

District: **TxDOT Houston**

PROJECT: **SH 105 from 10th St to LP 336**

EA:

| |
|----------|
| Arterial |
|----------|

PPNO:

| |
|-------------|
| 0338-04-060 |
|-------------|

3

INVESTMENT ANALYSIS SUMMARY RESULTS

| | |
|--------------------------------------|---------|
| Life-Cycle Costs (mil. \$) | \$21.1 |
| Life-Cycle Benefits (mil. \$) | \$507.5 |
| Net Present Value (mil. \$) | \$486.4 |
| Benefit / Cost Ratio: | 24.1 |
| Rate of Return on Investment: | 85.2% |
| Payback Period: | 1 year |

| ITEMIZED BENEFITS (mil. \$) | Average Annual | Total Over 20 Years |
|---|-----------------------|----------------------------|
| Travel Time Savings | \$3.0 | \$60.5 |
| Veh. Op. Cost Savings | \$0.1 | \$1.3 |
| Accident Cost Savings | \$22.3 | \$445.5 |
| Emission Cost Savings | \$0.0 | \$0.2 |
| TOTAL BENEFITS | \$25.4 | \$507.5 |
| Person-Hours of Time Saved | 242,501 | 4,850,024 |
| CO₂ Emissions Saved (tons) | 364 | 7,275 |
| CO₂ Emissions Saved (mil. \$) | \$0.0 | \$0.1 |

Should benefit-cost results include:

1) Induced Travel? (y/n) Default = Y

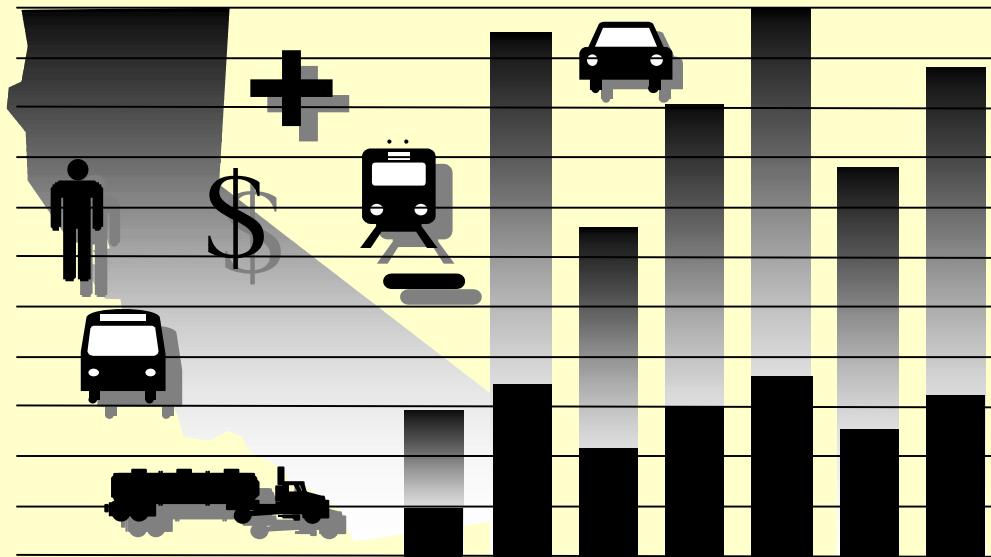
2) Vehicle Operating Costs? (y/n) Default = Y

3) Accident Costs? (y/n) Default = Y

4) Vehicle Emissions? (y/n) Default = Y
includes value for CO₂e



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



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

For questions and comments, please contact:

Barry Padilla

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

District: **TxDOT Houston**

PROJECT: **SH 105 from 10th St to LP 336**

Facility Type: **Arterial**
 CSJ #: **0338-04-060**

1A PROJECT DATA

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

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

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

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

1C HIGHWAY ACCIDENT DATA

Actual 3-Year Accident Data (from Table B)

| | Count (No.) | Rate |
|--------------------------------------|-------------|-------|
| Total Accidents (Tot) | 727 | 24.85 |
| Fatal Accidents (Fat) | 3 | 0.103 |
| Injury Accidents (Inj) | 249 | 8.51 |
| Property Damage Only (PDO) Accidents | 475 | 16.24 |

Statewide Basic Average Accident Rate

| | No Build | Build |
|---|----------|-------|
| Rate Group | | |
| Accident Rate (per million vehicle-miles) | 0.46 | 0.29 |
| Percent Fatal Accidents (Pct Fat) | 1.0% | 0.5% |
| Percent Injury Accidents (Pct Inj) | 49.2% | 27.0% |

1B HIGHWAY DESIGN AND TRAFFIC DATA

Highway Design

| | No Build | Build |
|---|----------|-------|
| Roadway Type (Fwy, Exp, Conv Hwy) | C | C |
| Number of General Traffic Lanes | 2 | 4 |
| Number of HOV/HOT Lanes | | |
| HOV Restriction (2 or 3) | | |
| Exclusive ROW for Buses (y/n) | N | |
| Highway Free-Flow Speed | 40 | 60 |
| Ramp Design Speed (if aux. lane/off-ramp proj.) | 35 | 35 |
| Length (in miles) Highway Segment | 2.6 | 2.6 |
| Impacted Length | 2.6 | 2.6 |

Average Daily Traffic

| | No Build | Build |
|--------------------|----------|--------|
| Current | 14,424 | |
| Base (Year 1) | 15,682 | 15,682 |
| Forecast (Year 20) | 27,638 | 27,638 |

Average Hourly HOV/HOT Lane Traffic

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

Percent Traffic in Weave: 0.0%

Percent Trucks (include RVs, if applicable): 8%

Truck Speed

On-Ramp Volume

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

Queue Formation (if queuing or grade crossing project)

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

Pavement Condition (if pavement project)

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

Average Vehicle Occupancy (AVO)

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

1D RAIL AND TRANSIT DATA

Annual Person-Trips

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

Percent Trips during Peak Period: 54%

Percent New Trips from Parallel Highway: 100%

Annual Vehicle-Miles

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

Average Vehicles/Train (if rail project)

Reduction in Transit Accidents

Percent Reduction (if safety project)

Average Transit Travel Time

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

Highway Grade Crossing

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

Transit Agency Costs (if TMS project)

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

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

Prepare Model for Second Road

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

| 1E PROJECT COSTS (enter costs in thousands of dollars) | | | | | | | | | |
|--|----------------------|-------|--------------|------------------|--------|------------|-----------------------------|--------------------------|---------------|
| Col. no. | (1) | (2) | (3) | (4) | (5) | (6) | (7) | | |
| Year | DIRECT PROJECT COSTS | | | SUBSEQUENT COSTS | | Mitigation | Transit Agency Cost Savings | TOTAL COSTS (in dollars) | |
| | Project Support | R / W | Construction | Maint./ Op. | Rehab. | | | Constant Dollars | Present Value |
| Construction Period | | | | | | | | | |
| 1 | | | \$10,700 | | | | | \$10,700,000 | \$10,700,000 |
| 2 | | | 10,700 | | | | | 10,700,000 | 10,388,350 |
| 3 | | | | | | | | 0 | 0 |
| 4 | | | | | | | | 0 | 0 |
| 5 | | | | | | | | 0 | 0 |
| 6 | | | | | | | | 0 | 0 |
| 7 | | | | | | | | 0 | 0 |
| 8 | | | | | | | | 0 | 0 |
| Project Open | | | | | | | | | |
| 1 | | | | | | | | \$0 | \$0 |
| 2 | | | | | | | | 0 | 0 |
| 3 | | | | | | | | 0 | 0 |
| 4 | | | | | | | | 0 | 0 |
| 5 | | | | | | | | 0 | 0 |
| 6 | | | | | | | | 0 | 0 |
| 7 | | | | | | | | 0 | 0 |
| 8 | | | | | | | | 0 | 0 |
| 9 | | | | | | | | 0 | 0 |
| 10 | | | | | | | | 0 | 0 |
| 11 | | | | | | | | 0 | 0 |
| 12 | | | | | | | | 0 | 0 |
| 13 | | | | | | | | 0 | 0 |
| 14 | | | | | | | | 0 | 0 |
| 15 | | | | | | | | 0 | 0 |
| 16 | | | | | | | | 0 | 0 |
| 17 | | | | | | | | 0 | 0 |
| 18 | | | | | | | | 0 | 0 |
| 19 | | | | | | | | 0 | 0 |
| 20 | | | | | | | | 0 | 0 |
| Total | \$0 | \$0 | \$21,400 | \$0 | \$0 | \$0 | \$0 | \$21,400,000 | \$21,088,350 |

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

HIGHWAY SPEED AND VOLUME INPUTS

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

No Build

Year 1

Peak Period

| | | | | |
|----------------|-------|--|-------|--|
| HOV Volume | 0 | | 0 | |
| Non-HOV Volume | 7,719 | | 7,719 | |
| Weaving Volume | 0 | | 0 | |
| Truck Volume | 671 | | 671 | |
| HOV Speed | 55.0 | | 55.0 | |
| Non-HOV Speed | 39.9 | | 39.9 | |
| Weaving Speed | 55.0 | | 55.0 | |
| Truck Speed | 39.9 | | 39.9 | |

Non-Peak Period

| | | | | |
|----------------|-------|--|-------|--|
| Non-HOV Volume | 6,709 | | 6,709 | |
| Weaving Volume | 0 | | 0 | |
| Truck Volume | 583 | | 583 | |
| Non-HOV Speed | 40.0 | | 40.0 | |
| Weaving Speed | 55.0 | | 55.0 | |
| Truck Speed | 40.0 | | 40.0 | |

Year 20

Peak Period

| | | | | |
|----------------|--------|--|--------|--|
| HOV Volume | 0 | | 0 | |
| Non-HOV Volume | 13,603 | | 13,603 | |
| Weaving Volume | 0 | | 0 | |
| Truck Volume | 1,183 | | 1,183 | |
| HOV Speed | 55.0 | | 55.0 | |
| Non-HOV Speed | 22.2 | | 22.2 | |
| Weaving Speed | 55.0 | | 55.0 | |
| Truck Speed | 22.2 | | 22.2 | |

Non-Peak Period

| | | | | |
|----------------|--------|--|--------|--|
| Non-HOV Volume | 11,824 | | 11,824 | |
| Weaving Volume | 0 | | 0 | |
| Truck Volume | 1,028 | | 1,028 | |
| Non-HOV Speed | 40.0 | | 40.0 | |
| Weaving Speed | 55.0 | | 55.0 | |
| Truck Speed | 40.0 | | 40.0 | |

Build

Year 1

Peak Period

| | | | | |
|----------------|-------|--|-------|--|
| HOV Volume | 0 | | 0 | |
| Non-HOV Volume | 7,719 | | 7,719 | |
| Weaving Volume | 0 | | 0 | |
| Truck Volume | 671 | | 671 | |
| HOV Speed | 55.0 | | 55.0 | |
| Non-HOV Speed | 60.0 | | 60.0 | |
| Weaving Speed | 55.0 | | 55.0 | |
| Truck Speed | 60.0 | | 60.0 | |

Non-Peak Period

| | | | | |
|----------------|-------|--|-------|--|
| Non-HOV Volume | 6,709 | | 6,709 | |
| Weaving Volume | 0 | | 0 | |
| Truck Volume | 583 | | 583 | |
| Non-HOV Speed | 60.0 | | 60.0 | |
| Weaving Speed | 55.0 | | 55.0 | |
| Truck Speed | 60.0 | | 60.0 | |

Year 20

Peak Period

| | | | | |
|----------------|--------|--|--------|--|
| HOV Volume | 0 | | 0 | |
| Non-HOV Volume | 13,603 | | 13,603 | |
| Weaving Volume | 0 | | 0 | |
| Truck Volume | 1,183 | | 1,183 | |
| HOV Speed | 55.0 | | 55.0 | |
| Non-HOV Speed | 60.0 | | 60.0 | |
| Weaving Speed | 55.0 | | 55.0 | |
| Truck Speed | 60.0 | | 60.0 | |

Non-Peak Period

| | | | | |
|----------------|--------|--|--------|--|
| Non-HOV Volume | 11,824 | | 11,824 | |
| Weaving Volume | 0 | | 0 | |
| Truck Volume | 1,028 | | 1,028 | |
| Non-HOV Speed | 60.0 | | 60.0 | |
| Weaving Speed | 55.0 | | 55.0 | |
| Truck Speed | 60.0 | | 60.0 | |

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

2B

HIGHWAY ACCIDENT RATES

| | Calculated by Model | Changed by User | Used for Proj. Eval. | Reason for Change |
|---|---------------------|-----------------|----------------------|-------------------|
| No Build | | | | |
| Fatal Accidents | 0.103 | | 0.103 | |
| Injury Accidents | 8.51 | | 8.51 | |
| PDO Accidents | 16.24 | | 16.24 | |
| Total Accidents | 24.853 | | | |
| Hwy Safety or Weaving Improvement <input type="text" value="0%"/> collision reduction factor (per HSIP Guidelines) | | | | |
| Adjustment Factor (Actual/Statewide Avg. Existing) | | | | |
| Fatal Accidents | 23.0457 | | 23.0457 | |
| Injury Accidents | 37.9651 | | 37.9651 | |
| PDO Accidents | 71.4044 | | 71.4044 | |
| Build | | | | |
| Fatal Accidents | 0.036 | | 0.036 | |
| Injury Accidents | 2.93 | | 2.93 | |
| PDO Accidents | 14.78 | | 14.78 | |
| Total Accidents | 17.749 | | | |

2C

RAMP AND ARTERIAL INPUTS

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

| | | |
|--|----------------------|--------------------------------|
| Detailed Information Available? (y/n) | | <input type="text" value="N"/> |
| Aggregate Segment Length (estimate as VMT/total volume) | | |
| All Ramps | <input type="text"/> | miles |
| Arterials | <input type="text"/> | miles |

| | Entered by User | Used for Proj. Eval. | Source/Notes |
|------------------------------------|----------------------|----------------------|--------------|
| No Build (Peak Period Only) | | | |
| Year 1 | | | |
| Aggregate Ramp Volume | <input type="text"/> | 0 | |
| Aggregate Arterial Volume | <input type="text"/> | 0 | |
| Average Ramp Speed | <input type="text"/> | 5.0 | |
| Average Arterial Speed | <input type="text"/> | 5.0 | |
| Year 20 | | | |
| Aggregate Ramp Volume | <input type="text"/> | 0 | |
| Aggregate Arterial Volume | <input type="text"/> | 0 | |
| Average Ramp Speed | <input type="text"/> | 5.0 | |
| Average Arterial Speed | <input type="text"/> | 5.0 | |
| Build (Peak Period Only) | | | |
| Year 1 | | | |
| Aggregate Ramp Volume | <input type="text"/> | 0 | |
| Aggregate Arterial Volume | <input type="text"/> | 0 | |
| Average Ramp Speed | <input type="text"/> | 5.0 | |
| Average Arterial Speed | <input type="text"/> | 5.0 | |
| Year 20 | | | |
| Aggregate Ramp Volume | <input type="text"/> | 0 | |
| Aggregate Arterial Volume | <input type="text"/> | 0 | |
| Average Ramp Speed | <input type="text"/> | 5.0 | |
| Average Arterial Speed | <input type="text"/> | 5.0 | |

2D

ANNUAL PERSON-TRIPS

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

| | No Build | Build | Induced |
|-----------------|-----------|-----------|---------|
| Year 1 | | | |
| Peak Period | | | |
| HOV Trips | 0 | 0 | |
| Non-HOV Trips | 2,508,647 | 2,508,647 | 0 |
| Truck Trips | 174,515 | 174,515 | 0 |
| Non-Peak Period | | | |
| Non-HOV Trips | 2,302,516 | 2,302,516 | 0 |
| Truck Trips | 151,681 | 151,681 | 0 |
| Total Trips | 5,137,359 | 5,137,359 | 0 |

| | | | |
|-----------------|-----------|-----------|---|
| Year 20 | | | |
| Peak Period | | | |
| HOV Trips | 0 | 0 | |
| Non-HOV Trips | 4,421,113 | 4,421,113 | 0 |
| Truck Trips | 307,556 | 307,556 | 0 |
| Non-Peak Period | | | |
| Non-HOV Trips | 4,057,838 | 4,057,838 | 0 |
| Truck Trips | 267,315 | 267,315 | 0 |
| Total Trips | 9,053,821 | 9,053,821 | 0 |

SUMMARY OF TRAVEL TIME BENEFITS

| Year | HIGHWAY | | | | | | | | |
|--------------|------------|---------------------|--------------|--------------------|------------|---------------|---------------------|------------------|--------------------|
| | Peak HOV | Peak Non-HOV | Peak Weaving | Peak Truck | Peak Ramp | Peak Arterial | Non-Peak Non-HOV | Non-Peak Weaving | Non-Peak Truck |
| 1 | \$0 | \$799,853 | \$0 | \$96,978 | \$0 | \$0 | \$728,652 | \$0 | \$83,660 |
| 20 | \$0 | \$3,408,321 | \$0 | \$413,241 | \$0 | \$0 | \$918,618 | \$0 | \$105,471 |
| 2 | \$0 | \$875,739 | \$0 | \$106,179 | \$0 | \$0 | \$744,644 | \$0 | \$85,496 |
| 3 | \$0 | \$956,065 | \$0 | \$115,918 | \$0 | \$0 | \$759,854 | \$0 | \$87,243 |
| 4 | \$0 | \$1,041,068 | \$0 | \$126,224 | \$0 | \$0 | \$774,305 | \$0 | \$88,902 |
| 5 | \$0 | \$1,131,013 | \$0 | \$137,130 | \$0 | \$0 | \$788,019 | \$0 | \$90,477 |
| 6 | \$0 | \$1,226,198 | \$0 | \$148,670 | \$0 | \$0 | \$801,017 | \$0 | \$91,969 |
| 7 | \$0 | \$1,326,955 | \$0 | \$160,886 | \$0 | \$0 | \$813,320 | \$0 | \$93,382 |
| 8 | \$0 | \$1,433,661 | \$0 | \$173,824 | \$0 | \$0 | \$824,949 | \$0 | \$94,717 |
| 9 | \$0 | \$1,546,737 | \$0 | \$187,534 | \$0 | \$0 | \$835,922 | \$0 | \$95,977 |
| 10 | \$0 | \$1,666,660 | \$0 | \$202,074 | \$0 | \$0 | \$846,260 | \$0 | \$97,164 |
| 11 | \$0 | \$1,793,968 | \$0 | \$217,509 | \$0 | \$0 | \$855,982 | \$0 | \$98,280 |
| 12 | \$0 | \$1,929,273 | \$0 | \$233,914 | \$0 | \$0 | \$865,105 | \$0 | \$99,327 |
| 13 | \$0 | \$2,073,267 | \$0 | \$251,373 | \$0 | \$0 | \$873,648 | \$0 | \$100,308 |
| 14 | \$0 | \$2,226,743 | \$0 | \$269,981 | \$0 | \$0 | \$881,629 | \$0 | \$101,224 |
| 15 | \$0 | \$2,390,604 | \$0 | \$289,848 | \$0 | \$0 | \$889,063 | \$0 | \$102,078 |
| 16 | \$0 | \$2,565,889 | \$0 | \$311,101 | \$0 | \$0 | \$895,968 | \$0 | \$102,871 |
| 17 | \$0 | \$2,753,798 | \$0 | \$333,884 | \$0 | \$0 | \$902,361 | \$0 | \$103,605 |
| 18 | \$0 | \$2,955,716 | \$0 | \$358,365 | \$0 | \$0 | \$908,256 | \$0 | \$104,282 |
| 19 | \$0 | \$3,173,260 | \$0 | \$384,742 | \$0 | \$0 | \$913,670 | \$0 | \$104,903 |
| Total | \$0 | \$37,274,786 | \$0 | \$4,519,376 | \$0 | \$0 | \$16,821,243 | \$0 | \$1,931,335 |

C

SUMMARY OF TRAVEL TIME BENEFITS (continued)

| Year | TRANSIT | | | | Present Value of Travel Time Benefits | Constant Dollars | Total Per-Hrs of Time Saved |
|--------------|-----------------|-----------------|---------------------|---------------------|---------------------------------------|---------------------|-----------------------------|
| | Peak In-Vehicle | Peak Out-of-Veh | Non-Peak In-Vehicle | Non-Peak Out-of-Veh | | | |
| 1 | \$0 | \$0 | \$0 | \$0 | \$1,709,144 | \$1,813,231 | 111,747 |
| 20 | \$0 | \$0 | \$0 | \$0 | \$4,845,651 | \$9,014,339 | 442,611 |
| 2 | \$0 | \$0 | \$0 | \$0 | \$1,812,058 | \$1,980,084 | 120,578 |
| 3 | \$0 | \$0 | \$0 | \$0 | \$1,919,079 | \$2,159,941 | 129,965 |
| 4 | \$0 | \$0 | \$0 | \$0 | \$2,030,499 | \$2,353,905 | 139,952 |
| 5 | \$0 | \$0 | \$0 | \$0 | \$2,146,638 | \$2,563,198 | 150,583 |
| 6 | \$0 | \$0 | \$0 | \$0 | \$2,267,854 | \$2,789,174 | 161,910 |
| 7 | \$0 | \$0 | \$0 | \$0 | \$2,394,543 | \$3,033,335 | 173,989 |
| 8 | \$0 | \$0 | \$0 | \$0 | \$2,527,150 | \$3,297,357 | 186,884 |
| 9 | \$0 | \$0 | \$0 | \$0 | \$2,666,169 | \$3,583,109 | 200,665 |
| 10 | \$0 | \$0 | \$0 | \$0 | \$2,812,157 | \$3,892,684 | 215,410 |
| 11 | \$0 | \$0 | \$0 | \$0 | \$2,965,739 | \$4,228,435 | 231,208 |
| 12 | \$0 | \$0 | \$0 | \$0 | \$3,127,620 | \$4,593,015 | 248,157 |
| 13 | \$0 | \$0 | \$0 | \$0 | \$3,298,597 | \$4,989,424 | 266,370 |
| 14 | \$0 | \$0 | \$0 | \$0 | \$3,479,577 | \$5,421,067 | 285,974 |
| 15 | \$0 | \$0 | \$0 | \$0 | \$3,671,593 | \$5,891,829 | 307,114 |
| 16 | \$0 | \$0 | \$0 | \$0 | \$3,875,830 | \$6,406,156 | 329,954 |
| 17 | \$0 | \$0 | \$0 | \$0 | \$4,093,647 | \$6,969,160 | 354,686 |
| 18 | \$0 | \$0 | \$0 | \$0 | \$4,326,620 | \$7,586,754 | 381,529 |
| 19 | \$0 | \$0 | \$0 | \$0 | \$4,576,575 | \$8,265,804 | 410,738 |
| Total | \$0 | \$0 | \$0 | \$0 | \$60,546,740 | \$90,832,000 | 4,850,024 |

SUMMARY OF VEHICLE OPERATING COST BENEFITS

| Year | HIGHWAY | | | | | | TRANSIT | | Present Value of Veh Op Cost Benefits | Constant Dollars | | |
|--------------|------------|--------------------|--------------|------------------|---------------|--------------------|------------------|--------------------|---------------------------------------|------------------|--------------------|--------------------|
| | Peak HOV | Peak Non-HOV | Peak Weaving | Peak Truck | Peak Arterial | Non-Peak Non-HOV | Non-Peak Weaving | Non-Peak Truck | | | Peak Period | Non-Peak Period |
| 1 | \$0 | (\$32,462) | \$0 | (\$5,081) | \$0 | (\$35,909) | \$0 | (\$5,520) | - | - | (\$78,972) | (\$83,782) |
| 20 | \$0 | \$286,215 | \$0 | \$42,555 | \$0 | (\$36,090) | \$0 | (\$5,548) | - | - | \$287,131 | \$534,148 |
| 2 | \$0 | (\$23,841) | \$0 | (\$3,848) | \$0 | (\$36,262) | \$0 | (\$5,574) | - | - | (\$69,526) | (\$75,972) |
| 3 | \$0 | (\$24,039) | \$0 | (\$3,880) | \$0 | (\$36,564) | \$0 | (\$5,621) | - | - | (\$70,104) | (\$78,903) |
| 4 | \$0 | (\$15,129) | \$0 | (\$2,460) | \$0 | (\$36,818) | \$0 | (\$5,660) | - | - | (\$60,066) | (\$69,633) |
| 5 | \$0 | (\$6,086) | \$0 | (\$1,164) | \$0 | (\$37,026) | \$0 | (\$5,692) | - | - | (\$49,967) | (\$59,663) |
| 6 | \$0 | \$3,056 | \$0 | \$146 | \$0 | (\$37,190) | \$0 | (\$5,717) | - | - | (\$39,705) | (\$48,832) |
| 7 | \$0 | \$18,399 | \$0 | \$2,347 | \$0 | (\$37,313) | \$0 | (\$5,736) | - | - | (\$22,304) | (\$28,254) |
| 8 | \$0 | \$33,808 | \$0 | \$4,557 | \$0 | (\$37,398) | \$0 | (\$5,749) | - | - | (\$4,783) | (\$6,241) |
| 9 | \$0 | \$49,238 | \$0 | \$6,770 | \$0 | (\$37,446) | \$0 | (\$5,756) | - | - | \$12,806 | \$17,210 |
| 10 | \$0 | \$64,648 | \$0 | \$8,981 | \$0 | (\$37,460) | \$0 | (\$5,759) | - | - | \$30,411 | \$42,096 |
| 11 | \$0 | \$80,000 | \$0 | \$11,184 | \$0 | (\$37,441) | \$0 | (\$5,756) | - | - | \$47,988 | \$68,419 |
| 12 | \$0 | \$102,941 | \$0 | \$14,696 | \$0 | (\$37,391) | \$0 | (\$5,748) | - | - | \$74,498 | \$109,403 |
| 13 | \$0 | \$125,723 | \$0 | \$18,038 | \$0 | (\$37,313) | \$0 | (\$5,736) | - | - | \$100,712 | \$152,337 |
| 14 | \$0 | \$146,771 | \$0 | \$21,497 | \$0 | (\$37,207) | \$0 | (\$5,720) | - | - | \$125,341 | \$195,277 |
| 15 | \$0 | \$169,106 | \$0 | \$24,773 | \$0 | (\$37,076) | \$0 | (\$5,700) | - | - | \$151,103 | \$242,476 |
| 16 | \$0 | \$191,155 | \$0 | \$28,152 | \$0 | (\$36,921) | \$0 | (\$5,676) | - | - | \$176,710 | \$292,075 |
| 17 | \$0 | \$223,452 | \$0 | \$33,071 | \$0 | (\$36,743) | \$0 | (\$5,648) | - | - | \$214,131 | \$364,544 |
| 18 | \$0 | \$222,244 | \$0 | \$32,893 | \$0 | (\$36,545) | \$0 | (\$5,618) | - | - | \$212,974 | \$373,452 |
| 19 | \$0 | \$253,757 | \$0 | \$37,694 | \$0 | (\$36,327) | \$0 | (\$5,584) | - | - | \$249,540 | \$450,697 |
| Total | \$0 | \$1,868,956 | \$0 | \$270,921 | \$0 | (\$738,441) | \$0 | (\$113,518) | - | - | \$1,287,919 | \$2,390,853 |

SUMMARY OF ACCIDENT REDUCTION BENEFITS

| Year | HIGHWAY | | | | | | | | | TRANSIT | Present Value of Accident Benefits | Constant Dollars |
|--------------|------------|----------------------|--------------|---------------------|---------------|----------------------|------------------|---------------------|-------------|----------------------|------------------------------------|------------------|
| | Peak HOV | Peak Non-HOV | Peak Weaving | Peak Truck | Peak Arterial | Non-Peak Non-HOV | Non-Peak Weaving | Non-Peak Truck | All Periods | | | |
| 1 | \$0 | \$10,662,346 | \$0 | \$927,161 | \$0 | \$9,267,273 | \$0 | \$805,850 | \$0 | \$21,662,629 | \$22,981,883 | |
| 20 | \$0 | \$10,716,118 | \$0 | \$931,836 | \$0 | \$9,314,009 | \$0 | \$809,914 | \$0 | \$21,771,877 | \$40,502,104 | |
| 2 | \$0 | \$10,767,144 | \$0 | \$936,273 | \$0 | \$9,358,359 | \$0 | \$813,770 | \$0 | \$21,875,546 | \$23,904,000 | |
| 3 | \$0 | \$10,856,792 | \$0 | \$944,069 | \$0 | \$9,436,277 | \$0 | \$820,546 | \$0 | \$22,057,683 | \$24,826,117 | |
| 4 | \$0 | \$10,932,083 | \$0 | \$950,616 | \$0 | \$9,501,717 | \$0 | \$826,236 | \$0 | \$22,210,652 | \$25,748,233 | |
| 5 | \$0 | \$10,993,778 | \$0 | \$955,981 | \$0 | \$9,555,340 | \$0 | \$830,899 | \$0 | \$22,335,999 | \$26,670,350 | |
| 6 | \$0 | \$11,042,606 | \$0 | \$960,227 | \$0 | \$9,597,779 | \$0 | \$834,589 | \$0 | \$22,435,201 | \$27,592,467 | |
| 7 | \$0 | \$11,079,263 | \$0 | \$963,414 | \$0 | \$9,629,639 | \$0 | \$837,360 | \$0 | \$22,509,676 | \$28,514,584 | |
| 8 | \$0 | \$11,104,416 | \$0 | \$965,601 | \$0 | \$9,651,502 | \$0 | \$839,261 | \$0 | \$22,560,780 | \$29,436,701 | |
| 9 | \$0 | \$11,118,705 | \$0 | \$966,844 | \$0 | \$9,663,921 | \$0 | \$840,341 | \$0 | \$22,589,812 | \$30,358,818 | |
| 10 | \$0 | \$11,122,742 | \$0 | \$967,195 | \$0 | \$9,667,430 | \$0 | \$840,646 | \$0 | \$22,598,013 | \$31,280,935 | |
| 11 | \$0 | \$11,117,111 | \$0 | \$966,705 | \$0 | \$9,662,536 | \$0 | \$840,220 | \$0 | \$22,586,573 | \$32,203,052 | |
| 12 | \$0 | \$11,102,372 | \$0 | \$965,424 | \$0 | \$9,649,725 | \$0 | \$839,107 | \$0 | \$22,556,628 | \$33,125,169 | |
| 13 | \$0 | \$11,079,061 | \$0 | \$963,397 | \$0 | \$9,629,464 | \$0 | \$837,345 | \$0 | \$22,509,267 | \$34,047,285 | |
| 14 | \$0 | \$11,047,689 | \$0 | \$960,669 | \$0 | \$9,602,197 | \$0 | \$834,974 | \$0 | \$22,445,529 | \$34,969,402 | |
| 15 | \$0 | \$11,008,746 | \$0 | \$957,282 | \$0 | \$9,568,349 | \$0 | \$832,030 | \$0 | \$22,366,408 | \$35,891,519 | |
| 16 | \$0 | \$10,962,699 | \$0 | \$953,278 | \$0 | \$9,528,328 | \$0 | \$828,550 | \$0 | \$22,272,855 | \$36,813,636 | |
| 17 | \$0 | \$10,909,996 | \$0 | \$948,695 | \$0 | \$9,482,520 | \$0 | \$824,567 | \$0 | \$22,165,778 | \$37,735,753 | |
| 18 | \$0 | \$10,851,062 | \$0 | \$943,571 | \$0 | \$9,431,297 | \$0 | \$820,113 | \$0 | \$22,046,043 | \$38,657,870 | |
| 19 | \$0 | \$10,786,307 | \$0 | \$937,940 | \$0 | \$9,375,014 | \$0 | \$815,219 | \$0 | \$21,914,479 | \$39,579,987 | |
| Total | \$0 | \$219,261,036 | \$0 | \$19,066,177 | \$0 | \$190,572,676 | \$0 | \$16,571,537 | \$0 | \$445,471,426 | \$634,839,865 | |

SUMMARY OF EMISSION REDUCTION BENEFITS

| Year | HIGHWAY | | | | | | | | |
|--------------|------------|------------------|--------------|-----------------|------------|---------------|-------------------|------------------|-------------------|
| | Peak HOV | Peak Non-HOV | Peak Weaving | Peak Truck | Peak Ramp | Peak Arterial | Non-Peak Non-HOV | Non-Peak Weaving | Non-Peak Truck |
| 1 | \$0 | (\$2,962) | \$0 | (\$1,078) | \$0 | \$0 | (\$3,430) | \$0 | (\$1,036) |
| 20 | \$0 | \$37,414 | \$0 | \$4,929 | \$0 | \$0 | (\$4,188) | \$0 | (\$706) |
| 2 | \$0 | (\$2,038) | \$0 | (\$964) | \$0 | \$0 | (\$3,520) | \$0 | (\$1,054) |
| 3 | \$0 | (\$2,092) | \$0 | (\$978) | \$0 | \$0 | (\$3,607) | \$0 | (\$1,071) |
| 4 | \$0 | (\$1,319) | \$0 | (\$850) | \$0 | \$0 | (\$3,691) | \$0 | (\$1,087) |
| 5 | \$0 | (\$282) | \$0 | (\$716) | \$0 | \$0 | (\$3,773) | \$0 | (\$1,102) |
| 6 | \$0 | \$774 | \$0 | (\$594) | \$0 | \$0 | (\$3,851) | \$0 | (\$1,116) |
| 7 | \$0 | \$2,468 | \$0 | (\$358) | \$0 | \$0 | (\$3,928) | \$0 | (\$1,129) |
| 8 | \$0 | \$4,070 | \$0 | \$357 | \$0 | \$0 | (\$3,428) | \$0 | (\$604) |
| 9 | \$0 | \$5,767 | \$0 | \$577 | \$0 | \$0 | (\$3,500) | \$0 | (\$614) |
| 10 | \$0 | \$7,538 | \$0 | \$807 | \$0 | \$0 | (\$3,571) | \$0 | (\$624) |
| 11 | \$0 | \$9,366 | \$0 | \$1,059 | \$0 | \$0 | (\$3,640) | \$0 | (\$634) |
| 12 | \$0 | \$12,022 | \$0 | \$1,433 | \$0 | \$0 | (\$3,708) | \$0 | (\$643) |
| 13 | \$0 | \$14,778 | \$0 | \$1,799 | \$0 | \$0 | (\$3,773) | \$0 | (\$652) |
| 14 | \$0 | \$17,578 | \$0 | \$2,194 | \$0 | \$0 | (\$3,837) | \$0 | (\$661) |
| 15 | \$0 | \$20,645 | \$0 | \$2,597 | \$0 | \$0 | (\$3,900) | \$0 | (\$669) |
| 16 | \$0 | \$23,605 | \$0 | \$3,010 | \$0 | \$0 | (\$3,960) | \$0 | (\$677) |
| 17 | \$0 | \$27,970 | \$0 | \$3,625 | \$0 | \$0 | (\$4,020) | \$0 | (\$685) |
| 18 | \$0 | \$28,293 | \$0 | \$3,669 | \$0 | \$0 | (\$4,077) | \$0 | (\$692) |
| 19 | \$0 | \$32,814 | \$0 | \$4,285 | \$0 | \$0 | (\$4,134) | \$0 | (\$699) |
| Total | \$0 | \$236,408 | \$0 | \$24,802 | \$0 | \$0 | (\$75,537) | \$0 | (\$16,156) |

SUMMARY OF EMISSION REDUCTION BENEFITS (continued)

| Year | TRANSIT | | | | Present Value of Emission Benefits | Constant Dollars | CO ₂ EMISSIONS SAVED | |
|--------------|------------|--------------|----------------|------------|------------------------------------|------------------|---------------------------------|------------------|
| | Peak Bus | Non-Peak Bus | Passenger Rail | Light Rail | | | tons/yr | PV \$/yr |
| 1 | \$0 | \$0 | \$0 | \$0 | (\$8,507) | (\$9,025) | (256) | (\$6,029) |
| 20 | \$0 | \$0 | \$0 | \$0 | \$37,448 | \$69,665 | 1,634 | \$31,954 |
| 2 | \$0 | \$0 | \$0 | \$0 | (\$7,576) | (\$8,279) | (232) | (\$5,410) |
| 3 | \$0 | \$0 | \$0 | \$0 | (\$7,749) | (\$8,721) | (241) | (\$5,564) |
| 4 | \$0 | \$0 | \$0 | \$0 | (\$6,948) | (\$8,054) | (213) | (\$4,870) |
| 5 | \$0 | \$0 | \$0 | \$0 | (\$5,873) | (\$7,013) | (182) | (\$4,128) |
| 6 | \$0 | \$0 | \$0 | \$0 | (\$4,788) | (\$5,888) | (149) | (\$3,342) |
| 7 | \$0 | \$0 | \$0 | \$0 | (\$2,947) | (\$3,733) | (87) | (\$1,927) |
| 8 | \$0 | \$0 | \$0 | \$0 | \$396 | \$516 | (27) | (\$591) |
| 9 | \$0 | \$0 | \$0 | \$0 | \$2,229 | \$2,996 | 44 | \$966 |
| 10 | \$0 | \$0 | \$0 | \$0 | \$4,149 | \$5,744 | 120 | \$2,587 |
| 11 | \$0 | \$0 | \$0 | \$0 | \$6,151 | \$8,770 | 200 | \$4,270 |
| 12 | \$0 | \$0 | \$0 | \$0 | \$9,104 | \$13,370 | 325 | \$6,880 |
| 13 | \$0 | \$0 | \$0 | \$0 | \$12,153 | \$18,382 | 458 | \$9,579 |
| 14 | \$0 | \$0 | \$0 | \$0 | \$15,273 | \$23,795 | 596 | \$12,363 |
| 15 | \$0 | \$0 | \$0 | \$0 | \$18,673 | \$29,965 | 742 | \$15,229 |
| 16 | \$0 | \$0 | \$0 | \$0 | \$21,978 | \$36,327 | 894 | \$18,174 |
| 17 | \$0 | \$0 | \$0 | \$0 | \$26,891 | \$45,779 | 1,118 | \$22,517 |
| 18 | \$0 | \$0 | \$0 | \$0 | \$27,193 | \$47,683 | 1,146 | \$22,843 |
| 19 | \$0 | \$0 | \$0 | \$0 | \$32,265 | \$58,275 | 1,385 | \$27,347 |
| Total | \$0 | \$0 | \$0 | \$0 | \$169,517 | \$310,553 | 7,275 | \$142,846 |

NET PRESENT VALUE CALCULATION

| Year | PRESENT VALUE OF USER BENEFITS | | | | PRESENT VALUE OF USER BENEFITS (road 2) | | | |
|----------------------------|--------------------------------|--------------------------|----------------------|-----------------------------|--|--------------------------|---------------------|-----------------------------|
| | Travel Time Savings | Vehicle Op. Cost Savings | Accident Reductions | Vehicle Emission Reductions | Travel Time Savings | Vehicle Op. Cost Savings | Accident Reductions | Vehicle Emission Reductions |
| Construction Period | | | | | | | | |
| 1 | | | | | | | | |
| 2 | | | | | | | | |
| 3 | | | | | | | | |
| 4 | | | | | | | | |
| 5 | | | | | | | | |
| 6 | | | | | | | | |
| 7 | | | | | | | | |
| 8 | | | | | | | | |
| Project Open | | | | | | | | |
| 1 | \$1,709,144 | (\$78,972) | \$21,662,629 | (\$8,507) | | | | |
| 2 | \$1,812,058 | (\$69,526) | \$21,875,546 | (\$7,576) | | | | |
| 3 | \$1,919,079 | (\$70,104) | \$22,057,683 | (\$7,749) | | | | |
| 4 | \$2,030,499 | (\$60,066) | \$22,210,652 | (\$6,948) | | | | |
| 5 | \$2,146,638 | (\$49,967) | \$22,335,999 | (\$5,873) | | | | |
| 6 | \$2,267,854 | (\$39,705) | \$22,435,201 | (\$4,788) | | | | |
| 7 | \$2,394,543 | (\$22,304) | \$22,509,676 | (\$2,947) | | | | |
| 8 | \$2,527,150 | (\$4,783) | \$22,560,780 | \$396 | | | | |
| 9 | \$2,666,169 | \$12,806 | \$22,589,812 | \$2,229 | | | | |
| 10 | \$2,812,157 | \$30,411 | \$22,598,013 | \$4,149 | | | | |
| 11 | \$2,965,739 | \$47,988 | \$22,586,573 | \$6,151 | | | | |
| 12 | \$3,127,620 | \$74,498 | \$22,556,628 | \$9,104 | | | | |
| 13 | \$3,298,597 | \$100,712 | \$22,509,267 | \$12,153 | | | | |
| 14 | \$3,479,577 | \$125,341 | \$22,445,529 | \$15,273 | | | | |
| 15 | \$3,671,593 | \$151,103 | \$22,366,408 | \$18,673 | | | | |
| 16 | \$3,875,830 | \$176,710 | \$22,272,855 | \$21,978 | | | | |
| 17 | \$4,093,647 | \$214,131 | \$22,165,778 | \$26,891 | | | | |
| 18 | \$4,326,620 | \$212,974 | \$22,046,043 | \$27,193 | | | | |
| 19 | \$4,576,575 | \$249,540 | \$21,914,479 | \$32,265 | | | | |
| 20 | \$4,845,651 | \$287,131 | \$21,771,877 | \$37,448 | | | | |
| Total | \$60,546,740 | \$1,287,919 | \$445,471,426 | \$169,517 | \$0 | \$0 | \$0 | \$0 |

| | |
|-----------|---|
| 4,850,024 | Person-Hours of Time Saved |
| 7,275 | CO ₂ Emissions Saved (tons) |
| \$142,846 | CO ₂ Emissions Saved (\$ PV) |

| | |
|-----------|---|
| 4,850,024 | Person-Hours of Time Saved |
| 7,275 | CO ₂ Emissions Saved (tons) |
| \$142,846 | CO ₂ Emissions Saved (\$ PV) |

| PRESENT VALUE OF USER BENEFITS (road 3) | | | | Present Value of Total User Benefits | Present Value of Total Project Costs | NET PRESENT VALUE |
|--|--------------------------|---------------------|-----------------------------|--------------------------------------|--------------------------------------|----------------------|
| Travel Time Savings | Vehicle Op. Cost Savings | Accident Reductions | Vehicle Emission Reductions | | | |
| | | | | \$0 | \$10,700,000 | (\$10,700,000) |
| | | | | \$0 | \$10,388,350 | (\$10,388,350) |
| | | | | \$0 | \$0 | \$0 |
| | | | | \$0 | \$0 | \$0 |
| | | | | \$0 | \$0 | \$0 |
| | | | | \$0 | \$0 | \$0 |
| | | | | \$0 | \$0 | \$0 |
| | | | | \$0 | \$0 | \$0 |
| | | | | \$23,284,293 | \$0 | \$23,284,293 |
| | | | | \$23,610,502 | \$0 | \$23,610,502 |
| | | | | \$23,898,909 | \$0 | \$23,898,909 |
| | | | | \$24,174,137 | \$0 | \$24,174,137 |
| | | | | \$24,426,796 | \$0 | \$24,426,796 |
| | | | | \$24,658,562 | \$0 | \$24,658,562 |
| | | | | \$24,878,968 | \$0 | \$24,878,968 |
| | | | | \$25,083,543 | \$0 | \$25,083,543 |
| | | | | \$25,271,016 | \$0 | \$25,271,016 |
| | | | | \$25,444,731 | \$0 | \$25,444,731 |
| | | | | \$25,606,451 | \$0 | \$25,606,451 |
| | | | | \$25,767,850 | \$0 | \$25,767,850 |
| | | | | \$25,920,729 | \$0 | \$25,920,729 |
| | | | | \$26,065,720 | \$0 | \$26,065,720 |
| | | | | \$26,207,778 | \$0 | \$26,207,778 |
| | | | | \$26,347,373 | \$0 | \$26,347,373 |
| | | | | \$26,500,447 | \$0 | \$26,500,447 |
| | | | | \$26,612,830 | \$0 | \$26,612,830 |
| | | | | \$26,772,860 | \$0 | \$26,772,860 |
| | | | | \$26,942,107 | \$0 | \$26,942,107 |
| \$0 | \$0 | \$0 | \$0 | \$507,475,601 | \$21,088,350 | \$486,387,252 |

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

B

INTERNAL RATE OF RETURN ON INVESTMENT AND PAYBACK PERIOD

| Year | USER BENEFITS IN CONSTANT DOLLARS | | | | USER BENEFITS IN CONSTANT DOLLARS (road 2) | | | |
|----------------------------|-----------------------------------|--------------------------|----------------------|-----------------------------|---|--------------------------|---------------------|-----------------------------|
| | Travel Time Savings | Vehicle Op. Cost Savings | Accident Reductions | Vehicle Emission Reductions | Travel Time Savings | Vehicle Op. Cost Savings | Accident Reductions | Vehicle Emission Reductions |
| Construction Period | | | | | | | | |
| 1 | | | | | | | | |
| 2 | | | | | | | | |
| 3 | | | | | | | | |
| 4 | | | | | | | | |
| 5 | | | | | | | | |
| 6 | | | | | | | | |
| 7 | | | | | | | | |
| 8 | | | | | | | | |
| Project Open | | | | | | | | |
| 1 | \$1,813,231 | (\$83,782) | \$22,981,883 | (\$9,025) | | | | |
| 2 | \$1,980,084 | (\$75,972) | \$23,904,000 | (\$8,279) | | | | |
| 3 | \$2,159,941 | (\$78,903) | \$24,826,117 | (\$8,721) | | | | |
| 4 | \$2,353,905 | (\$69,633) | \$25,748,233 | (\$8,054) | | | | |
| 5 | \$2,563,198 | (\$59,663) | \$26,670,350 | (\$7,013) | | | | |
| 6 | \$2,789,174 | (\$48,832) | \$27,592,467 | (\$5,888) | | | | |
| 7 | \$3,033,335 | (\$28,254) | \$28,514,584 | (\$3,733) | | | | |
| 8 | \$3,297,357 | (\$6,241) | \$29,436,701 | \$516 | | | | |
| 9 | \$3,583,109 | \$17,210 | \$30,358,818 | \$2,996 | | | | |
| 10 | \$3,892,684 | \$42,096 | \$31,280,935 | \$5,744 | | | | |
| 11 | \$4,228,435 | \$68,419 | \$32,203,052 | \$8,770 | | | | |
| 12 | \$4,593,015 | \$109,403 | \$33,125,169 | \$13,370 | | | | |
| 13 | \$4,989,424 | \$152,337 | \$34,047,285 | \$18,382 | | | | |
| 14 | \$5,421,067 | \$195,277 | \$34,969,402 | \$23,795 | | | | |
| 15 | \$5,891,829 | \$242,476 | \$35,891,519 | \$29,965 | | | | |
| 16 | \$6,406,156 | \$292,075 | \$36,813,636 | \$36,327 | | | | |
| 17 | \$6,969,160 | \$364,544 | \$37,735,753 | \$45,779 | | | | |
| 18 | \$7,586,754 | \$373,452 | \$38,657,870 | \$47,683 | | | | |
| 19 | \$8,265,804 | \$450,697 | \$39,579,987 | \$58,275 | | | | |
| 20 | \$9,014,339 | \$534,148 | \$40,502,104 | \$69,665 | | | | |
| Total | \$90,832,000 | \$2,390,853 | \$634,839,865 | \$310,553 | \$0 | \$0 | \$0 | \$0 |

| USER BENEFITS IN CONSTANT DOLLARS (road 3) | | | | Total User Benefits in Constant Dollars | Total Project Costs in Constant Dollars | ANNUAL RETURNS ON INVESTMENT | CUMULATIVE RETURNS AFTER PROJ OPENS |
|---|--------------------------------|------------------------|-----------------------------------|--|---|---------------------------------------|--|
| Travel Time Savings | Vehicle Op. Cost Savings | Accident Reductions | Vehicle Emission Reductions | | | | |
| | | | | \$0 | \$10,700,000 | (\$10,700,000) | |
| | | | | \$0 | \$10,700,000 | (\$10,700,000) | |
| | | | | \$0 | \$0 | \$0 | |
| | | | | \$0 | \$0 | \$0 | |
| | | | | \$0 | \$0 | \$0 | |
| | | | | \$0 | \$0 | \$0 | |
| | | | | \$0 | \$0 | \$0 | |
| | | | | \$0 | \$0 | \$0 | |
| | | | | \$24,702,307 | \$0 | \$24,702,307 | \$24,702,307 |
| | | | | \$25,799,833 | \$0 | \$25,799,833 | \$50,502,140 |
| | | | | \$26,898,433 | \$0 | \$26,898,433 | \$77,400,573 |
| | | | | \$28,024,451 | \$0 | \$28,024,451 | \$105,425,023 |
| | | | | \$29,166,872 | \$0 | \$29,166,872 | \$134,591,895 |
| | | | | \$30,326,921 | \$0 | \$30,326,921 | \$164,918,817 |
| | | | | \$31,515,932 | \$0 | \$31,515,932 | \$196,434,749 |
| | | | | \$32,728,334 | \$0 | \$32,728,334 | \$229,163,083 |
| | | | | \$33,962,132 | \$0 | \$33,962,132 | \$263,125,215 |
| | | | | \$35,221,458 | \$0 | \$35,221,458 | \$298,346,673 |
| | | | | \$36,508,676 | \$0 | \$36,508,676 | \$334,855,349 |
| | | | | \$37,840,956 | \$0 | \$37,840,956 | \$372,696,305 |
| | | | | \$39,207,428 | \$0 | \$39,207,428 | \$411,903,733 |
| | | | | \$40,609,543 | \$0 | \$40,609,543 | \$452,513,276 |
| | | | | \$42,055,790 | \$0 | \$42,055,790 | \$494,569,065 |
| | | | | \$43,548,194 | \$0 | \$43,548,194 | \$538,117,259 |
| | | | | \$45,115,236 | \$0 | \$45,115,236 | \$583,232,495 |
| | | | | \$46,665,759 | \$0 | \$46,665,759 | \$629,898,254 |
| | | | | \$48,354,762 | \$0 | \$48,354,762 | \$678,253,017 |
| | | | | \$50,120,255 | \$0 | \$50,120,255 | \$728,373,272 |
| \$0 | \$0 | \$0 | \$0 | \$728,373,272 | \$21,400,000 | \$706,973,272 | |

Total Construction Costs

\$21,400,000

| Years After Construction Begins | ANNUAL RETURNS ON INVESTMENT |
|---------------------------------|------------------------------|
| 1 | (\$10,700,000) |
| 2 | (\$10,700,000) |
| 3 | \$24,702,307 |
| 4 | \$25,799,833 |
| 5 | \$26,898,433 |
| 6 | \$28,024,451 |
| 7 | \$29,166,872 |
| 8 | \$30,326,921 |
| 9 | \$31,515,932 |
| 10 | \$32,728,334 |
| 11 | \$33,962,132 |
| 12 | \$35,221,458 |
| 13 | \$36,508,676 |
| 14 | \$37,840,956 |
| 15 | \$39,207,428 |
| 16 | \$40,609,543 |
| 17 | \$42,055,790 |
| 18 | \$43,548,194 |
| 19 | \$45,115,236 |
| 20 | \$46,665,759 |
| 21 | \$48,354,762 |
| 22 | \$50,120,255 |
| 23 | \$0 |
| 24 | \$0 |
| 25 | \$0 |
| 26 | \$0 |
| 27 | \$0 |
| 28 | \$0 |

Internal Rate of Return 85.22%

Payback Period 1 year

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

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

Parameters

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

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

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

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

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

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

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

Travel Demand Tables

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

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

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

Operating Cost Tables

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

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

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

Accident Tables

HIGHWAY INJURY SEVERITY FREQUENCY
(percent of injuries)

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

Source: 2009 SWITRS Annual Report, Table 8C

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

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

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

NUMBER OF FATALITIES
(events/accident)

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

NUMBER OF INJURIES
(events/accident)

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

NUMBER OF VEHICLES INVOLVED
(events/accident)

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

DISTRIBUTION OF ACCIDENT TYPES
(percent of accidents)

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

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

COST OF TRANSIT ACCIDENT EVENTS
(\$/event)

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

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

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

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

Source: Combination of above two tables

HIGHWAY-RAIL GRADE CROSSING INCIDENTS
(units in table)

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

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

COST OF HIGHWAY ACCIDENTS
(\$/accident)

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

Source: Combination of above four tables

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

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

Source: Taylor and Jain, 1991

Emissions Tables

HIGHWAY EMISSIONS FACTORS (g/mi)
Model Year 2011

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

HIGHWAY EMISSIONS FACTORS (g/mi)
Model Year 2031

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

Emissions Tables

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

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

HEALTH COST OF TRANSPORTATION EMISSIONS
(\$/ton)

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

CO₂e Uprater increase in value per year

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

PASSENGER TRAIN EMISSIONS FACTORS
(g/train-mile)

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

LIGHT RAIL EMISSIONS FACTORS
(g/veh-mile)

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

Source: California Air Resources Board

Pavement Adjustments (used only for pavement projects)

PAVEMENT DETERIORATION
(IRI in inches/mile)

| Year 0 | Year 20, By Loading | | |
|--------|---------------------|--------|-------|
| | Light | Medium | Heavy |
| 0 | 125 | 150 | 350 |
| 25 | 150 | 200 | 500 |
| 50 | 175 | 250 | 675 |
| 75 | 200 | 300 | 750 |
| 100 | 275 | 400 | 750 |
| 125 | 325 | 475 | 750 |
| 150 | 400 | 575 | 750 |
| 175 | 500 | 700 | 750 |
| 200 | 575 | 750 | 750 |
| 225 | 650 | 750 | 750 |
| 250 | 750 | 750 | 750 |
| 275 | 750 | 750 | 750 |
| 300 | 750 | 750 | 750 |
| 325 | 750 | 750 | 750 |
| 350 | 750 | 750 | 750 |
| 375 | 750 | 750 | 750 |
| 400 | 750 | 750 | 750 |
| 425 | 750 | 750 | 750 |
| 450 | 750 | 750 | 750 |

Source: Paterson, 1987

VEHICLE OPERATING SPEED
(percent adjustment)

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

Source: Botterill, 1996 and 1997

FUEL CONSUMPTION
(percent adjustment)

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

Source: Texas Transportation Institute, 1994

NON-FUEL COSTS
(percent adjustment)

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

Source: ARRB Research Board TR VOC Model

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

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

Source: Fitzpatrick, Brewer, and Venglar, 2003

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

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

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

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

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