
7	$29,272,064
8	$30,112,987
9	$30,877,451
10	$31,664,975
11	$32,582,928
12	$33,424,114
13	$34,294,247
14	$35,180,883
15	$36,227,194
16	$37,201,014
17	$38,214,642
18	$39,271,508
19	$40,490,373
20	$41,647,552
21	$42,860,624
22	$44,134,755
23	$45,611,378
24	$47,027,877
25	$48,524,817
26	$50,110,251
27	$0
28	$0

Internal Rate of Return **43.74%**

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.

Payback Period **2 years**

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)	1.00	1
Real Discount Rate	7.0%	2

Travel Time Parameters

	Value	Units	
Statewide Average Hourly Wage	$ 26.63	$/hr	3
Heavy and Light Truck Drivers			
Average Hourly Wage	$ 20.03	$/hr	3
Benefits and Costs	$ 10.40	$/hr	4
Value of Time			
Automobile	$ 12.92	$/hr/per	5
Truck	$ 24.93	$/hr/veh	5
Auto & Truck Composite		$/hr/veh	6
Transit	$ 12.92	$/hr/per	5
Out-of-Vehicle Travel	2	times	5
Incident-Related Travel	3	times	7
Travel Time Uprater	1.2%	annual incr	

Vehicle Operating Cost Parameters

Average Fuel Price			
Automobile (regular unleaded)	$ 3.08	$/gal	8
Truck (diesel)	$ 3.27	$/gal	8
Sales and Fuel Taxes			
State Sales Tax (gasoline)	2.25%	%	9
State Sales Tax (diesel)	9.00%	%	9
Average Local Sales Tax	0.50%	%	9
Federal Fuel Excise Tax (gasoline)	$ 0.184	$/gal	9
Federal Fuel Excise Tax (diesel)	$ 0.244	$/gal	9
State Fuel Excise Tax (gasoline)	$ 0.300	$/gal	9
State Fuel Excise Tax (diesel)	$ 0.130	$/gal	9
Fuel Cost Per Gallon (Exclude Taxes)			
Automobile	$ 2.50	$/gal	
Truck	$ 2.60	$/gal	
Non-Fuel Cost Per Mile			
Automobile	$ 0.319	$/mi	10
Truck	$ 0.440	$/mi	11
Idling Speed for Op. Costs and Emissions	5	mph	

Accident Cost Parameters

Cost of a Fatality	$ 9,600,000	$/event	12
Cost of an Injury			
Level A (Severe)	$ 1,008,000	$/event	12
Level B (Moderate)	$ 451,200	$/event	12
Level C (Minor)	$ 28,800	$/event	12
Cost of Property Damage	$ 4,198	$/event	12
Cost of Highway Accident			
Fatal Accident	$ 10,600,000	$/accident	
Injury Accident	$ 272,600	$/accident	
PDO Accident	$ 17,000	$/accident	
Average Cost	$ 151,800	$/accident	
Statewide Highway Accident Rates			
Fatal Accident	0.007	per mil veh-mi	13
Injury Accident	0.27	per mil veh-mi	13
PDO Accident	0.53	per mil veh-mi	13
Non-Freeway	1.05	per mil veh-mi	13

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) TIGER Benefit-Cost Analysis Resource Guide (Accident Cost Parameters: Fatality, Injury (Severe=>Serious), Emissions), 3) EAB's Value of Time Yearly Update, 4) EIA Fuel Cost

Highway Operations Parameters

	Value	Units	
Maximum V/C Ratio	1.56	-	15
Percent ADT in Peak Period	41.0%	%	
Percent ADT in Average Peak Hour	8.2%	%	
Annualization Factor	365	days/yr	

	Alpha	Beta	Capacity (vphpl)	Dep. Rate (vphpl)	
Freeway	0.20	10	2,000	1,800	15, 16
Expressway	0.20	10	2,000	1,800	15, 16
Conventional Highway	0.05	10	800	1,400	16
HOV Lanes	0.55	8	1,600		17

Non-HOV Lanes	Alpha	Beta	Capacity (vphpl)
No Build	0.05	10	800
Build	0.05	10	800

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	TRUE	GenHwy	
HOV Lane Addition	FALSE	HOV	Enter HOV restriction in section 1B
HOT Lane Addition	FALSE	HOT	Include toll payers as HOVs & check AVOs
Passing Lane	FALSE	Passing	Enter a truck speed in section 1B
Intersection	FALSE	Intersect	Remember to run model for both roads
Bypass	FALSE	Bypass	Remember to run model for both roads
Queuing	FALSE	Queuing	Add arrival rate & check departure rate in 1B
Pavement	FALSE	Pavement	Enter pavement condition in section 1B
Rail or Transit Cap Expansion			Please select a type of rail or transit project
Passenger Rail	FALSE	PassRail	Enter data in both sections 1B & 1E
Light-Rail (LRT)	FALSE	LRT	Enter data in both sections 1B & 1E
Bus	FALSE	Bus	Enter data in both sections 1B & 1E
Hwy-Rail Grade Crossing	FALSE	HwyRail	Put hwy design in 1B, safety in 1C & crossing in 1D
Hwy Operational Improvement			Please select a type of op. improvement
Auxiliary Lane	FALSE	AuxLane	Enter ramp design speed & on-ramp volume
Freeway Connector	FALSE	FreeConn	Check percent traffic in weave in section 1B
HOV Connector	FALSE	HOVConn	Check percent traffic in weave in section 1B
HOV Drop Ramp	FALSE	HOVDrop	Check percent traffic in weave in section 1B
Off-Ramp Widening	FALSE	OffRamp	Check percent traffic in weave in section 1B
On-Ramp Widening	FALSE	OnRamp	Enter on-ramp volume & metering strategy
HOV-2 to HOV-3 Conv	FALSE	HOV2to3	Check AVOs & trips in sections 1B & 2D
HOT Lane Conversion	FALSE	HOTConv	Check AVOs & trips in sections 1B & 2D
Transp Mgmt Systems (TMS)			Please select a type of TMS project
Ramp Metering	FALSE	RM	Enter model data, if avail, in sections 2A & 2C
Ramp Metering Signal Coord	FALSE	AM	Enter model data, if avail, in sections 2A & 2C
Incident Management	FALSE	IM	Enter model data, if avail, in sections 2A & 2C
Traveler Information	FALSE	TI	Enter model data, if avail, in sections 2A & 2C
Arterial Signal Management	FALSE	ASM	Complete only sections 1A, 1E & 2C
Transit Vehicle Location (AVL)	FALSE	AVL	Enter transit agency costs in section 1D
Transit Vehicle Signal Priority	FALSE	SigPriority	Check travel time in section 1D
Bus Rapid Transit (BRT)	FALSE	BRT	Enter free-flow bus lane speed in section 1B
TMS Lookup Code	NoAdj	TMSLookup	
User Modified Inputs	TRUE	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
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

(gal/veh-mi)

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	$9,600,000	$9,600,000	$9,600,000
Injury	$535,700	$535,700	$535,700
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	$566,400	$3,808,300	$2,432,200

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		$9,600,000	$535,700

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	$10,600,000	$10,900,000	$11,400,000	$11,100,000
Injury Accident	$272,600	$274,000	$287,200	$275,800
PDO Accident	$17,000	$16,300	$13,600	$16,400
All Types	$151,800	$181,100	$357,800	$194,500

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	5.3308	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	0.1057
	73	1.0679	423.65	0.0812	0.0468	0.0044	0.1093
	74	1.1181	423.87	0.0814	0.0468	0.0044	0.1129
	75	1.1683	424.09	0.0816	0.0468	0.0044	0.1165
	76	1.2588	424.42	0.0818	0.0468	0.0044	0.1224
	77	1.3492	424.76	0.0821	0.0468	0.0044	0.1284
	78	1.4396	425.09	0.0823	0.0468	0.0044	0.1343
	79	1.5300	425.43	0.0826	0.0469	0.0044	0.1403
	80	1.6204	425.77	0.0828	0.0469	0.0044	0.1463

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	0.7653	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	0.4622	0.0522	0.0076	0.1128
		77	0.8568	755.31	0.4828	0.0522	0.0077	0.1129
		78	0.8772	770.70	0.5034	0.0523	0.0079	0.1130
		79	0.8976	786.08	0.5239	0.0523	0.0080	0.1132
		80	0.9180	801.47	0.5445	0.0523	0.0082	0.1133

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	4.9935	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	0.3034
		74	3.0909	1774.01	16.8360	0.5602	0.0170	0.3073
		75	3.2412	1796.86	17.8762	0.5617	0.0170	0.3112
		76	3.4892	1834.31	19.6152	0.5641	0.0170	0.3171
		77	3.7372	1871.75	21.3542	0.5665	0.0170	0.3229
		78	3.9852	1909.20	23.0932	0.5690	0.0170	0.3287
		79	4.2332	1946.64	24.8322	0.5714	0.0170	0.3346
		80	4.4812	1984.09	26.5712	0.5738	0.0170	0.3404

Source: California Air Resources Board, EMFAC 2011

Notes: 1) Zero mph corresponds to starts, 2) Other emissions factors include idling emissions and exclude diurnal and evaporative emissions, 3) Five mph is best estimate for idling

HEALTH COST OF TRANSPORTATION EMISSIONS

($/ton)

Area	Proj Loc	CO	CO_2e	NO_X	PM_{10}	SO_X	VOC
LA/South Coast	1	$0	$41	$8,010	$366,414	$47,341	$2,032
CA Urban Area	2	$0	$41	$8,010	$366,414	$47,341	$2,032
CA Rural Area	3	$0	$41	$8,010	$366,414	$47,341	$2,032

CO_2e Uprater 2.0% 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 20, By Loading		
Year 0	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 Speed	Without Volume	With Speed	With Volume	Non-Highway Benefits TT	Non-Highway Benefits VOC	Non-Highway Benefits Em	Total Benefit	
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	*18*
ORsev	0.95	1.03	1.00	1.00	0.00	0.00	5.67	0.00	*18*
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	
TIoth	1.00	1.00	1.02	0.97	-0.11	-0.12	-0.35	1.00	
TIsev	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	Agency Costs 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