BENEFIT-COST ANALYSIS (BCA) RESOURCE GUIDE (NOVEMBER 2016)

How to Use This Guide

This BCA Resource Guide is a supplement to the *2016 Benefit-Cost Analysis Guidance for Grant Applicants* also found on this site (http://www.dot.gov/tiger/guidance) and on (https://www.transportation.gov/buildamerica/FASTLANEgrants). 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/guidance) and to the FASTLANE grants website (https://www.transportation.gov/buildamerica/FASTLANEgrants).

Updated 11/17/2016

I. *Recommended Monetized Values*

Each project generates unique impacts in its respective community, and the grant 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 and compared on a more equivalent "apples-to-apples" basis. 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 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)	$9,600,000 per fatality ($2015)	*Guidance on Treatment of the Economic Value of a Statistical Life in U.S. Department of Transportation Analyses (2016)* https://www.transportation.gov/office-policy/transportation-policy/2016-vsl-guidance

<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 ($2015)</th></tr>
<tr><td>AIS 1</td><td>Minor</td><td>0.003</td><td>$ 28,800</td></tr>
<tr><td>AIS 2</td><td>Moderate</td><td>0.047</td><td>$ 451,200</td></tr>
<tr><td>AIS 3</td><td>Serious</td><td>0.105</td><td>$ 1,008,000</td></tr>
<tr><td>AIS 4</td><td>Severe</td><td>0.266</td><td>$ 2,553,600</td></tr>
<tr><td>AIS 5</td><td>Critical</td><td>0.593</td><td>$ 5,692,800</td></tr>
<tr><td>AIS 6</td><td>Not survivable</td><td>1.000</td><td>$ 9,600,000</td></tr>
</table>
</td><td>Guidance on Treatment of the Economic Value of a Statistical Life in U.S. Department of Transportation Analyses (2016)

https://www.transportation.gov/office-policy/transportation-policy/2016-vsl-guidance

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>
<tr><td>Property Damage Only (PDO) Crashes</td><td>$4,198 per vehicle ($2015)</td><td>The Economic and Societal Impact of Motor Vehicle Crashes, 2010

NOTE:
Basis is PDO value of $3,862 ($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 (revised May 2015), Page 12, Table 1-2, Summary of Unit Costs, 2000”. The Resource Guide converted this value into 2015 dollars.</td></tr>
</table>

Cost/Benefit Category	Recommended Monetized Value(s)	Reference and Notes
Value of Travel Time	(see table below)	*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

Recommended Hourly Values of Travel Time Savings
(2015 U.S. $ per person-hour)

Category	Surface Modes* (except High-Speed Rail)	Air and High-Speed Rail Travel
Local Travel		
Personal	$13.60	
Business	$25.40	
All Purposes **	$14.10	
Intercity Travel		
Personal	$19.00	$36.10
Business	$25.40	$63.20
All Purposes **	$20.40	$47.10

Truck Drivers	$27.20
Bus Drivers	$28.30
Transit Rail Operators	$46.10
Locomotive Engineers	$41.60
Airline Pilots and Engineers	$86.70

* 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 $27.20 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.

Cost/Benefit Category	Recommended Monetized Value(s)	Reference and Notes
Damage Costs for Criteria Air Pollutant Emissions	<table><tr><th>Emission Type</th><th>$ / short ton ($2015)</th></tr><tr><td>Carbon dioxide (CO_2)</td><td>(varies)*</td></tr><tr><td>Volatile Organic Compounds (VOCs)</td><td>$1,844</td></tr><tr><td>Nitrogen oxides (NOx)</td><td>$7,266</td></tr><tr><td>Particulate matter (PM)</td><td>$332,405</td></tr><tr><td>Sulfur dioxide (SOx)</td><td>$42,947</td></tr></table> * See **"Social Cost of Carbon (3%)"** values below.	*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 2015 dollars. **NOTE:** Emissions units are frequently reported in "tons," but it is important to distinguish between short tons and metric tons. 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 usually measured in short tons. A short ton is 2,000 lbs., while a metric ton is 1,000 kg, equivalent to approximately 2,203 lbs.

<table>
<tr><th>Cost/Benefit Category</th><th>Recommended Monetized Value(s)</th><th>Reference and Notes</th></tr>
<tr>
<td>Social Cost of Carbon Dioxide (CO_2) Emissions (3% discount rate)</td>
<td>
<table>
<tr><th>Year</th><th>3% SCC (2015$)</th></tr>
<tr><td>2010</td><td>$35</td></tr>
<tr><td>2011</td><td>$36</td></tr>
<tr><td>2012</td><td>$37</td></tr>
<tr><td>2013</td><td>$38</td></tr>
<tr><td>2014</td><td>$40</td></tr>
<tr><td>2015</td><td>$41</td></tr>
<tr><td>2016</td><td>$43</td></tr>
<tr><td>2017</td><td>$44</td></tr>
<tr><td>2018</td><td>$45</td></tr>
<tr><td>2019</td><td>$46</td></tr>
<tr><td>2020</td><td>$47</td></tr>
<tr><td>2021</td><td>$47</td></tr>
<tr><td>2022</td><td>$49</td></tr>
<tr><td>2023</td><td>$50</td></tr>
<tr><td>2024</td><td>$51</td></tr>
<tr><td>2025</td><td>$52</td></tr>
<tr><td>2026</td><td>$53</td></tr>
<tr><td>2027</td><td>$54</td></tr>
<tr><td>2028</td><td>$55</td></tr>
<tr><td>2029</td><td>$55</td></tr>
<tr><td>2030</td><td>$57</td></tr>
</table>
<table>
<tr><th>Year</th><th>3% SCC (2015$)</th></tr>
<tr><td>2031</td><td>$58</td></tr>
<tr><td>2032</td><td>$59</td></tr>
<tr><td>2033</td><td>$60</td></tr>
<tr><td>2034</td><td>$61</td></tr>
<tr><td>2035</td><td>$62</td></tr>
<tr><td>2036</td><td>$63</td></tr>
<tr><td>2037</td><td>$64</td></tr>
<tr><td>2038</td><td>$66</td></tr>
<tr><td>2039</td><td>$67</td></tr>
<tr><td>2040</td><td>$68</td></tr>
<tr><td>2041</td><td>$69</td></tr>
<tr><td>2042</td><td>$69</td></tr>
<tr><td>2043</td><td>$70</td></tr>
<tr><td>2044</td><td>$71</td></tr>
<tr><td>2045</td><td>$72</td></tr>
<tr><td>2046</td><td>$73</td></tr>
<tr><td>2047</td><td>$75</td></tr>
<tr><td>2048</td><td>$76</td></tr>
<tr><td>2049</td><td>$77</td></tr>
<tr><td>2050</td><td>$78</td></tr>
</table>
</td>
<td>Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866 (May 2013; revised August 2016), page 25, Table A1 “Annual SCC Values: 2010-2050 (2007$/metric ton CO_2);” values for 3% discount rate https://www.whitehouse.gov/sites/default/files/omb/inforeg/scc-tsd-final-july-2015.pdf, converted to 2015$.

NOTE:
SCC values are reported per metric ton of carbon dioxide, and are already discounted to the reference years reported in the table. Unlike some previous OMB guidance on SCC values, the latest OMB guidance reports SCC values to the nearest dollar. The Resource Guide converted these to 2015 dollars and also reports the resulting values 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.</td>
</tr>
</table>

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, the value of reducing emissions of carbon dioxide (CO_2) varies with the year in which those emissions would have occurred. OMB guidance on valuing reductions in these emissions presents estimates of the per-ton values of reducing each metric ton of emissions in years from 2010 through 2050. These estimates are constructed by discounting the future damages that would have been caused by each ton of emissions that is avoided to the year in which those emissions would have occurred. For example, a ton of CO2 emissions during the year 2020 will lead to a stream of economic damages beginning that year and extending into the distant future.

The per-ton values of reducing emissions of each GHG should be multiplied by the number of tons of emissions that would be avoided or eliminated during each year of a transportation project's lifetime to estimate the stream of annual values for those anticipated reductions in emissions. The resulting values must then be discounted from the years in which the avoided emissions would have occurred their present value as of the base year used in the analysis of that project's benefits. For consistency with the values reported in the previous tables, a 3% rate should be used to discount the total value of emissions avoided in each future year to its present value in the base year.

However, applicants should continue to calculate the discounted present values of all benefits other than those from reducing emissions of CO_2 using both 3% and 7% rates, as recommended by OMB Circular A-94[1]. Applicants should then add these to the present value of anticipated future reductions in GHG emissions, calculated as described above, to determine the total present value of the project's benefits. Finally, these present values of the project's total benefits should be compared to its future costs – also discounted using the 3% and 7% rates – to determine its net present value at each discount rate.

The steps for calculating the present value of reductions in emissions of CO2 are described below:

i. Determine the base year to be used in evaluating the project and the years representing its expected lifetime. Using the tables on the previous pages, look up appropriate values for each year of the project's lifetime in which it is expected to reduce emissions of carbon dioxide.

ii. **Example:** A project is being analyzed using a base year of 2015, with its lifetime extending through 2020. It is expected to reduce CO2 emissions during 2020 by 100 metric tons in 2020, and we want to estimate the present value of the resulting economic benefits in the base year, measured in 2015$.

iii. Multiply the number of tons reduced in 2020 by the value of reducing each ton of CO_2 emissions during that year from the table on p. 7 above: 100 tons avoided x $47 = $4,700 benefits in 2020, expressed in 2015$.

    a. **Example:** 100 metric tons x $47/metric ton = $4,700. Since the $47 value is expressed in 2015$, the total benefit of $4,700 from reducing emissions in 2020 is measured in 2015$ as well.

iv. Discount the total benefit from reducing CO_2 emissions in 2020 to its present value in the base year (2015) using a 3% rate, rounding the result to whole dollars (the same precision with which the benefits of reducing each ton was reported in the table above). To perform this calculation, use the formula

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

Where *PV*= Present discounted value of a future payment from year *t*

[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).

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)

Thus the present value in the base year (2015) of benefits from reducing emissions in the year 2020 = $4,700 / [(1.03)^5] = $ 4,054. Again, this value is expressed in 2015$.

v. Perform similar calculations for any other years of the project's lifetime in which it is expected to reduce emissions, using the appropriate values for each year from the table on p. 7 above, and sum the resulting values to determine the present value of the project's emission-reduction benefits.

vi. Add the result to the discounted present value of the project's other benefits, also expressed in 2015$. For example, add $4,054 to the present value of the projects other benefits, which have been discounted to its 2015 base year at either 7% or 3%, to obtain the present value of its total benefits.

vii.

The spreadsheet on the following page illustrates how this process might look for a project with a 3-year construction period beginning in 2015, followed by a 6-year lifetime during which it generates benefits from reducing emissions of CO_2 as well as from other sources.

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

(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)
Year	**Calendar Year**	**Non-CO2 Benefits (2015$)**	**Project Costs (2015$)**	**Net non-CO2 Benefits [C+D]**	**Net Present Value of Non-CO2 Benefits at 7% [E/(1.07^A)]**	**Net Present Value of Non-CO2 Benefits at 3% [E/(1.03^A)]**	**CO2 Emissions Avoided (Metric Tons)**	**Value per Metric Ton Avoided SCC (2015$)**	**Undiscounted Value of Avoided Emissions [H*I]**	**Discounted Present Value of Avoided Emissions as of 2015 [J/(1.03^A)]**	**Net Present Value of Total Project Benefits at 7% [F+K]**	**Net Present Value of Total Project Benefits at 3% [G+K]**
0	2015	$0	($5,000,000)	($5,000,000)	($5,000,000)	($5,000,000)	-25	$41	($1,015)	($1,015)	($5,001,015)	($5,001,015)
1	2016	$0	($1,500,000)	($1,500,000)	($1,401,869)	($1,456,311)	-25	$43	($1,071)	($1,040)	($1,402,909)	($1,457,351)
2	2017	$0	($1,500,000)	($1,500,000)	($1,310,158)	($1,413,894)	-25	$44	($1,100)	($1,036)	($1,311,194)	($1,414,930)
3	2018	$5,000,000	($150,000)	$4,850,000	$3,959,045	$4,438,437	100	$45	$4,511	$4,128	$3,963,173	$4,442,565
4	2019	$5,000,000	($150,000)	$4,850,000	$3,700,042	$4,309,162	100	$46	$4,624	$4,108	$3,704,150	$4,313,270
5	2020	$5,000,000	($150,000)	$4,850,000	$3,457,983	$4,183,653	100	$47	$4,737	$4,086	$3,462,069	$4,187,739
6	2021	$5,000,000	($150,000)	$4,850,000	$3,231,760	$4,061,799	100	$47	$4,737	$3,967	$3,235,727	$4,065,766
7	2022	$5,000,000	($150,000)	$4,850,000	$3,020,336	$3,943,494	100	$48	$4,850	$3,943	$3,024,279	$3,947,437
8	2023	$5,000,000	($150,000)	$4,850,000	$2,822,744	$3,828,635	100	$50	$4,962	$3,917	$2,826,661	$3,832,552
				TOTALS	**$12,479,882**	**$16,894,975**			**$25,234**	**$21,058**	**$12,500,940**	**$16,916,033**

2. Converting Nominal Dollars into Real (Constant) Dollars

The recommended monetized values reported in this Guide convert values reported in their original source documents to 2015$, and require no further adjustment (except discounting to the project's base year when they are used to estimate benefits over its lifetime). However, benefits estimates reported in other sources will not necessarily be denominated in 2015$,and must be converted to that basis to make them comparable with the values reported in this guide. This includes both values that are denominated in current dollars of years other than 2015, as well as values that have already been converted to constant dollars of a year other than 2015.

Consumer Price Index (CPI). A 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,[2] as in the following calculation:

(Value in 2015 $) = (Value in Year Y $)

x (2015 value of CPI)/Year Y value of CPI)

For example, the value in 2015$ of one dollar in project costs (or benefits) that was originally measured in 2010 dollars is

2015 Value of $1 = CPI in 2015/CPI in 2010) x (237.017/ 218.056)
= $1.087

[2] 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/cpid1512.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).[3] 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.

[3] 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)
	O *No injury*	**C** *Possible Injury*	**B** *Non-incapacitating*	**A** *Incapacitating*	**K** *Killed*	**U** *Injured Severity Unknown*	**# Non-fatal Accidents** *Unknown if Injured*
AIS 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 $3235 ($2015) 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	$ 28,800	$ 2,090.02
AIS 2	0.00198	$ 451,200	$ 893.38
AIS 3	0.00008	$ 1,008,000	$ 80.64
AIS 4	0.00000	$ 2,553,600	$ -
AIS 5	0.00003	$ 5,692,800	$ 170.78
AIS 6	0.00000	$ 9,600,000	$ -
		TOTAL	**$ 3,234.82**

Tables 6 and 7 provide sample calculations for the monetization ($2015) 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 32 accidents reported in the most recent calendar year.[4] 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).

[4] 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 ($2015) of 32 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	$ -
1	1.08855	$ 31,350.24	3.44730	$ 99,282.24	3.84215	$ 110,653.92	1.66347	$ 47,907.94	0.00000	$ -	1.25456	$ 36,131.33
2	0.02970	$ 13,400.64	0.31955	$ 144,180.96	0.54490	$ 245,858.88	0.62724	$ 283,010.69	0.00000	$ -	0.20800	$ 93,849.60
3	0.00120	$ 1,209.6	0.05355	$ 53,978.40	0.15955	$ 160,826.40	0.43311	$ 436,574.88	0.00000	$ -	0.07716	$ 77,777.28
4	0.00000	$ -	0.00710	$ 18,130.56	0.03100	$ 79,161.60	0.11958	$ 305,359.49	0.00000	$ -	0.00884	$ 22,573.82
5	0.00045	$ 2,561.76	0.00065	$ 3,700.32	0.00505	$ 28,748.64	0.05349	$ 304,507.87	0.00000	$ -	0.02068	$ 117,727.10
Fatality	0.00000	$ -	0.00000	$ -	0.00000	$ -	0.00000	$ -	2.00000	$ 19,200,000.00	0.00000	$ -
SUBTOTALS	**15.00**	**$ 48,522.24**	**5.00**	**$ 319,272.48**	**5.00**	**$ 625,249.44**	**3.00**	**$ 1,377,360.86**	**2.00**	**$ 19,200,000.00**	**2.00**	**$ 348,059.14**

TOTAL VALUE OF FATALITIES & INJURIES	**$ 21,918,464.16**

Table 7. Sample Calculation for Monetizing ($2015) 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	$ -
1	0.00000	$ -	2.08695	$ 60,104.16
2	0.00000	$ -	0.44360	$ 200,152.32
3	0.00000	$ -	0.24085	$ 242,776.80
4	0.00000	$ -	0.03085	$ 78,778.56
5	0.00000	$ -	0.01395	$ 79,414.56
Fatality	1.00000	$ 9,600,000.00	0.00000	$ -
SUBTOTALS	**1.00**	**$ 9,600,000.00**	**5.00**	**$ 661,226.40**

TOTAL VALUE OF FATALITIES & INJURIES	**$ 10,261,226.40**

III. *Frequently Asked Questions (FAQs)*

1. Are all applicants required to submit a benefit-cost analysis with their 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. We are 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 application's benefit-cost analysis?

The *2016 Benefit-Cost Analysis Guidance* provides general information and guidance on conducting a benefit-cost analysis for 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 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 *2016 Benefit-Cost Analysis Guidance* 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, 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. We assume 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. Please note that the issue of double-counting is an important consideration when calculating economic development benefits for any proposed project. The *2016 Benefit-Cost Analysis Guidance* 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.

- **Wages and job creation:** In general, wages from project-induced job creation are considered transfer payments and should not be included in a typical benefit-cost analysis (see the *2016 Benefit-Cost Analysis Guidance).*

- **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 *2016 Benefit-Cost Analysis Guidance* 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.[5]

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

"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 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) 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

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

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 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 *2016 Benefit-Cost Analysis Guidance* does ask that Applicants "make every effort to make the results of their analyses as *transparent* and *reproducible* as possible". Applicants should provide all relevant files used for their BCA, including any spreadsheet files and technical memos describing the analysis, such as basic assumptions, methods, and the underlying data, in addition to any narrative text from the BCA and Application themselves. The *2016 Benefit-Cost Analysis Guidance* also provides a sample of a potential layout of how this information can be presented.

11. 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 associated with the port activity created.

12. 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 the grant, as well as any indirect costs) must be included in the BCA.

13. 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 and difficult to incorporate on an individual project level.