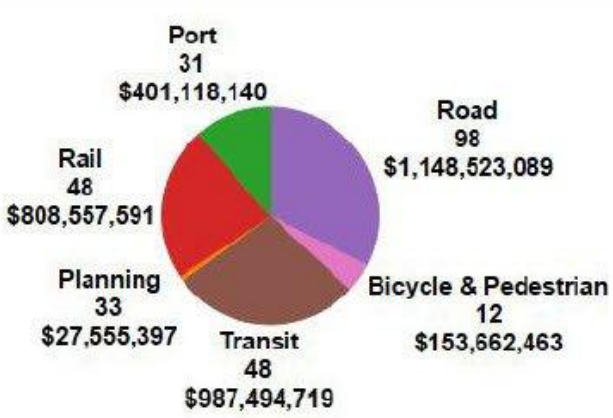
United States
Department of Transportation

About TIGER Grants

The Transportation Investment Generating Economic Recovery, or TIGER Discretionary Grant program, provides a unique opportunity for the DOT to invest in road, rail, transit and port projects that promise to achieve critical national objectives. Since 2009, Congress has dedicated more than $4.1 billion for six rounds to fund projects that have a significant impact on the Nation, a region or a metropolitan area. As can be seen below, a variety of project types have been awarded:



The TIGER program enables DOT to examine a broad array of projects on their merits, to help ensure that taxpayers are getting the highest value for every dollar invested. This focus is especially important in the current era of fiscal constraint. In each round of TIGER, DOT receives many applications to build and repair critical pieces of our freight and passenger transportation networks. Applicants must detail the benefits their project would deliver for five long-term outcomes: safety, economic competitiveness, state of good repair, livability and environmental sustainability. DOT also evaluates projects on their expected contributions to economic recovery, as well as their ability to facilitate innovation and new partnerships.

The competitive structure of the TIGER program and its broad eligibility allow project sponsors at the State and local level to avoid narrow, formula-based categories, and fund multi-modal, multi-jurisdictional projects not eligible for funding through traditional DOT programs. TIGER can fund port and freight rail projects, for example, which play a critical role in our ability to move freight, but which are not eligible for any other sources of Federal funds. Similarly, TIGER can provide capital funding directly to any public entity, including municipalities, counties, port authorities, tribal governments, MPOs, or others in contrast to traditional Federal programs which provide funding to very specific groups of applicants (mostly State DOTs and transit agencies). This flexibility allows TIGER and our traditional partners at the state and local level to work directly with a host of entities that own, operate and maintain much of our transportation infrastructure, but otherwise cannot turn to the Federal government for support.

By running a competitive process, DOT is able to reward applicants that exceed eligibility criteria and demonstrate a level of commitment that surpasses their peers. While TIGER can fund projects that have a local match as low as twenty percent of the total project costs, TIGER projects have historically achieved, on average, co-investment of two non-Federal dollars (including State, local, private and philanthropic funds) for every TIGER dollar invested. The high-level of co-investment achieved through TIGER, and the ability to foster creative and innovative approaches to transportation investments, is demonstrated across all types of TIGER projects.

Program Background

The Transportation Investment Generating Economic Recovery, or TIGER Discretionary Grant program, provides a unique opportunity for the U.S. Department of Transportation to invest in road, rail, transit and port projects that promise to achieve critical national objectives. Congress dedicated more than $4.1 billion to the program: $1.5 billion for TIGER I, $600 million for TIGER II, $526.944 million for FY 2011, $500 million for FY 2012, $473.847 million for FY2013, and $600 million for the FY 2014 round of TIGER Grants to fund projects that have a significant impact on the Nation, a region or a metropolitan area.

TIGER's highly competitive process, galvanized by tremendous applicant interest, allowed DOT to fund 51 innovative capital projects in TIGER I, and an additional 42 capital projects in TIGER II. TIGER II also featured a new Planning Grant category and 33 planning projects were also funded through TIGER II. In the FY 2011 round of TIGER Grants, DOT awarded 46 capital projects in 33 states and Puerto Rico. DOT awarded 47 capital projects in 34 states and the District of Columbia in the FY 2012 round. Last year the Department announced 52 capital projects in 37 states.

Each project is multi-modal, multi-jurisdictional or otherwise challenging to fund through existing programs. The TIGER program enables DOT to use a rigorous process to select projects with exceptional benefits, explore ways to deliver projects faster and save on construction costs, and make investments in our Nation's infrastructure that make communities more livable and sustainable.

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TIGER BENEFIT-COST ANALYSIS (BCA) RESOURCE GUIDE

How to Use This Guide

This BCA Resource Guide is a supplement to the *2014 Benefit-Cost Analysis Guidance for Tiger Grant Applicants* also found on this site (http://www.dot.gov/tiger/guidance). It provides technical information that Applicants will need for monetizing benefits and costs in their Benefit-Cost Analyses, as well as guidance on methodology and a selection of frequently asked questions from past TIGER grant applicants.
This guide is divided into three sections:

I. Recommended Monetized Values
For the purposes of providing as fair an "apples-to-apples" comparison as possible, applicants should use standard monetization values recommended in this section, which represent some of the values that are accepted for common practice at the U.S. Department of Transportation.

II. Technical Methodologies
This section provides guidance on the technical details of monetizing carbon dioxide (CO_2) emissions costs according to the Social Cost of Carbon standard developed by Federal agencies, converting nominal dollars into real dollars, and calculating the value of fatalities and injuries from vehicular crashes.

III. Frequently Asked Questions (FAQs)
This section provides answers to frequently asked questions from past TIGER applicants, with topics ranging from the logistical to the technical.

Updates to this document will be dated accordingly (with the nature of the updates noted on this cover page) and posted to the TIGER Discretionary Grants website (http://www.dot.gov/tiger).

Updated 4/18/14

I. Recommended Monetized Values

Each project generates unique impacts in its respective community, and the TIGER Evaluation process respects these differences, particularly within the context of benefit-cost analysis. While the impacts may differ from place to place, the Department does recognize certain monetized values (and monetizing methodologies) as standard, such that various projects from across the country may be evaluated on a more equivalent "apples-to-apples" basis of comparison. The following table summarizes key values for various types of benefits and costs that the Department recommends that applicants use in their benefit-cost analyses. However, benefits and costs for any reliable analysis are not limited only to this table. The applicant should provide documentation of sources and detailed calculations for monetized values of additional categories of benefits and costs. Similarly, applicants using different values for the benefit/cost categories presented below below should provide sources, calculations, and rationale for divergence from recommended values.

Table 1. Recommended Monetized Values

Cost/Benefit Category	Recommended Monetized Value(s)	Reference and Notes
Value of Statistical Life (VSL)	$9,200,000 per fatality ($2013)	*Guidance on Treatment of the Economic Value of a Statistical Life in U.S. Department of Transportation Analyses (2014)* http://www.dot.gov/office-policy/transportation-policy/guidance-treatment-economic-value-statistical-life

<table>
<tr><th>Cost/Benefit Category</th><th>Recommended Monetized Value(s)</th><th>Reference and Notes</th></tr>
<tr>
<td>Value of Injuries</td>
<td>
<table>
<tr><th>AIS Level</th><th>Severity</th><th>Fraction of VSL</th><th>Unit value ($2013)</th></tr>
<tr><td>AIS 1</td><td>Minor</td><td>0.003</td><td>$ 27,600</td></tr>
<tr><td>AIS 2</td><td>Moderate</td><td>0.047</td><td>$ 432,400</td></tr>
<tr><td>AIS 3</td><td>Serious</td><td>0.105</td><td>$ 966,000</td></tr>
<tr><td>AIS 4</td><td>Severe</td><td>0.266</td><td>$ 2,447,200</td></tr>
<tr><td>AIS 5</td><td>Critical</td><td>0.593</td><td>$ 5,455,600</td></tr>
<tr><td>AIS 6</td><td>Unsurvivable</td><td>1.000</td><td>$ 9,200,000</td></tr>
</table>
</td>
<td>Guidance on Treatment of the Economic Value of a Statistical Life in U.S. Department of Transportation Analyses (2014)

http://www.dot.gov/office-policy/transportation-policy/guidance-treatment-economic-value-statistical-life

NOTE:
Accident data (particularly those provided through law enforcement records) are typically reported as a single number (e.g. “X number of crashes in Year Y”) and/or on the KABCO scale of crash severity. Applicants should convert these values to the AIS scale before applying the recommended monetized values. See Part II Section 3 (“Converting Available Accident Data into AIS Data”).</td>
</tr>
</table>

Cost/Benefit Category	Recommended Monetized Value(s)	Reference and Notes
Property Damage Only (PDO) Crashes	$3,927 per vehicle ($2013)	*The Economic and Societal Impact of Motor Vehicle Crashes, 2010 (forthcoming April 2014)* **NOTE:** Basis is PDO value of $3,682 ($2010) per vehicle involved in a PDO crash is an updated value currently used by NHTSA and based on the methodology and original 2000 dollar value referenced in *The Economic and Societal Impact of Motor Vehicle Crashes, 2010*, Page 12, Table 2, Summary of Unit Costs, 2000". Also, while the cost of PDO crashes is presented here in 2010 dollars, applicants should convert this value (along with other monetized values presented in this section) to dollars applicable to whatever base year you are using, using the methodology discussed below in **Part II, Section 2 ("Converting Nominal Dollars into Real (Constant) Dollars").** The Resource Guide converted this value into 2013 dollars.

<table>
<tr><th>Cost/Benefit Category</th><th>Recommended Monetized Value(s)</th><th>Reference and Notes</th></tr>
<tr>
<td>Value of Travel Time</td>
<td>
<table>
<tr><th colspan="3">Recommended Hourly Values of Travel Time Savings
(2013 U.S. $ per person-hour)</th></tr>
<tr><th>Category</th><th>Surface Modes*
(except High-Speed Rail)</th><th>Air and
High-Speed Rail Travel</th></tr>
<tr><td>Local Travel</td><td></td><td></td></tr>
<tr><td>Personal</td><td>$12.42</td><td></td></tr>
<tr><td>Business</td><td>$25.23</td><td></td></tr>
<tr><td>All Purposes **</td><td>$12.98</td><td></td></tr>
<tr><td>Intercity Travel</td><td></td><td></td></tr>
<tr><td>Personal</td><td>$17.39</td><td>$33.05</td></tr>
<tr><td>Business</td><td>$24.44</td><td>$60.74</td></tr>
<tr><td>All Purposes **</td><td>$18.90</td><td>$44.24</td></tr>
<tr><td>Truck Drivers</td><td>$25.75</td><td></td></tr>
<tr><td>Bus Drivers</td><td>$26.69</td><td></td></tr>
<tr><td>Transit Rail Operators</td><td>$45.77</td><td></td></tr>
<tr><td>Locomotive Engineers</td><td>$38.14</td><td></td></tr>
<tr><td>Airline Pilots and Engineers</td><td>$83.32</td><td></td></tr>
</table>
* Surface figures apply to all combinations of in-vehicle and other transit time. Walk access, waiting, and transfer time in personal travel should be valued at $24.85 per hour for personal travel when actions affect only those elements of travel time.

** These are weighted averages, using distributions of travel by trip purpose on various modes. Distribution for local travel by surface modes: 95.4% personal, 4.6% business. Distribution for intercity travel by conventional surface modes: 78.6% personal, 21.4% business. Distribution for intercity travel by air or high-speed rail: 59.6% personal, 40.4% business. Surface figures derived using annual person-miles of travel (PMT) data from the 2001 National Household Travel Survey. http://nhts.ornl.gov/. Air figures use person-trip data.
</td>
<td>Revised Departmental Guidance on Valuation of Travel Time in Economic Analysis (Revision 2 – corrected)
http://www.dot.gov/office-policy/transportation-policy/guidance-value-time</td>
</tr>
</table>

<table>
<tr><th>Cost/Benefit Category</th><th>Recommended Monetized Value(s)</th><th>Reference and Notes</th></tr>
<tr>
<td>Value of Emissions</td>
<td>
<table>
<tr><th>Emission Type</th><th>$ / short ton ($2013)</th><th>$ / metric ton ($2013)</th></tr>
<tr><td>Carbon dioxide (CO_2)</td><td>(varies)*</td><td>(varies)*</td></tr>
<tr><td>Volatile Organic Compounds (VOCs)</td><td>$1,813</td><td>$1,999</td></tr>
<tr><td>Nitrogen oxides (NOx)</td><td>$7,147</td><td>$7,877</td></tr>
<tr><td>Particulate matter (PM)</td><td>$326,935</td><td>$360,383</td></tr>
<tr><td>Sulfur dioxide (SOx)</td><td>$42,240</td><td>$46,561</td></tr>
</table>
* See “Social Cost of Carbon (3%)” values below.
</td>
<td>
Corporate Average Fuel Economy for MY2017-MY2025 Passenger Cars and Light Trucks (August 2012), page 922, Table VIII-16, "Economic Values Used for Benefits Computations (2010 dollars)" http://www.nhtsa.gov/staticfiles/rulemaking/pdf/cafe/FRIA_2017-2025.pdf

The Resource Guide converts these values into 2013 dollars.

NOTE:
Emissions units are frequently reported as “tons” throughout documents such as the CAFE rulemaking referenced above. There is a distinction between short tons, long tons, and metric tons, however. Carbon dioxide emissions (as reported in the SCC guidance and elsewhere) are typically reported in metric tons, whereas emissions for VOCs, NOx, PMs, and SOx are measured in short tons. The English “long ton” is not used in these tabulations. A short ton is 2000 lbs., while a metric ton is approximately 2,205 lbs., and a long ton is 2,240 lbs.
</td>
</tr>
</table>

Cost/Benefit Category	Recommended Monetized Value(s)	Reference and Notes
Social Cost of Carbon (3%)		*Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866* (May 2013; revised November 2013), page 18, Table A1 "Annual SCC Values: 2010-2050 (2007$/metric ton CO_2)" http://www.whitehouse.gov/sites/default/files/omb/assets/inforeg/technical-update-social-cost-of-carbon-for-regulator-impact-analysis.pdf **NOTE:** - The social cost of carbon as reported by the Technical Update represents the present value (discounted to the year shown) of marginal future climate damage, in five-year intervals through 2050, valued in 2007 dollars per metric ton of carbon dioxide, and discounted to the year shown at varying annual rates. The Resource Guide interpolates between the "3%" values shown in the Technical Update to create an annual series, converts it into 2013 dollars using the GDP deflator, and rounds to the nearest dollar. - See **Part II, Section 1 ("Clarification on the Social Cost of Carbon (SCC) Guidance and the Annual SCC Values")**, for methodology of how to use 3% SCC values in TIGER BCA.

Year	3% SCC (2013$)
2010	36
2011	37
2012	38
2013	39
2014	40
2015	42
2016	43
2017	44
2018	45
2019	46
2020	47
2021	48
2022	49
2023	50
2024	51
2025	53
2026	53
2027	54
2028	55
2029	56
2030	57

Year	3% SCC (2013$)
2031	58
2032	59
2033	60
2034	61
2035	62
2036	63
2037	65
2038	66
2039	67
2040	68
2041	69
2042	70
2043	70
2044	71
2045	72
2046	73
2047	74
2048	76
2049	77
2050	78

II. Technical Methodologies

1. Clarification on the *Social Cost of Carbon* (SCC) Guidance and the Annual SCC Values

As noted in the recommended emissions values from Section I, there is no longer a fixed unit cost to carbon dioxide (CO_2) emissions. The Federal interagency Social Cost of Carbon (SCC) guidance states that the value of carbon dioxide emissions changes over time and should be discounted at the lower discount rates of 2.5%, 3%, or 5%.

However, the lack of 7% SCC values does not mean that applicants should ignore 7% discounting for the BCA. The document and its findings imply that carbon emissions are valued differently from other benefits and costs from the perspective of discount rate. Applicants should continue to calculate discounted present values for all benefits and costs (that *exclude* carbon dioxide emissions) at 7% and 3%, as recommended by OMB Circular A-94[1]. To these non-carbon NPV benefits, the Applicant should then add the corresponding net value of carbon dioxide emissions, as calculated from the 3% SCC value. The methodology for calculating this net value of carbon dioxide emissions is described below:

i. Determine your base year and the life cycle years for the project. Look up the corresponding 3% average value for each corresponding year in which the carbon dioxide emissions occur. The TIGER Program recommends the use of the 3% average values as provided in the document *Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866* (May 2013; updated November 2013)[2] on page 39 in Table A-1 "Annual SCC Values 2010-2050 (in 2007 dollars)".

   a. **Example:** Our project has base year 2014, with project life through 2020. We want to know how to value a carbon dioxide emissions reduction of 100 metric tons in 2020.

   b. **[NOTE]** The SCC values are given in 2007 dollars. We convert these to 2013 base year dollars by multiplying by the corresponding CPI ratio.

ii. Multiply the quantity of tons reduced in 2020 by the 3% SCC value in that same year.

   a. **Example:** 100 tons x $52.00= $5,200.00 benefits in 2020.

iii. Discount forward the 2020 carbon dioxide benefits *only* to the base year (2014) present value at the same SCC discount rate (3%). Recall that

$$PV = \frac{FV}{(1+i)^t}$$

Where *PV*= Present discounted value of a future payment from year *t*
FV = Future Value of payment in year *t*
i = Discount rate applied
t = Years in the future for payment (where base year of analysis is *t* = 0)

[1] White House Office of Management and Budget, Circular A-94 *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs* (October 29, 1992) (http://www.whitehouse.gov/sites/default/files/omb/assets/a94/a094.pdf).

[2] Interagency Working Group on Social Cost of Carbon, United States Government, *Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866* (May 2013; revised November 2013) http://www.whitehouse.gov/sites/default/files/omb/assets/inforeg/technical-update-social-cost-of-carbon-for-regulator-impact-analysis.pdf

a. **Example:** NPV in 2014 (for year 2020 benefits) = $5,200.00 / [(1.03)^6] = $4,354.92

iv. Add the sum of these yearly NPV SCC values to the calculated net present value of all other benefits (which will exclude carbon emissions).

a. **Example:** Add $4,354.92 to the non-Carbon net benefits (discounted at 7% and 3%) for year 2020 to get the total NPV benefits for year 2020.

The spreadsheet on the following page demonstrates what the methodology would look like for a sample multi-year analysis.

Table 2. Sample Calculation for Applying Social Cost of Carbon to TIGER Benefit-Cost Analysis

(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)
Year	Calendar Year	Non-CO2 Benefits (2013$)	Non-CO2 Costs (2013$)	Net non-CO2 Benefits [C+D]	7% NPV Non-CO2 Benefits [E/(1.07^A)]	3% NPV Non-CO2 Benefits [E/(1.03^A)]	CO2 Reduced (Metric Tons)	3% SCC (2013$)	Undiscounted CO2 Costs @ 3% Avg SCC [H*I]	NPV CO2 Costs @ 3% Avg SCC [J/(1.03^A)]	7% NPV Total Benefits [F+K]	3% NPV Total Benefits [G+K]
0	2014	$0	($5,000,000)	($5,000,000)	($5,000,000)	($5,000,000)	-25	$44.00	($1,100.00)	($1,100.00)	($5,001,100)	($5,001,100)
1	2015	$0	($1,500,000)	($1,500,000)	($1,401,869)	($1,456,311)	-25	$45.00	($1,125.00)	($1,092.23)	($1,402,961)	($1,457,403)
2	2016	$0	($1,500,000)	($1,500,000)	($1,310,158)	($1,413,894)	-25	$46.00	($1,150.00)	($1,083.99)	($1,311,242)	($1,414,978)
3	2017	$5,000,000	($150,000)	$4,850,000	$3,959,045	$4,438,437	100	$47.00	$4,700.00	$4,301.17	$3,963,346	$4,442,738
4	2018	$5,000,000	($150,000)	$4,850,000	$3,700,042	$4,309,162	100	$49.00	$4,900.00	$4,353.59	$3,704,396	$4,313,516
5	2019	$5,000,000	($150,000)	$4,850,000	$3,457,983	$4,183,653	100	$51.00	$5,100.00	$4,399.30	$3,462,382	$4,188,052
6	2020	$5,000,000	($150,000)	$4,850,000	$3,231,760	$4,061,799	100	$52.00	$5,200.00	$4,354.92	$3,236,115	$4,066,154
7	2021	$5,000,000	($150,000)	$4,850,000	$3,020,336	$3,943,494	100	$52.00	$5,200.00	$4,228.08	$3,024,564	$3,947,722
8	2022	$5,000,000	($150,000)	$4,850,000	$2,822,744	$3,828,635	100	$54.00	$5,400.00	$4,262.81	$2,827,007	$3,832,898
				TOTALS	**$12,479,882**	**$16,894,975**			$27,125.00	$22,623.64	$12,502,507	**$16,917,599**

2. Converting Nominal Dollars into Real (Constant) Dollars

In providing the recommended monetized values from Section I, this Guide provides numbers from their original source documents whenever possible. This means that the various values provided (and any other additional figures found in the general BCA literature) are monetized in several different years' dollars. However, establishing an "apples-to-apples" comparison of monetized benefits and costs requires a comparison of dollar values for a single base year. Conversion from nominal dollars into real (constant) dollars is a necessary task for Applicants. Two methods for conversion are discussed below.

GDP Price Deflators. In order to convert nominal dollars from one year to another, one can simply multiply by the ratio of annual GDP price deflators, as reported by the US Department of Commerce's Bureau of Economic Analysis.[3]

In order to convert Year Y dollars into Year Z dollars, conduct the following calculation:

(Year Z $) = (Year Y $) x [(Year Z GDP Price Deflator)/(Year Y GDP Price Deflator)]

i. **Example:** What is the 2013 real value of $1,000,000 earned in 2000 using annual GDP price deflators (2010=100)?

(2013 Real Value of $1,000,000) = ($1,000,000) x (105.315/80.911)
= $1,301,615.34

Consumer Price Index (CPI). Another similar method of converting dollars is to multiply by the ratio of annual average Consumer Price Indices (CPIs), as reported by the US Department of Labor's Bureau of Labor Statistics,[4] as in the following calculation:

(Year Z $) = (Year Y $) x [(Year Z CPI)/(Year Y CPI)]

ii. **Example:** What is the 2013 real value of $1,000,000 earned in 2000 using annual average urban CPIs?

(2013 Real Value of $1,000,000) = ($1,000,000) x (232.594/172.2)
= $1,350,720

It is worth noting that the CPI in the above example (and its corresponding hyperlink) is for urban areas only, and that BLS does provide CPI numbers for specific expenditure categories (see http://www.bls.gov/cpi/ for more comprehensive CPI data).

The differences between using the GDP price deflator and CPI are sufficiently small that either methodology is acceptable for the TIGER BCA. For the purposes of transparency, it would be useful for Applicants to note which method they used, if applicable.

[3] https://research.stlouisfed.org/fred2/series/USAGDPDEFAISMEI

[4] U.S. Department of Labor, Bureau of Labor Statistics, Consumer Price Index – All Urban Consumers (CPI-U), U.S. City Average, All Items (http://www.bls.gov/cpi/cpid1401.pdf).

3. Converting Available Accident Data into AIS Data

As indicated by the information in Section I, this Guide recommends monetizing the value of injuries according to the maximum Abbreviated Injury Scale (AIS).[5] However, the Department does recognize that accident data that are available to Applicants may not be reported as AIS numbers. Law enforcement data may use the KABCO Scale, which is a measure of the observed severity of the victim's functional injury at the crash scene. In some cases, the Applicant may only have a single reported number of accidents on a particular project site, but have no injury and/or injury severity data for any of those accidents. With accidents reported in KABCO-scale or with unknown injury/severity information, it is necessary for the Applicant to convert the available data into AIS.

Table 3. Comparison of Injury Severity Scales (KABCO vs AIS vs Unknown)

Reported Accidents *(KABCO or # Accidents Reported)*	
O	No injury
C	Possible Injury
B	Non-incapacitating
A	Incapacitating
K	Killed
U	Injured (Severity Unknown)
# Accidents Reported	Unknown if Injured

Reported Accidents *(AIS)*	
0	No injury
1	Minor
2	Moderate
3	Serious
4	Severe
5	Critical
6	Unsurvivable

The National Highway Traffic Safety Administration (NHTSA) provides a conversion matrix (Table 4) that allows KABCO-reported and generic accident data to be re-interpreted as AIS data. The premise of the matrix works in this way: it is understood that an injury observed and reported at the crash site may actually end up being more/less severe than the KABCO scale indicates. Similarly, any accident can – statistically speaking – generate a number of different injuries for the parties involved. Each column of the conversion matrix represents a probability distribution of the different AIS-level injuries that are statistically associated with a corresponding KABCO-scale injury or a generic accident.

[5] The maximum Abbreviated Injury Scale is also sometimes represented by the acronym "MAIS." For the purposes of this Guide, any reference to "MAIS" is equivalent to "AIS".

Table 4. KABCO/Unknown – AIS Data Conversion Matrix

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
AIS	O *No injury*	C *Possible Injury*	B *Non-incapacitating*	A *Incapacitating*	K *Killed*	U *Injured Severity Unknown*	# Non-fatal Accidents *Unknown if Injured*
0	0.92534	0.23437	0.08347	0.03437	0.00000	0.21538	0.43676
1	0.07257	0.68946	0.76843	0.55449	0.00000	0.62728	0.41739
2	0.00198	0.06391	0.10898	0.20908	0.00000	0.10400	0.08872
3	0.00008	0.01071	0.03191	0.14437	0.00000	0.03858	0.04817
4	0.00000	0.00142	0.00620	0.03986	0.00000	0.00442	0.00617
5	0.00003	0.00013	0.00101	0.01783	0.00000	0.01034	0.00279
Fatality	0.00000	0.00000	0.00000	0.00000	1.00000	0.00000	0.00000
Sum(Prob)	***1.00***	***1.00***	***1.00***	***1.00***	***1.00***	***1.00***	***1.00***

Source: National Highway Traffic Safety Administration, July 2011.

For example, if an injury is recorded as "O" on the KABCO scale at the crash site, there is about a 92.5% probability that it is indeed a "No injury" (AIS 0). But there is a 7.26% chance that it is a Minor injury (AIS 1), a 0.198% chance that it may turn out to be a Moderate injury (AIS 2), a small 0.008 chance that it is a Serious injury (AIS 3), and an even smaller 0.003% chance that it is actually a Critical injury (AIS 5). Recalling the Value of Injuries from Table 1, this would mean that one "O" reported injury is valued at about $3,100 ($2013) and interpreted as a willingness-to-pay to avoid the accident. This value results from multiplying the "O" accident's associated AIS-level probabilities by the recommended unit Value of Injuries, and then summing the products.

Table 5. KABCO– AIS Data Conversion for KABCO "O" Accident

AIS 0	0.92534	$ -	$ -
AIS 1	0.07257	$ 27,600	$ 2,002.93
AIS 2	0.00198	$ 432,400	$ 856.15
AIS 3	0.00008	$ 966,000	$ 77.28
AIS 4	0.00000	$ 2,447,200	$ -
AIS 5	0.00003	$ 5,455,600	$ 163.67
AIS 6	0.00000	$ 9,200,000	$ -
		TOTAL	**$ 3,100.03**

Tables 6 and 7 provide sample calculations for the monetization ($2013) of fatalities and injuries from accidents. By converting KABCO data into AIS and then monetizing according to the recommended values, the Applicant represented in Table 6 may be providing a baseline value of fatalities and injuries caused by 27 accidents reported in the most recent calendar year.[6] The same Applicant may have calculated the values in Table 7 to estimate their benefits of their project, which they anticipate may reduce accident rates (by at least one fatal accident and 5 non-fatal accidents per year).

[6] Accident data may not be presented on an annual basis when it is provided to Applicants (i.e. an available report requested in Fall 2011 may record total accidents from 2005-2010). For the purposes of the BCA, is important to annualize data when possible.

Table 6. Sample Calculation for Monetizing Value ($2013) of 27 Reported KABCO-scaled Accidents (O=15, C-=5, B=5, A=3, K=2, U=2)

(1)	(2)		(3)		(4)		(5)		(6)		(7)	
	O *No injury*		**C** *Possible Injury*		**B** *Non-incapacitating*		**A** *Incapacitating*		**K** *Killed*		**U** *Injured Severity Unknown*	
Accident Counts	**15**	**$ Value** [Pr(AIS$_x$)*Value(AIS$_x$)]	**5**	**$ Value** [Pr(AIS$_x$)*Value(AIS$_x$)]	**5**	**$ Value** [Pr(AIS$_x$)*Value(AIS$_x$)]	**3**	**$ Value** [Pr(AIS$_x$)*Value(AIS$_x$)]	**2**	**$ Value** [Pr(AIS$_x$)*Value(AIS$_x$)]	**2**	**$ Value** [Pr(AIS$_x$)*Value(AIS$_x$)]
AIS 0	13.88010	$ -	1.17185	$ -	0.41735	$ -	0.10311	$ -	0.00000	$ -	0.43076	$ -
AIS 1	1.08855	$ 30,043.98	3.44730	$ 95,145.48	3.84215	$ 106,043.34	1.66347	45,911.77	0.00000	$ -	1.25456	$ 34,625.86
AIS 2	0.02970	$ 12,842.28	0.31955	$ 138,173.42	0.54490	$ 235,614.76	0.62724	$ 271,218.58	0.00000	$ -	0.20800	$ 89,939.20
AIS 3	0.00120	$ 1,159.20	0.05355	$ 51,729.30	0.15955	$ 154,125.30	0.43311	$ 418,384.26	0.00000	$ -	0.07716	$ 74,536.56
AIS 4	0.00000	$ -	0.00710	$ 17,375.12	0.03100	$ 75,863.20	0.11958	$ 292,563.64	0.00000	$ -	0.00884	$ 21,633.24
AIS 5	0.00045	$ 2,455.02	0.00065	$ 3,546.14	0.00505	$ 27,550.78	0.05349	$ 291,820.04	0.00000	$ -	0.02068	$ 112,821.81
AIS Fatality	0.00000	$ -	0.00000	$ -	0.00000	$ -	0.00000	$ -	2.00000	$ 18,400,000.00	0.00000	$ -
SUBTOTALS	**15.00**	**$ 46,500.48**	**5.00**	**$ 305,969.46**	**5.00**	**$ 599,197.38**	**3.00**	**$ 1,319,898.29**	**2.00**	**$ 18,400,000.00**	**2.00**	**$ 333,556.67**

TOTAL VALUE OF FATALITIES & INJURIES	**$ 21,005,122.28**

Table 7. Sample Calculation for Monetizing ($2013) Accident Reduction (1 Fatal Accident, 5 Non-fatal Accidents)

Accident Counts	**1**	**$ Value** Fatalities * VSL	**5**	**$ Value** [Pr(AIS$_x$)*Value(AIS$_x$)]
AIS 0	0.00000	$ -	2.18380	$ -
AIS 1	0.00000	$ -	2.08695	$ 57,599.82
AIS 2	0.00000	$ -	0.44360	$ 191,812.64
AIS 3	0.00000	$ -	0.24085	$ 232,661.10
AIS 4	0.00000	$ -	0.03085	$ 75,496.12
AIS 5	0.00000	$ -	0.01395	$ 76,105.62
AIS Fatality	1.00000	$ 9,200,000.00	0.00000	$ -
SUBTOTALS	**1.00**	**$ 9,200,000.00**	**5.00**	**$ 633,675.30**

TOTAL VALUE OF FATALITIES & INJURIES	**$ 9,833,675.30**

III. Frequently Asked Questions (FAQs)

1. Are all applicants required to submit a benefit-cost analysis with their TIGER application? We are proposing only a small project and have very limited resources to conduct a full benefit-cost analysis.

A Benefit-Cost Analysis (BCA) is required of all applicants. The TIGER team is sensitive to the fact that different applicants have different resource constraints, and that complex forecasts and analyses are not always a cost-effective option. However, given the quality of BCAs received in previous rounds of TIGER from applicants of all sizes, we also believe that a transparent, reproducible, thoughtful and reasonable BCA is possible for all projects. The goal of a well-produced BCA is to provide a more objective assessment of a project, and why a project sponsor has prioritized that specific project over other alternatives and proposals. An Applicant's evaluative process of assessing benefits and costs can only help to support an already complete application.

2. Where can I find information on how to develop my TIGER application's benefit-cost analysis?

The *2014 Benefit-Cost Analysis Guidance for Tiger Grant Applicants* provides general information and guidance on conducting a benefit-cost analysis for TIGER grant applications. Additionally, the Department has previously sponsored several informational sessions with regard to benefit-cost analysis:

- DOT held an eight-hour workshop to offer technical assistance in developing benefit-cost analyses in 2010. That session can be viewed here: http://mediasite.yorkcast.com/webcast/Viewer/?peid=48d006182cf5438680a75b7c6dfc2c9e
- An archive of the 2011 90-minute webinar on TIGER benefit-cost analysis can be found here: http://fhwa.adobeconnect.com/p2evpxuzqrm/?launcher=false&fcsContent=true&pbMode=normal
- The Department also partnered with Smart Growth America to provide assistance for rural communities as they develop benefit-cost analyses. An archive of the 2-hour webinar can be found here: http://www.smartgrowthamerica.org/2011/09/02/tiger-and-rural-america-part-2-webinar-materials-now-online/

3. Please explain Discounting in the Benefit-Cost Analysis section.

The Notice requires discounting future benefits at a real discount rate of 7% following guidance from OMB in Circulars A-4 and A-94 (http://www.whitehouse.gov/omb/circulars/). Applicants should also provide an alternative analysis with a real discount rate of 3%.

The formula for present discounted value is:

$$PV = \frac{FV}{(1+i)^t}$$

Where *PV*= Present discounted value of a future payment from year *t*
FV = Future Value of payment in year *t*
i = Discount rate applied
t = Years in the future for payment (where base year of analysis is *t* = 0)

An example of the present value formula in action (at the 7% and 3% discount rates) is Columns F and G of the *Sample Calculation for Applying Social Cost of Carbon to TIGER Benefit-Cost Analysis* spreadsheet provided under Section II.1 of this guide.

Infrequently, benefits or costs will be the same in constant dollars for all years. In these limited cases, an applicant can calculate the formula for the present value of an ordinary annuity instead of showing a year-by-year calculation (http://en.wikipedia.org/wiki/Annuity_(finance_theory)). For example, 10.594 is the discount factor for a constant benefit stream over 20 years at a discount rate of seven percent (14.877 at three percent). If the constant annual benefit is $500,000, then the present value of the benefits is $5.297 million ($500,000 * 10.594). For analyses based on 20 years, applicants may use these discount factors. For other time horizons, the applicant must show the calculation of the discount factor of the ordinary annuity formula.

4. Could you clarify how the benefit-cost analysis differs from an economic impact analysis?

A benefit-cost analysis measures the dollar value of the benefits and costs to all the members of society. The benefits, for example, are the dollar value of what all the people in society would be willing to pay to have the project built. If people would be willing to pay more than the project actually costs, then the project has positive net benefits (benefits minus costs).

An economic impact analysis, on the other hand, measures "impacts," which are not the same thing as benefits. Impacts, for example, include the dollar value of all jobs created by a project. While jobs are a good thing, the benefit of a job is not measured by how much we pay the person who has a job, but by the increase in the productivity of that person compared with what the person would have been producing if the project were not funded. Economic impact analysis also generally measures local effects of a project, not overall effects on society as a whole. Some projects create positive effects on one community but negative effects on other communities. The "impacts" simply look at the positive effects, while the benefits consider negative effects as well as positive effects.

5. For TIGER transit project applicants, would it be appropriate to use the cost-effectiveness measure (as calculated under New Starts guidance) instead of calculating travel time savings using the TIGER recommended guidance?

Please note that the value of time (VOT) as referenced in the context of TIGER Grants is an actual value of time – that is, a monetized value assigned to each hour of travel time saved by users of the

transportation system. The calculation prescribed by the New Starts process that is commonly referenced as value of travel time savings is actually a Cost-Effectiveness value, a measure of what the value of travel time savings would have to be to equal the level of estimated capital and operating costs. This is essentially more of an adjusted program value – not the actual transportation consumer's dollar valuation of time saved or lost through use of the transportation system, and therefore we would not recommend the use of this number in the proposed project TIGER BCA.

If you have a cost-effectiveness measure, you should still calculate the VOT as recommended in Section I of this document ("Recommended Monetized Values"). You should take the estimated travel time savings (hours of personal and business travel saved, as referenced in Section I, Table 1, "Value of Travel Time") from the proposed transit project and multiply by the national hourly values of travel time for each type of travel. The dollar value of benefits other than travel time savings directly generated by the project (highway congestion reduction, economic development, environmental, other indirect benefits) should be calculated separately. Please be sure to include clear documentation of assumptions and calculations in your BCA for all calculated benefits and costs.

6. Must costs of externalities created during construction be included in the benefit-cost analysis?

Yes, any external costs incurred during construction phases (especially if that construction phase is lengthy) should be included in the BCA. In general, the calculation of costs for a BCA should not merely be the estimated dollars paid to deliver the project – they should include costs over the entire life cycle of the project (operations and maintenance, scheduled rehabilitation, etc.) as well as external costs (noise, travel time delay, etc.). The *2014 Benefit-Cost Analysis Guidance for Tiger Grant Applicants* addresses these topics specifically under the "Other" section. Specifically, the section states that "applicants should include, to the extent possible, costs to users during construction, such as delays and increased vehicle operating costs associated with work zones or detours."

7. Our proposed TIGER grant transit project would have multiple impacts in our community beyond travel-time savings – specifically on property values, low-income wages, and automobile operating costs. Do you have any specific sources of information regarding these benefits and how our agency may calculate them?

The impacts of transit investment vary depending on geographic location and are largely dependent on the travel demand data generated for the proposed project. The TIGER Team assumes that the sponsoring agency and their technical team have developed the most appropriate model for estimating realistic travel demand changes resulting from the proposed project (and its alternatives) and will use the outcomes of that usership model to estimate the direct and indirect benefits and costs for the analysis. It is important to provide a clear explanation of the underlying assumptions, values, and calculations as part of the transparent documentation of the BCA.

Specifically addressing the topics above:

- **Property Values:** Change in property value is one of the benefits generally attributed to transit investment. The topic – along with other benefits and costs considered in transit investments – is discussed well within TCRP Report 78: *Estimating the Benefits and Costs of Public Transit Projects: A*

Guidebook for Practitioners (2002).[7] Please note that the issue of double-counting is an important consideration when calculating economic development benefits for any proposed project. The *2014 Benefit-Cost Analysis Guidance for Tiger Grant Applicants* discusses economic development benefits ("Other"). It is important, when estimating expected property value increases in one metropolitan area based on actual increases in another area, to make sure that the transit improvements in the two areas are comparable. For example, you should not estimate property value increases for a light rail system in one city based on experience with a heavy rail system in another city.

- **Low-income wages and job creation:** A BCA focus on low-income wage earners is relevant when a transportation project can potentially increase the wages of an affected population. In general, wages from project-induced job creation are considered transfer payments and should not be included in a typical benefit-cost analysis. However, the *2014 Benefit-Cost Analysis Guidance for Tiger Grant Applicants* makes the important distinction of increased wages as a reflection of higher labor productivity benefits and leaves its calculation to the discretion of the Applicant. Applicants need to demonstrate rigorously how such productivity benefits are estimated and the exact period of time over which the productivity benefits occur. Simply asserting these gains is inadequate. To this end, Applicants should make sure that productivity benefits from higher-paying jobs are not double-counted with other benefits and are *net* societal estimates (i.e., the productivity benefits are newly generated and not simply transferred from another jurisdiction).

- **Auto operating cost savings:** Any savings from private automobile operating costs would presumably be generated from reduced auto traffic estimated by the travel demand model. The *2014 Benefit-Cost Analysis Guidance for Tiger Grant Applicants* does not provide a specific value of auto operating cost, but such estimates (on a per mile basis) do exist. AAA publishes data on per-mile driving cost that incorporates costs for fuel, maintenance, tires, insurance, fees (license and registration) and taxes, depreciation, and financing.[8]

8. Our agency is proposing to construct the Applicant Project either with TIGER grant funding or toll revenues. Would the toll-funded option be considered an "alternative" in the benefit-cost analysis?

Within the context of the TIGER grants, "alternatives" are generally intended to mean projects that significantly differ from the proposed project in technology, alignment/location, design and/or construction schedule. Alternative projects would generate different levels of benefits and costs in the various societal benefit/cost categories such as travel time savings, emissions, safety, life cycle costs, externalities, etc. Financing a project with a TIGER grant versus toll financing is not really an alternative project, though the difference in financing could affect the travel demand on the project and hence affect the benefits. We would consider alternative financing approaches to be a variation within the same basic project.

A benefit-cost analysis is expected to minimally compare the benefits and costs of the proposed project against the most realistic base case (what would be the most likely scenario if the project were not built)

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[7] Transportation Research Board – National Research Council, TCRP Report 78 – *Estimating the Benefits and Costs of Public Transit Projects: A Guidebook for Practioners* (TCRP Report 78), 2002 (http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp78/guidebook/tcrp78.pdf).

[8] AAA Exchange, "Your Driving Costs" (http://exchange.aaa.com/wp-content/uploads/2013/04/Your-Driving-Costs-2013.pdf).

and any viable alternatives under consideration. The BCA should demonstrate why the proposed project is better than all other alternatives.

9. For reference, is there an accepted ratio for short-term and long-term job creation as a function of the project costs? This would help establish a starting point for more detailed assessment.

After discussions with the White House Council of Economic Advisers, the USDOT estimates that there are 13,000 short-term job-years created per one billion dollars of government investment (or $76,900 per job-year). Previous guidance had stated that every $92,000 of investment is equivalent to one job-year. These estimates include direct on-site jobs, indirect jobs in supplier industries, and jobs that are induced in consumer goods and services industries as workers with direct and indirect jobs spend their increased incomes. These or any other well-documented and reasonable estimates of short-term job creation would be acceptable values to use. Since all projects create about the same number of short-term jobs per million dollars spent, the most important information about short-term job creation is how quickly these jobs are created, so applicants should provide quarter-by-quarter estimates of the timing of short-term job creation, showing how many jobs they expect to create in each quarter. Long-term job creation will vary greatly depending on the nature of the project, so there are no accepted ratios for long-term job creation. Applicants should attempt to measure the level of long-term economic activity induced by the project, and the level of labor-intensity associated with that economic activity. Analysis of such long-term economic activity and job creation should be estimated on a year-by-year basis. Applicants can share their estimated numbers of jobs produced in the qualitative portions of the application.

While we are interested in the short-term economic impact of job creation caused by a TIGER project, these impacts should not be included in the benefit-cost analysis. The benefit-cost analysis should include only the short- and long-term increases in labor productivity associated with the jobs created by the project. The Notice of Funding Availability reminds applicants that job creation is primarily just a transfer payment – the benefits gained by the employee are costs to the employer, and therefore net benefits are zero. New jobs only yield net benefits if the jobs created actually increase the overall productivity of workers. Applicants should fully understand these distinctions before including job creation effects as part of net benefits.

10. Are there specific worksheets, forms, or formats that are required for the BCA?

There is no “specific worksheet” or format that is required for submittal, but the *2014 Benefit-Cost Analysis Guidance for Tiger Grant Applicants* does ask that Applicants “make every effort to make the results of their analyses as *transparent* and *reproducible* as possible”. This means that spreadsheets should be accompanied by a narrative describing all of the basic assumptions, methods, and data underlying the analysis – in addition to any narrative text from the BCA and Application themselves. The *2014 Benefit-Cost Analysis Guidance for Tiger Grant Applicants* also provides a sample of a potential layout of how this information can be presented.

11. We have a project where buses, pedestrians, and bikers cannot go through a tunnel, with no reasonable alternative. Are there standard methods for monetizing these benefits?

When beginning any BCA, it is necessary to think about at least two different scenarios: one in which the proposed project is built and a second scenario in which is described the most realistic scenario if the project is not built (a base case, or "no-build" alternative). If there were an alternative route that buses, pedestrians, and bicycles could take to avoid the tunnel, then the benefits of the project would be the value of the delays avoided by not having to take that alternative route. If there is no alternative route, then it becomes impossible for bus riders, pedestrians, and bicyclists to travel to destinations served by the tunnel, and the benefits are the value to riders of being able to access those destinations. Measuring the dollar value of these accessibility benefits is difficult – they are analytically equal to the toll that bus riders, pedestrians, and bicyclists would be willing to pay to use the tunnel. It may be possible to gather such information through survey data. The bus fare that passengers would be willing to pay to access these points is one indicator of the value that passengers place on being able to travel on these routes.

12. Regarding ports and harbors, is it fair to include benefits to the US economy that would be diverted from other nations, say, Canada and Mexico?

Yes. The benefits to be counted are benefits to U.S. residents. Hence, benefits resulting from diversion of port activity to the U.S. can be considered without deducting any costs associated with loss of port activity in Canada or Mexico. Remember, however, that the dollar value of port activity is not a benefit – it is a payment for a service provided, and hence is a transfer payment, not a net benefit. Benefits would include only the cost savings or increases in productivity associated with the port activity created.

13. If a project has already been funded for preliminary design and land purchase from a different funding source, yet is seeking construction funds through this program, would the land purchase and preliminary design be included in the benefit-cost analysis?

Yes. The entire cost of the proposed project (including land purchase, preliminary design, and any other relevant components not funded by TIGER, as well as any indirect costs) must be included in the BCA.

14. Would you explain more about what might be included in agglomeration benefits and what methodologies might be used to estimate them?

Methodologies for determining agglomeration benefits are not yet well-established. It is generally agreed that agglomeration benefits can be significant, but it is also agreed that the significance of these benefits falls as the distance between the points joined by a transportation project increases. Agglomeration benefits are therefore generally more significant within the context of a metropolitan area than they are in an intercity context. In general, the methodology for estimating agglomeration benefits involves examining wage rates and output and productivity levels in locations that are well-connected to other populations, and comparing these measures of income and output to locations that are not well-connected to other populations. This can allow estimation of coefficients that measure the impact of connectedness to incomes and output. A summary of recent literature on agglomeration

benefits can be found in Daniel J. Graham, "Agglomeration, Productivity, and Transport Investment," *Journal of Transport Economics and Policy*, v. 41, Part 3 (September 2007), pp. 317-343.