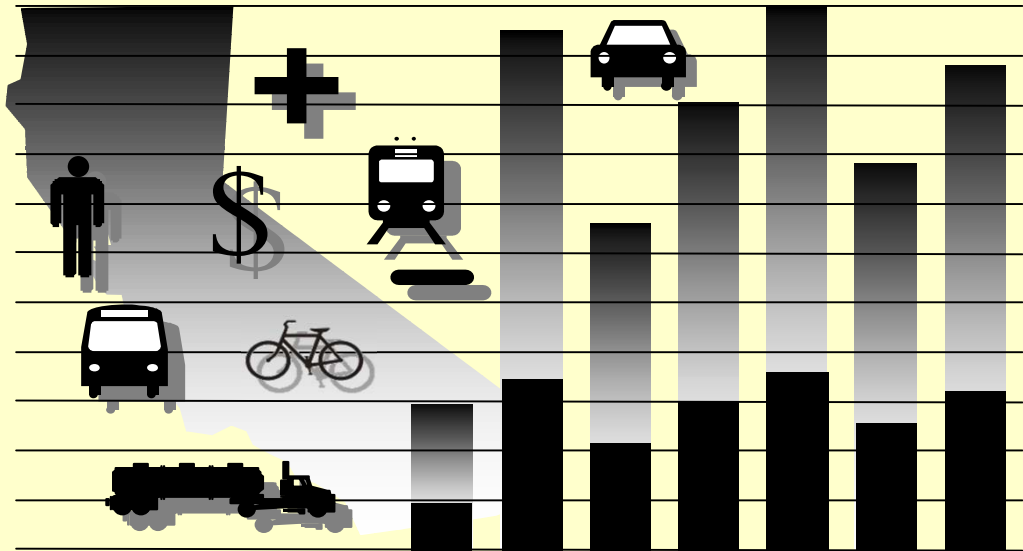




# California Life-Cycle Benefit/Cost Analysis Model (Cal-B/C Corridor) Version 8.1



Office of Transportation Economics  
Division of Transportation Planning  
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## CALIFORNIA LIFE-CYCLE BENEFIT/COST ANALYSIS MODEL (Cal-B/C Corridor)

### INTRODUCTION

Cal-B/C Corridor is a post-processor, benefit-cost tool for preparing economic analyses of highway and transit projects. The model conducts benefit-cost analyses using the changes in vehicle-miles traveled (VMT) and vehicle-hours traveled (VHT), or person-miles traveled (PMT) and person-hours traveled (PHT), estimated in traffic and planning models. Cal-B/C Corridor is derived from the Cal-B/C Sketch model, but it has a flexible design to support a variety of inputs, including segment and speed bin data from regional travel demand and micro-simulation models. The Cal-B/C Corridor model uses the same assumptions and parameters and produces results fully comparable with Cal-B/C Sketch.

Provided that a project is already modeled in a traffic or planning model, Cal-B/C Corridor is able to calculate lifecycle costs, lifecycle benefits, net present value, benefit/cost ratio, internal rate of return, and payback period using appropriate input data. Five main categories of annual benefits are calculated directly within the model:

- Travel time savings (reduced travel time and new trips)
- Travel time reliability benefits (increased reliability of travel time)
- Vehicle operating cost savings (reduced fuel and non-fuel operating costs)
- Accident cost savings (reduced cost to society related to safety)
- Emission cost savings (air quality and greenhouse gas benefits).

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

Basic project data, model setup, and project costs

2) Model Inputs

Traffic or planning model input data in terms of VMT, VHT, PMT, PHT, out-of-pocket costs, and crash rates

3) Results

Summary results of analysis

Travel Time

Calculation of travel time impacts

Consumer Surplus

Calculation of benefits for new trips that result from project implementation, which are reported with travel time benefits

Reliability

Calculation of travel time reliability benefits

Vehicle Operating Costs

Calculation of changes in highway vehicle operating costs

Accident Costs

Calculation of benefits resulting from improved safety

Emissions

Calculation of emissions impacts

Final Calculations

Calculation of net present value, internal rate of return, and payback period

Parameters

Economic assumptions, lookup tables, and other model parameters consistent with other Cal-B/C models

Cal-B/C Corridor is designed so that the user generally needs to insert data only in the **green boxes** (light gray when printed) on the Project Information and Model Inputs worksheets. Summary results are shown on the Results worksheet. The remaining worksheets are provided for the user to see, but the model performs calculations automatically.

In the process of economic analysis, some generally accepted economic assumptions are necessary. These assumptions include the real discount rate, unit user costs (e.g., value of time), consumption rates (e.g., fuel consumption and vehicle emissions), crash rates, 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 Model Inputs 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 projects by entering data primarily in the Project Information and Model Inputs worksheets. These worksheets cover information regarding project characteristics, analysis inputs, traffic model data that drives the costs and benefits of infrastructure investments. The results are calculated automatically and displayed on the Results page. The section below explains the input data required to analyze projects.

### **PROJECT DATA** (Box 1A)

*This section provides general information about the highway or transit improvements. At the top of the Project Information sheet, the user can insert information about the improvements, such as the project name, Caltrans District, and funding information.*

#### **Project Location**

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

#### **Project Timing**

- 2 Enter the current year. All benefits and costs are discounted to the year entered in this cell.
- 3 Enter the year when construction begins. This should represent the first year of construction expenditures.
- 4 Enter the project opening year. This should represent the first year when economic benefits will begin accruing in the analysis.

### **MODEL STRUCTURE** (Box 1B)

*This section allows the user to customize Cal-B/C Corridor and specify the number of model groups, safety groups, reliability groups, and years to be included in the analysis. Once these have been selected, press "Create Model" button to save the model with the selected numbers of structure elements. If the user wishes to change the model structure (i.e., number of model groups or years), the user will need to start again from the beginning.*

- 5 Enter the number of model groups to be analyzed. Cal B/C Corridor is flexible so model groups can be defined by several classifications including time-of-day, vehicle type, trip purpose, section of roadway, roadway classification, or speed bin. For example, defining data by 1-mph speed bins would require about 70 model groups. If these were defined separately for automobiles and trucks, then about 140 model groups would be needed. For most applications, 100 to 200 model groups will be adequate. The model will accommodate a maximum of 500 model groups.
- 6 Enter the number of safety groups to be analyzed. By default, this number is set to be equal to the number of model groups. However, the value in this cell can be set to a different number of safety groups, depending on the structure of safety data available to the user. For example, safety groups could be defined by segment, road classification, or mode.
- 7 Enter the number of reliability groups to be analyzed. By default, this number is set to be equal to the number of model groups. However, the value in this cell can be set to a different number of reliability groups, depending on the structure of reliability data available to the user. Reliability groups should be defined based on where travel time reliability conditions are similar. This could be a segment, corridor, subarea, or network.
- 8 Enter the number of years in the analysis period. Lifecycle benefits will be calculated for the total number of years specified. The results displayed on the Results worksheet are representative of the total benefits for all model groups over the years in the analysis period. The model will handle a maximum of 50 years.
- 9 Click the 'Create Model' button to generate a version of the Cal-B/C Corridor model with the number of model groups and years specified. A new model must be generated to make any future adjustments to the number of model groups, safety groups, reliability groups, or the length of the analysis period.

### **PROJECT COSTS (Box 1C)**

*Net project costs should be inserted in the years they are expected to occur. Costs should be inserted for the construction period and the operating period (specified in the Model Structure) after construction completion. The box will automatically label years according to the construction start year provided by the user in the Project Data box. All costs should be inserted in thousands of dollars.*

- 10 Enter the project's initial costs in constant dollars consistent with the current year entered in Box 1A. Costs should be entered for project support, right-of-way, and construction. Costs should be entered for each year of construction. The model is set up for 8 years of construction, but costs should be entered only for the number of years defined in Box 1A. If less than 8 years of construction are selected, the years may overlap with the Project Costs.
- 11 Enter estimated future incremental maintenance/operating and rehabilitation costs in constant dollars. These figures should be entered for all years after the project opens.
- 12 Enter any estimated mitigation costs or transit agency cost savings in constant dollars during construction and during the operating period after construction completion.
- 13 Insert any other costs not already included.

### **DEFINITION OF MODEL GROUPS AND YEARS (Box 2A)**

*The Model Inputs page allows the user to define the data available from a traffic or planning model and enter that data. In Box 2A, the user defines the model groups to be used in the analysis and identifies the base and forecast years for the traffic or planning model available.*

- 14 Select the mode for each model group from the following options: Bus, Passenger Train, Light Rail, and Highway.
- 15 Provide a name and description for each model group. The name is a short “nickname” that will appear on subsequent tables in the model. The description column allows the user to define the model group in more detail than provided by the name. Both of these entries are optional.
- 16 For Highway mode, enter the average vehicle occupancy (AVO) for each model group. This AVO will be copied automatically to the aggregate model data in Boxes 2C and 2D, but the user can change the AVO if necessary. For example, the AVO may change between the base year and forecast year or from the No Build scenario to the Build scenario. For other modes, AVO information is not used in further calculations.
- 17 For Highway mode, if automobile and truck data are combined, enter the percentage of trucks in the total traffic. If automobile and truck data are entered separately in more than one model group, the percent trucks can be set to 0 percent and 100 percent as appropriate. Like the AVO data, this information will be copied automatically to the aggregate model data in Boxes 2C and 2D, but it can be changed. For other modes, the percentage of trucks information is not used in further calculations.
- 18 Enter the base year and forecast year of the traffic model outputs. In the analysis, the model will automatically interpolate data to estimate benefits for interim years.

#### **AVERAGE PROFILE FOR DIVERTED TRIPS/INDUCED TRIPS (Box 2B)**

*For every Transit model group (a model group for a mode other than Highway), the user must determine whether the mode exists in the No Build scenario. If the mode does not exist, the user must enter the parameters for the least cost alternative to that mode in Box 2B. The user must input data on average speed and average trip length for the years selected in Box 2A. These parameters are different for diverted and induced trips. If a Highway mode is selected in Box 2A or the Transit mode exists in the Build scenario (based on data entered in Boxes 2C and 2D), the average profile for diverted trips/induced trips data are not required and the appropriate cells in Box 2B will be grayed out.*

- 19 Enter average speed for diverted trips in the base year specified in Box 2A. Enter average trip length for diverted trips in the base year. Enter average speed for diverted trips in the forecast year specified in Box 2A. Enter average trip length for diverted trips in the forecast year.
- 20 Enter average speed for induced trips in the base year. Enter average trip length for induced trips in the base year. Enter average speed for induced trips in the forecast year. Enter average trip length for induced trips in the forecast year.

#### **AGGREGATE MODEL DATA (Boxes 2C and 2D)**

*The user enters output from a traffic or planning model (i.e., microsimulation or travel demand model) in Boxes 2C and 2D. The inputs required for Highway and Transit modes are different.*

*For Highway model groups, the user needs to enter only VMT and VHT data. Vehicle speeds are calculated automatically from this information. The number of trips can be entered for induced demand calculations or ignored. The user should check AVO and percent truck information, which is copied automatically from Box 2A.*

*For Transit model groups (Bus, Passenger Train, and Light Rail), another set of inputs is required. The number of trips is very important for the calculations to work. If a mode is not included in the No Build, then pay special attention to Box 2B inputs.*

- 21 For Highway model groups, enter the total daily VMT and VHT in the No Build and Build scenarios for each model group. For Transit model groups, enter the total daily PMT and PHT in the No Build and Build scenarios for each model group. These values should be entered for the base and forecast year specified earlier. Boxes 2C and 2D will be labeled with the appropriate years. Additionally, any out-of-pocket costs are entered in these boxes.
- 22 For Highway model groups, the AVO and Percent Trucks specified for each model group in Box 2A are also populated in Boxes 2C and 2D. These should be changed only if they vary from the base year to the forecast year or from the No Build scenario to the Build scenario.
- 23 The user can also enter trip data. For Highway model groups, this information is required to estimate induced demand. If the trip data are not entered, the model calculates benefits without induced demand. The detailed tables for travel time calculations will list the number of trips as 1 (if trip data are not entered), but this does not affect the calculations and should not be changed. For Transit model groups, the number of trips is required in the No Build and Build scenarios.
- 24 While filling out the tables, keep in mind that for Highway model groups, Trips and VMT refer to vehicle trips and vehicle-miles traveled. For Transit Groups, Trips and VMT refer to person (transit) trips and transit vehicle-miles traveled.

### **DEFINITIONS OF SAFETY GROUPS AND YEARS (Box 2E)**

*In Box 2E (similar to Box 2A), the user defines the safety groups to be used in the analysis and identifies the base and forecast years for the safety data.*

- 25 Select the mode for each safetygroup from the following options: Bus, Passenger Train, Light Rail, and Highway.
- 26 Provide a name and description for each safety group. The name is a short “nickname” that will appear on subsequent safety tables in the model. The description column allows the user to define the model group in more detail than provided by the name.
- 27 For Highway safety groups, enter reduction factors that indicate the percentage by which crash rates decrease from the No Build scenario to the Build scenario. The factors may be different for fatal, injury, and property damage only crashes. The user is not required to enter reduction factors for Bus, Passenger Train, and Light Rail modes.

### **SAFETY DATA (Boxes 2F and 2G)**

*The user enters data needed to calculate safety benefits into this box. Data needs are different for Highway safety groups and Transit (Bus, Passenger Train, and Light Rail) safety groups.*

- 28 For Highway safety groups, enter VMT and crash rates per million VMT for each severity of crashes.
- 29 For Transit safety groups, only enter transit vehicles miles traveled (VMT). The number of accident events will be estimated automatically using standard values in the Parameters worksheet. In these values need to be modified, the user must go to the Parameters worksheet.

## **DEFINITIONS OF RELIABILITY GROUPS AND YEARS (Box 2H)**

*In Box 2H (similar to Boxes 2A and 2E), the user defines the reliability groups to be used in the analysis and identifies the base and forecast years for the reliability data. Reliability groups should be defined according to areas that are expected to have similar travel time reliability or impacted by similar reliability factors. Examples include segments, corridors, subareas, or an entire model.*

- 30 Provide a name and description for each reliability group. The name is a short “nickname” that will appear on subsequent tables in the model. The description column allows the user to define the model group in more detail than provided by the name.
- 31 Provide the duration (in hours) of traffic for each reliability group, and background in the Build and No Build scenarios, as well as roadway length, number of lanes, free-flow speed, and average vehicle occupancy.

## **RELIABILITY DATA (Boxes 2I and 2J)**

*The user enters data needed to calculate travel time reliability benefits into this box.*

- 32 Provide the vehicle-hours traveled and the percent of truck traffic for each reliability group in the No Build and Build scenarios. The user enters this data for the base year and forecast periods.

## **TRAVEL TIME RELIABILITY (Box 2K)**

*The model estimates the standard deviation of travel time using general relationships and data entered in the model. The user may adjust the standard deviations of travel time for automobiles and trucks in each reliability group by entering an adjustment factor.*

- 33 Adjustment factors are calculated as the ratio of the standard deviations calculated by the model to the standard deviation changes entered by the user. The user may override the adjustment factors to scale the standard deviations calculated.

## **Next Steps**

Once the required values are entered into the Project Information and Model Inputs worksheets, the aggregate results of the analysis are automatically compiled on the Results worksheet. This worksheet includes toggles for adding and removing benefits from the calculations, including induced trips, traveled time reliability, vehicle operating cost savings, accident cost savings, and emissions cost savings. A more detailed breakdown of the results by year and benefit type is available on the Final Calculations worksheet.

There is also a Parameters worksheet, identical to the one found in other Cal-B/C models. Since Cal-B/C Sketch requires more operational parameters for its sketch planning methods and other Cal-B/C tools require specialized parameters, several of the values found on the Parameters worksheet are not used in Cal-B/C Corridor. This design is intentional, so the same Parameters worksheet can be used in all models. A few cells (e.g., project type) are left blank to avoid Excel error messages. On the Parameters page, the user can change economic values and the annualization factor to match traffic or planning model data.

District:

PROJECT:

EA:   
PPNO:

1A **PROJECT DATA**

**Type of Project**

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

**Project Timing**

Current Year

Year Construction Begins

Year Project Opens

1B **MODEL STRUCTURE**

		Values In This Model
Number of Model Groups	<input type="text" value="6"/>	<input type="text" value="6"/>
Number of Safety Groups	<input type="text" value="6"/>	<input type="text" value="6"/>
Number of Reliability Groups	<input type="text" value="6"/>	<input type="text" value="6"/>
Years	<input type="text" value="20"/>	<input type="text" value="20"/>





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.

1C PROJECT COSTS (enter costs in thousands of dollars)									
Col. no.	(1)	(2)	(3)	(4)	(5)	(6)	(7)		
Year	DIRECT PROJECT COSTS			SUBSEQUENT COSTS		Mitigation	Transit Agency Cost Savings	TOTAL COSTS (in dollars)	
	Project Support	R / W	Construction	Maint./ Op.	Rehab.			Constant Dollars	Present Value
<b>Construction Period</b>									
2023	\$11,933	\$3,000	\$16,142					\$31,075,567	\$29,880,353
2024	2,333		\$16,142					18,475,567	17,081,700
2025	2,333		\$16,142					18,475,567	16,424,712
2026								0	0
2027								0	0
2028								0	0
2029								0	0
2030								0	0
<b>Project Open</b>									
2026				\$10				\$10,000	\$8,548
2027				\$10				10,000	8,219
2028				\$10				10,000	7,903
2029				\$10				10,000	7,599
2030				\$10				10,000	7,307
2031				\$10				10,000	7,026
2032				\$10				10,000	6,756
2033				\$10				10,000	6,496
2034				\$10				10,000	6,246
2035				\$10				10,000	6,006
2036				\$10				10,000	5,775
2037				\$10				10,000	5,553
2038				\$10				10,000	5,339
2039				\$10				10,000	5,134
2040				\$10				10,000	4,936
2041				\$10				10,000	4,746
2042				\$10				10,000	4,564
2043				\$10				10,000	4,388
2044				\$10				10,000	4,220
2045				\$10				10,000	4,057
<b>Total</b>	<b>\$16,600</b>	<b>\$3,000</b>	<b>\$48,427</b>	<b>\$200</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>	<b>\$68,226,701</b>	<b>\$63,507,582</b>

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



DEFINITIONS OF MODEL GROUPS AND YEARS

Model Group	Select Mode	Name	Description	Arg. Vehicle Occupancy (AVO)	Percent Trucks
Model Group 1	Highway	IS Off-ramp to Ave 280		1.45	24.0%
Model Group 2	Highway	IS On-ramp from Ave 280		1.45	24.0%
Model Group 3	Highway	NS Off-ramp to Ave 280		1.45	24.0%
Model Group 4	Highway	NS On-ramp from Ave 280		1.45	24.0%
Model Group 5	Highway	IS Mainline		1.45	24.0%
Model Group 6	Highway	IS Mainline		1.45	24.0%
Base Year		2008			
Forecast Year		2028			

MODEL DATA - YEAR 2026

REQUIRED FOR

No Build	TRANSEIT		Passenger		Out-of-Pocket Cost (\$ per trip)	Speed	Average	
	Number of Trips (Trips) ---	Vehicles Traveled (VMT) -	Vehicle Hours Traveled (VHT) -	Passenger Miles Traveled (PMT) -			Passenger Hours Traveled (PHT) -	Vehicle Occupancy (AVO)
1 SB Off-ramp to Ave 200	2,500	48			42.0	1.40	24.0%	
2 SB On-ramp from Ave 200	1,486	28			53.1	1.40	24.0%	
3 NB Off-ramp to Ave 200	1,525	41			37.2	1.40	24.0%	
4 NB On-ramp from Ave 200	2,513	50			43.1	1.40	24.0%	
5 NB Mainline	50,516	728			69.4	1.40	24.0%	
6 SB Mainline	48,617	702			69.4	1.40	24.0%	
TOTAL	0	102,718	1,503	0	0			

Group	1	2	3	4	5	6	TOTAL	
1 SB Off-ramp to Ave 280	1,584	47				42.3	1.45	24.0%
2 SB On-ramp from Ave 280	1,555	38				54.1	1.45	24.0%
3 NB Off-ramp to Ave 280	1,584	32				46.3	1.45	24.0%
4 NB On-ramp from Ave 280	2,072	37				76.3	1.45	24.0%
5 SB Mainline	47,069	676				69.2	1.45	24.0%
6 SB Mainline	43,431	624				69.0	1.45	24.0%
TOTAL	57,205	824	0	0	0			

\* For Highway Model Groups, Tips and VMT refer to vehicle trips and vehicle-miles travelled. For Transit Model Groups, Tips and VMT refer to person (transit) trips and transit vehicle-miles travelled.  
 \*\*Number of Trips is an optional field for Highway Model Groups, unless Transit Model Groups are included. This is a required input if induced demand exists.

**AVERAGE PROFILE FOR DIVERTED TRIPS/INDUCED TRIPS**

Typical "No Build" conditions for persons "on the margin" who will divert from highway to transit in Build Scenario, or for induced trips. This profile should reflect a lower cost alternative than the average traffic profile entered in Table 2C and 2D.

**For Trips Diverting from Highway to Transit**

**Least Cost Alternative (for Induced Trips)**

No. Build	Average Trip		Average Trip		Average Trip		Average Trip	
	Average Speed in Year 2026 (mph)	Length in Year 2026 (miles)	Average Speed in Year 2046 (mph)	Length in Year 2046 (miles)	Average Speed in Year 2026 (mph)	Length in Year 2026 (miles)	Average Speed in Year 2046 (mph)	Length in Year 2046 (miles)
Model Group 1								
Model Group 2								
Model Group 3								
Model Group 4								
Model Group 5								
Model Group 6								

MODEL DATA - YEAR 2046

REQUIRED FOR

REQUIRED FOR	Number of Trips (Trips/Day)	Vehicle Miles Traveled (VMT)	Vehicle Hours Traveled (VHT)	Passenger Miles Traveled (PMT)	Passenger Hours Traveled (PHT)	Out-of- Pocket Cost (\$ per trip)	Speed	Average Vehicle Occupancy (AVO)	Percent Trucks
<b>No Build</b>									
1 SB Off-ramp to Ave 280	2,587	82	39			41.0	1.40	24.0%	
2 SB On-ramp from Ave 280	2,056	39	39			32.7	1.45	24.0%	
3 NB Off-ramp to Ave 280	2,100	58	36.4			42.1	1.45	24.0%	
4 NB On-ramp from Ave 280	3,180	74	42.1			40.1	1.45	24.0%	
5 NB Mainline	64,125	328	69.1			40.1	1.45	24.0%	
6 SB Mainline	61,714	309	69.1			40.1	1.45	24.0%	
<b>TOTAL</b>	<b>0</b>	<b>135,737</b>	<b>2,054</b>	<b>0</b>	<b>0</b>				



Route							
1 SB Off-ramp to Ave 280	2,585	88		42.1	1.45	24.0%	
2 SB On-ramp from Ave 280	2,098	35		95.2	1.45	24.0%	
3 NB Off-ramp to Ave 280	2,075	44		47.2	1.45	24.0%	
4 NB On-ramp from Ave 280	2,604	35		74.4	1.45	24.0%	
5 SB Mainline	55,693	119		69.2	1.45	24.0%	
6 SB Mainline	53,301	769		69.2	1.45	24.0%	
TOTAL	0	119,224	1,722	0	0		

\* For Highway Model Groups, Trips and VMT refer to vehicle trips and vehicle-miles traveled. For Transit Model Groups, Trips and VMT refer to person (board) trips and transit vehicle-miles traveled.  
 \*\*Number of Trips is an optional field for Highway Model Groups, unless Transit Model Groups are included. This is a required input if induced demand exists.

DEFINITIONS OF SAFETY GROUPS AND YEARS

	Select Mode	Name	Description	Fatal Reduction	Injury Reduction	POD Reduction
				Factor	Factor	Factor
Safety Group 1	Highway	SB Off-ramp to Ave 280		90.0%	76.0%	27.0%
Safety Group 2	Highway	SB On-ramp from Ave 280		90.0%	76.0%	27.0%
Safety Group 3	Highway	NB Off-ramp to Ave 280		90.0%	76.0%	27.0%
Safety Group 4	Highway	NB On-ramp from Ave 280		90.0%	76.0%	27.0%
Safety Group 5	Highway	SB Mainline		25.0%	25.0%	25.0%
Safety Group 6	Highway	SB Mainline		25.0%	25.0%	25.0%
Safety Base Year		2020				
Safety Forecast Year		2040				

**SAFETY DATA - YEAR 2026**

	Vehicle Miles Traveled (VMT)	Fatal Crash Rate Per 100M	Injury Crash Rate Per 100M	PDO Crash Rate Per 100M	Number of Fatal Crashes	Number of Injury Crashes	Number of PDO Crashes
<b>No Build</b>							
1 SB Off-ramp to Ave 280	2,059	0.000	0.92	1.81	0.000	0.0019	0.0081
2 SB On-ramp from Ave 280	1,488	0.000	0.44	0.56	0.000	0.0007	0.0056
3 NB Off-ramp to Ave 280	1,525	0.000	0.14	0.29	0.000	0.0002	0.0024
4 NB On-ramp from Ave 280	2,813	0.000	0.60	0.46	0.000	0.0000	0.0011
5 NB Mainline	50,519	0.000	0.20	0.48	0.000	0.0011	0.0344
6 SB Mainline	48,477	0.014	0.22	0.87	0.007	0.0027	0.0251
<b>TOTAL</b>	<b>106,971</b>				<b>0.007</b>	<b>0.0236</b>	<b>0.0732</b>
Total VMT in model groups equals total VMT in safety groups							

Route	1	2	3	4	5	6	7
1 SB Off-ramp to Ave 280	1,382	0.000	0.32	1.34	0.000	0.0004	0.0025
2 SB On-ramp from Ave 280	1,515	0.000	0.11	0.42	0.000	0.0002	0.0005
3 NB Off-ramp to Ave 280	1,301	0.000	0.33	1.23	0.000	0.0001	0.0001
4 NB On-ramp from Ave 280	2,072	0.000	0.06	0.34	0.000	0.0000	0.0007
5 SB Mainline	47,401	0.000	0.15	0.51	0.000	0.0071	0.0461
6 SB Mainline	45,461	0.011	0.17	0.50	0.000	0.0072	0.0275
TOTAL	97,132					0.0206	0.0728

Total VMT in model groups equals total VMT in safety groups.

\*For Highway Model Groups, VMT refers to vehicle miles traveled. For Transit Model Groups, VMT refers to transit vehicle miles traveled.



**SAFETY DATA - YEAR 2046**

No Buils	Vehicle Miles Traveled (VMT)	Fatal Crash Rate Per MVM	Injury Crash Rate Per MVM	PDO Crash Rate Per MVM	Number of Fatal Crashes	Number of Injury Crashes	Number of PDO Crashes
1 SB Off-ramp to Ave 280	2,259	0.000	0.02	1.83	0.0000	0.0004	0.0047
2 SB On-ramp from Ave 280	2,056	0.000	0.44	0.58	0.0000	0.0000	0.0012
3 NB Off-ramp to Ave 280	2,109	0.000	0.14	0.29	0.0000	0.0003	0.0006
4 NB On-ramp from Ave 280	3,180	0.000	0.00	0.46	0.0000	0.0000	0.0015
5 NB Mainline	64,725	0.000	0.20	0.68	0.0000	0.0126	0.0436
6 SB Mainline	81,174	0.000	0.24	0.87	0.0000	0.0136	0.0413
<b>TOTAL</b>	<b>136,723</b>				<b>0.0000</b>	<b>0.0300</b>	<b>0.0959</b>

Total VMT in traffic hours equals 7,924,138 VMT in safety inputs

Model							
1 SB Off-ramp to Ave 280	2,885	0.001	0.22	1.34	0.0000	0.0008	0.0035
2 SB On-ramp from Ave 280	2,296	0.000	0.11	0.42	0.0000	0.0002	0.0009
3 NE Off-ramp to Ave 280	2,075	0.000	0.03	0.21	0.0000	0.0001	0.0004
4 NE On-ramp from Ave 280	2,604	0.000	0.00	0.34	0.0000	0.0000	0.0009
5 NE Mainline	36,861	0.001	0.15	0.51	0.0001	0.0005	0.0021
6 SB Mainline	53,351	0.011	0.17	0.50	0.0006	0.0038	0.0151
TOTAL	112,847				0.0007	0.0042	0.0170
Total VMT in traffic signals equals total VMT in roadway inputs.							

\*For Highway Model Groups, VMT refers to vehicle-miles traveled. For Transit Model Groups, VMT refers to transit vehicle-miles traveled.

(2)

**RELIABILITY DATA - YEAR 2026**

No Build	VMT	VMT	% Truck	Avg. Speed	Volume
1 SB Off-ramp to Ave 200	2,055	48	24%	43	3,897
2 SB On-ramp from Ave 200	1,485	21	24%	53	3,195
3 NB Off-ramp to Ave 200	1,525	41	24%	37	3,177
4 NB On-ramp from Ave 200	2,111	58	24%	41	3,580
5 NB Mainline	25,518	726	24%	85	6,427
6 SB Mainline	48,517	702	24%	82	6,182
<b>TOTAL</b>	<b>59,191</b>	<b>1,605</b>			<b>26,151</b>

Total VMT in traffic inputs equals total VMT in reliability inputs.

(3)

**RELIABILITY DATA - YEAR 2046**

No Build	VMT	VMT	% Truck	Avg. Speed	Volume
1 SB Off-ramp to Ave 200	2,585	62	24%	42	4,527
2 SB On-ramp from Ave 200	2,055	30	24%	53	4,283
3 NB Off-ramp to Ave 200	2,100	58	24%	36	4,394
4 NB On-ramp from Ave 200	3,160	74	24%	41	4,514
5 NB Mainline	64,120	928	24%	89	9,189
6 SB Mainline	67,714	893	24%	82	7,852
<b>TOTAL</b>	<b>75,734</b>	<b>2,054</b>			<b>35,825</b>

Total VMT in traffic inputs equals total VMT in reliability inputs.



Build	VMT	VMT	% Truck	Avg. Speed	Volume
1 SB Off-ramp to Ave 280	1,955	47	24%	54	3,197
2 SB On-ramp from Ave 280	1,515	28	24%	54	3,196
3 NB Off-ramp to Ave 280	1,500	32	24%	47	3,152
4 NB On-ramp from Ave 280	2,072	72	24%	71	3,572
5 SB Mainline	47,028	876	24%	70	5,981
6 SB Mainline	43,431	624	24%	70	5,522
TOTAL	57,421	1,283			24,522

Total VMT in traffic inputs equals total VMT in reliability inputs

Build	VMT	VMT	% Truck	Avg. Speed	Volume
1 SB Off-ramp to Ave 280	2,955	88	24%	54	4,821
2 SB On-ramp from Ave 280	2,086	38	24%	55	4,367
3 NB Off-ramp to Ave 280	2,075	44	24%	47	4,353
4 NB On-ramp from Ave 280	2,604	95	24%	74	4,490
5 SB Mainline	55,691	1,019	24%	69	7,212
6 SB Mainline	53,391	769	24%	69	6,781
TOTAL	65,224	1,772			31,724

Total VMT in traffic inputs equals total VMT in reliability inputs

**TRAVEL TIME RELIABILITY**  
(for adjustments to Reliability Calculations, standard deviation of travel time in seconds/vehicle)

Adjustment Factor	Mode	Calculated by			Reason for Change	Mode	Calculated by			Reason for Change
		Model	Used for Proj.	User			Model	Used for Proj.	User	
Reliability Group 1	Automobile	1.00				Truck	1.00			
Reliability Group 2	Automobile	1.00				Truck	1.00			
Reliability Group 3	Automobile	1.00				Truck	1.00			
Reliability Group 4	Automobile	1.00				Truck	1.00			
Reliability Group 5	Automobile	1.00				Truck	1.00			
Reliability Group 6	Automobile	1.00				Truck	1.00			

District: **6**  
 PROJECT: **Caldwell Interchange**

EA: 

06-48740
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 PPNO: 

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3

## INVESTMENT ANALYSIS SUMMARY RESULTS

<b>Life-Cycle Costs (mil. \$)</b>	\$63.5
<b>Life-Cycle Benefits (mil. \$)</b>	\$84.9
<b>Net Present Value (mil. \$)</b>	\$21.4
<b>Benefit / Cost Ratio:</b>	1.34
<b>Rate of Return on Investment:</b>	6.7%
<b>Payback Period:</b>	11 years

	Total Over 20 Years	Average Annual
<b>ITEMIZED BENEFITS (mil. \$)</b>		
Travel Time Savings	\$28.8	\$1.4
Travel Time Reliability Benefits	\$1.7	\$0.1
Veh. Op. Cost Savings	\$28.0	\$1.4
Accident Cost Savings	\$24.5	\$1.2
Emission Cost Savings	\$2.0	\$0.1
<b>TOTAL BENEFITS</b>	<b>\$84.9</b>	<b>\$4.2</b>
Person-Hours of Time Saved	2,357,015	117,851
Fatalities Avoided	2	0
Injuries Avoided	113	6
PDO Avoided	746	37

**Should benefit-cost results include:**

<b>1) Induced Travel? (y/n)</b>	Y	Default = Y
<b>2) Travel Time Reliability? (y/n)</b>	Y	Default = Y
<b>3) Vehicle Operating Costs? (y/n)</b>	Y	Default = Y
<b>3) Accident Costs? (y/n)</b>	Y	Default = Y
<b>4) Vehicle Emissions? (y/n)</b> includes value for CO <sub>2</sub> e	Y	Default = Y

	Tons		Value (mil. \$)	
	Total Over 20 Years	Average Annual	Total Over 20 Years	Average Annual
<b>EMISSIONS REDUCTION</b>				
CO Emissions Saved	47	2	\$0.0	\$0.0
CO <sub>2</sub> Emissions Saved	45,204	2,260	\$1.7	\$0.1
NO <sub>x</sub> Emissions Saved	25	1	\$0.2	\$0.0
PM <sub>10</sub> Emissions Saved	1	0	\$0.0	\$0.0
PM <sub>2.5</sub> Emissions Saved	1	0		
SO <sub>x</sub> Emissions Saved	0	0	\$0.0	\$0.0
VOC Emissions Saved	1	0	\$0.0	\$0.0

SUMMARY OF TRAVEL TIME BENEFITS

Year	1 SB Off-ramp to Ave 280	2 SB On-ramp from Ave 280	3 NB Off-ramp to Ave 280	4 NB On-ramp from Ave 280	5 NB Mainline	6 SB Mainline	Present Value of Travel Time Benefits	Constant Dollars	Total Per-Hrs of Time Saved
2026	\$9,468	\$0	\$85,211	\$293,506	\$492,333	\$719,563	\$1,600,081	\$1,871,868	89,443
2027	\$5,917	\$455	\$84,210	\$285,859	\$499,798	\$713,737	\$1,589,976	\$1,934,449	92,434
2028	\$2,626	\$875	\$83,160	\$278,366	\$505,960	\$707,294	\$1,578,281	\$1,997,029	95,424
2029	(\$421)	\$1,263	\$82,065	\$271,026	\$510,909	\$700,291	\$1,565,134	\$2,059,609	98,414
2030	(\$3,237)	\$1,619	\$80,932	\$263,839	\$514,729	\$692,780	\$1,550,663	\$2,122,189	101,404
2031	(\$5,836)	\$1,945	\$79,765	\$256,804	\$517,500	\$684,812	\$1,534,990	\$2,184,769	104,395
2032	(\$8,231)	\$2,245	\$78,568	\$249,920	\$519,296	\$676,431	\$1,518,229	\$2,247,350	107,385
2033	(\$10,433)	\$2,518	\$77,345	\$243,186	\$520,188	\$667,682	\$1,500,486	\$2,309,930	110,375
2034	(\$12,453)	\$2,767	\$76,099	\$236,600	\$520,243	\$658,606	\$1,481,863	\$2,372,510	113,365
2035	(\$14,302)	\$2,993	\$74,836	\$230,161	\$519,525	\$649,240	\$1,462,452	\$2,435,090	116,356
2036	(\$15,990)	\$3,198	\$73,556	\$223,867	\$518,092	\$639,620	\$1,442,342	\$2,497,670	119,346
2037	(\$17,528)	\$3,383	\$72,265	\$217,717	\$516,001	\$629,779	\$1,421,616	\$2,560,251	122,336
2038	(\$18,924)	\$3,548	\$70,964	\$211,708	\$513,304	\$619,750	\$1,400,351	\$2,622,831	125,326
2039	(\$20,186)	\$3,696	\$69,656	\$205,840	\$510,052	\$609,560	\$1,378,618	\$2,685,411	128,317
2040	(\$21,323)	\$3,827	\$68,344	\$200,110	\$506,290	\$599,238	\$1,356,486	\$2,747,991	131,307
2041	(\$22,343)	\$3,943	\$67,029	\$194,517	\$502,063	\$588,807	\$1,334,016	\$2,810,572	134,297
2042	(\$23,253)	\$4,044	\$65,715	\$189,057	\$497,413	\$578,293	\$1,311,269	\$2,873,152	137,287
2043	(\$24,060)	\$4,131	\$64,403	\$183,730	\$492,377	\$567,716	\$1,288,298	\$2,935,732	140,278
2044	(\$24,770)	\$4,206	\$63,094	\$178,533	\$486,993	\$557,098	\$1,265,154	\$2,998,312	143,268
2045	(\$25,390)	\$4,269	\$61,791	\$173,464	\$481,295	\$546,456	\$1,241,885	\$3,060,892	146,258
<b>Total</b>	<b>(\$250,669)</b>	<b>\$54,927</b>	<b>\$1,479,008</b>	<b>\$4,587,811</b>	<b>\$10,144,361</b>	<b>\$12,806,753</b>	<b>\$28,822,190</b>	<b>\$49,327,607</b>	<b>2,357,015</b>

## SUMMARY OF PERSON-HOURS SAVED

Year	1 SB Off-ramp to Ave 280	2 SB On-ramp from Ave 280	3 NB Off-ramp to Ave 280	4 NB On-ramp from Ave 280	5 NB Mainline	6 SB Mainline
2026	529	0	4,763	16,407	27,521	40,223
2027	344	26	4,896	16,618	29,056	41,493
2028	159	53	5,028	16,830	30,591	42,763
2029	(26)	79	5,160	17,042	32,125	44,034
2030	(212)	106	5,293	17,254	33,660	45,304
2031	(397)	132	5,425	17,465	35,195	46,574
2032	(582)	159	5,557	17,677	36,730	47,844
2033	(767)	185	5,689	17,889	38,265	49,114
2034	(953)	212	5,822	18,100	39,800	50,385
2035	(1,138)	238	5,954	18,312	41,334	51,655
2036	(1,323)	265	6,086	18,524	42,869	52,925
2037	(1,508)	291	6,219	18,735	44,404	54,195
2038	(1,694)	318	6,351	18,947	45,939	55,465
2039	(1,879)	344	6,483	19,159	47,474	56,736
2040	(2,064)	370	6,616	19,371	49,009	58,006
2041	(2,249)	397	6,748	19,582	50,543	59,276
2042	(2,435)	423	6,880	19,794	52,078	60,546
2043	(2,620)	450	7,013	20,006	53,613	61,816
2044	(2,805)	476	7,145	20,217	55,148	63,087
2045	(2,990)	503	7,277	20,429	56,683	64,357
<b>Total</b>	<b>(24,610)</b>	<b>5,028</b>	<b>120,404</b>	<b>368,358</b>	<b>842,037</b>	<b>1,045,798</b>





Year	AVERAGE VOLUME (vehicles/hour)		AVERAGE SPEED (mph)		RECURRING (hrs)
	No Build	Build	No Build	Build	No Build
2026	2,353	2,399	53.1	54.1	0.000
2046	3,255	3,319	52.7	55.2	0.000

2026	2,353	2,399	53.1	54.1	0.000
2027	2,398	2,445	53.1	54.2	0.000
2028	2,443	2,491	53.0	54.2	0.000
2029	2,488	2,537	53.0	54.3	0.000
2030	2,533	2,583	53.0	54.3	0.000
2031	2,578	2,629	53.0	54.4	0.000
2032	2,624	2,675	53.0	54.4	0.000
2033	2,669	2,721	52.9	54.5	0.000
2034	2,714	2,767	52.9	54.5	0.000
2035	2,759	2,813	52.9	54.6	0.000
2036	2,804	2,859	52.9	54.6	0.000
2037	2,849	2,905	52.9	54.7	0.000
2038	2,894	2,951	52.9	54.7	0.000
2039	2,939	2,997	52.8	54.8	0.000
2040	2,985	3,043	52.8	54.8	0.000
2041	3,030	3,089	52.8	54.9	0.000
2042	3,075	3,135	52.8	54.9	0.000
2043	3,120	3,181	52.8	55.0	0.000
2044	3,165	3,227	52.8	55.1	0.000
2045	3,210	3,273	52.7	55.1	0.000

<b>Total</b>					
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3 NB Off-ramp to Ave 280

Year	AVERAGE VOLUME (vehicles/hour)		AVERAGE SPEED (mph)		RECURRING (hrs)
	No Build	Build	No Build	Build	No Build
2026	2,415	2,375	37.2	46.9	0.000
2046	3,339	3,285	36.4	47.2	0.000

2026	2,415	2,375	37.2	46.9	0.000
2027	2,461	2,421	37.2	46.9	0.000
2028	2,507	2,466	37.1	46.9	0.000
2029	2,553	2,512	37.1	46.9	0.000
2030	2,600	2,557	37.0	46.9	0.000
2031	2,646	2,603	37.0	46.9	0.000
2032	2,692	2,648	36.9	47.0	0.000
2033	2,738	2,694	36.9	47.0	0.000
2034	2,784	2,739	36.9	47.0	0.000
2035	2,831	2,785	36.8	47.0	0.000
2036	2,877	2,830	36.8	47.0	0.000
2037	2,923	2,876	36.7	47.0	0.000
2038	2,969	2,921	36.7	47.0	0.000
2039	3,016	2,967	36.7	47.1	0.000



2040	3,062	3,012	36.6	47.1	0.000
2041	3,108	3,058	36.6	47.1	0.000
2042	3,154	3,103	36.5	47.1	0.000
2043	3,201	3,149	36.5	47.1	0.000
2044	3,247	3,194	36.4	47.1	0.000
2045	3,293	3,240	36.4	47.1	0.000

<b>Total</b>
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4 NB On-ramp from Ave 280

Year	AVERAGE VOLUME (vehicles/hour)		AVERAGE SPEED (mph)		RECURRING (hrs)
	No Build	Build	No Build	Build	No Build
2026	2,728	2,715	43.3	76.7	0.000
2046	3,431	3,412	42.7	74.4	0.000

2026	2,728	2,715	43.3	76.7	0.000
2027	2,764	2,750	43.3	76.6	0.000
2028	2,799	2,785	43.3	76.5	0.000
2029	2,834	2,820	43.2	76.4	0.000
2030	2,869	2,854	43.2	76.3	0.000
2031	2,904	2,889	43.2	76.2	0.000
2032	2,939	2,924	43.1	76.0	0.000
2033	2,974	2,959	43.1	75.9	0.000
2034	3,009	2,994	43.1	75.8	0.000
2035	3,045	3,029	43.0	75.7	0.000
2036	3,080	3,064	43.0	75.6	0.000
2037	3,115	3,098	43.0	75.5	0.000
2038	3,150	3,133	43.0	75.3	0.000
2039	3,185	3,168	42.9	75.2	0.000
2040	3,220	3,203	42.9	75.1	0.000
2041	3,255	3,238	42.9	75.0	0.000
2042	3,290	3,273	42.8	74.9	0.000
2043	3,325	3,308	42.8	74.8	0.000
2044	3,361	3,342	42.8	74.6	0.000
2045	3,396	3,377	42.7	74.5	0.000

<b>Total</b>
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5 NB Mainline

Year	AVERAGE VOLUME (vehicles/hour)		AVERAGE SPEED (mph)		RECURRING (hrs)
	No Build	Build	No Build	Build	No Build
2026	4,885	4,545	69.4	69.5	0.000
2046	6,201	5,482	69.1	69.3	0.000

2026	4,885	4,545	69.4	69.5	0.000
2027	4,950	4,592	69.4	69.5	0.000
2028	5,016	4,639	69.4	69.5	0.000
2029	5,082	4,686	69.3	69.5	0.000

2030	5,148	4,733	69.3	69.5	0.000
2031	5,214	4,779	69.3	69.5	0.000
2032	5,280	4,826	69.3	69.5	0.000
2033	5,345	4,873	69.3	69.5	0.000
2034	5,411	4,920	69.3	69.4	0.000
2035	5,477	4,967	69.3	69.4	0.000
2036	5,543	5,014	69.2	69.4	0.000
2037	5,609	5,060	69.2	69.4	0.000
2038	5,674	5,107	69.2	69.4	0.000
2039	5,740	5,154	69.2	69.4	0.000
2040	5,806	5,201	69.2	69.4	0.000
2041	5,872	5,248	69.2	69.4	0.000
2042	5,938	5,294	69.2	69.4	0.000
2043	6,003	5,341	69.1	69.3	0.000
2044	6,069	5,388	69.1	69.3	0.000
2045	6,135	5,435	69.1	69.3	0.000

<b>Total</b>
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6 SB Mainline

Year	AVERAGE VOLUME (vehicles/hour)		AVERAGE SPEED (mph)		RECURRING (hrs)
	No Build	Build	No Build	Build	No Build
2026	4,701	4,197	69.5	69.6	0.000
2046	5,967	5,154	69.1	69.3	0.000

2026	4,701	4,197	69.5	69.6	0.000
2027	4,764	4,244	69.4	69.5	0.000
2028	4,828	4,292	69.4	69.5	0.000
2029	4,891	4,340	69.4	69.5	0.000
2030	4,954	4,388	69.4	69.5	0.000
2031	5,017	4,436	69.4	69.5	0.000
2032	5,081	4,484	69.3	69.5	0.000
2033	5,144	4,532	69.3	69.5	0.000
2034	5,207	4,579	69.3	69.5	0.000
2035	5,271	4,627	69.3	69.4	0.000
2036	5,334	4,675	69.3	69.4	0.000
2037	5,397	4,723	69.3	69.4	0.000
2038	5,461	4,771	69.2	69.4	0.000
2039	5,524	4,819	69.2	69.4	0.000
2040	5,587	4,867	69.2	69.4	0.000
2041	5,651	4,914	69.2	69.4	0.000
2042	5,714	4,962	69.2	69.4	0.000
2043	5,777	5,010	69.2	69.3	0.000
2044	5,841	5,058	69.1	69.3	0.000
2045	5,904	5,106	69.1	69.3	0.000

<b>Total</b>
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<b>Std. Dev. Of TTI = (0.71 x (TTI Mean - 1) ^ 0.56) x Impacted Length / FF Speed</b>		
hours/vehicle	mi	mph
<b>Reliability Savings = Change in Std. Dev. Of TTI x Avg. Value of Reliability</b>		
\$/yr	hrs/yr	\$/hr
<b>Avg. Value of Reliability = Avg. Value of Time x Reliability Ratio</b>		
\$/hr	\$/hr	
<b>Induced = Change in Trips x Change in Std. Dev. of TTI x 0.5</b>		

## AUTOMOBILE BENEFITS

DELAY RATE (/mi)	STANDARD DEVIATION OF TRAVEL TIME INDEX (hours/vehicle)		RELIABILITY BENEFIT (person-hours/yr)		Constant Dollars
	Build	No Build	Build	Existing Users	
0.000	0.001	0.001	116	0	\$1,503
0.000	0.001	0.001	168	0	\$2,173
0.000	0.001	0.001	116	0	\$1,503
0.000	0.001	0.001	119	0	\$1,537
0.000	0.001	0.001	121	0	\$1,570
0.000	0.001	0.001	124	0	\$1,604
0.000	0.001	0.001	126	0	\$1,637
0.000	0.001	0.001	129	0	\$1,671
0.000	0.001	0.001	131	0	\$1,704
0.000	0.001	0.001	134	0	\$1,738
0.000	0.001	0.001	137	0	\$1,771
0.000	0.001	0.001	139	0	\$1,804
0.000	0.001	0.001	142	0	\$1,838
0.000	0.001	0.001	144	0	\$1,871
0.000	0.001	0.001	147	0	\$1,905
0.000	0.001	0.001	150	0	\$1,938
0.000	0.001	0.001	152	0	\$1,972
0.000	0.001	0.001	155	0	\$2,005
0.000	0.001	0.001	157	0	\$2,039
0.000	0.001	0.001	160	0	\$2,072
0.000	0.001	0.001	162	0	\$2,106
0.000	0.001	0.001	165	0	\$2,139
					<b>\$36,425</b>

DELAY RATE (/mi)	STANDARD DEVIATION OF TRAVEL TIME INDEX (hours/vehicle)		RELIABILITY BENEFIT (person-hours/yr)		Constant Dollars
	Build	No Build	Build	Existing Users	
0.000	0.001	0.001	270	3	\$3,528
0.000	0.001	0.001	373	4	\$4,881
0.000	0.001	0.001	270	3	\$3,528
0.000	0.001	0.001	275	3	\$3,595
0.000	0.001	0.001	280	3	\$3,663
0.000	0.001	0.001	285	3	\$3,731
0.000	0.001	0.001	290	3	\$3,798
0.000	0.001	0.001	295	3	\$3,866
0.000	0.001	0.001	301	3	\$3,934
0.000	0.001	0.001	306	3	\$4,001
0.000	0.001	0.001	311	3	\$4,069
0.000	0.001	0.001	316	3	\$4,137
0.000	0.001	0.001	321	3	\$4,204
0.000	0.001	0.001	326	3	\$4,272
0.000	0.001	0.001	332	3	\$4,340
0.000	0.001	0.001	337	3	\$4,407
0.000	0.001	0.001	342	3	\$4,475
0.000	0.001	0.001	347	3	\$4,542
0.000	0.001	0.001	352	3	\$4,610
0.000	0.001	0.001	357	3	\$4,678
0.000	0.001	0.001	363	4	\$4,745
0.000	0.001	0.001	368	4	\$4,813
					<b>\$83,408</b>

DELAY RATE (/mi)	STANDARD DEVIATION OF TRAVEL TIME INDEX (hours/vehicle)		RELIABILITY BENEFIT (person-hours/yr)		Constant Dollars
	Build	No Build	Build	Existing Users	
0.000	0.001	0.001	1,224	0	\$15,869
0.000	0.001	0.001	1,694	0	\$21,953
0.000	0.001	0.001	1,224	0	\$15,869
0.000	0.001	0.001	1,248	0	\$16,174
0.000	0.001	0.001	1,271	0	\$16,478
0.000	0.001	0.001	1,295	0	\$16,782
0.000	0.001	0.001	1,318	0	\$17,086
0.000	0.001	0.001	1,342	0	\$17,390
0.000	0.001	0.001	1,365	0	\$17,694
0.000	0.001	0.001	1,389	0	\$17,999
0.000	0.001	0.001	1,412	0	\$18,303
0.000	0.001	0.001	1,436	0	\$18,607
0.000	0.001	0.001	1,459	0	\$18,911
0.000	0.001	0.001	1,483	0	\$19,215
0.000	0.001	0.001	1,506	0	\$19,519
0.000	0.001	0.001	1,530	0	\$19,824

0.000	0.001	0.001	1,553	0	\$20,128
0.000	0.001	0.001	1,577	0	\$20,432
0.000	0.001	0.001	1,600	0	\$20,736
0.000	0.001	0.001	1,623	0	\$21,040
0.000	0.001	0.001	1,647	0	\$21,344
0.000	0.001	0.001	1,670	0	\$21,649

					<b>\$375,181</b>
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DELAY RATE (mi)	STANDARD DEVIATION OF TRAVEL TIME INDEX (hours/vehicle)		RELIABILITY BENEFIT (person-hours/yr)		Constant Dollars
	Build	No Build	Build	Existing Users	
0.000	0.002	0.001	2,508	0	\$32,504
0.000	0.002	0.001	3,152	0	\$40,849

0.000	0.002	0.001	2,508	0	\$32,504
0.000	0.002	0.001	2,540	0	\$32,921
0.000	0.002	0.001	2,572	0	\$33,338
0.000	0.002	0.001	2,605	0	\$33,755
0.000	0.002	0.001	2,637	0	\$34,173
0.000	0.002	0.001	2,669	0	\$34,590
0.000	0.002	0.001	2,701	0	\$35,007
0.000	0.002	0.001	2,733	0	\$35,425
0.000	0.002	0.001	2,766	0	\$35,842
0.000	0.002	0.001	2,798	0	\$36,259
0.000	0.002	0.001	2,830	0	\$36,676
0.000	0.002	0.001	2,862	0	\$37,094
0.000	0.002	0.001	2,894	0	\$37,511
0.000	0.002	0.001	2,927	0	\$37,928
0.000	0.002	0.001	2,959	0	\$38,345
0.000	0.002	0.001	2,991	0	\$38,763
0.000	0.002	0.001	3,023	0	\$39,180
0.000	0.002	0.001	3,055	0	\$39,597
0.000	0.002	0.001	3,088	0	\$40,015
0.000	0.002	0.001	3,120	0	\$40,432

					<b>\$729,355</b>
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DELAY RATE (mi)	STANDARD DEVIATION OF TRAVEL TIME INDEX (hours/vehicle)		RELIABILITY BENEFIT (person-hours/yr)		Constant Dollars
	Build	No Build	Build	Existing Users	
0.000	0.006	0.006	2,296	0	\$29,755
0.000	0.006	0.006	2,769	0	\$35,885

0.000	0.006	0.006	2,296	0	\$29,755
0.000	0.006	0.006	2,320	0	\$30,062
0.000	0.006	0.006	2,343	0	\$30,368
0.000	0.006	0.006	2,367	0	\$30,675



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

B

1 SB Off-ramp to Ave 280

Present Value
\$1,285
\$848

Year	AVERAGE VOLUME (vehicles/hour)		AVERAG (m
	No Build	Build	No Build
2026	882	767	42.9
2046	1,110	1,109	41.8

\$1,285
\$1,263
\$1,241
\$1,219
\$1,196
\$1,174
\$1,151
\$1,129
\$1,106
\$1,084
\$1,061
\$1,039
\$1,017
\$995
\$973
\$952
\$931
\$909
\$889
\$868

2026	882	767	42.9
2027	894	784	42.8
2028	905	801	42.8
2029	917	818	42.7
2030	928	836	42.7
2031	939	853	42.6
2032	951	870	42.6
2033	962	887	42.5
2034	973	904	42.4
2035	985	921	42.4
2036	996	938	42.3
2037	1,007	955	42.3
2038	1,019	972	42.2
2039	1,030	989	42.2
2040	1,041	1,006	42.1
2041	1,053	1,024	42.0
2042	1,064	1,041	42.0
2043	1,076	1,058	41.9
2044	1,087	1,075	41.9
2045	1,098	1,092	41.8

**\$21,482**

**Total**

2 SB On-ramp from Ave 280

<b>Present Value</b>
\$3,016
\$1,904

\$3,016
\$2,955
\$2,895
\$2,835
\$2,775
\$2,716
\$2,657
\$2,599
\$2,541
\$2,484
\$2,428
\$2,372
\$2,317
\$2,263
\$2,209
\$2,156
\$2,104
\$2,053
\$2,002
\$1,953

**\$49,331**

Year	AVERAGE VOLUME (vehicles/hour)		AVERAG (mp
	No Build	Build	No Build
2026	743	758	53.1
2046	1,028	1,048	52.7

2026	743	758	53.1
2027	757	772	53.1
2028	772	787	53.0
2029	786	801	53.0
2030	800	816	53.0
2031	814	830	53.0
2032	829	845	53.0
2033	843	859	52.9
2034	857	874	52.9
2035	871	888	52.9
2036	886	903	52.9
2037	900	917	52.9
2038	914	932	52.9
2039	928	946	52.8
2040	943	961	52.8
2041	957	975	52.8
2042	971	990	52.8
2043	985	1,004	52.8
2044	1,000	1,019	52.8
2045	1,014	1,033	52.7

**Total**

3 NB Off-ramp to Ave 280

<b>Present Value</b>
\$13,565
\$8,564

\$13,565
\$13,294
\$13,023
\$12,753
\$12,485
\$12,218
\$11,954
\$11,692
\$11,432
\$11,175
\$10,921
\$10,670
\$10,422
\$10,177

Year	AVERAGE VOLUME (vehicles/hour)		AVERAG (mp
	No Build	Build	No Build
2026	763	750	37.2
2046	1,055	1,038	36.4

2026	763	750	37.2
2027	777	764	37.2
2028	792	779	37.1
2029	806	793	37.1
2030	821	808	37.0
2031	836	822	37.0
2032	850	836	36.9
2033	865	851	36.9
2034	879	865	36.9
2035	894	879	36.8
2036	909	894	36.8
2037	923	908	36.7
2038	938	923	36.7
2039	952	937	36.7



\$9,936
\$9,698
\$9,464
\$9,233
\$9,006
\$8,783

**\$221,898**

2040	967	951	36.6
2041	982	966	36.6
2042	996	980	36.5
2043	1,011	994	36.5
2044	1,025	1,009	36.4
2045	1,040	1,023	36.4

**Total**

4 NB On-ramp from Ave 280

<b>Present Value</b>
\$27,784
\$15,936

Year	AVERAGE VOLUME (vehicles/hour)		AVERAG (mp
	No Build	Build	No Build
2026	862	857	43.3
2046	1,083	1,078	42.7

\$27,784
\$27,059
\$26,348
\$25,651
\$24,970
\$24,302
\$23,650
\$23,011
\$22,387
\$21,776
\$21,180
\$20,597
\$20,027
\$19,471
\$18,928
\$18,398
\$17,881
\$17,377
\$16,884
\$16,404

2026	862	857	43.3
2027	873	868	43.3
2028	884	879	43.3
2029	895	890	43.2
2030	906	901	43.2
2031	917	912	43.2
2032	928	923	43.1
2033	939	934	43.1
2034	950	945	43.1
2035	961	956	43.0
2036	973	967	43.0
2037	984	978	43.0
2038	995	989	43.0
2039	1,006	1,000	42.9
2040	1,017	1,011	42.9
2041	1,028	1,022	42.9
2042	1,039	1,033	42.8
2043	1,050	1,044	42.8
2044	1,061	1,056	42.8
2045	1,072	1,067	42.7

**\$434,086**

**Total**

5 NB Mainline

<b>Present Value</b>
\$25,435
\$14,000

Year	AVERAGE VOLUME (vehicles/hour)		AVERAG (mp
	No Build	Build	No Build
2026	1,543	1,435	69.4
2046	1,958	1,731	69.1

\$25,435
\$24,709
\$24,000
\$23,310

2026	1,543	1,435	69.4
2027	1,563	1,450	69.4
2028	1,584	1,465	69.4
2029	1,605	1,480	69.3

\$22,638
\$21,982
\$21,344
\$20,722
\$20,117
\$19,527
\$18,953
\$18,394
\$17,850
\$17,321
\$16,806
\$16,305
\$15,818
\$15,344
\$14,883
\$14,435

**\$389,894**

2030	1,626	1,495	69.3
2031	1,646	1,509	69.3
2032	1,667	1,524	69.3
2033	1,688	1,539	69.3
2034	1,709	1,554	69.3
2035	1,730	1,568	69.3
2036	1,750	1,583	69.2
2037	1,771	1,598	69.2
2038	1,792	1,613	69.2
2039	1,813	1,628	69.2
2040	1,833	1,642	69.2
2041	1,854	1,657	69.2
2042	1,875	1,672	69.2
2043	1,896	1,687	69.1
2044	1,917	1,702	69.1
2045	1,937	1,716	69.1

**Total**

**6 SB Mainline**

<b>Present Value</b>
\$0
\$0

\$0
\$0
\$0
\$0
\$0
\$0
\$0
\$0
\$0
\$0
\$0
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\$0
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\$0
\$0
\$0
\$0
\$0

**\$0**

Year	AVERAGE VOLUME (vehicles/hour)		AVERAG (mp
	No Build	Build	No Build
2026	1,484	1,325	69.5
2046	1,884	1,628	69.1

2026	1,484	1,325	69.5
2027	1,504	1,340	69.4
2028	1,524	1,355	69.4
2029	1,544	1,371	69.4
2030	1,564	1,386	69.4
2031	1,584	1,401	69.4
2032	1,604	1,416	69.3
2033	1,624	1,431	69.3
2034	1,644	1,446	69.3
2035	1,664	1,461	69.3
2036	1,684	1,476	69.3
2037	1,704	1,491	69.3
2038	1,724	1,507	69.2
2039	1,744	1,522	69.2
2040	1,764	1,537	69.2
2041	1,784	1,552	69.2
2042	1,804	1,567	69.2
2043	1,824	1,582	69.2
2044	1,844	1,597	69.1
2045	1,864	1,612	69.1

**Total**

Dollars)  
 ) ^ Year

## TRUCK BENEFITS

E SPEED (mph)	RECURRING DELAY RATE (hrs/mi)		STANDARD DEVIATION OF TRAVEL TIME INDEX (hours/vehicle)		RELIABILITY (person Existing Users)
	No Build	Build	No Build	Build	
42.2	0.000	0.000	0.001	0.001	25
42.1	0.000	0.000	0.001	0.001	37

42.2	0.000	0.000	0.001	0.001	25
42.2	0.000	0.000	0.001	0.001	26
42.2	0.000	0.000	0.001	0.001	26
42.2	0.000	0.000	0.001	0.001	27
42.2	0.000	0.000	0.001	0.001	28
42.2	0.000	0.000	0.001	0.001	28
42.2	0.000	0.000	0.001	0.001	29
42.2	0.000	0.000	0.001	0.001	29
42.2	0.000	0.000	0.001	0.001	30
42.2	0.000	0.000	0.001	0.001	30
42.2	0.000	0.000	0.001	0.001	31
42.1	0.000	0.000	0.001	0.001	31
42.1	0.000	0.000	0.001	0.001	32
42.1	0.000	0.000	0.001	0.001	33
42.1	0.000	0.000	0.001	0.001	33
42.1	0.000	0.000	0.001	0.001	34
42.1	0.000	0.000	0.001	0.001	34
42.1	0.000	0.000	0.001	0.001	35
42.1	0.000	0.000	0.001	0.001	35
42.1	0.000	0.000	0.001	0.001	36

E SPEED (mph)	RECURRING DELAY RATE (hrs/mi)		STANDARD DEVIATION OF TRAVEL TIME INDEX (hours/vehicle)		RELIABILITY (person Existing Users)
	Build	No Build	Build	No Build	
54.1	0.000	0.000	0.001	0.001	59
55.2	0.000	0.000	0.001	0.001	81

54.1	0.000	0.000	0.001	0.001	59
54.2	0.000	0.000	0.001	0.001	60
54.2	0.000	0.000	0.001	0.001	61
54.3	0.000	0.000	0.001	0.001	62
54.3	0.000	0.000	0.001	0.001	63
54.4	0.000	0.000	0.001	0.001	64
54.4	0.000	0.000	0.001	0.001	65
54.5	0.000	0.000	0.001	0.001	67
54.5	0.000	0.000	0.001	0.001	68
54.6	0.000	0.000	0.001	0.001	69
54.6	0.000	0.000	0.001	0.001	70
54.7	0.000	0.000	0.001	0.001	71
54.7	0.000	0.000	0.001	0.001	72
54.8	0.000	0.000	0.001	0.001	73
54.8	0.000	0.000	0.001	0.001	74
54.9	0.000	0.000	0.001	0.001	76
54.9	0.000	0.000	0.001	0.001	77
55.0	0.000	0.000	0.001	0.001	78
55.1	0.000	0.000	0.001	0.001	79
55.1	0.000	0.000	0.001	0.001	80

E SPEED (mph)	RECURRING DELAY RATE (hrs/mi)		STANDARD DEVIATION OF TRAVEL TIME INDEX (hours/vehicle)		RELIABILITY (person Existing Users)
	Build	No Build	Build	No Build	
46.9	0.000	0.000	0.001	0.001	267
47.2	0.000	0.000	0.001	0.001	369

46.9	0.000	0.000	0.001	0.001	267
46.9	0.000	0.000	0.001	0.001	272
46.9	0.000	0.000	0.001	0.001	277
46.9	0.000	0.000	0.001	0.001	282
46.9	0.000	0.000	0.001	0.001	287
46.9	0.000	0.000	0.001	0.001	292
47.0	0.000	0.000	0.001	0.001	297
47.0	0.000	0.000	0.001	0.001	302
47.0	0.000	0.000	0.001	0.001	308
47.0	0.000	0.000	0.001	0.001	313
47.0	0.000	0.000	0.001	0.001	318
47.0	0.000	0.000	0.001	0.001	323
47.0	0.000	0.000	0.001	0.001	328
47.1	0.000	0.000	0.001	0.001	333

47.1	0.000	0.000	0.001	0.001	338
47.1	0.000	0.000	0.001	0.001	343
47.1	0.000	0.000	0.001	0.001	348
47.1	0.000	0.000	0.001	0.001	354
47.1	0.000	0.000	0.001	0.001	359
47.1	0.000	0.000	0.001	0.001	364

E SPEED (mph)	RECURRING DELAY RATE (hrs/mi)		STANDARD DEVIATION OF TRAVEL TIME INDEX (hours/vehicle)		RELIABILITY (person Existing Users)
	Build	No Build	Build	No Build	
76.7	0.000	0.000	0.002	0.001	546
74.4	0.000	0.000	0.002	0.001	686

76.7	0.000	0.000	0.002	0.001	546
76.6	0.000	0.000	0.002	0.001	553
76.5	0.000	0.000	0.002	0.001	560
76.4	0.000	0.000	0.002	0.001	567
76.3	0.000	0.000	0.002	0.001	574
76.2	0.000	0.000	0.002	0.001	581
76.0	0.000	0.000	0.002	0.001	588
75.9	0.000	0.000	0.002	0.001	595
75.8	0.000	0.000	0.002	0.001	602
75.7	0.000	0.000	0.002	0.001	609
75.6	0.000	0.000	0.002	0.001	616
75.5	0.000	0.000	0.002	0.001	623
75.3	0.000	0.000	0.002	0.001	630
75.2	0.000	0.000	0.002	0.001	637
75.1	0.000	0.000	0.002	0.001	644
75.0	0.000	0.000	0.002	0.001	651
74.9	0.000	0.000	0.002	0.001	658
74.8	0.000	0.000	0.002	0.001	665
74.6	0.000	0.000	0.002	0.001	672
74.5	0.000	0.000	0.002	0.001	679

E SPEED (mph)	RECURRING DELAY RATE (hrs/mi)		STANDARD DEVIATION OF TRAVEL TIME INDEX (hours/vehicle)		RELIABILITY (person Existing Users)
	Build	No Build	Build	No Build	
69.5	0.000	0.000	0.006	0.006	500
69.3	0.000	0.000	0.006	0.006	603

69.5	0.000	0.000	0.006	0.006	500
69.5	0.000	0.000	0.006	0.006	505
69.5	0.000	0.000	0.006	0.006	510
69.5	0.000	0.000	0.006	0.006	515



C

<b>SAFETY BENEFIT</b> i-hours/yr)		
<b>New (Induced)</b>	<b>Constant Dollars</b>	<b>Present Value</b>
0	\$997	\$853
0	\$1,442	\$563

0	\$997	\$853
0	\$1,020	\$838
0	\$1,042	\$823
0	\$1,064	\$809
0	\$1,086	\$794
0	\$1,109	\$779
0	\$1,131	\$764
0	\$1,153	\$749
0	\$1,175	\$734
0	\$1,197	\$719
0	\$1,220	\$704
0	\$1,242	\$690
0	\$1,264	\$675
0	\$1,286	\$660
0	\$1,309	\$646
0	\$1,331	\$632
0	\$1,353	\$617
0	\$1,375	\$603
0	\$1,397	\$590
0	\$1,420	\$576

	<b>\$24,172</b>	<b>\$14,255</b>
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<b>Automobile</b>
<b>Year</b>
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
2036
2037
2038
2039
2040
2041
2042
2043
2044
2045

**Total**

**Truck**

TY BENEFIT (hours/yr) New (Induced)	Constant Dollars	Present Value
1	\$2,341	\$2,001
1	\$3,239	\$1,264

1	\$2,341	\$2,001
1	\$2,386	\$1,961
1	\$2,431	\$1,921
1	\$2,476	\$1,881
1	\$2,521	\$1,842
1	\$2,565	\$1,802
1	\$2,610	\$1,763
1	\$2,655	\$1,725
1	\$2,700	\$1,687
1	\$2,745	\$1,649
1	\$2,790	\$1,611
1	\$2,835	\$1,574
1	\$2,880	\$1,538
1	\$2,925	\$1,501
1	\$2,970	\$1,466
1	\$3,014	\$1,431
1	\$3,059	\$1,396
1	\$3,104	\$1,362
1	\$3,149	\$1,329
1	\$3,194	\$1,296

	<b>\$55,350</b>	<b>\$32,736</b>
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Year
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<b>Total</b>
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TY BENEFIT (hours/yr) New (Induced)	Constant Dollars	Present Value
0	\$10,531	\$9,002
0	\$14,568	\$5,683

0	\$10,531	\$9,002
0	\$10,733	\$8,822
0	\$10,935	\$8,642
0	\$11,137	\$8,463
0	\$11,339	\$8,285
0	\$11,540	\$8,108
0	\$11,742	\$7,933
0	\$11,944	\$7,759
0	\$12,146	\$7,586
0	\$12,348	\$7,416
0	\$12,550	\$7,247
0	\$12,751	\$7,080
0	\$12,953	\$6,916
0	\$13,155	\$6,753



0	\$13,357	\$6,593
0	\$13,559	\$6,436
0	\$13,761	\$6,280
0	\$13,963	\$6,127
0	\$14,164	\$5,977
0	\$14,366	\$5,829

	<b>\$248,973</b>	<b>\$147,254</b>
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<b>TY BENEFIT</b> -hours/yr) <b>New (Induced)</b>	<b>Constant Dollars</b>	<b>Present Value</b>
0	\$21,570	\$18,438
0	\$27,108	\$10,575

0	\$21,570	\$18,438
0	\$21,847	\$17,956
0	\$22,123	\$17,485
0	\$22,400	\$17,022
0	\$22,677	\$16,570
0	\$22,954	\$16,127
0	\$23,231	\$15,694
0	\$23,508	\$15,270
0	\$23,785	\$14,856
0	\$24,062	\$14,451
0	\$24,339	\$14,055
0	\$24,616	\$13,668
0	\$24,893	\$13,290
0	\$25,169	\$12,921
0	\$25,446	\$12,561
0	\$25,723	\$12,209
0	\$26,000	\$11,866
0	\$26,277	\$11,531
0	\$26,554	\$11,205
0	\$26,831	\$10,886

	<b>\$484,006</b>	<b>\$288,063</b>
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<b>TY BENEFIT</b> -hours/yr) <b>New (Induced)</b>	<b>Constant Dollars</b>	<b>Present Value</b>
0	\$19,746	\$16,879
0	\$23,814	\$9,290

0	\$19,746	\$16,879
0	\$19,949	\$16,397
0	\$20,153	\$15,927
0	\$20,356	\$15,469



## SUMMARY OF TRAVEL TIME RELIABILITY BENEFITS

1	2	3	4	5
B Off-ramp to Ave 2	On-ramp from Ave B	B Off-ramp to Ave 2	On-ramp from Ave	NB Mainline
\$1,285	\$3,016	\$13,565	\$27,784	\$25,435
\$1,263	\$2,955	\$13,294	\$27,059	\$24,709
\$1,241	\$2,895	\$13,023	\$26,348	\$24,000
\$1,219	\$2,835	\$12,753	\$25,651	\$23,310
\$1,196	\$2,775	\$12,485	\$24,970	\$22,638
\$1,174	\$2,716	\$12,218	\$24,302	\$21,982
\$1,151	\$2,657	\$11,954	\$23,650	\$21,344
\$1,129	\$2,599	\$11,692	\$23,011	\$20,722
\$1,106	\$2,541	\$11,432	\$22,387	\$20,117
\$1,084	\$2,484	\$11,175	\$21,776	\$19,527
\$1,061	\$2,428	\$10,921	\$21,180	\$18,953
\$1,039	\$2,372	\$10,670	\$20,597	\$18,394
\$1,017	\$2,317	\$10,422	\$20,027	\$17,850
\$995	\$2,263	\$10,177	\$19,471	\$17,321
\$973	\$2,209	\$9,936	\$18,928	\$16,806
\$952	\$2,156	\$9,698	\$18,398	\$16,305
\$931	\$2,104	\$9,464	\$17,881	\$15,818
\$909	\$2,053	\$9,233	\$17,377	\$15,344
\$889	\$2,002	\$9,006	\$16,884	\$14,883
\$868	\$1,953	\$8,783	\$16,404	\$14,435
<b>\$21,482</b>	<b>\$49,331</b>	<b>\$221,898</b>	<b>\$434,086</b>	<b>\$389,894</b>

1	2	3	4	5
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<b>B Off-ramp to Ave 2</b>	<b>On-ramp from Ave 3</b>	<b>B Off-ramp to Ave 2</b>	<b>On-ramp from Ave 3</b>	<b>NB Mainline</b>
\$853	\$2,001	\$9,002	\$18,438	\$16,879
\$838	\$1,961	\$8,822	\$17,956	\$16,397
\$823	\$1,921	\$8,642	\$17,485	\$15,927
\$809	\$1,881	\$8,463	\$17,022	\$15,469
\$794	\$1,842	\$8,285	\$16,570	\$15,023
\$779	\$1,802	\$8,108	\$16,127	\$14,588
\$764	\$1,763	\$7,933	\$15,694	\$14,164
\$749	\$1,725	\$7,759	\$15,270	\$13,751
\$734	\$1,687	\$7,586	\$14,856	\$13,349
\$719	\$1,649	\$7,416	\$14,451	\$12,958
\$704	\$1,611	\$7,247	\$14,055	\$12,577
\$690	\$1,574	\$7,080	\$13,668	\$12,206
\$675	\$1,538	\$6,916	\$13,290	\$11,846
\$660	\$1,501	\$6,753	\$12,921	\$11,494
\$646	\$1,466	\$6,593	\$12,561	\$11,153
\$632	\$1,431	\$6,436	\$12,209	\$10,820
\$617	\$1,396	\$6,280	\$11,866	\$10,497
\$603	\$1,362	\$6,127	\$11,531	\$10,182
\$590	\$1,329	\$5,977	\$11,205	\$9,877
\$576	\$1,296	\$5,829	\$10,886	\$9,579
<b>\$14,255</b>	<b>\$32,736</b>	<b>\$147,254</b>	<b>\$288,063</b>	<b>\$258,737</b>





<b>6</b> <b>SB Mainline</b>	<b>Present Value of Reliability Benefits</b>	<b>Constant Dollars</b>
\$0	\$114,729	\$98,071
\$0	\$111,792	\$91,885
\$0	\$108,911	\$86,074
\$0	\$106,086	\$80,617
\$0	\$103,318	\$75,493
\$0	\$100,605	\$70,684
\$0	\$97,949	\$66,171
\$0	\$95,347	\$61,936
\$0	\$92,801	\$57,964
\$0	\$90,310	\$54,238
\$0	\$87,873	\$50,745
\$0	\$85,490	\$47,470
\$0	\$83,161	\$44,400
\$0	\$80,884	\$41,524
\$0	\$78,659	\$38,828
\$0	\$76,486	\$36,303
\$0	\$74,363	\$33,938
\$0	\$44,916	\$19,711
\$0	\$43,665	\$18,425
\$0	\$42,444	\$17,220
<b>\$0</b>	<b>\$1,719,791</b>	<b>\$1,091,696</b>











B

**SUMMARY OF VEHICLE OPERATING COST BENEFITS**

Year	1 SB Off-ramp to Ave 280	2 SB On-ramp from Ave 280	3 NB Off-ramp to Ave 280	4 NB On-ramp from Ave 280	5 NB Mainline	6 SB Mainline	Present Value of Veh Op Cost Benefits	Constant Dollars
2026	\$11,960	(\$6,030)	\$4,077	\$45,492	\$584,722	\$869,167	\$1,509,387	\$1,765,769
2027	\$8,864	(\$5,909)	\$3,991	\$44,317	\$593,693	\$861,350	\$1,506,305	\$1,832,651
2028	\$5,988	(\$5,787)	\$3,905	\$43,165	\$601,109	\$852,848	\$1,501,228	\$1,899,532
2029	\$3,321	(\$5,667)	\$3,820	\$42,036	\$607,076	\$843,726	\$1,494,313	\$1,966,414
2030	\$850	(\$5,547)	\$3,736	\$40,930	\$611,695	\$834,044	\$1,485,709	\$2,033,295
2031	(\$1,436)	(\$5,428)	\$4,112	\$39,848	\$615,061	\$823,859	\$1,476,015	\$2,100,829
2032	(\$3,548)	(\$6,479)	\$4,019	\$38,787	\$617,263	\$813,223	\$1,463,267	\$2,165,992
2033	(\$5,494)	(\$6,336)	\$3,928	\$37,750	\$618,385	\$802,187	\$1,450,420	\$2,232,855
2034	(\$7,286)	(\$6,195)	\$3,838	\$36,735	\$618,509	\$790,797	\$1,436,397	\$2,299,718
2035	(\$8,932)	(\$6,055)	\$3,749	\$35,742	\$617,708	\$779,096	\$1,421,307	\$2,366,581
2036	(\$10,441)	(\$5,917)	\$3,661	\$34,771	\$616,053	\$767,126	\$1,405,254	\$2,433,444
2037	(\$11,820)	(\$5,780)	\$3,574	\$33,650	\$613,612	\$754,923	\$1,388,160	\$2,499,998
2038	(\$13,078)	(\$5,645)	\$3,489	\$32,728	\$610,448	\$742,525	\$1,370,467	\$2,566,858
2039	(\$14,221)	(\$5,512)	\$3,405	\$31,826	\$606,619	\$729,964	\$1,352,080	\$2,633,718
2040	(\$15,257)	(\$5,381)	\$3,322	\$30,945	\$602,182	\$717,270	\$1,333,081	\$2,700,577
2041	(\$16,193)	(\$6,287)	\$3,241	\$30,085	\$597,189	\$704,473	\$1,312,508	\$2,765,257
2042	(\$17,033)	(\$6,135)	\$3,160	\$29,246	\$591,689	\$691,599	\$1,292,526	\$2,832,084
2043	(\$17,786)	(\$5,985)	\$3,082	\$28,426	\$585,728	\$678,674	\$1,272,140	\$2,898,911
2044	(\$18,455)	(\$5,838)	\$3,004	\$27,627	\$579,351	\$665,720	\$1,251,409	\$2,965,738
2045	(\$19,046)	(\$5,693)	\$2,928	\$26,846	\$572,598	\$652,758	\$1,230,392	\$3,032,565
<b>Total</b>	<b>(\$149,043)</b>	<b>(\$117,604)</b>	<b>\$72,041</b>	<b>\$710,953</b>	<b>\$12,060,688</b>	<b>\$15,375,328</b>	<b>\$27,952,364</b>	<b>\$47,992,787</b>
							FALSE	TRUE

**SUMMARY OF FUEL COST SAVINGS**

Year	1 SB Off-ramp to Ave 280	2 SB On-ramp from Ave 280	3 NB Off-ramp to Ave 280	4 NB On-ramp from Ave 280	5 NB Mainline	6 SB Mainline	Present Value of Veh Op Cost Benefits	Constant Dollars
2026	\$3,419	(\$3,073)	\$1,336	(\$7,330)	\$202,262	\$300,654	\$425,068	\$497,269
2027	\$2,636	(\$3,132)	\$1,361	(\$7,420)	\$213,579	\$309,868	\$424,848	\$516,893
2028	\$1,852	(\$3,190)	\$1,385	(\$7,510)	\$224,897	\$319,082	\$424,016	\$536,516
2029	\$1,068	(\$3,249)	\$1,409	(\$7,600)	\$236,215	\$328,296	\$422,620	\$556,139
2030	\$284	(\$3,308)	\$1,434	(\$7,690)	\$247,533	\$337,510	\$420,704	\$575,763
2031	(\$500)	(\$3,366)	\$2,111	(\$7,780)	\$258,850	\$346,724	\$418,769	\$596,039
2032	(\$1,283)	(\$5,155)	\$2,147	(\$7,871)	\$270,168	\$355,938	\$414,758	\$613,943
2033	(\$2,067)	(\$5,243)	\$2,182	(\$7,961)	\$281,486	\$365,152	\$411,541	\$633,548
2034	(\$2,851)	(\$5,332)	\$2,218	(\$8,051)	\$292,804	\$374,365	\$407,958	\$653,153
2035	(\$3,635)	(\$5,420)	\$2,254	(\$8,141)	\$304,122	\$383,579	\$404,041	\$672,758
2036	(\$4,419)	(\$5,509)	\$2,289	(\$8,231)	\$315,439	\$392,793	\$399,823	\$692,363
2037	(\$5,202)	(\$5,597)	\$2,325	(\$8,330)	\$326,757	\$402,007	\$395,159	\$711,659
2038	(\$5,986)	(\$5,686)	\$2,361	(\$8,724)	\$338,075	\$411,221	\$390,426	\$731,261
2039	(\$6,770)	(\$5,774)	\$2,397	(\$8,818)	\$349,393	\$420,435	\$385,473	\$750,862
2040	(\$7,554)	(\$5,862)	\$2,432	(\$8,911)	\$360,710	\$429,649	\$380,323	\$770,464
2041	(\$8,338)	(\$8,131)	\$2,468	(\$9,005)	\$372,028	\$438,863	\$373,964	\$787,885
2042	(\$9,121)	(\$8,252)	\$2,504	(\$9,099)	\$383,346	\$448,077	\$368,512	\$807,454
2043	(\$9,905)	(\$8,373)	\$2,540	(\$9,192)	\$394,664	\$457,290	\$362,926	\$827,023
2044	(\$10,689)	(\$8,494)	\$2,575	(\$9,286)	\$405,981	\$466,504	\$357,224	\$846,592
2045	(\$11,473)	(\$8,615)	\$2,611	(\$9,380)	\$417,299	\$475,718	\$351,424	\$866,161
<b>Total</b>	<b>(\$80,534)</b>	<b>(\$110,761)</b>	<b>\$42,340</b>	<b>(\$166,630)</b>	<b>\$6,195,608</b>	<b>\$7,763,726</b>	<b>\$7,939,576</b>	<b>\$13,643,748</b>

B

**SUMMARY OF ACCIDENT COST BENEFITS**

Year	1 SB Off-ramp to Ave 280	2 SB On-ramp from Ave 280	3 NB Off-ramp to Ave 280	4 NB On-ramp from Ave 280	5 NB Mainline	6 SB Mainline	Present Value of Accident Cost Benefits	Constant Dollars
2026	\$85,066	\$28,350	\$9,523	\$1,415	\$202,946	\$1,184,694	\$1,511,995	\$1,768,820
2027	\$82,552	\$27,783	\$9,332	\$1,379	\$199,199	\$1,159,237	\$1,479,481	\$1,800,015
2028	\$80,105	\$27,217	\$9,141	\$1,343	\$195,440	\$1,133,985	\$1,447,231	\$1,831,209
2029	\$77,724	\$26,654	\$8,952	\$1,307	\$191,675	\$1,108,961	\$1,415,273	\$1,862,403
2030	\$75,408	\$26,093	\$8,763	\$1,273	\$187,911	\$1,084,185	\$1,383,633	\$1,893,597
2031	\$73,155	\$25,537	\$8,576	\$1,239	\$184,153	\$1,059,674	\$1,352,333	\$1,924,791
2032	\$70,964	\$24,984	\$8,390	\$1,205	\$180,406	\$1,035,444	\$1,321,394	\$1,955,985
2033	\$68,833	\$24,436	\$8,206	\$1,173	\$176,675	\$1,011,511	\$1,290,834	\$1,987,179
2034	\$66,761	\$23,894	\$8,023	\$1,141	\$172,964	\$987,887	\$1,260,670	\$2,018,374
2035	\$64,747	\$23,357	\$7,843	\$1,110	\$169,277	\$964,584	\$1,230,917	\$2,049,568
2036	\$62,789	\$22,826	\$7,664	\$1,080	\$165,617	\$941,612	\$1,201,588	\$2,080,762
2037	\$60,885	\$22,301	\$7,488	\$1,050	\$161,989	\$918,980	\$1,172,694	\$2,111,956
2038	\$59,035	\$21,783	\$7,314	\$1,021	\$158,395	\$896,696	\$1,144,245	\$2,143,150
2039	\$57,238	\$21,272	\$7,142	\$993	\$154,838	\$874,767	\$1,116,250	\$2,174,344
2040	\$55,491	\$20,768	\$6,973	\$965	\$151,320	\$853,199	\$1,088,716	\$2,205,538
2041	\$53,794	\$20,271	\$6,806	\$938	\$147,844	\$831,995	\$1,061,648	\$2,236,733
2042	\$52,146	\$19,782	\$6,641	\$912	\$144,411	\$811,160	\$1,035,052	\$2,267,927
2043	\$50,545	\$19,300	\$6,479	\$886	\$141,024	\$790,698	\$1,008,931	\$2,299,121
2044	\$48,989	\$18,826	\$6,320	\$861	\$137,683	\$770,609	\$983,289	\$2,330,315
2045	\$47,479	\$18,360	\$6,163	\$837	\$134,391	\$750,896	\$958,126	\$2,361,509
<b>Total</b>	<b>\$1,293,707</b>	<b>\$463,794</b>	<b>\$155,738</b>	<b>\$22,129</b>	<b>\$3,358,157</b>	<b>\$19,170,776</b>	<b>\$24,464,301</b>	<b>\$41,303,295</b>

**B SUMMARY OF EMISSION REDUCTION BENEFITS**

Year	1 SB Off-ramp to Ave 280	2 SB On-ramp from Ave 280	3 NB Off-ramp to Ave 280	4 NB On-ramp from Ave 280	5 NB Mainline	6 SB Mainline	Present Value of Emission Benefits	Constant Dollars
2026	\$763	(\$639)	\$758	(\$1,387)	\$44,528	\$66,190	\$110,213	\$128,933
2027	\$575	(\$637)	\$751	(\$1,368)	\$45,940	\$66,652	\$111,914	\$136,160
2028	\$395	(\$634)	\$745	(\$1,348)	\$47,267	\$67,061	\$113,485	\$143,595
2029	\$222	(\$632)	\$738	(\$1,329)	\$48,511	\$67,422	\$114,932	\$151,243
2030	\$58	(\$629)	\$732	(\$1,310)	\$49,677	\$67,734	\$116,261	\$159,112
2031	(\$99)	(\$626)	\$912	(\$1,292)	\$50,767	\$68,002	\$117,663	\$167,472
2032	(\$250)	(\$949)	\$904	(\$1,273)	\$51,786	\$68,226	\$118,444	\$175,326
2033	(\$254)	(\$777)	\$189	(\$3,093)	\$39,031	\$50,633	\$85,729	\$131,976
2034	(\$343)	(\$773)	\$186	(\$3,046)	\$39,710	\$50,772	\$86,507	\$138,500
2035	(\$428)	(\$769)	\$182	(\$2,998)	\$40,343	\$50,883	\$87,213	\$145,216
2036	(\$509)	(\$764)	\$179	(\$2,952)	\$40,931	\$50,968	\$87,851	\$152,130
2037	(\$587)	(\$760)	\$175	(\$2,966)	\$41,475	\$51,027	\$88,364	\$159,138
2038	(\$662)	(\$755)	\$171	(\$2,920)	\$41,979	\$51,061	\$88,874	\$166,459
2039	(\$733)	(\$751)	\$168	(\$2,875)	\$42,442	\$51,072	\$89,324	\$173,994
2040	(\$801)	(\$746)	\$165	(\$2,831)	\$42,868	\$51,061	\$89,716	\$181,749
2041	(\$865)	(\$1,043)	\$161	(\$2,787)	\$43,257	\$51,028	\$89,752	\$189,093
2042	(\$972)	(\$1,035)	\$158	(\$2,743)	\$43,611	\$50,975	\$89,993	\$197,185
2043	(\$1,031)	(\$1,028)	\$154	(\$2,701)	\$43,932	\$50,903	\$90,229	\$205,611
2044	(\$1,087)	(\$1,020)	\$151	(\$2,659)	\$44,220	\$50,812	\$90,417	\$214,281
2045	(\$1,140)	(\$1,013)	\$148	(\$2,617)	\$44,477	\$50,704	\$90,559	\$223,202
<b>Total</b>	<b>(\$7,748)</b>	<b>(\$15,980)</b>	<b>\$7,727</b>	<b>(\$46,495)</b>	<b>\$886,751</b>	<b>\$1,133,183</b>	<b>\$1,957,439</b>	<b>\$3,340,374</b>

SUMMARY OF EMISSION REDUCTION BENEFITS (continued)

Year	TONS EMISSIONS SAVED (tons/yr)							DOLLARS EMISSIONS SAVED (PV \$/yr)					
	CO	CO <sub>2</sub>	NO <sub>x</sub>	PM <sub>10</sub>	SO <sub>x</sub>	VOC	PM <sub>2.5</sub>	CO	CO <sub>2</sub>	NO <sub>x</sub>	PM <sub>10</sub>	SO <sub>x</sub>	VOC
2026	3	2,001	1	0	0	0	0	\$178	\$88,866	\$17,671	\$2,455	\$973	\$70
2027	3	2,079	1	0	0	0	0	\$177	\$90,578	\$17,654	\$2,462	\$972	\$70
2028	3	2,158	1	0	0	0	0	\$176	\$92,191	\$17,613	\$2,465	\$970	\$69
2029	3	2,237	2	0	0	0	0	\$175	\$93,709	\$17,548	\$2,465	\$967	\$69
2030	3	2,315	2	0	0	0	0	\$173	\$95,134	\$17,462	\$2,460	\$963	\$69
2031	3	2,398	2	0	0	0	0	\$172	\$96,629	\$17,385	\$2,452	\$957	\$68
2032	3	2,469	2	0	0	0	0	\$171	\$97,582	\$17,242	\$2,433	\$948	\$68
2033	2	1,918	1	0	0	0	0	\$90	\$74,345	\$8,875	\$1,690	\$705	\$25
2034	2	1,978	1	0	0	0	0	\$89	\$75,198	\$8,814	\$1,682	\$699	\$24
2035	2	2,038	1	0	0	0	0	\$88	\$75,991	\$8,746	\$1,672	\$693	\$24
2036	2	2,098	1	0	0	0	0	\$87	\$76,725	\$8,669	\$1,660	\$686	\$24
2037	2	2,156	1	0	0	0	0	\$86	\$77,336	\$8,599	\$1,642	\$677	\$24
2038	2	2,216	1	0	0	0	0	\$85	\$77,960	\$8,509	\$1,627	\$669	\$23
2039	2	2,276	1	0	0	0	0	\$83	\$78,532	\$8,413	\$1,611	\$661	\$23
2040	2	2,336	1	0	0	0	0	\$82	\$79,053	\$8,311	\$1,594	\$653	\$23
2041	2	2,388	1	0	0	0	0	\$81	\$79,264	\$8,176	\$1,568	\$640	\$22
2042	2	2,446	1	0	0	0	0	\$80	\$79,637	\$8,076	\$1,547	\$631	\$22
2043	2	2,506	1	0	0	0	0	\$78	\$80,017	\$7,963	\$1,527	\$622	\$22
2044	2	2,566	1	0	0	0	0	\$77	\$80,353	\$7,846	\$1,507	\$612	\$22
2045	2	2,626	1	0	0	0	0	\$76	\$80,647	\$7,727	\$1,485	\$602	\$21
<b>Total</b>	<b>47</b>	<b>45,204</b>	<b>25</b>	<b>1</b>	<b>0</b>	<b>1</b>	<b>1</b>	<b>\$2,306</b>	<b>\$1,669,746</b>	<b>\$231,301</b>	<b>\$38,004</b>	<b>\$15,301</b>	<b>\$782</b>

NET PRESENT VALUE CALCULATION

Year	PRESENT VALUE OF USER BENEFITS (location 1) Vehicle					PRESENT VALUE OF USER (location 2) Vehicle		
	Travel Time Savings	Reliability Savings	Op. Cost Savings	Accident Reductions	Vehicle Emission Reductions	Travel Time Savings	Reliability Savings	Op. Cost Savings
<b>Construction Period</b>								
2023								
2024								
2025								
2026								
2027								
2028								
2029								
2030								
<b>Project Open</b>								
2026	\$1,600,081	\$114,729	\$1,509,387	\$1,511,995	\$110,213			
2027	\$1,589,976	\$111,792	\$1,506,305	\$1,479,481	\$111,914			
2028	\$1,578,281	\$108,911	\$1,501,228	\$1,447,231	\$113,485			
2029	\$1,565,134	\$106,086	\$1,494,313	\$1,415,273	\$114,932			
2030	\$1,550,663	\$103,318	\$1,485,709	\$1,383,633	\$116,261			
2031	\$1,534,990	\$100,605	\$1,476,015	\$1,352,333	\$117,663			
2032	\$1,518,229	\$97,949	\$1,463,267	\$1,321,394	\$118,444			
2033	\$1,500,486	\$95,347	\$1,450,420	\$1,290,834	\$86,729			
2034	\$1,481,863	\$92,801	\$1,436,397	\$1,260,670	\$86,507			
2035	\$1,462,452	\$90,310	\$1,421,307	\$1,230,917	\$87,213			
2036	\$1,442,342	\$87,873	\$1,405,254	\$1,201,588	\$87,851			
2037	\$1,421,616	\$85,490	\$1,388,160	\$1,172,694	\$88,364			
2038	\$1,400,351	\$83,161	\$1,370,467	\$1,144,245	\$88,874			
2039	\$1,378,618	\$80,884	\$1,352,080	\$1,116,250	\$89,324			
2040	\$1,356,486	\$78,659	\$1,333,081	\$1,088,716	\$89,716			
2041	\$1,334,016	\$76,486	\$1,312,508	\$1,061,648	\$89,752			
2042	\$1,311,269	\$74,363	\$1,292,526	\$1,035,052	\$89,993			
2043	\$1,288,298	\$44,916	\$1,272,140	\$1,008,931	\$90,229			
2044	\$1,265,154	\$43,665	\$1,251,409	\$983,289	\$90,417			
2045	\$1,241,885	\$42,444	\$1,230,392	\$958,126	\$90,559			
<b>Total</b>	\$28,822,190	\$1,719,791	\$27,952,364	\$24,464,301	\$1,957,439	\$0	\$0	\$0

2,357,015	Person-Hours of Time Saved
tons	\$ PV
47	\$2,306 CO Saved
45,204	\$1,669,746 CO <sub>2</sub> Saved
25	\$231,301 NO <sub>x</sub> Saved
1	\$38,004 PM <sub>10</sub> Saved
1	PM <sub>2.5</sub> Saved
0	\$15,301 SO <sub>x</sub> Saved
1	\$782 VOC Saved
2	Fatalities Avoided
113	Injuries Avoided
746	PDO Avoided

	Person-Hours of Time Saved
tons	\$ PV
	CO Saved
	CO <sub>2</sub> Saved
	NO <sub>x</sub> Saved
	PM <sub>10</sub> Saved
	PM <sub>2.5</sub> Saved
	SO <sub>x</sub> Saved
	VOC Saved
	Fatalities Avoided
	Injuries Avoided
	PDO Avoided





B

INTERNAL RATE OF RETURN ON INVESTMENT AND PAYBACK PERIOD

Present Value of Total User Benefits	Present Value of Total Project Costs	NET PRESENT VALUE
\$0	#####	(\$29,880,353)
\$0	#####	(\$17,081,700)
\$0	#####	(\$16,424,712)
\$0	\$0	\$0
\$0	\$0	\$0
\$0	\$0	\$0
\$0	\$0	\$0
\$0	\$0	\$0
\$0	\$0	\$0
\$4,846,405	\$8,548	\$4,837,857
\$4,799,467	\$8,219	\$4,791,248
\$4,749,136	\$7,903	\$4,741,232
\$4,695,738	\$7,599	\$4,688,139
\$4,639,584	\$7,307	\$4,632,277
\$4,581,606	\$7,026	\$4,574,580
\$4,519,282	\$6,756	\$4,512,526
\$4,422,817	\$6,496	\$4,416,321
\$4,358,238	\$6,246	\$4,351,992
\$4,292,200	\$6,006	\$4,286,194
\$4,224,909	\$5,775	\$4,219,134
\$4,156,325	\$5,553	\$4,150,773
\$4,087,097	\$5,339	\$4,081,758
\$4,017,156	\$5,134	\$4,012,023
\$3,946,658	\$4,936	\$3,941,722
\$3,874,410	\$4,746	\$3,869,664
\$3,803,203	\$4,564	\$3,798,639
\$3,704,514	\$4,388	\$3,700,126
\$3,633,934	\$4,220	\$3,629,714
\$3,563,405	\$4,057	\$3,559,348
<b>\$84,916,084</b>	<b>#####</b>	<b>\$21,408,502</b>

Year	USER BENEFITS IN CONSTANT DOLLARS				
	Travel Time Savings	Reliability Savings	(Location 1) Vehicle Op. Cost Savings	Accident Reductions	Vehicle Emission Reductions
<b>Construction Period</b>					
2023					
2024					
2025					
2026					
2027					
2028					
2029					
2030					
<b>Project Open</b>					
2026	\$1,871,868	\$98,071	\$1,765,769	\$1,768,820	\$128,933
2027	\$1,934,449	\$91,885	\$1,832,651	\$1,800,015	\$136,160
2028	\$1,997,029	\$86,074	\$1,899,532	\$1,831,209	\$143,595
2029	\$2,059,609	\$80,617	\$1,966,414	\$1,862,403	\$151,243
2030	\$2,122,189	\$75,493	\$2,033,295	\$1,893,597	\$159,112
2031	\$2,184,769	\$70,684	\$2,100,829	\$1,924,791	\$167,472
2032	\$2,247,350	\$66,171	\$2,165,992	\$1,955,985	\$175,326
2033	\$2,309,930	\$61,936	\$2,232,855	\$1,987,179	\$183,976
2034	\$2,372,510	\$57,964	\$2,299,718	\$2,018,374	\$193,500
2035	\$2,435,090	\$54,238	\$2,366,581	\$2,049,568	\$203,524
2036	\$2,497,670	\$50,745	\$2,433,444	\$2,080,762	\$214,162
2037	\$2,560,251	\$47,470	\$2,499,998	\$2,111,956	\$225,142
2038	\$2,622,831	\$44,400	\$2,566,858	\$2,143,150	\$236,308
2039	\$2,685,411	\$41,524	\$2,633,718	\$2,174,344	\$247,764
2040	\$2,747,991	\$38,828	\$2,700,577	\$2,205,538	\$259,439
2041	\$2,810,572	\$36,303	\$2,765,257	\$2,236,733	\$271,424
2042	\$2,873,152	\$33,938	\$2,832,084	\$2,267,927	\$283,727
2043	\$2,935,732	\$31,711	\$2,898,911	\$2,299,121	\$296,396
2044	\$2,998,312	\$18,425	\$2,965,738	\$2,330,315	\$309,423
2045	\$3,060,892	\$17,220	\$3,032,565	\$2,361,509	\$322,836
<b>Total</b>	<b>\$49,327,607</b>	<b>\$1,091,696</b>	<b>\$47,992,787</b>	<b>\$41,303,295</b>	<b>\$3,340,374</b>



Total User Benefits in Constant Dollars	Total Project Costs in Constant Dollars	ANNUAL RETURNS ON INVESTMENT	CUMULATIVE RETURNS AFTER PROJ OPENS
\$0	\$31,075,567	(\$31,075,567)	
\$0	\$18,475,567	(\$18,475,567)	
\$0	\$18,475,567	(\$18,475,567)	
\$0	\$0	\$0	
\$0	\$0	\$0	
\$0	\$0	\$0	
\$0	\$0	\$0	
\$0	\$0	\$0	
\$5,633,462	\$10,000	\$5,623,462	\$5,623,462
\$5,795,159	\$10,000	\$5,785,159	\$11,408,621
\$5,957,438	\$10,000	\$5,947,438	\$17,356,059
\$6,120,286	\$10,000	\$6,110,286	\$23,466,345
\$6,283,686	\$10,000	\$6,273,686	\$29,740,031
\$6,448,545	\$10,000	\$6,438,545	\$36,178,576
\$6,610,823	\$10,000	\$6,600,823	\$42,779,400
\$6,723,876	\$10,000	\$6,713,876	\$49,493,276
\$6,887,065	\$10,000	\$6,877,065	\$56,370,341
\$7,050,694	\$10,000	\$7,040,694	\$63,411,034
\$7,214,751	\$10,000	\$7,204,751	\$70,615,786
\$7,378,813	\$10,000	\$7,368,813	\$77,984,599
\$7,543,698	\$10,000	\$7,533,698	\$85,518,298
\$7,708,991	\$10,000	\$7,698,991	\$93,217,288
\$7,874,684	\$10,000	\$7,864,684	\$101,081,972
\$8,037,957	\$10,000	\$8,027,957	\$109,109,929
\$8,204,286	\$10,000	\$8,194,286	\$117,304,215
\$8,359,085	\$10,000	\$8,349,085	\$125,653,300
\$8,527,071	\$10,000	\$8,517,071	\$134,170,371
\$8,695,389	\$10,000	\$8,685,389	\$142,855,760
<b>\$143,055,760</b>	<b>\$68,226,701</b>	<b>\$74,829,059</b>	<b>\$142,855,760</b>

Total Construction Costs **\$68,026,701**

Years After Construction Begins	ANNUAL RETURNS ON INVESTMENT
2023	(\$31,075,567)
2024	(\$18,475,567)
2025	(\$18,475,567)
2026	\$5,623,462
2027	\$5,785,159
2028	\$5,947,438
2029	\$6,110,286
2030	\$6,273,686
2031	\$6,438,545
2032	\$6,600,823
2033	\$6,713,876
2034	\$6,877,065
2035	\$7,040,694
2036	\$7,204,751
2037	\$7,368,813
2038	\$7,533,698
2039	\$7,698,991
2040	\$7,864,684
2041	\$8,027,957
2042	\$8,194,286
2043	\$8,349,085
2044	\$8,517,071
2045	\$8,685,389
2046	\$0
2047	\$0
2048	\$0
2049	\$0
2050	\$0

Internal Rate of Return **6.74%**

Payback Period **11 years**

The INTERNAL RATE OF RETURN (IRR) is the discount rate at which benefits and costs are equal. For a project with an IRR greater than the Discount Rate, benefits are greater than costs, and the project is profitable. 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 construction costs) to equal zero. For a project with a Payback Period longer than the life-cycle of the project, the project is not profitable. The Payback Period varies inversely with the Benefit-Cost Ratio: shorter Payback Period indicates a higher Benefit-Cost Ratio.

	ADT					Segment (m)
	No-Build			Build		No-Build
	2020	2026	2046	2026	2046	
SB Off to Ave 280	1,534	7,244	9,107	6,299	9,107	0.28
SB On from Ave 280	1,264	6,299	8,714	6,299	8,714	0.24
NB Off to Ave 280	1,347	6,299	8,714	6,299	8,714	0.24
NB On from Ave 280	1,458	7,244	9,107	7,244	9,107	0.35
NB Mainline	35,671	38,501	48,874	35,827	43,207	1.31
SB Mainline	34,329	37,052	47,034	33,077	40,622	1.31

t Length i)	VMT				VHT			
	No-Build		Build		No-Build		Build	
	2026	2046	2026	2046	2026	2046	2026	2046
0.31	2,059	2,589	1,982	2,865	48	62	47	68
0.24	1,486	2,056	1,515	2,096	28	39	28	38
0.24	1,525	2,109	1,500	2,075	41	58	32	44
0.29	2,513	3,160	2,072	2,604	58	74	27	35
1.31	50,518	64,129	47,009	56,693	728	928	676	818
1.31	48,617	61,714	43,401	53,301	700	893	624	769

**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	2021
Economic Update Factor (Using GDP Deflator)	1.00
Real Discount Rate	4.0%

Mode Types
Bus
Pass Train
Light Rail
Highway

Travel Time Parameters		
	Value	Units
Statewide Average Hourly Wage	\$ 32.44	\$/hr
<b>Heavy and Light Truck Drivers</b>		
Average Hourly Wage	\$ 23.96	\$/hr
Benefits and Costs	\$ 11.92	\$/hr
<b>Value of Time</b>		
Automobile	\$ 16.20	\$/hr/per
Truck	\$ 35.90	\$/hr/veh
Auto & Truck Composite	\$ 22.40	\$/hr/veh
Transit	\$ 16.20	\$/hr/per
Out-of-Vehicle Travel	2	times
Incident-Related Travel	3	times
Travel Time Uprater	0.0%	annual incr
<b>Vehicle Operating Cost Parameters</b>		
<b>Average Fuel Price</b>		
Automobile (regular unleaded)	\$ 3.81	\$/gal
Truck (diesel)	\$ 3.87	\$/gal
<b>Sales and Fuel Taxes</b>		
State Sales Tax (gasoline)	2.25%	%
State Sales Tax (diesel)	13.00%	%
Average Local Sales Tax	0.50%	%
Federal Fuel Excise Tax (gasoline)	\$ 0.183	\$/gal
Federal Fuel Excise Tax (diesel)	\$ 0.243	\$/gal
State Fuel Excise Tax (gasoline)	\$ 0.511	\$/gal
State Fuel Excise Tax (diesel)	\$ 0.389	\$/gal
<b>Fuel Cost Per Gallon (Exclude Taxes)</b>		
Automobile	\$ 3.00	\$/gal
Truck	\$ 2.80	\$/gal
<b>Non-Fuel Cost Per Mile</b>		
Automobile	\$ 0.356	\$/mi
Truck	\$ 0.440	\$/mi
Idling Speed for Op. Costs and Emissions	5	mph
<b>Accident Cost Parameters</b>		
Cost of a Fatality	\$ 11,800,000	\$/event
<b>Cost of an Injury</b>		
Level A (Severe)	\$ 536,800	\$/event
Level B (Moderate)	\$ 146,200	\$/event
Level C (Minor)	\$ 74,700	\$/event
Cost of Property Damage	\$ 3,100	\$/event
<b>Cost of Highway Crash</b>		
Fatal Crash	\$ 13,600,000	\$/crash
Injury Crash	\$ 179,600	\$/crash
PDO Crash	\$ 9,900	\$/crash
Average Cost	\$ 348,200	\$/crash
<b>Statewide Highway Crash Rates</b>		
Fatal Crash	0.005	per mil veh-mi
Injury Crash	0.28	per mil veh-mi
PDO Crash	0.61	per mil veh-mi
Non-Freeway	1.04	per mil veh-mi

Highway Operations Parameters				
	Value	Units		
Maximum V/C Ratio	1.56	-		
Percent ADT in Peak Period		%		
Percent ADT in Average Peak Hour		%		
Annualization Factor	365	days/yr		
<b>Capacity and Dep. Rate</b>				
	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	
<b>Non-HOV Lanes</b>				
No Build	Alpha	Beta	Capacity (vp/hpl)	
Build				

Sources: 16) Highway Capacity Manual, 17) NCHRP 387, 18) PeMS data

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 2020, 4) BLS Employment Cost Index, 5) USDOT Department Guidance 2021, 6) California Department of Transportation TSI and Traffic Operations, 7) IDAS model, 8) AAA Daily Fuel Gauge Report 2021, 9) California Board of Equalization, 10) Caltrans Transportation Funding in California 2020, 11) AAA Yo Driving Costs 2021, 12) American Transportation Research Institute 2021, 13) USDOT VSL

Active Transportation Parameters		
General Travel Activity Characteristics Parameters	Value	Units
Cycling Days per Year	365	days
Walking Days per Year	365	days
School Days per Year	180	days
<b>Vehicle Statistics</b>		
Average Vehicle Speed	25	mph
Average Vehicle Occupancy	1.51	persons / veh
<b>Active Transportation User Characteristics</b>		
Average Cycling Speed	8.70	mph
Average Walking Speed	3.30	mph
Number of Unlinked Cycling Trips per Day	2.23	trips
Number of Unlinked Pedestrian Trips per Day	2.10	trips
Diversion of Cyclists from Personal Vehicles	50%	assumption
Diversion of Pedestrians from Personal Vehicles	50%	assumption
<b>Value of Travel Time</b>		
Adults	\$ 16.20	\$/hr/per
Children	\$ 16.20	\$/hr/per
<b>Cycling Journey Quality - Facility Preference Factors as Function of Distance by Facility Class</b>		
Class I	0.57	-
Class II	0.49	-
Class III	0.92	-
Class IV	0.49	-
<i>Note: Class IV assumed to be the same as Class II</i>		
<b>Walking Journey Quality Values per Mile by Amenity</b>		
Street Lighting	\$0.110	\$/mi
Curb Level	\$0.078	\$/mi
Crowding	\$0.055	\$/mi
Pavement Evenness	\$0.026	\$/mi
Information Panels	\$0.026	\$/mi
Benches	\$0.017	\$/mi
Directional Signage	\$0.017	\$/mi
<b>Health (Absenteeism Reduction)</b>		
Average Absence of Employees	3.50	days/yr
Percentage Covered by Short-Term Sick Leave	86%	%
Percentage of Sick Days Reduced When Active at Least 30 Minutes per Day	6%	%
<b>Health (Mortality Reduction)</b>		
Percentage of Cyclists Aged 16-64	44.6%	%
Percentage of Pedestrians Aged 16-74	79.9%	%
Percentage Reduction in Mortality per 365 Annual Cycling Miles	4.5%	%
Percentage Reduction in Mortality per 365 Annual Walking Miles	9.0%	%
Mortality Rate - All Causes (Aged 20-64)	252	#/100,000 people
Mortality Rate - All Causes (Aged 20-74)	392	#/100,000 people

Sources: 19) 2017 National Household Travel Survey, 20) 2017 WHO HEAT Model Documentation, 21) Hood et al., 2011, 22) Heuman et al., 2005, 23) Maestas et al., 2018, 24) World Health Organization, 2003, 25) California Health and Human Services Agency, 2019 Final Deaths



**Travel Demand Tables**

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

DEMAND FOR TRAVEL IN PEAK PERIOD (percent of total daily travel)						
Number of Hours in Peak Period	Urban				Rural	
	So. California Fwy/Exp	Other	No. California Fwy/Exp	Other	Fwy/Exp	Other
1	8.5%	8.5%	8.5%	8.5%	8.5%	8.5%
2	16.8%	16.8%	16.8%	16.8%	16.8%	16.8%
3	25.0%	25.0%	25.0%	25.0%	25.0%	25.0%
4	32.8%	32.8%	32.8%	32.8%	32.8%	32.8%
5	40.3%	40.3%	40.3%	40.3%	40.3%	40.3%
6	47.4%	47.4%	47.4%	47.4%	47.4%	47.4%
7	54.2%	54.2%	54.2%	54.2%	54.2%	54.2%
8	60.8%	60.8%	60.8%	60.8%	60.8%	60.8%
9	67.1%	67.1%	67.1%	67.1%	67.1%	67.1%
10	73.4%	73.4%	73.4%	73.4%	73.4%	73.4%
11	79.0%	79.0%	79.0%	79.0%	79.0%	79.0%
12	84.3%	84.3%	84.3%	84.3%	84.3%	84.3%
13	88.6%	88.6%	88.6%	88.6%	88.6%	88.6%
14	91.6%	91.6%	91.6%	91.6%	91.6%	91.6%
15	94.3%	94.3%	94.3%	94.3%	94.3%	94.3%
16	96.4%	96.4%	96.4%	96.4%	96.4%	96.4%
17	97.6%	97.6%	97.6%	97.6%	97.6%	97.6%
18	98.5%	98.5%	98.5%	98.5%	98.5%	98.5%
19	99.1%	99.1%	99.1%	99.1%	99.1%	99.1%
20	99.4%	99.4%	99.4%	99.4%	99.4%	99.4%
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, 2010-2012 California Household Travel Survey, Final Report Appendix, June 2013

AGE COHORTS FOR MORTALITY RISK REDUCTION (percent of population)				
Mode	Age Cohort	Urban		
		South	North	Rural
Cycling	Age 16-64	54.9%	54.9%	44.6%
Walking	Age 16-74	80.5%	80.5%	79.9%

AVERAGE DISTANCE PER ACTIVE TRANSPORTATION TRIP (miles/trip)				
Mode	Age Cohort	Urban		
		South	North	Rural
Cycling	Adults	2.29	2.29	7.89
	Children <16	0.99	0.99	0.78
Walking	Adults	0.68	0.68	0.60
	Children <16	0.63	0.63	1.08

TRIP PURPOSE FOR ACTIVE TRANSPORTATION TRIPS (percent of trips)				
Mode	Trip Purpose	Urban		
		South	North	Rural
Cycling	Commuting	18.6%	18.6%	9.9%
	Recreation	46.1%	46.1%	62.2%
	Other Destination	35.3%	35.3%	27.9%
Walking	Commuting	5.2%	5.2%	6.2%
	Recreation	55.0%	55.0%	63.5%
	Other Destination	39.8%	39.8%	30.3%

Source: 2017 National Household Travel Survey, California Sample

**Operating Cost Tables**

**FUEL CONSUMPTION RATES**  
(gal/veh-mi)

Speed	Auto*	Truck
5	0.0515	0.1400
6	0.0501	0.1377
7	0.0488	0.1355
8	0.0476	0.1333
9	0.0464	0.1312
10	0.0452	0.1291
11	0.0429	0.1238
12	0.0407	0.1186
13	0.0387	0.1137
14	0.0367	0.1090
15	0.0349	0.1044
16	0.0351	0.1029
17	0.0352	0.1015
18	0.0354	0.1000
19	0.0356	0.0986
20	0.0358	0.0972
21	0.0354	0.0940
22	0.0350	0.0909
23	0.0345	0.0879
24	0.0341	0.0850
25	0.0337	0.0822
26	0.0334	0.0813
27	0.0331	0.0803
28	0.0328	0.0794
29	0.0325	0.0785
30	0.0322	0.0776
31	0.0317	0.0778
32	0.0313	0.0781
33	0.0308	0.0784
34	0.0304	0.0787
35	0.0300	0.0790
36	0.0298	0.0794
37	0.0297	0.0799
38	0.0296	0.0803
39	0.0295	0.0808
40	0.0293	0.0812
41	0.0294	0.0813
42	0.0294	0.0813
43	0.0295	0.0814
44	0.0295	0.0814
45	0.0295	0.0814
46	0.0299	0.0786
47	0.0302	0.0758
48	0.0305	0.0731
49	0.0309	0.0705
50	0.0312	0.0680
51	0.0316	0.0707
52	0.0321	0.0735
53	0.0325	0.0764
54	0.0330	0.0794
55	0.0334	0.0826
56	0.0337	0.0865
57	0.0340	0.0907
58	0.0343	0.0950
59	0.0345	0.0995
60	0.0348	0.1043
61	0.0351	0.1062
62	0.0353	0.1083
63	0.0356	0.1104
64	0.0358	0.1125
65	0.0361	0.1146
66	0.0361	0.1138
67	0.0362	0.1130
68	0.0363	0.1123
69	0.0364	0.1115
70	0.0365	0.1107

\* Includes motorcycles & medium duty vehicles  
 Note: Five mph is best estimate for idling

Source: California Air Resources Board,  
 EMFAC2021, 2024 & 2044 average

**Accident Tables**

**HIGHWAY INJURY SEVERITY FREQUENCY**  
(percent of injuries)

Event	Urban	Suburban	Rural	Average
Severe Injury (A)	5.12%	5.12%	5.12%	5.12%
Other Visible Injury (B)	25.30%	25.30%	25.30%	25.30%
Complaint of Pain (C)	69.57%	69.57%	69.57%	69.57%

Source: 2017 SWITRS Annual Report, Table 6C

**RATES FOR NON-HIGHWAY ACCIDENT EVENTS**  
(events/million veh-mi)

Event	Pass Train	Light Rail	Bus	Freight Rail
Fatality	0.0804	0.2416	0.0372	1.0368
Injury	0.2855	2.9209	3.5526	7.3121
All Accidents	0.3128	4.1374	2.0523	13.2505

Sources: USDOT, Transportation Statistics Annual Report, Table 2-33, 2010 to 2019 average  
FRA, Office of Safety Analysis, Table 1.13, 2011 to 2020 CY average

**NUMBER OF FATALITIES**  
(events/crash)

Crash Type	Urban	Suburban	Rural	Average
Fatal Crash	1.09	1.08	1.14	1.11

**NUMBER OF INJURIES**  
(events/crash)

Crash Type	Urban	Suburban	Rural	Average
Fatal Crash	0.81	0.82	1.12	0.95
Injury Crash	1.44	1.43	1.50	1.44

**NUMBER OF VEHICLES INVOLVED**  
(events/crash)

Crash Type	Urban	Suburban	Rural	Average
Fatal Crash	1.51	1.69	1.58	1.63
Injury Crash	1.82	2.10	1.59	1.99
PDO Crash	1.80	2.03	1.59	1.96

**DISTRIBUTION OF CRASH TYPES**  
(percent of crashes)

Crash Type	Urban	Suburban	Rural	Average
Fatal Crash	0.45%	0.73%	2.04%	0.73%
Injury Crash	31.95%	33.13%	36.01%	32.77%
PDO Crash	67.60%	66.14%	61.96%	66.50%

Source: California Department of Transportation, TASAS Unit, 2010 to 2013 average  
26) Crash Data on California State Highways 2018

**COST OF NON-HIGHWAY ACCIDENT EVENTS**  
(\$/event)

Event	Pass Train	Light Rail	Bus	Freight Rail
Fatality	\$11,800,000	\$11,800,000	\$11,800,000	\$11,800,000
Injury	\$211,900	\$211,900	\$211,900	\$211,900
Prop Damage	\$90,000	\$14,200	\$4,300	\$156,700

Sources: FTA, Transit Safety & Security Statistics, 2002 to 2011 average  
FRA, Office of Safety Analysis, Table 3.16, 2018 to 2020 average

**COSTS OF NON-HIGHWAY ACCIDENTS**  
(\$/million veh-mi)

Value	Pass Train	Light Rail	Bus	Freight Rail
Cost	\$1,037,400	\$3,528,600	\$1,200,600	\$15,860,000

Source: Combination of above two tables

**HIGHWAY-RAIL GRADE CROSSING INCIDENTS**  
(units in table)

Value	Incident	Fatality	Injury
Total Events	847	80	462
Avg per Incident		0.0945	0.5455
Cost per Event		\$11,800,000	\$211,900

Source: FRA, Office of Safety Analysis, 5.10 - Hwy/Rail Incidents Summary  
Table, California, Motor Vehicles, Public Crossings, Jan 2011 to Dec 2020

**COST OF HIGHWAY CRASHES**  
(\$/crash)

Crash Type	Urban	Suburban	Rural	Average
Fatal Crash	\$13,000,000	\$12,800,000	\$13,600,000	\$13,200,000
Injury Crash	\$173,300	\$173,000	\$179,600	\$173,800
PDO Crash	\$11,200	\$12,600	\$9,900	\$12,200
All Types	\$121,400	\$159,100	\$348,200	\$161,400

Source: Combination of above four tables

**PASSING LANE CRASH 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 2024								
Mode	Speed	CO	CO2	NOX	PM10	SOX	VOC	PM2.5
Auto	0	3.5182	78.9185	0.3056	0.0022	0.0008	0.3900	0.0020
	5	1.3616	55.4365	0.0959	0.0070	0.0055	0.0868	0.0065
	6	1.3409	538.7039	0.0933	0.0065	0.0053	0.0797	0.0060
	7	1.3206	522.4754	0.0907	0.0060	0.0052	0.0732	0.0055
	8	1.3005	506.7358	0.0881	0.0055	0.0050	0.0672	0.0051
	9	1.2807	491.4703	0.0857	0.0051	0.0049	0.0617	0.0047
	10	1.2613	476.6647	0.0833	0.0047	0.0047	0.0567	0.0043
	11	1.2223	452.5800	0.0804	0.0043	0.0045	0.0518	0.0039
	12	1.1846	429.7124	0.0775	0.0039	0.0042	0.0473	0.0036
	13	1.1480	408.0001	0.0748	0.0036	0.0040	0.0433	0.0033
	14	1.1126	387.3849	0.0721	0.0033	0.0038	0.0396	0.0030
	15	1.0783	367.8114	0.0696	0.0030	0.0036	0.0361	0.0027
	16	1.0442	366.7610	0.0702	0.0029	0.0036	0.0348	0.0026
	17	1.1103	365.7136	0.0708	0.0028	0.0036	0.0335	0.0025
	18	1.1267	364.6693	0.0714	0.0027	0.0036	0.0323	0.0024
	19	1.1433	363.6278	0.0720	0.0026	0.0036	0.0311	0.0024
	20	1.1601	362.5894	0.0726	0.0025	0.0036	0.0300	0.0023
	21	1.1563	356.2510	0.0724	0.0024	0.0035	0.0287	0.0022
	22	1.1524	350.0234	0.0723	0.0022	0.0035	0.0275	0.0021
	23	1.1486	343.9046	0.0721	0.0022	0.0034	0.0263	0.0020
	24	1.1448	337.8928	0.0719	0.0021	0.0033	0.0252	0.0019
	25	1.1410	331.9861	0.0718	0.0020	0.0033	0.0242	0.0018
	26	1.1286	327.2741	0.0711	0.0019	0.0032	0.0232	0.0017
	27	1.1164	322.6289	0.0703	0.0018	0.0032	0.0222	0.0017
	28	1.1042	318.0497	0.0696	0.0017	0.0031	0.0213	0.0016
	29	1.0922	313.5355	0.0689	0.0017	0.0031	0.0204	0.0015
	30	1.0804	309.0854	0.0682	0.0016	0.0031	0.0196	0.0015
	31	1.0681	304.8313	0.0679	0.0016	0.0030	0.0190	0.0014
	32	1.0561	300.6357	0.0675	0.0015	0.0030	0.0184	0.0014
	33	1.0441	296.4979	0.0671	0.0014	0.0029	0.0178	0.0013
	34	1.0323	292.4171	0.0667	0.0014	0.0029	0.0172	0.0013
	35	1.0206	288.3924	0.0663	0.0013	0.0029	0.0167	0.0012
	36	1.0098	287.1873	0.0661	0.0013	0.0028	0.0163	0.0012
	37	0.9991	285.9872	0.0658	0.0013	0.0028	0.0159	0.0012
	38	0.9885	284.7922	0.0656	0.0012	0.0028	0.0155	0.0011
	39	0.9780	283.6021	0.0653	0.0012	0.0028	0.0152	0.0011
	40	0.9677	282.4170	0.0651	0.0012	0.0028	0.0148	0.0011
	41	0.9542	282.6316	0.0649	0.0012	0.0028	0.0146	0.0011
	42	0.9408	282.8464	0.0647	0.0011	0.0028	0.0144	0.0010
	43	0.9277	283.0613	0.0645	0.0011	0.0028	0.0142	0.0010
	44	0.9147	283.2764	0.0643	0.0011	0.0028	0.0140	0.0010
	45	0.9020	283.4917	0.0641	0.0011	0.0028	0.0138	0.0010
	46	0.8950	286.1470	0.0643	0.0011	0.0028	0.0138	0.0010
	47	0.8882	288.8273	0.0645	0.0011	0.0029	0.0138	0.0010
	48	0.8814	291.5326	0.0647	0.0011	0.0029	0.0137	0.0010
	49	0.8746	294.2633	0.0649	0.0011	0.0029	0.0137	0.0010
	50	0.8679	297.0195	0.0652	0.0011	0.0029	0.0137	0.0010
	51	0.8608	300.5677	0.0655	0.0011	0.0030	0.0138	0.0010
	52	0.8537	304.1583	0.0659	0.0011	0.0030	0.0139	0.0010
	53	0.8467	307.7918	0.0663	0.0011	0.0030	0.0140	0.0010
	54	0.8398	311.4687	0.0667	0.0011	0.0031	0.0141	0.0010
	55	0.8329	315.1895	0.0671	0.0011	0.0031	0.0142	0.0010
	56	0.8167	317.3875	0.0668	0.0011	0.0031	0.0143	0.0010
	57	0.8008	319.6009	0.0666	0.0011	0.0032	0.0144	0.0010
	58	0.7852	321.8297	0.0664	0.0011	0.0032	0.0144	0.0011
	59	0.7699	324.0740	0.0662	0.0012	0.0032	0.0145	0.0011
	60	0.7549	326.3340	0.0660	0.0012	0.0032	0.0146	0.0011
	61	0.7519	328.7321	0.0672	0.0012	0.0032	0.0151	0.0011
	62	0.7490	331.1477	0.0684	0.0012	0.0033	0.0156	0.0011
	63	0.7460	333.5812	0.0697	0.0013	0.0033	0.0160	0.0012
	64	0.7430	336.0325	0.0710	0.0013	0.0033	0.0165	0.0012
	65	0.7401	338.5018	0.0723	0.0013	0.0033	0.0171	0.0012
	66	0.7380	339.0778	0.0728	0.0014	0.0034	0.0172	0.0012
	67	0.7359	339.6547	0.0732	0.0014	0.0034	0.0173	0.0013
	68	0.7338	340.2326	0.0737	0.0014	0.0034	0.0175	0.0013
	69	0.7318	340.8115	0.0742	0.0014	0.0034	0.0176	0.0013
	70	0.7297	341.3914	0.0746	0.0014	0.0034	0.0178	0.0013

HIGHWAY EMISSIONS FACTORS (g/mi)								
Model Year 2024								
Mode	Speed	CO	CO2	NOX	PM10	SOX	VOC	PM2.5
Auto	0	1.7535	60.2289	0.1686	0.0008	0.0006	0.1451	0.0008
	5	0.5559	330.9034	0.0223	0.0019	0.0033	0.0249	0.0018
	6	0.5576	324.7042	0.0221	0.0018	0.0032	0.0233	0.0016
	7	0.5594	318.6210	0.0219	0.0017	0.0031	0.0217	0.0015
	8	0.5612	312.6518	0.0218	0.0016	0.0031	0.0203	0.0014
	9	0.5630	306.7945	0.0216	0.0014	0.0030	0.0189	0.0013
	10	0.5647	301.0469	0.0214	0.0014	0.0030	0.0177	0.0012
	11	0.5479	285.9535	0.0206	0.0012	0.0028	0.0161	0.0011
	12	0.5315	271.6169	0.0199	0.0011	0.0027	0.0147	0.0010
	13	0.5156	257.9991	0.0192	0.0010	0.0026	0.0134	0.0009
	14	0.5002	245.0640	0.0185	0.0009	0.0024	0.0122	0.0009
	15	0.4853	232.7774	0.0178	0.0008	0.0023	0.0111	0.0008
	16	0.5039	236.9560	0.0184	0.0008	0.0023	0.0109	0.0008
	17	0.5232	241.2096	0.0190	0.0008	0.0024	0.0107	0.0008
	18	0.5433	245.5396	0.0197	0.0008	0.0024	0.0105	0.0007
	19	0.5641	249.9473	0.0203	0.0008	0.0025	0.0103	0.0007
	20	0.5855	254.4341	0.0210	0.0008	0.0025	0.0101	0.0007
	21	0.5910	253.2384	0.0211	0.0008	0.0025	0.0098	0.0007
	22	0.5964	252.0482	0.0213	0.0007	0.0025	0.0094	0.0007
	23	0.6018	250.8636	0.0215	0.0007	0.0025	0.0091	0.0006
	24	0.6072	249.6847	0.0217	0.0007	0.0025	0.0088	0.0006
	25	0.6127	248.5112	0.0218	0.0007	0.0025	0.0085	0.0006
	26	0.6144	247.3900	0.0220	0.0006	0.0024	0.0083	0.0006
	27	0.6161	247.0709	0.0221	0.0006	0.0024	0.0080	0.0006
	28	0.6178	246.3539	0.0222	0.0006	0.0024	0.0078	0.0006
	29	0.6195	245.6389	0.0224	0.0006	0.0024	0.0076	0.0005
	30	0.6212	244.9261	0.0225	0.0006	0.0024	0.0074	0.0005
	31	0.6126	241.3366	0.0222	0.0006	0.0024	0.0071	0.0005
	32	0.6042	237.7997	0.0220	0.0005	0.0024	0.0068	0.0005
	33	0.5959	234.3147	0.0217	0.0005	0.0023	0.0065	0.0005
	34	0.5877	230.8807	0.0215	0.0005	0.0023	0.0063	0.0005
	35	0.5796	227.4970	0.0212	0.0005	0.0022	0.0060	0.0004
	36	0.5729	226.5716	0.0211	0.0005	0.0022	0.0058	0.0004
	37	0.5664	225.6499	0.0210	0.0004	0.0022	0.0057	0.0004
	38	0.5599	224.7319	0.0208	0.0004	0.0022	0.0055	0.0004
	39	0.5535	223.8177	0.0207	0.0004	0.0022	0.0053	0.0004
	40	0.5471	222.9072	0.0206	0.0004	0.0022	0.0052	0.0004
	41	0.5398	223.3585	0.0205	0.0004	0.0022	0.0051	0.0004
	42	0.5325	223.8107	0.0205	0.0004	0.0022	0.0050	0.0004
	43	0.5253	224.2638	0.0204	0.0004	0.0022	0.0050	0.0004
	44	0.5182	224.7179	0.0203	0.0004	0.0022	0.0049	0.0004
	45	0.5112	225.1728	0.0203	0.0004	0.0022	0.0048	0.0004
	46	0.5081	228.0552	0.0203	0.0004	0.0023	0.0048	0.0004
	47	0.5051	230.9745	0.0204	0.0004	0.0023	0.0048	0.0004
	48	0.5021	233.9312	0.0205	0.0004	0.0023	0.0048	0.0004
	49	0.4991	236.9257	0.0206	0.0004	0.0023	0.0048	0.0004
	50	0.4961	239.9586	0.0207	0.0004	0.0024	0.0048	0.0004
	51	0.4937	243.8377	0.0209	0.0004	0.0024	0.0049	0.0004
	52	0.4913	247.7794	0.0211	0.0004	0.0024	0.0049	0.0004
	53	0.4889	251.7849	0.0213	0.0004	0.0025	0.0050	0.0004
	54	0.4866	255.8552	0.0215	0.0004	0.0025	0.0051	0.0004
	55	0.4842	259.9912	0.0217	0.0004	0.0026	0.0051	0.0004
	56	0.4772	263.6460	0.0218	0.0004	0.0026	0.0052	0.0004
	57	0.4703	265.3279	0.0220	0.0004	0.0026	0.0053	0.0004
	58	0.4635	268.0372	0.0222	0.0004	0.0026	0.0054	0.0004
	59	0.4568	270.7741	0.0223	0.0004	0.0027	0.0055	0.0004
	60	0.4502	273.5390	0.0225	0.0004	0.0027	0.0057	0.0004
	61	0.4455	275.3018	0.0227	0.0005	0.0027	0.0058	0.0004
	62	0.4408	277.0760	0.0229	0.0005	0.0027	0.0059	0.0004
	63	0.4362	278.					

Emissions Tables

HIGHWAY EMISSIONS FACTORS (g/mi)								
Model Year 2024								
Mode	Speed	CO	CO2	NOX	PM10	SOX	VOC	PM2.5
Auto	0	3.5182	78.9185	0.3056	0.0022	0.0008	0.3900	0.0020
	5	1.3616	555.4365	0.0959	0.0070	0.0055	0.0868	0.0065
	6	1.3409	538.7039	0.0933	0.0065	0.0053	0.0797	0.0060
	7	1.3206	522.4754	0.0907	0.0060	0.0052	0.0732	0.0055
	8	1.3005	506.7358	0.0881	0.0055	0.0050	0.0672	0.0051
	8	1.3150	11.0294	1.0065	0.0001	0.0001	0.0703	0.0001
	5	2.3136	1696.8926	2.1959	0.0482	0.0164	0.3065	0.0460
	6	2.2436	1668.3322	2.2233	0.0464	0.0161	0.2881	0.0443
Truck	7	2.1757	1640.2524	2.2511	0.0447	0.0157	0.2708	0.0426
	8	2.1098	1612.8453	2.2792	0.0430	0.0154	0.2546	0.0410
	9	2.0460	1585.5029	2.3076	0.0414	0.0151	0.2393	0.0395
	10	1.9841	1558.8172	2.3365	0.0398	0.0148	0.2249	0.0380
	11	1.8688	1490.2476	2.1839	0.0377	0.0141	0.2111	0.0360
	12	1.7601	1424.6943	2.0413	0.0357	0.0135	0.1981	0.0341
	13	1.6578	1362.0246	1.9080	0.0338	0.0129	0.1860	0.0323
	14	1.5615	1302.1116	1.7834	0.0320	0.0124	0.1746	0.0306
	15	1.4707	1244.8340	1.6670	0.0303	0.0118	0.1639	0.0290
	16	1.3769	1231.6228	1.6477	0.0292	0.0117	0.1517	0.0269
	17	1.2890	1218.5517	1.6286	0.0282	0.0116	0.1404	0.0251
	18	1.2067	1205.6194	1.6097	0.0274	0.0115	0.1300	0.0233
	19	1.1297	1192.8244	1.5910	0.0277	0.0113	0.1204	0.0217
	20	1.0576	1180.1651	1.5726	0.0211	0.0112	0.1114	0.0201
	21	1.0154	1138.1322	1.5314	0.0208	0.0108	0.1089	0.0199
	22	0.9749	1097.5964	1.4913	0.0206	0.0104	0.1069	0.0197
	23	0.9361	1058.5043	1.4522	0.0204	0.0101	0.1041	0.0195
	24	0.8988	1020.8046	1.4141	0.0201	0.0097	0.1017	0.0192
	25	0.8629	984.4475	1.3771	0.0199	0.0093	0.0995	0.0190
	26	0.8297	974.5904	1.3491	0.0188	0.0092	0.0935	0.0180
	27	0.7977	964.8319	1.3216	0.0178	0.0091	0.0879	0.0170
	28	0.7670	955.1712	1.2948	0.0168	0.0090	0.0827	0.0161
	29	0.7374	945.6072	1.2684	0.0159	0.0089	0.0777	0.0152
	30	0.7090	936.1389	1.2426	0.0151	0.0088	0.0731	0.0144
	31	0.6779	941.2716	1.2298	0.0144	0.0089	0.0682	0.0137
	32	0.6482	946.4323	1.2171	0.0138	0.0089	0.0636	0.0131
	33	0.6198	951.6214	1.2046	0.0131	0.0089	0.0593	0.0126
	34	0.5926	956.8389	1.1921	0.0126	0.0090	0.0553	0.0120
	35	0.5666	962.0850	1.1798	0.0120	0.0090	0.0516	0.0115
	36	0.5505	967.4195	1.1663	0.0118	0.0091	0.0488	0.0113
	37	0.5349	972.7836	1.1529	0.0116	0.0091	0.0462	0.0110
	38	0.5197	978.1775	1.1396	0.0113	0.0091	0.0437	0.0108
	39	0.5050	983.6013	1.1266	0.0111	0.0092	0.0413	0.0106
	40	0.4906	989.0551	1.1136	0.0109	0.0092	0.0391	0.0104
41	0.4868	984.5077	1.0994	0.0110	0.0092	0.0382	0.0105	
42	0.4829	979.9812	1.0854	0.0111	0.0091	0.0374	0.0106	
43	0.4791	975.4754	1.0715	0.0111	0.0091	0.0366	0.0106	
44	0.4753	970.9904	1.0579	0.0112	0.0091	0.0359	0.0107	
45	0.4716	966.5261	1.0444	0.0113	0.0090	0.0351	0.0108	
46	0.4762	930.2224	1.0417	0.0115	0.0087	0.0368	0.0110	
47	0.4809	895.2823	1.0391	0.0118	0.0084	0.0386	0.0112	
48	0.4857	861.6546	1.0364	0.0120	0.0081	0.0405	0.0115	
49	0.4905	829.2899	1.0338	0.0123	0.0078	0.0425	0.0117	
50	0.4953	798.1410	1.0311	0.0125	0.0075	0.0445	0.0120	
51	0.4801	830.7086	1.0417	0.0131	0.0078	0.0425	0.0125	
52	0.4653	864.6052	1.0523	0.0136	0.0081	0.0405	0.0130	
53	0.4510	899.8946	1.0631	0.0142	0.0085	0.0386	0.0136	
54	0.4371	936.6040	1.0739	0.0149	0.0088	0.0369	0.0142	
55	0.4236	974.8216	1.0849	0.0155	0.0091	0.0352	0.0148	
56	0.4100	1022.8646	1.0932	0.0164	0.0096	0.0315	0.0157	
57	0.3969	1073.2754	1.0815	0.0173	0.0101	0.0282	0.0165	
58	0.3841	1126.1707	1.0797	0.0183	0.0105	0.0252	0.0175	
59	0.3718	1181.6728	1.0780	0.0193	0.0111	0.0226	0.0184	
60	0.3599	1239.9103	1.0763	0.0203	0.0116	0.0202	0.0195	
61	0.3501	1264.0964	1.1266	0.0216	0.0118	0.0202	0.0206	
62	0.3406	1288.7544	1.1792	0.0229	0.0121	0.0201	0.0219	
63	0.3313	1313.8933	1.2343	0.0243	0.0123	0.0201	0.0232	
64	0.3223	1339.5296	1.2920	0.0258	0.0126	0.0201	0.0247	
65	0.3135	1365.6518	1.3524	0.0274	0.0128	0.0200	0.0262	
66	0.3131	1350.2912	1.3589	0.0276	0.0127	0.0209	0.0264	
67	0.3127	1335.1033	1.3655	0.0278	0.0125	0.0218	0.0266	
68	0.3124	1320.0862	1.3722	0.0281	0.0124	0.0228	0.0269	
69	0.3120	1305.2381	1.3788	0.0283	0.0123	0.0238	0.0271	
70	0.3116	1290.5569	1.3855	0.0286	0.0122	0.0248	0.0273	

HIGHWAY EMISSIONS FACTORS (g/mi)								
Model Year 2044								
Mode	Speed	CO	CO2	NOX	PM10	SOX	VOC	PM2.5
Auto	0	1.7535	60.2289	0.1686	0.0008	0.0006	0.1451	0.0008
	5	0.5559	330.9034	0.0223	0.0019	0.0033	0.0249	0.0018
	6	0.5576	324.7042	0.0221	0.0018	0.0032	0.0233	0.0016
	7	0.5594	318.6210	0.0219	0.0017	0.0031	0.0217	0.0015
	8	0.5612	312.6518	0.0218	0.0016	0.0031	0.0203	0.0014
	8	0.6659	5.1023	0.7656	0.0000	0.0001	0.0203	0.0000
	5	0.6516	865.1623	0.4277	0.0100	0.0083	0.0478	0.0095
	6	0.6625	866.0485	0.5016	0.0097	0.0083	0.0465	0.0092
Truck	7	0.6737	866.9357	0.5882	0.0094	0.0082	0.0453	0.0090
	8	0.6850	867.8238	0.6897	0.0091	0.0082	0.0441	0.0087
	9	0.6966	868.7128	0.8088	0.0088	0.0082	0.0430	0.0084
	10	0.7083	869.6027	0.9484	0.0086	0.0081	0.0419	0.0082
	11	0.6600	836.5388	0.8852	0.0083	0.0078	0.0398	0.0079
	12	0.6150	804.7321	0.8261	0.0080	0.0075	0.0378	0.0077
	13	0.5731	774.1348	0.7710	0.0078	0.0073	0.0359	0.0074
	14	0.5340	744.7008	0.7196	0.0076	0.0070	0.0341	0.0072
	15	0.4976	716.3860	0.6716	0.0073	0.0067	0.0324	0.0070
	16	0.4584	707.5870	0.6712	0.0069	0.0067	0.0303	0.0066
	17	0.4222	698.8566	0.6709	0.0065	0.0066	0.0283	0.0062
	18	0.3890	690.2534	0.6706	0.0061	0.0065	0.0265	0.0058
	19	0.3583	681.7562	0.6703	0.0057	0.0064	0.0247	0.0055
	20	0.3300	673.3635	0.6699	0.0054	0.0063	0.0231	0.0052
	21	0.3157	654.8921	0.6323	0.0054	0.0062	0.0230	0.0051
	22	0.3021	636.9274	0.5968	0.0053	0.0060	0.0229	0.0051
	23	0.2890	619.4555	0.5632	0.0053	0.0058	0.0227	0.0050
	24	0.2765	602.4829	0.5316	0.0052	0.0057	0.0226	0.0050
	25	0.2645	585.9364	0.5017	0.0052	0.0055	0.0225	0.0049
	26	0.2525	579.6648	0.4836	0.0050	0.0054	0.0213	0.0047
	27	0.2410	573.4603	0.4662	0.0047	0.0054	0.0202	0.0045
	28	0.2300	567.3222	0.4493	0.0045	0.0053	0.0191	0.0043
	29	0.2196	561.2498	0.4331	0.0043	0.0053	0.0181	0.0041
	30	0.2096	555.2424	0.4175	0.0041	0.0052	0.0172	0.0039
	31	0.2018	559.8303	0.4131	0.0040	0.0052	0.0162	0.0038
	32	0.1942	564.4561	0.4088	0.0039	0.0053	0.0153	0.0038
	33	0.1870	569.1201	0.4045	0.0039	0.0053	0.0144	0.0037
	34	0.1800	573.8226	0.4003	0.0038	0.0053	0.0136	0.0036
	35	0.1733	578.5640	0.3961	0.0037	0.0054	0.0128	0.0035
	36	0.1688	584.0671	0.3883	0.0038	0.0054	0.0122	0.0036
	37	0.1645	589.6225	0.3806	0.0038	0.0055	0.0116	0.0037
	38	0.1603	595.2308	0.3731	0.0039	0.0055	0.0110	0.0038
	39	0.1561	600.8924	0.3658	0.0040	0.0056	0.0105	0.0038
	40	0.1521	606.6079	0.3586	0.0041	0.0056	0.0100	0.0039
41	0.1479	611.8629	0.3530	0.0044	0.0057	0.0098	0.0042	
42	0.1438	617.1633	0.3474	0.0046	0.0057	0.0096	0.0044	
43	0.1399	622.5096	0.3420	0.0049	0.0058	0.0094	0.0047	
44	0.1360	627.9023	0.3366	0.0052	0.0058	0.0093	0.0050	
45	0.1323							



**HEALTH COST OF TRANSPORTATION EMISSIONS**

(\$/ton)

Area	Proj Loc	CO	CO <sub>2e</sub>	NO <sub>x</sub>	PM <sub>10</sub>	SO <sub>x</sub>	VOC
LA/South Coast	1	\$170	\$48	\$69,200	\$566,800	\$213,000	\$4,300
CA Urban Area	2	\$90	\$48	\$20,300	\$163,700	\$81,700	\$1,415
CA Rural Area	3	\$80	\$48	\$15,100	\$116,700	\$59,000	\$1,110

CO<sub>2e</sub> Uprater: 2.0% increase in value per year

Sources: McCubbin and Delucchi, 1996 for emissions other than CO<sub>2e</sub>  
 Interagency Working Group on Social Cost of Carbon, United States Government, 2021 for CO<sub>2e</sub>

**PASSENGER TRAIN EMISSIONS FACTORS**

(g/train-mile)

Mode	Year	CO	CO <sub>2</sub>	NO <sub>x</sub>	PM <sub>10</sub>	SO <sub>x</sub>	VOC	PM <sub>2.5</sub>
Passenger Train	2010	8.11	5150.45	96.11	2.03			2.03
	2040	0.41	359.31	4.87	0.00			0.00

**LIGHT RAIL EMISSIONS FACTORS**

(g/veh-mile)

Mode	Year	CO	CO <sub>2</sub>	NO <sub>x</sub>	PM <sub>10</sub>	SO <sub>x</sub>	VOC	PM <sub>2.5</sub>
Light Rail	2021	0.31	1241.73	0.39	0.07	0.09	0.03	0.06
	2022	0.31	1241.73	0.39	0.07	0.09	0.03	0.06

**FREIGHT LOCOMOTIVE EMISSIONS FACTORS**

(g/gal)

Mode	Year	CO	CO <sub>2</sub>	NO <sub>x</sub>	PM <sub>10</sub>	SO <sub>x</sub>	VOC	PM <sub>2.5</sub>
Freight Rail	2020	26.62	10,217	107.38	3.20			3.11
	2030	26.62	10,217	70.92	1.88			1.83

Freight Rail Fuel Efficiency: 480 ton-miles/gal  
 Fuel Burned at Idle: 4 gal/hr

Sources: Argonne National Laboratory, Energy Systems, GREET Model, 2021  
 FTA, National Transit Database, Fuel and Energy, 2019  
 Energy Information Administration, Electricity Retail Sales, 2019  
 Association of American Railroads, Freight Rail & Preserving the Environment, April 2021  
 California Environmental Protection Agency / Air Resources Board, Technology Assessment: Freight Locomotives, November 2016

**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	1.000	1.025
25	1.000	1.025
50	1.000	1.025
75	1.000	1.025
100	1.000	1.025
125	1.000	1.025
150	1.000	1.013
175	1.000	1.000
200	1.000	0.980
225	1.000	0.949
250	1.000	0.919
275	0.991	0.890
300	0.981	0.862
325	0.971	0.834
350	0.961	0.808
375	0.952	0.782
400	0.942	0.758
425	0.932	0.734
450	0.923	0.709

Source: Botterill, 1996 and 1997

FUEL CONSUMPTION (percent adjustment)		
IRI	Auto	Truck
0	0.971	0.961
25	0.977	0.965
50	0.980	0.970
75	0.982	0.975
100	0.985	0.980
125	0.990	0.986
150	0.995	0.993
175	1.000	1.000
200	1.005	1.007
225	1.012	1.017
250	1.019	1.026
275	1.027	1.036
300	1.034	1.047
325	1.041	1.058
350	1.050	1.070
375	1.061	1.085
400	1.072	1.100
425	1.082	1.114
450	1.093	1.129

Source: Texas Transportation Institute, 1994

NON-FUEL COSTS (percent adjustment)		
IRI	Auto	Truck
0	1.000	1.000
25	1.000	1.000
50	1.000	1.000
75	1.000	1.000
100	1.000	1.000
125	1.000	1.000
150	1.017	1.018
175	1.034	1.038
200	1.052	1.058
225	1.070	1.078
250	1.088	1.097
275	1.105	1.117
300	1.123	1.137
325	1.141	1.156
350	1.159	1.176
375	1.176	1.196
400	1.194	1.216
425	1.212	1.235
450	1.230	1.255

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	1.000	1.000
0.002	0.982	0.988
0.004	0.964	0.976
0.006	0.945	0.964
0.008	0.927	0.952
0.010	0.909	0.939
0.012	0.891	0.927
0.014	0.873	0.915
0.016	0.855	0.903
0.018	0.836	0.891
0.020	0.789	0.879
0.022	0.747	0.867
0.024	0.706	0.855
0.026	0.664	0.842
0.028	0.623	0.817
0.030	0.581	0.799
0.032	0.540	0.761
0.034	0.498	0.734
0.036	0.476	0.706
0.038	0.473	0.678
0.040	0.471	0.650
0.042	0.468	0.623
0.044	0.466	0.595
0.046	0.463	0.567
0.048	0.460	0.540
0.050	0.458	0.512
0.052	0.455	0.484
0.054	0.453	0.476
0.056	0.453	0.474
0.058	0.453	0.473
0.060	0.453	0.471
0.062	0.453	0.469
0.064	0.453	0.467
0.066	0.453	0.466
0.068	0.453	0.464
0.070	0.453	0.462
0.072	0.453	0.460
0.074	0.453	0.459
0.076	0.453	0.457
0.078	0.453	0.455
0.080	0.453	0.453

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	1.00
ORsev	0.95	1.03	1.00	1.00	0.00	0.00	5.67	1.00
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
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  
27) 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

27  
27

**Reliability Tables** (used for calculating travel time reliability impacts if included)

<b>C11 RELIABILITY PARAMETERS</b> (coefficients for standard deviation calculations)			
AlphaTTI	BetaTTI	AlphaSTD	BetaSTD
1.0274	1.2204	0.71	0.56

Source: Pricing and Travel Time Reliability Enhancements in the SANDAG Activity-Based Travel Model: Final Report, 2016.

<b>RELIABILITY RATIO</b> (value of reliability relative to value of time)	
Mode	Value
Auto	0.8
Truck	1.1

Source: SHRP2 Project C11: Reliability Analysis Tool: User's Guide, January 2013.