MEMORANDUM

TO: Texas Department of Transportation Construction Division

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DATE: March 1, 2019

RE: Updated Estimate of Roadway User Cost for Personal Vehicles and Commercial Trucks

Summary

The value of delay time is an estimate of the average differential cost of the extra travel time resulting from delay. For passenger car motorists, this value of delay time is based upon the median hourly wage rate for all occupations plus excess fuel costs associated with slower speed. For truck drivers, the value of delay time is expressed as the wage rate of the driver plus employee benefits provided by the trucking company plus excess fuel costs due to delay associated with slower speed. In addition, total operating cost per mile was calculated based on vehicle operating costs plus accident cost (as represented by insurance cost) for inclusion in those instances where additional miles of driven as a result of construction (a detour or alternate route).

As shown in Table 1 on the following page, researchers estimate the 2018 value of delay time for personal travel to be $29.35 per vehicle per hour ($28.07 for the value of time plus $1.28 due to excess fuel burn due to congested traffic) based on an average occupancy of 1.5 persons per vehicle. Where additional miles of travel are involved (for example, a detour around the construction site) the cost for personal vehicles is $0.597 cents per mile for each additional mile of travel. The commercial truck value of delay time for 2018 is estimated to be $39.47 per vehicle per hour ($33.41 for the value of travel time plus $6.06 due to excess fuel burn in congested traffic) based on an average vehicle occupancy of 1.14 persons per vehicle. Where additional miles of travel are involved, the cost for commercial trucks is estimated to be $1.103 cents per mile for each additional mile of travel. (Note: The excess fuel burn calculations are based on an average congested speed during construction of 15 miles per hour.)
### Table 1: Elements of 2018 Value of Delay Time for Personal and Commercial Vehicles

**Personal Vehicles**

<table>
<thead>
<tr>
<th>Element</th>
<th>Value ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value of Driver Time per Hour</td>
<td>18.71</td>
</tr>
<tr>
<td>Average Occupancy per Vehicle</td>
<td>1.5</td>
</tr>
<tr>
<td>Value of Driver Time x Average Occupancy per Vehicle</td>
<td>28.07</td>
</tr>
<tr>
<td>Excess Fuel Burn per Hour due to Delay</td>
<td>1.28</td>
</tr>
<tr>
<td><strong>TOTAL DELAY TIME ($28.07 + $1.28)</strong></td>
<td>29.35</td>
</tr>
<tr>
<td>Cost per Mile for Additional Travel Due to Detour</td>
<td>0.597</td>
</tr>
</tbody>
</table>

**Commercial Vehicles**

<table>
<thead>
<tr>
<th>Element</th>
<th>Value ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value of Driver Time per Hour</td>
<td>21.08</td>
</tr>
<tr>
<td>Value of Driver Benefits per Hour</td>
<td>6.43</td>
</tr>
<tr>
<td>Subtotal of Driver Time and Benefits</td>
<td>27.51</td>
</tr>
<tr>
<td>Average Occupancy per Vehicle</td>
<td>1.14</td>
</tr>
<tr>
<td>Value of Driver Time and Benefits x Average Occupancy per Vehicle</td>
<td>33.41</td>
</tr>
<tr>
<td>Excess Fuel Burn per Hour due to Delay</td>
<td>6.06</td>
</tr>
<tr>
<td><strong>TOTAL DELAY TIME ($33.41 + $1.28)</strong></td>
<td>39.47</td>
</tr>
<tr>
<td>Cost per Mile for Additional Travel Due to Detour</td>
<td>1.103</td>
</tr>
</tbody>
</table>

### What Changed and Why?

There are a few updates in this report with respect to value of delay time for both passenger and commercial trucks. Key assumptions include:

1) All elements of the operating cost for personal vehicles were updated to remain consistent with those published by the American Automobile Association in their annual report entitled *Your Driving Costs*.

2) All elements of the operating cost for commercial trucks are were updated to remain consistent with those published by the American Transportation Research Institute (ATRI) in their annual survey of members.

3) ATRI values for driver wages used as a basis of commercial travel calculations were updated. The median wage for tractor-trailer truck drivers and light truck/delivery truck drivers as published by the Bureau of Labor Statistics, U.S. Department of Labor, in their Occupational Employment Statistics series are used to provide a reasonableness check on ATRI survey results. (To arrive at one rate, median wages for tractor-trailer truck drivers and light truck/delivery truck drivers were weighted by the proportionate share each has of the total commercial truck vehicle fleet.)

4) Gasoline and diesel fuel prices were updated.
5) The calculation procedure was updated with new values of delay travel and operating cost as a result of fuel price changes.

6) Other procedures and values used in this report are consistent with those used in the *Urban Mobility Report* published by TTI and the Accelerated Construction Benefit/Cost Model developed by TTI for TxDOT.

7) The estimated average vehicle occupancy for personal vehicles remained at 1.50 persons per vehicle.

8) The estimated average vehicle occupancy for commercial trucks remained at 1.14 persons per vehicle.

The value of travel time for personal travel was updated and remains consistent with the median wage for all occupations as published by the Bureau of Labor Statistics, U.S. Department of Labor, in their Occupational Employment Statistics series.

**Estimated Cost of Delay Time for Personal Vehicles**

The value of vehicle occupant time is based on median BLS wage estimates for all occupations. The median hourly wage for 2018 has not yet been released. However, the BLS estimates that wages increased 2.46 percent during the first half of 2018. Assuming that percentage held for the remainder of 2018, the estimate for 2018 would be $18.71 on a per person basis and yield an estimated value of delay time of $28.07 per personal vehicle using a vehicle occupancy rate of 1.5 persons per vehicle.

The annual *Your Driving Costs* report produced by the American Automobile Association was used as a basis to calculate the marginal cost per mile of travel for passenger vehicles. The individual costs associated with the different classes of vehicles were weighted to produce a fleetwide average that represents the vehicle fleet currently in use in Texas. Those data yielded an operating cost estimate of $0.597 cents per mile as shown in Table 2 below.

**Table 2: Passenger Vehicle Operating Costs per Mile**

<table>
<thead>
<tr>
<th>Cost Element</th>
<th>Small Sedan</th>
<th>Medium Sedan</th>
<th>Large Sedan</th>
<th>Small SUV</th>
<th>Medium SUV</th>
<th>Small Minivan</th>
<th>Medium Minivan</th>
<th>Pickups</th>
<th>Weighted Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel</td>
<td>$0.072</td>
<td>$0.090</td>
<td>$0.111</td>
<td>$0.087</td>
<td>$0.118</td>
<td>$0.110</td>
<td>$0.139</td>
<td>$0.108</td>
<td></td>
</tr>
<tr>
<td>Maintenance, Repair, Tires</td>
<td>$0.068</td>
<td>$0.079</td>
<td>$0.084</td>
<td>$0.081</td>
<td>$0.083</td>
<td>$0.078</td>
<td>$0.083</td>
<td>$0.080</td>
<td></td>
</tr>
<tr>
<td>Insurance</td>
<td>$0.088</td>
<td>$0.082</td>
<td>$0.081</td>
<td>$0.072</td>
<td>$0.073</td>
<td>$0.074</td>
<td>$0.083</td>
<td>$0.082</td>
<td></td>
</tr>
<tr>
<td>License, Registration, Taxes</td>
<td>$0.031</td>
<td>$0.046</td>
<td>$0.052</td>
<td>$0.041</td>
<td>$0.058</td>
<td>$0.051</td>
<td>$0.066</td>
<td>$0.051</td>
<td></td>
</tr>
<tr>
<td>Depreciation</td>
<td>$0.151</td>
<td>$0.239</td>
<td>$0.260</td>
<td>$0.195</td>
<td>$0.248</td>
<td>$0.267</td>
<td>$0.235</td>
<td>$0.225</td>
<td></td>
</tr>
<tr>
<td>Finance Charges</td>
<td>$0.029</td>
<td>$0.047</td>
<td>$0.051</td>
<td>$0.041</td>
<td>$0.058</td>
<td>$0.052</td>
<td>$0.065</td>
<td>$0.051</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>$0.439</strong></td>
<td><strong>$0.583</strong></td>
<td><strong>$0.639</strong></td>
<td><strong>$0.517</strong></td>
<td><strong>$0.638</strong></td>
<td><strong>$0.632</strong></td>
<td><strong>$0.671</strong></td>
<td><strong>$0.597</strong></td>
<td></td>
</tr>
</tbody>
</table>

Source: American Automobile Association
Methodology for Value of Delay Time for Commercial Vehicles

Since the last major revision to the UMR commercial travel time methodology, the American Transportation Research Institute (ATRI) began an annual survey of their membership to determine estimates of operational trucking costs. TTI has closely followed ATRI’s survey and has determined it currently provides the most accurate data available for commercial truck operating costs and should serve as the basis for the truck value of delay time estimate used in the UMR.

The ATRI survey disaggregates variable costs into nine categories: fuel, lease/purchase payments, repairs and maintenance, insurance, permits and licenses, tires, tolls, and driver wages and benefits. (For purposes of this report, the Gulf Coast PADD price, as published by the Energy Information Administration, U.S. Department of Energy, were substituted for the fuel costs included in the ATRI survey.) Values are calculated on a per-mile and per-hour basis. Table 3 provides a summary of the survey results expressed on a per-mile basis for the period 2009 through 2017 published by ATRI, which indicates an estimated average operating cost for commercial trucks of $1.103 per mile for 2018. (Note: Values for 2018 were estimated by TTI based on the methodology described on pages 4 thru 6 of this memorandum.)

Table 3: Estimates of Truck Costs per Mile: 2009 through 2017 Calculated by ATRI, 2018 Data Estimated by TTI

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel</td>
<td>$0.405</td>
<td>$0.486</td>
<td>$0.590</td>
<td>$0.641</td>
<td>$0.645</td>
<td>$0.583</td>
<td>$0.403</td>
<td>$0.357</td>
<td>$0.410</td>
<td>$0.492</td>
</tr>
<tr>
<td>Truck/Trailer Lease or Purchase Payments</td>
<td>$0.257</td>
<td>$0.184</td>
<td>$0.189</td>
<td>$0.174</td>
<td>$0.163</td>
<td>$0.215</td>
<td>$0.230</td>
<td>$0.255</td>
<td>$0.264</td>
<td>$0.272</td>
</tr>
<tr>
<td>Repairs and Maintenance</td>
<td>$0.123</td>
<td>$0.124</td>
<td>$0.152</td>
<td>$0.138</td>
<td>$0.148</td>
<td>$0.156</td>
<td>$0.156</td>
<td>$0.166</td>
<td>$0.167</td>
<td>$0.172</td>
</tr>
<tr>
<td>Truck Insurance Premiums</td>
<td>$0.054</td>
<td>$0.059</td>
<td>$0.067</td>
<td>$0.063</td>
<td>$0.064</td>
<td>$0.071</td>
<td>$0.074</td>
<td>$0.075</td>
<td>$0.075</td>
<td>$0.077</td>
</tr>
<tr>
<td>Permits and Licenses</td>
<td>$0.029</td>
<td>$0.040</td>
<td>$0.038</td>
<td>$0.022</td>
<td>$0.026</td>
<td>$0.019</td>
<td>$0.019</td>
<td>$0.022</td>
<td>$0.023</td>
<td>$0.024</td>
</tr>
<tr>
<td>Tires</td>
<td>$0.029</td>
<td>$0.035</td>
<td>$0.042</td>
<td>$0.044</td>
<td>$0.041</td>
<td>$0.044</td>
<td>$0.043</td>
<td>$0.035</td>
<td>$0.038</td>
<td>$0.039</td>
</tr>
<tr>
<td>Tolls</td>
<td>$0.024</td>
<td>$0.012</td>
<td>$0.017</td>
<td>$0.019</td>
<td>$0.019</td>
<td>$0.023</td>
<td>$0.020</td>
<td>$0.024</td>
<td>$0.027</td>
<td>$0.026</td>
</tr>
<tr>
<td>TOTAL</td>
<td>$0.921</td>
<td>$0.940</td>
<td>$1.095</td>
<td>$1.101</td>
<td>$1.106</td>
<td>$1.113</td>
<td>$0.945</td>
<td>$0.934</td>
<td>$1.004</td>
<td>$1.103</td>
</tr>
</tbody>
</table>

Sources: American Transportation Research Institute (years 2009-2015), Texas Transportation Institute (2018). Note: ATRI data from 2008 through 2017 are used in the calculation. Only data from 2009 forward are shown here due to space limitations.

Researchers used the ATRI estimates as a basis for calculating the 2018 commercial truck value of delay time for use in the UMR and other studies. To do so, it was necessary to make several adjustments to the ATRI estimates to update them to 2018. Those methodological adjustments are as follows:

1. Segregated non-fuel and non-labor marginal costs from other costs.
2. Subtracted fuel costs.
3. Calculated the mean and median average percent increase in non-fuel, non-labor marginal costs.
4. Selected the median average percent increase in non-fuel, non-labor marginal cost and apply the increase to the ATRI 2015 non-fuel, non-labor costs to determine cost-per-mile operating costs for 2018.
5. Determined an estimate of fuel efficiency (miles/gallon) for tractor-trailer and straight trucks.
6. Determined an estimate of percent of commercial trucks that are tractor-trailer trucks and straight trucks.
7. Determined a labor cost estimate.
8. Estimated the cost of driver benefits.
9. Estimated an average speed for tractor-trailer trucks and straight trucks.

In the ATRI survey, the mean annual increase from 2008 through 2017 in non-fuel, non-labor costs per mile was calculated at 3.5 percent and the median annual increase calculated to be 2.9 percent. The annual percent change ranged from -11.7 percent to +16.7 percent. Given the wide range in annual percent change, the median value was used to calculate an estimate for non-fuel, non-labor cost-per-mile estimate for 2018 because the median is less impacted by outliers in the data.

The mean annual percentage of the cost of driver benefits as a percent of driver wages was calculated to be 30.6 percent per and the median was calculated to be 30.2 percent for the period 2008 through 2017. The annual percent change ranged from 26.2 percent to 36.3 percent. Again, the median value of 30.2 percent was chosen as an estimate of the cost of driver benefits as a percentage of driver wages because it is less affected by the outliers in the data.

As noted above, several additional estimates were made based on conversations with industry members and the past experience of research professionals to produce a 2018 estimate of truck value of delay time. They are as follows:

- **Estimate of percent of trucks by type** –
  - Tractor-trailer trucks: 60 percent
  - Straight trucks: 40 percent

- **Estimate of truck VMT by type** –
  - Tractor-trailer trucks: 77.5
  - Straight trucks: 22.5

- **Estimate of average truck occupancy** –
  - Tractor-trailer trucks: 1.1 persons per truck
  - Straight trucks: 1.2 persons per truck
  - Weighted average: 1.14 persons per truck

- **Average vehicle speed** –
  - Tractor-trailer trucks: 45 miles per hour
  - Straight trucks: 30 miles per hour
  - Weighted average: 39 miles per hour

Using the calculation procedures outlined above, these data yielded an estimated operational truck value of $1.103 cents per mile shown in Table 3.
Finally, researchers obtained 2018 driver wages from the National Occupational Employment and Wage Estimates for the United States published by the U.S. Department of Labor, Bureau of Labor Statistics (BLS). The median hourly driver wage reported by the BLS for a heavy truck or tractor-trailer truck driver was reported to be $20.92 with the median driver wage for a light or delivery truck drive reported as $15.49 per hour. Weighting the wages by the distribution of trucks by type produces a blended wage rate of $19.70 per hour. However, using previously reported driver wage rates produced by the ATRI surveys, calculating the median annual change in wage rate and then applying that increase to the 2017 rate produced an estimate for 2018 of $22.51 per hour. Given the disparity between the BLS and ATRI estimates, the ATRI wage rate was selected for use in 2018 calculation. The basis for this decision is two-fold. First, it is believed the ATRI survey more accurately reflects market conditions given the shortage of truck drivers and, second, provides the most recent data available.

Including driver benefits at a rate of 30.2 percent of driver wages (the median value shown in the ATRI data for the period 2008 through 2017) multiplied by an average weighted occupancy of 1.14 persons per vehicle yields an estimate of $33.41 per hour of delay time for commercial trucks.

How to Use These Values: Doing the Calculation by Hand

There are several ways to calculate road user cost associated with a construction project. The key element to remember is that the value of interest is the cost associated additional travel time and extra fuel consumption in a given period that is incurred as a result of a construction project. To calculate value of construction delay, assume the following values:

- Project Duration: 180 days
- Average Operating Speed Prior to Construction: 40 miles per hour
- Average Operating Speed During Construction: 15 miles per hour
- Segment Length: 1 mile
- Average Daily Traffic: 20,000 vehicles
- Percent Trucks: 15 percent
- Value of travel time for personal vehicles: $28.07
- Value of travel time for commercial trucks: $33.41
- Wasted fuel per mile for personal vehicles (assuming 15mph congested speed): $1.28
- Wasted fuel per mile for commercial trucks (assuming 15mph congested speed): $6.06

With those values alone, it is possible to calculate the value of construction delay. To do so, use the following steps:

Step 1: Calculate the number of personal vehicles and commercial trucks per day.
- 20,000 total vehicles x 15 percent commercial trucks = 3,000 commercial trucks
- 20,000 total vehicles x 85 percent personal vehicles = 17,000 personal vehicles
Step 2: Calculate the travel time for the area prior to construction.
(60 minutes/40 mph average operating speed prior to construction) x 1.0 segment length = 1.5 minutes of travel time prior to construction

Step 3: Calculate the travel time for the area during construction.
(60 minutes /15 mph average operating speed during construction) x 1.0 segment length = 4.0 minutes of travel time during construction

Step 4: Calculate the amount of additional travel time (delay) due to construction.
4.0 minutes of travel time during construction – 1.5 minutes of travel time prior to construction = 2.5 minutes of delay due to construction

Step 5: Calculate the delay in hours.
(2.5 minutes of delay x 17,000 personal vehicles per day)/60 minutes per hour = 708 hours of passenger vehicle delay

(2.5 minutes of delay x 3,000 commercial trucks per day)/60 minutes per hour = 125 hours of commercial truck delay

Step 6: Calculate the value of delay per day.
(708 hours of delay for personal vehicles x $28.07 per hour) + (125 hours of delay for commercial trucks x $33.41) = $24,050 in delay time per day

Step 7: Calculate the value of excess fuel used per day due to delay.
(17,000 personal vehicles per day x $0.0854 per mile in excess fuel burn x 1 mile segment) + (3,000 commercial trucks per day x $0.4042 per mile in excess fuel burn x 1 mile segment) = $2,664 in excess fuel per day

Step 8: Calculate total delay per day.
$24,050 per day in delay time + $2,664 in excess fuel per day = $26,714 in total delay and excess fuel cost per day due to construction

Step 7: Calculate the value of delay associated with the project (if needed).
$26,714 in delay per day x 180 day project duration = $4.81 million in total delay

New to this calculation is a process where delay value can be determined in the event a detour around construction is used by some of the traffic.

This calculation is based on a per mile operating cost developed from data provided by ATRI (for commercial trucks) and AAA (for personal vehicles). As mentioned elsewhere in this report (See Tables 2 and 3) the per mile operating cost is $0.597 for personal vehicles and $1.103 for commercial trucks.
For the purpose of this example, assume the same speeds, construction segment length, commercial truck/passenger, and volumes used in the prior example. In addition, assume that 10 percent of the traffic used the alternate route shown in Figure 1 and that the average speed on the alternate route is 40 miles per hour.

**Figure 1: Alternate Route/Detour Calculation**

In this example, 2,000 vehicles (1,700 personal vehicles and 300 trucks) would use the alternate route. To calculate the impact of the alternate route do the following steps:

**Step 1:** Calculate the additional operating cost of the vehicles.
\[
((1,700 \text{ personal vehicles} \times \$0.597 \text{ per mile}) + (300 \text{ commercial trucks} \times \$1.103 \text{ per mile})) \times 2 \text{ mile alternate route length} = \$2,692 \text{ per day in additional vehicle operating cost.}
\]
(Note: The total length of the alternate route is 2.5 miles. However, only 2 extra miles are driven because, as shown in Figure 1, the ½ mile on either side of the construction zone would have been driven if the construction were not taking place.)

**Step 2:** Calculate the travel time cost for personal vehicles associated with the alternate route.
\[
(((60 \text{ minutes in an hour}/40 \text{ miles per hour travel speed}) \times 1,700 \text{ personal vehicles})/60 \text{ minutes in an hour}) \times \$28.07 \text{ per hour in travel time cost}) \times 2 \text{ miles} = \$2,386 \text{ in additional travel time cost for personal vehicles per day}
\]

**Step 3:** Calculate the travel time cost for commercial trucks associated with using the alternate route.
\[
(((60 \text{ minutes in an hour}/40 \text{ miles per hour travel speed}) \times 300 \text{ commercial vehicles})/60 \text{ minutes in an hour}) \times \$33.41 \text{ per hour in travel time cost}) \times 2 \text{ miles} = \$501 \text{ in additional travel time cost for commercial trucks per day}
\]

**Step 4:** Add the travel time and operating costs for both personal vehicles and commercial trucks to get obtain the total cost of using the alternate route.
\[
\$2,692 \text{ per day in additional vehicle operating cost} + \$2,386 \text{ in additional travel time cost for personal vehicles per day} + \$501 \text{ in additional travel time cost for commercial trucks per day} = \$5,579 \text{ per day in total cost associated with using the alternate route.}
\]
(Note: Remember to subtract the number of vehicles using the alternate route from the vehicles total number of vehicles on the original route.)
Sources:


Energy Information Administration. Petroleum and Other Liquids – Prices.  https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=EMD_EPD2DXL0_PTE_NUS_DPG&f=A
