BENEFIT-COST ANALYSIS FOR ANAHEIM TIGER APPLICATION

Report Prepared by System Metrics under contract with the Southern California Association of Governments (SCAG)
August 2009

This document provides a description of the input data and the methodological standards used for the analysis of the City of Anaheim Gene Autry Way (West) Highway/I-5 HOV Interchange Project submitted for TIGER Discretionary Grant Funding.

ANALYSIS FRAMEWORK

The TIGER project is expected to produce both quantifiable and less tangible, qualitative benefits. The benefit-cost analysis conducted for the Anaheim project includes quantifiable benefits and considers impacts and externalities of sufficient quality.

The benefit-cost analysis was conducted using the California Lifecycle Benefit/Cost Analysis Model (Cal-B/C). The California Department of Transportation (Caltrans) developed the model in the mid-1990s and it has been used to evaluate capital projects proposed for the State Transportation Improvement Program (STIP) since 1996. Cal-B/C is consistent with the procedures outlined in the Federal Highway Administration's (FHWA) *Economic Analysis Primer (2003)*. For the TIGER Discretionary Grant Applications, its assumptions and economic values have been modified to adhere to the requirements stipulated in 74 FR 28755 (2009-06-17).

The Cal-B/C model uses a standard 20-year lifecycle to facilitate comparisons across projects. A typical benefit-cost analysis measures four primary categories of user benefits:

- Travel time savings
- Vehicle operating cost reductions
- Safety improvements
- Emission reductions, including greenhouse gases.

For the TIGER Discretionary Grant application, the benefit-cost analysis has been expanded to include benefits due to noise impacts.

Cal-B/C estimates annual user benefits over a 20-year lifecycle in constant dollars for each benefit category. Future benefits are discounted to present

values using a real discount rate. Benefits are estimated separately for multiple groups defined by types of users, modes, facilities and times of day. Project costs are estimated annually from the start of construction to 20 years after projects open. Project costs include right-of-way, construction, and project support costs as well as incremental operating and maintenance costs.

The definition of project cost is more inclusive than construction costs or the funding requested from TIGER Discretionary Grants. This methodology is conservative, but it reflects the true agency costs over the lifecycle of the proposed projects. Extensive documentation for the Cal-B/C model is available on the California Department of Transportation (Caltrans) website.

The Cal-B/C model has been updated several times since it was first developed with the most recent update completed in 2009. The current version includes the ability to estimate reductions in CO2 emissions (in US tons) and monetize the global benefits of reducing US CO2 emissions. The methodology for monetizing greenhouse gas emissions is consistent with Chapter VIII of the *Final Regulatory Impact Analysis* of the National Highway Traffic Safety Administration (NHTSA) rulemaking on *Corporate Average Fuel Economy (CAFE) for MY 2011 Passenger Cars and Light Trucks* (March 2009), which is referenced in TIGER application guidelines.

Several sources of input data were consulted. Examples include: project study reports, environmental impact reports, traffic counts, model outputs (such as from SYNCHRO, CORSIM, and regional planning models), the Caltrans Accident Surveillance and Analysis System (TASAS), and other transportation databases.

ECONOMIC ASSUMPTIONS

This section summarizes the economic assumptions added to the Cal-B/C model to comply with the guidelines outlined in 74 FR 28759 (2009-06-17). In cases where the TIGER Discretionary Grant Guidelines did not specify value, the standard Cal-B/C assumptions were retained. With the exception of travel time benefits, all benefits and costs are valued in 2009 dollars. The mobility benefits are estimated using US Department of Transportation (US DOT) guidance on the value of time, which is in 2000 dollars. This lowers the value of the travel time benefits by more than 20 percent compared to using a value in 2009 dollars. Since travel time improvements are a primary benefit, the lower value of time reduces the benefit-cost ratios significantly.

Discount Rate

The Cal-B/C model typically uses a rate of 4 percent to discount future benefits and costs to present value. To be consistent with the guidance in the Federal Register, this discount rate has been increased to 7 percent (per OMB in Circulars A–4 *Regulatory Analysis (09/17/2003)* and A–94 *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs*). In addition to this primary analysis, an alternative analysis was conducted using a 3-percent discount rate. Results are presented for both analyses. The 3-percent discount rate demonstrates higher benefits by including a higher value for long-term benefits.

Value of Time

The analysis uses values of time consistent with the US DOT's *Revised Department Guidance: Valuation of Travel Time in Economic Analysis (02/11/2003)*. Exhibits 1 and 2 show the values per person-hour provided in the guidance. These values are in 2000 dollars. The US DOT guidance on the Value of Time (VOT) states that "The Office of the Assistant Secretary for Transportation Policy will publish periodic updates of the values of travel time to be used in DOT economic analyses" and that "analysts should not update the values recommended in the guidance using economy-wide measures of general price inflation such as the Consumer Price Index or GDP Deflator." This could be interpreted that the value of time may be updated to 2009 values using the Bureau of Labor Statistics (BLS) wage rate data cited in the guidance. (NHTSA followed this approach in its rulemaking for MY 2011 CAFE standards.) However, this analysis adopted a more conservative approach and used the 2000 figures provided in the US DOT guidance. The travel time benefits would be considerably higher (likely more than 20 percent higher) if they were updated to 2009 values to be consistent with the other benefits. The standard Cal-B/C average vehicle occupancy (AVO) assumptions have been used to convert vehicle-hour travel time savings to person-hour travel time savings.

Exhibit 1: Recommended Hourly Values of Travel Time Savings

Recommended Hourly Values of Travel Time Savings (2000 U.S. $ per person-hour)			
Category	Surface Modes*	Air Travel**	Truck Drivers
Local Travel			
Personal	$10.60	--	--
Business	$21.20	--	$18.10
All Purposes ***	$11.20	--	--
Intercity Travel			
Personal	$14.80	$23.30	--
Business	$21.20	$40.10	$18.10
All Purposes ***	$15.60	$28.60	--

Exhibit 2: Plausible Ranges for Hourly Values of Travel Time Savings

Plausible Ranges for Hourly Values of Travel Time Savings (2000 U.S. $ per person-hour)					
Category	Surface Modes*		Air Travel**		Truck Drivers
	Low	High	Low	High	
Local Travel					
Personal	$7.40	$12.70	--	--	--
Business	$17.00	$25.40	--	--	$18.10
All Purposes ***	$7.90	$13.40			--
Intercity Travel					
Personal	$12.70	$19.00	$20.00	$30.00	--
Business	$17.00	$25.40	$32.10	$48.10	$18.10
All Purposes ***	$13.20	$19.80	$23.80	$35.60	--

Value of Statistical Life

The latest US DOT guidance (*Treatment of the Economic Value of a Statistical Life in Departmental Analyses – 2009 Annual Revisi*on, 03/18/2009) provides a value of statistical life (VSL) of $5.8 million in 2007 dollars. Since this guidance does not discourage updates to the value, the benefit analysis for the TIGER application uses a VSL of $6.0 million in 2009 dollars. The US DOT value was updated using the GDP deflator, which is found in Historical Table 10.1 of the President's Budget for Fiscal Year 2010. Although the US DOT guidance allows a range of alternative VSLs to be provided in the analysis, this analysis presents results using the midpoint VLS consistent with US DOT guidance.

Injury Costs

The US DOT guidance provides a method for estimating the value of injury reduction. The value is calculated by using a fraction of VSL that depends on the severity of injury. Exhibit 3 shows the fractions provided in the guidance.

Exhibit 3: Relative Disutility Factors by Injury Severity Level (MAIS)

MAIS Level	Severity	Fraction of VSL
MAIS 1	Minor	0.0020
MAIS 2	Moderate	0.0155
MAIS 3	Serious	0.0575
MAIS 4	Severe	0.1875
MAIS 5	Critical	0.7625
MAIS 6	Fatal	1.0000

California collects accident data in its TASAS database using the American National Standards Institute (ANSI) standard rather than the Maximum Abbreviated Injury Scale (MAIS). To estimate appropriate injury values, the California statistics are assumed to be equivalent to the following:

- Severe Injury (A) = MAIS 4 (Severe)
- Other Visible Injury (B) = MAIS 2 (Moderate)
- Complaint of Pain (C) = MAIS 1 (Minor).

Property Damage Due to Accidents

The TIGER application guidelines do not provide guidance on evaluating the costs of property damage due to highway, rail, or transit accidents. This analysis uses the standard Cal-B/C values. These values were updated to 2009 dollars using the GDP deflator for consistency with the other values in the benefit-cost analysis.

Vehicle Operating Costs

The Cal-B/C model includes a combination of fuel and non-fuel vehicle operating costs. For the TIGER benefit-cost analysis, the value of fuel found in NHTSA's *Final Regulatory Impact Analysis of the CAFE for MY 2011 Passenger Cars and Light Trucks* was updated from 2007 dollars ($3.33 per gallon) to 2009 dollars

($3.46 per gallon). The original value can be found in Table VIII-5 on page VIII-60 of the NHTSA report. This value excludes the transfer payments associated with fuel taxes.

Non-fuel operating costs include vehicle wear and tear as well as depreciation. For these costs, the benefit-cost analysis uses the standard Cal-B/C values updated by the GDP deflator to 2009 dollars:

- Automobiles = $0.251
- Trucks = $0.377.

Noise

The Federal Register cites NHTSA's *Final Regulatory Impact Analysis of the CAFE for MY 2011 Passenger Cars and Light Trucks* as the source of information for valuing the social benefits of externalities. The report includes a cost estimate of $0.07 per mile (in 2007 dollars) for noise, which can be found on page VIII-57. The original source of this cost is the 1997 Federal Highway Cost Allocation Study. Updated to 2009 dollars using the GDP deflator, this cost remains at $0.07 per mile. The benefit-cost analysis uses this value to approximate the social benefit of noise impacts due to changes in vehicle-miles traveled (VMT). Since Cal-B/C does not include a separate benefit category for noise impacts, the value of noise impact is added to the value of non-fuel vehicle operating costs, which are also calculated on a VMT basis.

Emission Costs

The benefit-cost analysis includes emissions rates estimated using factors from the California Air Resources Board (CARB) EMFAC model for on-road vehicles and other CARB sources for other modes. The emissions are monetized using values consistent with those found in NHTSA's *Final Regulatory Impact Analysis of the CAFE for MY 2011 Passenger Cars and Light Trucks*. The values are updated to 2009 dollars using the GDP deflator.

The Federal Register refers to an estimate of $33 per metric ton of carbon cited on page VIII-45 of the NHTSA's *Final Regulatory Impact Analysis of the CAFE for MY 2011 Passenger Cars and Light Trucks*. As shown on page VIII-47 of the NHTSA report, this is the value per metric ton of carbon dioxide equivalent (CO_2e), which is consistent with the methodology in Cal-B/C. The CO_2e value has been converted from metric tons to US tons for consistency with EMFAC emissions rate data.

Exhibit 4 provides the emission values used in the analysis. In the case of CO_2e, this is value for the first year only. The benefit-cost analysis includes a 2.4 percent annual increase in greenhouse damage costs consistent with the methodology in the NHTSA report and the TIGER application guidance.

Exhibit 4: Cost per US Ton Estimates of Emissions (2009 dollars)

CO	CO_2e	NO_X	PM_{10}	SO_X	VOC
$0	$34	$4,150	$174,500	$16,600	$1,750

Project-Specific Assumptions

Currently, only the eastern half of Gene Autry Way is constructed and used by commuters to gain access to the I-5 High Occupancy Vehicle (HOV) direct connect drop ramps. Without the proposed connection to the west, commuters from the west (which includes the Anaheim Resort, Disneyland, California Adventure and the Anaheim Convention Center) must enter from the Katella Avenue general purpose on-ramps and weave across four lanes of freeway traffic to gain access to the carpool lanes. This creates congestion and a safety hazard.

The benefit-cost analysis considers the benefits of eliminating the weave across the freeway to access the HOV lanes using the standard HOV drop ramp weaving algorithms in Cal-B/C. The analysis ignores the impact on existing general purpose on-ramps and off-ramps caused by diverting carpools to the Gene Autry Way ramp. The analysis also ignores any impact the new ramp has on through HOV traffic. It is assumed that all carpools entering or exiting the highway use the HOV drop ramps.

Traffic data for the benefit-cost analysis comes from the June 2009 Modified Access Report. This report used the Anaheim Traffic Analysis Model (ATAM) to develop traffic forecasts in the immediate vicinity of the project area. A post-processing methodology was applied to traffic forecasts estimated by the model to achieve future traffic volumes which reasonably reflect appropriate growth consistent with existing traffic volumes. Actual ground counts from Year 2007 were used to post-process future traffic forecasts.

There are additional accessibility benefits due to Gene Autry Way connecting origins and destinations east and west of Interstate 5. The benefits have been included in the analysis by estimating the reduction in travel time compared to crossing at Katella Avenue. The analysis assumes an average distance traveled of 0.5 miles.

There are expected to be safety benefits due to the reduction in weaving HOV vehicles, but the benefits are not included in this analysis. The evaluation of safety benefits is complicated by the current half interchange configuration. This has led to a higher than average accident at Gene Autry Way. It is expected that the increased use and completion of the interchange would yield a lower accident rate at Gene Autry Way and the reduced weaving would reduce the accident rate at the Katella Avenue interchange. These benefits would be in addition to the ones estimated for this discretionary grant application.

Summary of Results

Exhibit 5 shows the results of the benefit-cost analysis for the I-5 Gene Autry Way Interchange Construction Project using a 7-percent discount rate. It also shows the alternate analysis using the 3-percent discount rate. In both cases, the project costs are slightly lower than the total project costs presented earlier in the TIGER application due to discounting. The net benefit equals the total discounted benefits minus the total discounted costs, while the benefit-cost (B/C) ratio represents the benefits divided by the costs. The exhibit also shows the total reduction in tons of CO_2 over the 20 year period as well as the value in 2009 dollars using the methodology described earlier.

The project will deliver undiscounted user benefits equal to the project costs within five years. Since the requested TIGER Discretionary Grant is a small portion of the overall project costs, the payback period on the grant money will be much shorter.

Exhibit 5: Benefit-Cost Results for I-5 Gene Autry Way Interchange Construction Project

Analysis Scenario	Total Discounted Benefits (mil. $)	Total Discounted Costs (mil. $)	Net Benefit (mil. $)	B/C Ratio	Total CO_2 Reduction over 20 Yrs (tons)	Total CO_2 Reduction over 20 Yrs (mil. $)
7% Discount Rate	$211.7	$72.5	$139.2	2.9	170,878	$3.4
3% Discount Rate	$317.2	$73.9	$243.3	4.3	170,878	$5.4

Please see the following pages for detailed data supporting Exhibit 5.

The following table is a summary of the results produced by the California Lifecycle Benefit/Cost Analysis Model (Cal-B/C). The California Department of Transportation (Caltrans) developed the model in the mid-1990s and it has been used to evaluate capital projects proposed for the State Transportation Improvement Program (STIP) since 1996. Cal-B/C is consistent with the procedures outlined in the Federal Highway Administration's (FHWA) *Economic Analysis Primer (2003)*. The very detailed Excel spreadsheets that produced these itemized benefits can be produced upon request:

ITEMIZED BENEFITS (mil. $)	Annual	20 Years
Travel Time Savings	$8.3	$166.8
Veh. Op. Cost Savings	$1.8	$36.7
Accident Cost Savings	$0.2	$3.2
Emission Cost Savings	$0.3	$5.1
TOTAL BENEFITS	$10.6	$211.7
Person-Hours of Time Saved	1,474,080	29,481,609

Travel Time Savings

The Gene Autry Way/I-5 HOV Interchange Project saves nearly 29.5 million person-hours of delay over a 20-year period. At values of $11.20 per automobile passenger and $18.10 per truck (and discounted over time), these savings are worth approximately $166.9 million.

The HOV drop ramps reduce weaving on the mainline freeway. This accounts for nearly 27.5 million person-hours of delay savings or about 93 percent of the total travel time savings. Trucks account for only about 10 percent of traffic on the corridor, so most of the travel time savings is attributable to automobiles.

The project also completes Gene Autry Way across I-15 and allows people to drive from one side of the freeway to another without driving out of their way to a nearby overcrossing at Katella Avenue. Nearly 12,000 vehicles daily must currently divert. In 20 years, this is expected to increase to over 19,000 vehicles daily. The interchange project eliminates these diversions and is expected to attract another 5,600 vehicles within 20 years. The provision of a new overcrossing at Gene Autry Way is expected to save approximately 2 million person-hours of delay over the 20 years.

Vehicle Operating Cost Savings

The Gene Autry Way/I-5 HOV Interchange Project produces vehicle operating cost benefits worth about $36.7 million over 20 years. Approximately two-thirds of these benefits occur on I-5 where reduced weaving results in higher and more fuel efficient travel speeds and saves nearly 15 million gallons of fuel over 20 years.

The other one-third of the vehicle operating cost benefits occur as a result of Gene Autry Way providing a direct connection across I-15. This will reduce wear and tear on vehicles (worth about $8.3 million over 20 years) as well as fuel consumption (worth about $4.3 million over 20 years). The reduced fuel consumption along Gene Autry Way is equivalent to about 1.5 million gallons of fuel.

Accident Cost Savings

The Gene Autry Way/I-5 HOV Interchange Project is expected to have a marginal safety impact. The HOV drop ramp will eliminate weaving by high occupancy vehicles in the vicinity of Katella Avenue, but it will also add another stream of entering vehicles. The project analysis conservatively assumes that the accident rate is unchanged as a result of the project.

Although the project will entice additional vehicles to use the new freeway crossing at Gene Autry Way, it will slightly reduce accidents on the surface road. The project eliminates the diversion to Katella Avenue and the accompanying exposure to accidents. The produces benefits equal to nearly $3 million or the avoidance of about 2.5 accidents per year.

Emissions Cost Savings

The Gene Autry Way/I-5 HOV Interchange Project is expected to reduce emissions commensurate with the reduction in fuel consumption. The majority of the emissions benefits are due to a 20-year reduction in greenhouse gas emissions of 170,878 tons worth about $3.4 million. Other emission reductions include changes in carbon dioxide (CO_2), nitrogen oxide (NO_x), volatile organic compounds (VOC), particulate matter (PM_{10}), and sulfur oxide (SO_x). The reduction in all emissions is worth about $5.1 million over 20 years.