



# 2024 SmartWay Online Logistics Tool: Technical Documentation

**U.S. Version 1.0 (Data Year 2023)**

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(Data Year 2023)**

**Transportation and Climate Division  
Office of Transportation and Air Quality  
U.S. Environmental Protection Agency**

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## Overview

The SmartWay Logistics Tool is intended to help logistics companies estimate and assess their carbon, PM, and NO<sub>x</sub> emissions associated with goods movement in the U.S. freight trucking, rail, air and barge sectors.<sup>1</sup>

The SmartWay truck, barge, air, and logistics carrier emissions performance data that EPA has included in the Tool, along with industry average Class I rail CO<sub>2</sub> data, allows logistics companies to generate more accurate emissions performance estimates and mass emissions inventories. The Tool allows logistics companies to track their freight-related emissions performance from year to year and help optimize their emissions performance by allowing them to better estimate the emissions impact of individual carriers.

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<sup>1</sup> Future versions of the tool may help partners evaluate the emissions performance associated with ocean going vessels.

## 1.0 Tool Inputs and Calculations

After logistics companies enter their company and contact information, they provide basic information about each business unit they operate, including name, SCAC, MCN, NSC, and US DOT Number, as well as details regarding business unit type and business focus. Logistics companies then identify each carrier they use for each logistics business unit. Next, users proceed to input activity data for each carrier specified.

### EMISSION INVENTORY AND PERFORMANCE METRIC CALCULATIONS

After inputting the required mileage and/or ton-mile information for each carrier used, the Tool will calculate the associated total mass emissions (i.e., an emissions inventory) based on the mileage-related activity data entered, as well as various emission performance metrics (e.g., composite grams/mile and grams/ton-mile – see below).

Carrier-specific emissions are first calculated either on a ton-mile basis (as ton miles x grams per ton-mile), or on a miles basis (miles x grams per mile), depending on the SmartWay Category as shown in Table 1.<sup>2</sup> Any modes/categories not listed have a limited data availability and their emissions are calculated using ton-miles.

**Table 1. Emissions Calculation Basis by SmartWay Category**

| SmartWay Category    | Activity Basis | $D_{tm}$ | $D_m$ |
|----------------------|----------------|----------|-------|
| Refrigerated         | Ton-miles      | 1        | 0     |
| Mixed                | Ton-miles      | 1        | 0     |
| TL/Dry Van           | Ton-miles      | 1        | 0     |
| Flatbed              | Miles          | 0        | 1     |
| Moving               | Miles          | 0        | 1     |
| Dray                 | Miles          | 0        | 1     |
| Non-SW Truck General | Ton-Miles      | 1        | 0     |
| Specialized          | Miles          | 0        | 1     |
| Expedited            | Miles          | 0        | 1     |
| Auto                 | Miles          | 0        | 1     |
| Tanker               | Miles          | 0        | 1     |
| Heavy/Bulk           | Miles          | 0        | 1     |

The partner's mass emissions are calculated by summing the individual carrier emissions. Then, fleet average emission factors are calculated by dividing mass emissions by total ton-miles and total miles to obtain grams per ton-mile and grams per mile, respectively. The fleet average payload is calculated by dividing total ton-miles by total miles.

<sup>2</sup> Note that the Tool does not need partners to enter a payload or ton-mile estimate for SmartWay Categories whose emissions are based on Miles, as the payload estimate will not affect the overall emissions footprint. However, the calculated emission factors and average payload estimate are affected by the assigned payload.

Overall, carrier emissions are calculated using the following equations, where  $D_{tm}$  and  $D_m$  are dummy variables with values of either 0 or 1, as shown in Table 1 above.

$$E_c = D_{tm} * \text{TonMiles} * gtm + D_m * \text{Miles} * gm$$

Total emissions:

$$E_{tot} = \sum_c E_c$$

Emission factors and average payload (APL):

$$gtm = \frac{E_{tot}}{\sum_c \text{TonMiles}_c}$$

$$gm = \frac{E_{tot}}{\sum_c \text{Miles}_c}$$

$$APL = \frac{\sum_c \text{TonMiles}_c}{\sum_c \text{Miles}_c}$$

The emissions inventory for each carrier/mode combination displayed in the Business Unit, Emissions by Carrier, and Emissions by Mode Reports is calculated using the equations shown above. To calculate composite, business unit-wide emissions and associated performance metrics (i.e., overall g/mile and g/ton-mile performance), the Tool simply sums the emissions, miles and ton-miles for the associated business unit and divides the total emissions by total miles and ton-miles as appropriate.

## TON-MILE CALCULATION

Correctly calculating Ton-Miles is critically important for the accurate determination of your carbon footprint. You can calculate your company's ton-miles as follows.

Determine the ton-miles hauled per year attributable to each carrier. A ton-mile is one ton moving one mile. DO NOT ESTIMATE TON-MILES BY SIMPLY MULTIPLYING TOTAL MILES BY TOTAL TONS - this calculation effectively assumes your entire tonnage is transported on EACH AND EVERY shipment and will clearly overstate your ton-miles.

Many companies track their ton-miles and can report them directly without further calculation. For example, logistics company systems are often set up to associate a payload with the mileage traveled on each trip by carrier and are then summed at the end of the year. If such information is not available, there are two ways to calculate ton-miles:

1. Companies can determine their average payload per carrier, multiply the average payload by the total miles per carrier, and sum the results for all carriers for the reporting year; or
2. Set Ton-miles per carrier = 
$$\frac{\text{total miles per carrier} \times \text{total tons per carrier}}{\text{total \# of trips per carrier}}$$

**NOTE:** In both ton-mile calculations, empty miles are not factored in while the fuel used to drive those empty miles is factored in.

To check your estimate, divide ton-miles by miles. The result is your fleet-average payload. If this number is not reasonable, (e.g., typically between 15 and 25 tons for Class 8b trucks), please check your calculations.

## CARRIER EMISSIONS PERFORMANCE DATA

The current SmartWay program provides CO<sub>2</sub>, NO<sub>x</sub> and PM gram per mile, and gram per ton-mile emission factors for truck, rail, logistics, air and barge freight transport providers. SmartWay may incorporate emission factors from ocean-going vessel transport providers in the future.

## TRUCK CARRIER PERFORMANCE

Truck carrier performance data utilized by the current Logistics Tool is based on 2024 Truck Partner Tool submittals for activity in 2023. Performance data includes g/mile and g/ton-mile for each truck carrier. Note that g/mile and g/ton-mile values represent midpoints for the appropriate SmartWay Category, rather than exact performance levels for a given carrier. Truck SmartWay Categories include:

- |                |                |
|----------------|----------------|
| • TL Dry Van   | • Auto Carrier |
| • LTL Dry Van  | • Expedited    |
| • Refrigerated | • Heavy/Bulk   |
| • Flatbed      | • Moving       |
| • Tanker       | • Specialized  |
| • Dray         | • Mixed        |
| • Package      |                |

Truck fleets are placed into a SmartWay Category and ranked with other SmartWay partner's fleet in that same category based on the following rules:

1. If 75% or more of the fleet's Operation is Drayage the fleet will be categorized as a Drayage fleet, regardless of what you specify for fleet's Body Type.

Otherwise

1. If 75% or more of the fleet's Body Type is Moving, Heavy/Bulk, Refrigerated, Tanker, Auto Carrier, or Flatbed then the fleet will be categorized as that matching body type.

2. If the sum of the fleet's Utility Body Type and Special Hauler Body Type is 75% or more, then the fleet will be categorized as Specialized/Utility.
3. If 75% or more of the fleet's Body Type is Dry Van or Chassis then:
  - a. If 75% or more of the fleet's Operation is Truckload then the fleet will be categorized as TL/Dry Van.
  - b. If 75% or more of the fleet's Operation is Less than Truckload then the fleet will be categorized as LTL/Dry Van.
  - c. If 75% or more of the fleet's Operation is Package then the fleet will be categorized as Package.
  - d. If 75% or more of the fleet's Operation is Expedited then the fleet will be categorized as Expedited.
4. Otherwise, if none of the above conditions exist the fleet will be categorized as a Mixed fleet.

The following provides an overview of the process used to estimate the carrier-specific performance ranges.

### Truck Performance Categories

In the 2024 SmartWay Online Truck Tool, data is collected at the individual company fleet level. Fleets are characterized by a) business type: for-hire or private, b) operational type: truckload/expedited, less than truckload, dry, expedited, or package delivery, and c) equipment type: dry van, refrigerated van, flatbed, tanker, chassis (container), heavy/bulk, auto carrier, moving, or specialized (e.g., hopper, livestock, others.)

The possible categories are shown below.

| For Hire  |         |        |         |        |         |            |              |        |             |
|-----------|---------|--------|---------|--------|---------|------------|--------------|--------|-------------|
|           | Dry Van | Reefer | Flatbed | Tanker | Chassis | Heavy/Bulk | Auto Carrier | Moving | Specialized |
| TL        |         |        |         |        |         |            |              |        |             |
| LTL       |         |        |         |        |         |            |              |        |             |
| Dray      |         |        |         |        |         |            |              |        |             |
| Expedited |         |        |         |        |         |            |              |        |             |
| Package   |         |        |         |        |         |            |              |        |             |
| Private   |         |        |         |        |         |            |              |        |             |
|           | Dry Van | Reefer | Flatbed | Tanker | Chassis | Heavy/Bulk | Auto Carrier | Moving | Specialized |
| TL        |         |        |         |        |         |            |              |        |             |
| LTL       |         |        |         |        |         |            |              |        |             |
| Dray      |         |        |         |        |         |            |              |        |             |
| Expedited |         |        |         |        |         |            |              |        |             |
| Package   |         |        |         |        |         |            |              |        |             |

Note that while Specialized fleets have disparate operations/equipment types and thus do not compare well, they are also unlikely to compete with one another, so it was deemed acceptable to aggregate these disparate fleets into one category.

For-hire and private fleets are combined in the SmartWay Categories. There are relatively few private fleets compared to for-hire fleets. Because owners of private fleets generally hire their own fleets exclusively, it was determined that grouping for-hire and private fleets together would not be detrimental to for-hire fleets, and the simplicity of one for-hire and private category outweighed the benefits of listing fleets separately. Grouping for-hire and private separately would have doubled the number of SmartWay Categories. Therefore, fleets can thus be categorized as shown below.

| For Hire and Private |         |        |         |        |         |            |              |        |             |
|----------------------|---------|--------|---------|--------|---------|------------|--------------|--------|-------------|
|                      | Dry Van | Reefer | Flatbed | Tanker | Chassis | Heavy/Bulk | Auto Carrier | Moving | Specialized |
| TL                   |         |        |         |        |         |            |              |        |             |
| LTL                  |         |        |         |        |         |            |              |        |             |
| Dray                 |         |        |         |        |         |            |              |        |             |
| Expedited            |         |        |         |        |         |            |              |        |             |
| Package              |         |        |         |        |         |            |              |        |             |

Individual fleets were then placed into SmartWay Categories. The following shows the relative number of fleets for the various category intersections, with darker shadings indicating more fleets.

|           | Dry Van | Reefer | Flatbed | Tanker | Chassis | Heavy/Bulk | Auto Carrier | Moving | Specialized | Mixed |
|-----------|---------|--------|---------|--------|---------|------------|--------------|--------|-------------|-------|
| TL        |         |        |         |        |         |            |              |        |             |       |
| LTL       |         |        |         | -      | -       | -          |              |        | -           |       |
| Dray      |         |        | -       | -      |         | -          | -            | -      |             |       |
| Expedited |         | -      | -       | -      | -       |            | -            | -      | -           |       |
| Package   |         | -      | -       | -      | -       | -          | -            |        |             | -     |
| Mixed     |         |        |         | -      |         | -          |              | -      | -           | -     |

SmartWay then considered combining categories with similar characteristics for simplification purposes. One prerequisite was that there needed to be a minimum number of fleets in each category. SmartWay determined that a category needed a minimum of 25 fleets to be created. It was also determined that dry van and chassis (i.e., intermodal container) groups functioned primarily as dry van transport, so these categories were combined. While most refrigerated carriers were truckload, a few less than truckload refrigerated fleets exist, so these categories were combined. Although no expedited or package refrigerated fleets were identified, these categories were also combined into one overall refrigerated category so that no operation and equipment type intersections would be left undefined. A similar situation was identified with flatbed, tanker, heavy/bulk, auto carrier, moving, and specialized fleets. All dray fleets were collapsed into

one category. Any fleet that had mixed operation and/or mixed equipment was placed into a single mixed category. Finally, logistics business units were also included and retained as unique categories.

The final performance categories for 2023 are illustrated below. The solid colors indicate how operation and equipment type assignments vary by performance category. For example, if 75% or more of a fleet's mileage is associated with reefer trucks, the fleet is assigned to the Reefer category *regardless* of the operation percentage across truckload, expedited, LTL, and package categories. However, the Reefer category assignment is overridden if the operation category is greater than or equal to 75% dray or logistics. Similar assignment rules apply to flatbed, tanker, heavy/bulk, auto carrier, moving, and specialized equipment types, as described above. Only the Dry Van/Chassis equipment category is subdivided by the truckload, expedited, LTL, and package operation categories, meaning that the 75% threshold must be met for *both* equipment and operation type in these cases. All other equipment/operation type percentage distributions are assigned to the Mixed category.

**Figure 1. SmartWay Carrier Categories and Data Specificity 2023 Data Year**

| TRUCK     | Dry Van<br>& Chassis                                                                                            | Reefer                | Flatbed               | Tanker                | Heavy<br>& Bulk       | Auto<br>Carrier       | Moving                | Specialized<br>& Utility      | Mixed                            |
|-----------|-----------------------------------------------------------------------------------------------------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-------------------------------|----------------------------------|
| Dray      | Dray<br>5 Performance Levels                                                                                    |                       |                       |                       |                       |                       |                       |                               |                                  |
| Truckload | Truckload DryVan<br>5 Performance Levels                                                                        | Reefer                | Flatbed               | Tanker                | Heavy<br>& Bulk<br>5  | Auto<br>Carrier<br>5  | Moving<br>5           | Specialized<br>& Utility<br>5 | Mixed<br>5                       |
| Expedited | Expedited<br>5 Performance Levels                                                                               | 5                     | 5                     | 5                     | 5                     | 5                     | 5                     | 5                             | 5                                |
| LTL       | LTL<br>5 Performance Levels                                                                                     | Performance<br>Levels | Performance<br>Levels | Performance<br>Levels | Performance<br>Levels | Performance<br>Levels | Performance<br>Levels | Performance<br>Levels         | Performance<br>Levels            |
| Package   | Package Delivery<br>5 Performance Levels                                                                        |                       |                       |                       |                       |                       |                       |                               |                                  |
| Mixed     | Mixed                                                                                                           |                       |                       |                       |                       |                       |                       |                               | Less than 75%<br>in any category |
| Rail      | Single Modal Average for All Rail<br>(No company differentiation allowed per Association of American Railroads) |                       |                       |                       |                       |                       |                       |                               |                                  |
| Barge     | Company Specific Data                                                                                           |                       |                       |                       |                       |                       |                       |                               |                                  |
| Air       | Company Specific Data                                                                                           |                       |                       |                       |                       |                       |                       |                               |                                  |
| Logistics | 10 Performance Levels                                                                                           |                       |                       |                       |                       |                       |                       |                               |                                  |

It is possible that SmartWay will expand these categories in the future based on in-use experience or as a result of further data analysis, and/or requests from industry.

Fleets *within a SmartWay Category* have been ranked from lowest emission factor (best) to highest emission factor (worst) for each of the following metrics: CO<sub>2</sub> g/mile, CO<sub>2</sub> g/ton-mile, NO<sub>x</sub> g/mile, NO<sub>x</sub> g/ton-mile, PM<sub>10</sub> g/mile and PM<sub>10</sub> g/ton-mile. When SmartWay Categories are established, fleets within a category are separated into 5 ranges such that a roughly equal number of fleets are in each range. (Logistics fleets are an

exception, being separated into 10 bins.) Each range thus represents a group of emission factors and the associated ranking “cutpoints” (transition points from one rank to the next). The new range cutpoints are displayed as numbers with significant digits appropriate to emission factors in that range. The midpoint of the range is used as the emission factor for all fleets in that range.

It would be simpler and more straightforward to use fleet-specific emission factors, however the trucking industry expressed concern that revealing exact data could be used to back-calculate mile per gallon numbers. The methodology described above prevents a determination of an exact mpg figure, while at the same time attributing an emission factor much more precisely than a modal default number. Given the large number of trucking fleets, and thus opportunity for fleets to be very close to each other in performance, SmartWay believes it is acceptable and appropriate to break truck fleets into 5 performance ranges for each SmartWay Category.

The table below illustrates the ranges for CO<sub>2</sub> g/mile for the TL/Dry Van SmartWay Category, using 2023 Truck Partner data as an example.

**Table 2. Emission Factor Ranges for TL Dry Van CO<sub>2</sub> g/mile (2023 Data)**

| Bin # | Fleets Per Bin | Grams Per Mile Min | Grams Per Mile Max | Grams Per Mile Range Midpoint |
|-------|----------------|--------------------|--------------------|-------------------------------|
| 1     | 239            | 0                  | 1,388              | 1,346                         |
| 2     | 249            | 1,388              | 1,472              | 1,430                         |
| 3     | 294            | 1,472              | 1,562              | 1,517                         |
| 4     | 265            | 1,562              | 1,669              | 1,615                         |
| 5     | 242            | 1,669              | 3,050              | 1,711                         |

Similar tables have been developed for all performance SmartWay Categories. The “midpoint” of each performance range is the data that the online logistics tool uses to represent the emission performance of a specific fleet that is in the associated range. Once the categories and ranges have been established, the fleets of any new companies joining SmartWay will fall into one of the predefined categories/ranges for that reporting year. SmartWay may update the category/range structure periodically.

Performance estimates for non-SmartWay truck carriers were calculated based on the lowest performing truck partners. Since no data exist to define non-SmartWay fleets, SmartWay believes the prudent approach is to assign conservative emission factors to non-SmartWay companies. Also, this policy makes it likely that any company joining SmartWay will see better emission factors displayed than the non-SmartWay default emission factors.

The non-SmartWay performance metrics were calculated by taking the performance range delta (max - min) for the highest bin within each SmartWay Category and using the delta to calculate a non-SmartWay carrier midpoint for that Category. For truck carriers the midpoint for non-SmartWay carriers is the midpoint for Range 5 plus the Bin 5 range delta. For example, if the Range 5 midpoint was 10.5 and the range delta was

1.0, then the non-SmartWay midpoint is calculated to be 11.5.<sup>3</sup> Table 3 summarizes the 2023 data year performance metrics for non-SmartWay Truck Carriers.

**Table 3. Non-SmartWay Truck Carrier Performance Metrics (Data Year 2023)**

| Category      | CO <sub>2</sub> g/tmi | CO <sub>2</sub> g/mi | NO <sub>x</sub> g/tmi | NO <sub>x</sub> g/mi | PM <sub>2.5</sub> g/tmi | PM <sub>2.5</sub> g/mi |
|---------------|-----------------------|----------------------|-----------------------|----------------------|-------------------------|------------------------|
| Auto Carrier  | 131                   | 2,290                | 0.320                 | 6.000                | 0.00310                 | 0.05180                |
| Dray          | 112                   | 1,983                | 0.636                 | 12.000               | 0.01250                 | 0.25400                |
| Expedited     | 831                   | 1,866                | 0.570                 | 5.100                | 0.00720                 | 0.02450                |
| Flatbed       | 96                    | 2,031                | 0.355                 | 7.800                | 0.00580                 | 0.12400                |
| Heavy/Bulk    | 106                   | 2,479                | 0.345                 | 9.500                | 0.00620                 | 0.14230                |
| LTL/Dry Van   | 265                   | 1,714                | 0.595                 | 4.290                | 0.00280                 | 0.01820                |
| Mixed/General | 125                   | 1,966                | 0.340                 | 5.700                | 0.00330                 | 0.05950                |
| Moving        | 455                   | 1,749                | 0.535                 | 7.000                | 0.01150                 | 0.25750                |
| Package       | 1115                  | 1,348                | 0.970                 | 3.150                | 0.00800                 | 0.00850                |
| Refrigerated  | 109                   | 2,057                | 0.275                 | 5.100                | 0.00200                 | 0.03650                |
| Specialized   | 152                   | 2,158                | 0.475                 | 6.200                | 0.00460                 | 0.04320                |
| Tanker        | 80                    | 1,902                | 0.206                 | 4.730                | 0.00220                 | 0.04900                |
| TL/Dry Van    | 108                   | 1,795                | 0.286                 | 4.510                | 0.00140                 | 0.01920                |

As discussed in the Online Logistics Tool User Guide, depending upon the type of data available for a given carrier, the user may input ton-miles or miles, and rely on carrier data to back-calculate the other value. For example, providing ton-miles and average payload allows the Tool to estimate total miles, by dividing the former by the latter.

When the "Miles Only" data availability option is selected, the Online Logistics Tool uses a default payload value for the associated SmartWay Category. Default values were determined by first plotting the range of reported payloads for all carriers within a SmartWay Category that were hired by Logistics Partners in the 2018 data year. The default payload value for each Category was selected to minimize the sum of the differences between each carrier's reported payload and the default value.<sup>4</sup> This approach effectively equalizes the areas above and below the 0% line in the plots – see Figure 2 for an example.

<sup>3</sup> The performance metrics for the Non-SmartWay "General" Truck Category, which can be selected by partners when a carrier's SmartWay Category is unknown, is set equal to the performance metrics for the Non-SmartWay Mixed Truck Category within the tool.

<sup>4</sup> The default payload value for the General Truck category is set equal to the average payload reported by logistics partners across all truck SmartWay Categories.

**Figure 2. Reported Logistics Partner Payloads (2018) vs Default (9.58 tons)**

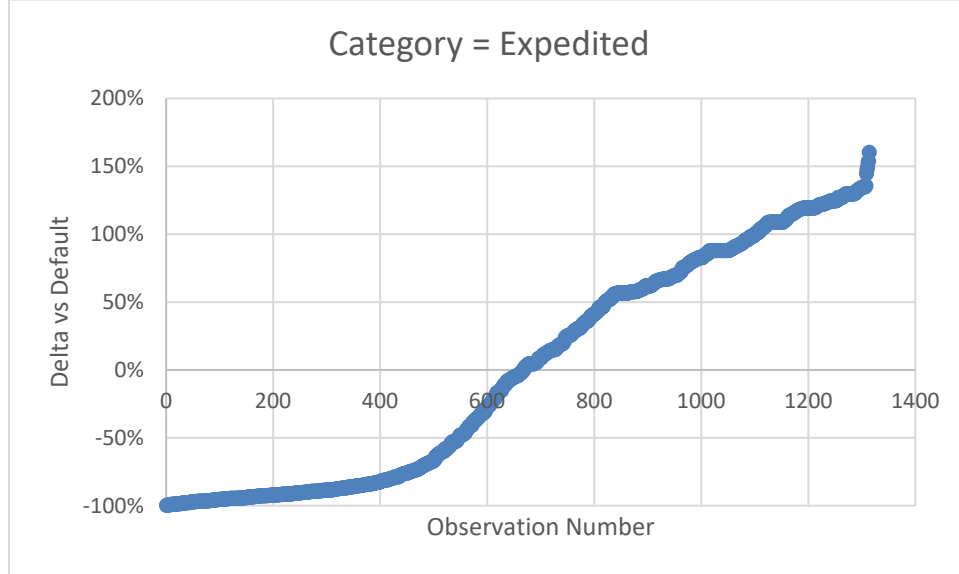


Table 4 presents the default payloads used for “Miles Only” selections for each SmartWay Truck Category.

**Table 4. Default “Miles Only” Payload Values (Data Year 2021)**

| Category     | Tons  |
|--------------|-------|
| Dray         | 16.18 |
| Expedited    | 9.58  |
| Specialized  | 17.20 |
| LTL          | 6.34  |
| Auto Carrier | 15.12 |
| Heavy Bulk   | 16.75 |
| TL/Dry Van   | 16.35 |
| Moving       | 10.73 |
| Flatbed      | 17.32 |
| Mixed        | 16.15 |
| General      | 16.12 |
| Package      | 5.86  |
| Tanker       | 18.33 |
| Refrigerated | 17.60 |

## LOGISTICS CARRIER PERFORMANCE

Logistic carriers have their own performance bins based on the carrier tool submittals for the most recent available calendar year.

Non-SmartWay carrier performance for the SmartWay Categories is estimated in the same way as is done for non-SmartWay Truck carriers. Table 5 summarizes the 2022 data year performance metrics for non-SmartWay Logistics Carriers.

**Table 5. Non-SmartWay Logistics Carrier Performance Metrics (Data Year 2022)**

| Category  | CO <sub>2</sub> g/tmi | CO <sub>2</sub> g/mi | NO <sub>x</sub> g/tmi | NO <sub>x</sub> g/mi | PM <sub>2.5</sub> g/tmi | PM <sub>2.5</sub> g/mi |
|-----------|-----------------------|----------------------|-----------------------|----------------------|-------------------------|------------------------|
| Logistics | 189                   | 2,555                | 0.610                 | 7.950                | 0.00950                 | 0.12850                |

## AIR AND BARGE CARRIER PERFORMANCE

Air and barge carriers have agreed to have their actual emissions results made public, and barge performance values used in the Logistics Tool are carrier-specific. The gram per mile performance values for barge carriers correspond to individual barge (nautical) miles travelled, rather than miles travelled by a string of barges or the associated tug(s).

Non-SmartWay barge carrier gram per mile and gram per ton-mile performance is set to be 25% higher than the worst performing SmartWay barge carrier.

Performance levels for non-SmartWay air freight are based on partner submittals, increasing the highest values reported by partners to provide a reasonable margin of error. These values will be reassessed as more air partner data are obtained. The performance metrics are shown in Table 6.

**Table 6. Performance Metrics for Non-SmartWay Air and Barge Carriers**

|                | CO <sub>2</sub> /tmi | CO <sub>2</sub> /mi | NO <sub>x</sub> /tmi | NO <sub>x</sub> /mi | PM/tmi | PM/mi |
|----------------|----------------------|---------------------|----------------------|---------------------|--------|-------|
| Short-haul Air | 4,300                | 100,000             | 40                   | 900                 | 2      | 35    |
| Long-haul Air  | 1,500                | 50,000              | 20                   | 650                 | 1      | 25    |
| Barge          | 18.58                | 23,295              | 0.64                 | 672                 | 0.02   | 22.24 |

## RAIL CARRIER PERFORMANCE

For Class 1 railroads, rail carrier performance data are collected and displayed in the Logistics Tool at the industry average level derived from Class 1 rail company data. Carrier performance data for Class 2 and 3 railroads are actual values calculated from their submitted tools. Gram per ton-mile factors were determined by dividing total fuel use by total ton-miles and multiplied by a rail diesel CO<sub>2</sub> factor (10,180 g CO<sub>2</sub>/gal diesel fuel), from publicly available data submitted in the 2017 railroad R-1 reports to the Department of Transportation. 2017 R-1 data was also used to obtain total railcar-miles per year for all Class 1 carriers, to

estimate gram per railcar-mile factors. *Industry average values are currently assumed for all Class 1 rail carriers in the carrier file, regardless of SmartWay Partnership status.* Specific rail companies may have the opportunity to provide company-specific data in the future. The R-1 data and corresponding CO<sub>2</sub> performance data are presented in Table 7 below.

**Table 7. Rail Carrier Performance Metric Calculation Inputs & Results  
(2017 R-1 Data)**

| Rail Company                  | Gal/Yr ('000)<br>Sch. 750 Line 4 | Freight Ton<br>Mi/Yr ('000)<br>Sch. 755 line<br>110 | Railcar Mi/Yr<br>( '000) Sch. 755<br>sum of lines 30,<br>46, 64 & 82 | g<br>CO <sub>2</sub> /railcar<br>mile | g<br>CO <sub>2</sub> /short<br>ton mile |
|-------------------------------|----------------------------------|-----------------------------------------------------|----------------------------------------------------------------------|---------------------------------------|-----------------------------------------|
| <b>BNSF Railway</b>           | 1,353,897                        | 665,948,516                                         | 11,606,520                                                           | 1,187                                 | 20.70                                   |
| <b>CSX Transportation</b>     | 426,721                          | 208,127,221                                         | 4,713,411                                                            | 922                                   | 20.87                                   |
| <b>Grand Trunk</b>            | 116,986                          | 62,708,628                                          | 1,486,205                                                            | 801                                   | 18.99                                   |
| <b>Kansas City Southern</b>   | 68,873                           | 34,582,626                                          | 724,012                                                              | 968                                   | 20.27                                   |
| <b>Norfolk Southern*</b>      | 458,179                          | 201,451,969                                         | 4,383,081                                                            | 1,064                                 | 23.15                                   |
| <b>Soo Line</b>               | 65,299                           | 35,244,079                                          | 745,550                                                              | 892                                   | 18.86                                   |
| <b>Union Pacific</b>          | 1,016,161                        | 466,721,215                                         | 10,090,926                                                           | 1,025                                 | 22.16                                   |
| <b>Total/Industry Average</b> | <b>3,506,116</b>                 | <b>1,674,784,254</b>                                | <b>33,749,705</b>                                                    | <b>980</b>                            | <b>20.72</b>                            |

\* and combined subsidiaries

NO<sub>x</sub> and PM emission factors for Class 1 rail carriers are also based on industry averages. Please see the "Background on Illustrative (Modal Average) U.S. Truck and Rail Factors" in Appendix A for further details.

Average payloads per loaded railcar were calculated for all Class 1 carriers by dividing the value for annual ton-miles hauled by an estimate for loaded railcar-miles, based on 2008 R-1 data. The calculation uses the Total Revenue and Non-Revenue Ton-Miles as listed in the R-1 Report on line 114 of schedule 755 divided by the Total loaded Railcar-Miles (the sum of lines 30 and 64 of schedule 755) along with the factor for fuel gallons consumed for loaded freight that is created based on the percentage of loaded freight to total freight multiplied by the total diesel fuel value listed on schedule 750 Line 4. The following table summarizes the estimated average payload per railcar, by carrier.

**Table 8. Rail Carrier Average Payload**

| Carrier                     | Avg Payload/Loaded<br>Railcar (tons) |
|-----------------------------|--------------------------------------|
| <b>BNSF Railway</b>         | 108                                  |
| <b>CSX Transportation</b>   | 85                                   |
| <b>Grand Trunk</b>          | 80                                   |
| <b>Kansas City Southern</b> | 91                                   |

| Carrier          | Avg Payload/Loaded Railcar (tons) |
|------------------|-----------------------------------|
| Norfolk Southern | 76                                |
| Soo Line         | 77                                |
| Union Pacific    | 91                                |
| Industry Average | 93                                |

Average railcar volumes were calculated for all carriers by first estimating an average volume for each major railcar type listed in the R-1 forms (schedule 755, lines 15-81). The assumptions used to estimate these volumes are provided in Table 9. The railcar-miles reported for each railcar type were multiplied by these average volumes to estimate annual cubic foot-miles travelled by car type for each company and for the industry average. The distribution of cubic foot-miles across car types was used as the weighting factor to estimate a single average railcar volume for each company. These values and the resulting volume estimates are presented in Table 10.

**Table 9. Railcar Volume Assumptions and Sources**

| Railcar Type                                              | Cubic Feet | Source/Method<br><i>Key: Norfolk Southern Railroad (NS)<sup>5</sup>, Union Pacific Railroad (UP)<sup>6</sup>, Burlington Northern Santa Fe Railroad (BNSF)<sup>7</sup>, CSX Transportation Railroad (CSX)<sup>8</sup>, World Trade Press Guide to Railcars (GTRC)<sup>9</sup>, Chicago Rail Car Leasing (CRCL)<sup>10</sup>, Union Tank Car Company (UTCC)<sup>11</sup>, U.S Department of Agriculture (USDA)<sup>12</sup></i>                                                                                                                                                                          |
|-----------------------------------------------------------|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Boxcar 50 ft and longer including equipped boxcars</b> | 7,177      | Based on the average of the following boxcar types:<br><u>50ft</u> assumed to be 5694 [reflecting the average of 5355 (NS), 5431 (UP), 5238 (CSX), 6175 (BNSF), 6269 (GTRC)].<br><u>60ft</u> assumed to be 6,648 [reflecting the average of 6618 (NS), 6389 (UP), 6085 (CSX), 7500 (BNSF)].<br><u>50ft high cube</u> assumed to be 6,304 [reflecting the average of 6339 (NS) and 6269 (CSX)].<br><u>60 ft. high cube</u> assumed to be 6917 [reflecting the average of 7499 (NS) , 6646 (CSX), and 6607 (GTRC)].<br><u>86ft</u> assumed to be 9999 (NS).<br><u>Auto parts</u> assumed to be 7499 (NS). |
| <b>Boxcar 40ft</b>                                        | 4,555      | Based on estimate of 50ft boxcar volume described above. Assumed 40ft length would result in 20% reduction in volume.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

<sup>5</sup> Norfolk Southern Intermodal and Automotive Equipment. <https://www.norfolksouthern.com/en/ship-by-rail/shipping-tools/equipment/intermodal-automotive-equipment>. Accessed 5-8-2024.

<sup>6</sup> UP Rail Equipment Descriptions, UP Rail Equipment Descriptions. <https://www.uprr.com/customers/equip-resources/cartypes/index.shtml>. Accessed 5-8-2024.

<sup>7</sup> BNSF Individual Railcar Equipment. <http://www.bnsf.com/ship-with-bnsf/ways-of-shipping/individual-railcar.html#subtabs-3>. Accessed 5-8-2024.

<sup>8</sup> CSX Railroad Equipment. <https://www.csx.com/index.cfm/customers/resources/equipment/railroad-equipment/>. Accessed 5-8-2024.

<sup>9</sup> World Trade Press, World Trade Resources Guide to Railcars 2010.

<sup>10</sup> Chicago Freight Car Leasing Company, Railcar Types. <https://chicagofreightcar.com/>. Accessed 5-8-2024.

<sup>11</sup> UTLX Tank Car Designs and Descriptions. <https://www.utlx.com/tank-car-overview/>. Accessed 5-8-2024.

<sup>12</sup> U.S. Department of Agriculture (USDA), 1992, *Weights, Measures, and Conversion Factors for Agricultural Commodities and Their Products*, Agricultural Handbook Number 697, Economic Research Service, Washington, DC. Available at: [https://www.ers.usda.gov/webdocs/publications/41880/33132\\_ah697\\_002.pdf?v=42487](https://www.ers.usda.gov/webdocs/publications/41880/33132_ah697_002.pdf?v=42487). Accessed 5-8-2024.

**Table 9. Railcar Volume Assumptions and Sources**

| Railcar Type                                                                                                                         | Cubic Feet | Source/Method<br><i>Key: Norfolk Southern Railroad (NS)<sup>5</sup>, Union Pacific Railroad (UP)<sup>6</sup>, Burlington Northern Santa Fe Railroad (BNSF)<sup>7</sup>, CSX Transportation Railroad (CSX)<sup>8</sup>, World Trade Press Guide to Railcars (GTRC)<sup>9</sup>, Chicago Rail Car Leasing (CRCL)<sup>10</sup>, Union Tank Car Company (UTCC)<sup>11</sup>, U.S Department of Agriculture (USDA)<sup>12</sup></i>                                                                                                 |
|--------------------------------------------------------------------------------------------------------------------------------------|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Flat car – all types except for multi-level</b>                                                                                   | 6,395      | Based on the average of the following flat car types:<br><u>60ft</u> assumed to be 6739 (BNSF).<br><u>89ft</u> assumed to be 9372(BNSF).<br><u>Coil</u> assumed to be 3387(NS).<br><u>Covered coil</u> assumed to be 5294 [reflecting the average of 8328 (NS) and 2260 (BNSF)].<br><u>Center beam</u> assumed to be 6546 [reflecting the average of 5857 (UP) and 7236 (BNSF)].<br><u>Bulkhead</u> assumed to be 7030 (BNSF).                                                                                                 |
| <b>Multi-level flat car</b>                                                                                                          | 13,625     | Based on the average of the following multi-level flat car types:<br><u>Unilevel</u> (that carry very large cargo, such as vehicles/tractors) assumed to be 12183 (NS).<br><u>Bi-level</u> assumed to be 14381(NS).<br><u>Tri-level</u> assumed to be 14313 (based on average of 15287 (NS) and 13339 (BNSF)).                                                                                                                                                                                                                 |
| <b>Flat Car – all types-including multi-level</b><br><i>[not used in analysis, except for estimating volume of "All Other Cars"]</i> | 7,428      | Based on the average volumes of the flatcar types described above including multi-level as a single flat car type.                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Gondola – all types Including equipped</b>                                                                                        | 5,190      | Based on the average of the following gondola car types:<br><u>52-53ft</u> assumed to be 2626 [based on average of 2665 (NS), 2743 (CSX), 2400 (BNSF), and 2697(CRLC)].<br><u>60-66ft</u> assumed to be 3372 [based on average of 3281 (NS), 3242 (CSX), 3350 (BNSF), CRCL-3670, and 3366 (GTRC)].<br><u>Municipal Waste</u> assumed to be 7999 (NS).<br><u>Woodchip</u> assumed to be 7781[based on average of 7862 (NS) and 7700 (CRCL)].<br><u>Coal</u> assumed to be 4170 [based on average of 3785 (NS) and 4556 (BNSF)]. |
| <b>Refrigerated - Mechanical /non-Mechanical</b>                                                                                     | 6,202      | Based on the average of the following refrigerated car types:<br><u>48-72ft</u> assumed to be 6963 [based on average of 6043 (UP) and 7883 (BNSF)].<br><u>50ft</u> assumed to be 5167(GTRC).<br><u>40-90 ft.</u> assumed to be 6476 [based on average of 6952 (UP) and 6000 (BNSF)].                                                                                                                                                                                                                                           |

**Table 9. Railcar Volume Assumptions and Sources**

| Railcar Type                   | Cubic Feet | Source/Method<br><i>Key: Norfolk Southern Railroad (NS)<sup>5</sup>, Union Pacific Railroad (UP)<sup>6</sup>, Burlington Northern Santa Fe Railroad (BNSF)<sup>7</sup>, CSX Transportation Railroad (CSX)<sup>8</sup>, World Trade Press Guide to Railcars (GTRC)<sup>9</sup>, Chicago Rail Car Leasing (CRCL)<sup>10</sup>, Union Tank Car Company (UTCC)<sup>11</sup>, U.S Department of Agriculture (USDA)<sup>12</sup></i>                                                                                                                                                                                                                          |
|--------------------------------|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Open Top Hopper                | 4,220      | Based on the average of the following open top hopper car types:<br><u>42ft</u> assumed to be 3000 (UP).<br><u>54ft</u> assumed to be 3700 (UP).<br><u>60ft</u> assumed to be 5188 [based on average of 5125 (UP) and 5250 (GTRC)]. <u>45ft+</u> assumed to be 4105 [based on average of 4500 (UP) and 3710 (BNSF)].<br><u>Woodchip</u> assumed to be 7075 [based on average of 7525 (NS), 5999 (UP), and 7700 (CRCL)].<br><u>Small Aggregate</u> assumed to be 2252 [based on average of 2150 (NS), 2106 (BNSF), and 2500 (CRCL)].                                                                                                                     |
| Covered Hopper                 | 4,188      | Based on the average of the following covered top hopper car types:<br><u>45ft</u> assumed to be 5250 (GTRC).<br><u>Aggregate</u> assumed to be 2575 [based on average of 2150 (NS) and 3000 (CRCL)].<br><u>Small Cube Gravel</u> assumed to be 2939 [based on average of 2655 (NS), 3100 (CSX), and 3063 (BNSF)].<br><u>Med-Large Cube Ores and Sand</u> assumed to be 4169 [based on average of 3750 (NS) and 4589 (BNSF)].<br><u>Jumbo</u> assumed to be 5147 [based on average of 4875 (NS), 4462 (CSX), 5175 (BNSF), and 6075 (CRCL)].<br><u>Pressure Differential (flour)</u> assumed to be 5050 [based on average of 5124 (NS) and 4975 (CRCL)]. |
| Tank Cars under 22,000 gallons | 2,314      | Assumes 1 gallon=0.1337 cubic foot (USDA).<br>Based on small tank car average volume of 17304 gallons, which is the average of the following currently manufactured tank car volume design capacities of 13470, 13710, 15100, 15960, 16410, 17300, 19900, 20000, 20590, and 20610 gallons (GTRC).                                                                                                                                                                                                                                                                                                                                                       |
| Tank Cars over 22,000 gallons  | 3,857      | Assumes 1 gallon=0.1337 (USDA).<br>Based on large tank car volume of 28851 gallons, which is the average of the following currently manufactured tank car volume design capacities of 23470, 25790, 27200, 28700, 30000, 33000, and 33800 gallons (GTRC).                                                                                                                                                                                                                                                                                                                                                                                               |
| All Other Cars                 | 5,014      | Based on average volume presented above for each of the nine railcar types (all flatcars are represented by the line item that includes multi-level flatcars - 7428).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

**Table 10. Rail Carrier Average Volume Determination**

| Freight Car Types<br>(R1 Schedule 755) | Avg. Cu Ft. | BNSF                |                   |
|----------------------------------------|-------------|---------------------|-------------------|
|                                        |             | Railcar Miles (x1K) | Cu Ft Miles (x1K) |
| Box-Plain 40-Foot                      | 4,555       | 1                   | 4,555             |
| Box-Plain 50-Foot & Longer             | 7,177       | 9,338               | 67,018,826        |
| Box-Equipped                           | 7,177       | 147,226             | 1,056,641,002     |
| Gondola-Plain                          | 5,190       | 379,762             | 1,970,964,780     |
| Gondola-Equipped                       | 5,190       | 75,894              | 393,889,860       |
| Hopper-Covered                         | 4,188       | 758,442             | 3,176,355,096     |
| Hopper-Open Top-General Service        | 4,220       | 65,077              | 274,624,940       |
| Hopper-Open Top-Special Service        | 4,220       | 137,449             | 580,034,780       |
| Refrigerator-Mechanical                | 6,202       | 19,272              | 119,524,944       |
| Refrigerator-Non-Mechanical            | 6,202       | 32,910              | 204,107,820       |
| Flat-TOFC/COFC                         | 6,395       | 520,521             | 3,328,731,795     |
| Flat-Multi-Level                       | 13,625      | 38,624              | 526,252,000       |
| Flat-General Service                   | 6,395       | 357                 | 2,283,015         |
| Flat-All Other                         | 6,395       | 71,826              | 459,327,270       |
| All Other Car Types-Total              | 5,772       | 20,146              | 116,282,712       |
| Average Railcar Cubic Feet             |             |                     | 5,811             |

| Freight Car Types (R1 Schedule 755) | CSX                 |                   |
|-------------------------------------|---------------------|-------------------|
|                                     | Railcar Miles (x1K) | Cu Ft Miles (x1K) |
| Box-Plain 40-Foot                   | -                   | -                 |
| Box-Plain 50-Foot & Longer          | 6,987               | 50,145,699        |
| Box-Equipped                        | 144,631             | 1,038,016,687     |
| Gondola-Plain                       | 137,256             | 712,358,640       |
| Gondola-Equipped                    | 64,532              | 334,921,080       |
| Hopper-Covered                      | 153,315             | 642,083,220       |
| Hopper-Open Top-General Service     | 78,412              | 330,898,640       |
| Hopper-Open Top-Special Service     | 35,451              | 149,603,220       |
| Refrigerator-Mechanical             | 17,117              | 106,159,634       |
| Refrigerator-Non-Mechanical         | 11,923              | 73,946,446        |
| Flat-TOFC/COFC                      | 125,828             | 804,670,060       |
| Flat-Multi-Level                    | 29,956              | 408,150,500       |
| Flat-General Service                | 162                 | 1,035,990         |
| Flat-All Other                      | 31,913              | 204,083,635       |
| All Other Car Types-Total           | 19,861              | 114,637,692       |
| Average Railcar Cubic Feet          |                     | 6,389             |

| Freight Car Types (R1 Schedule 755) | Grand Trunk         |                   |
|-------------------------------------|---------------------|-------------------|
|                                     | Railcar Miles (x1K) | Cu Ft Miles (x1K) |
| Box-Plain 40-Foot                   | 0                   | -                 |
| Box-Plain 50-Foot & Longer          | 2,119               | 15,208,063        |
| Box-Equipped                        | 66,110              | 474,471,470       |
| Gondola-Plain                       | 6,467               | 33,563,730        |
| Gondola-Equipped                    | 19,201              | 99,653,190        |
| Hopper-Covered                      | 44,239              | 185,272,932       |
| Hopper-Open Top-General Service     | 9,114               | 38,461,080        |
| Hopper-Open Top-Special Service     | 32,621              | 137,660,620       |
| Refrigerator-Mechanical             | 312                 | 1,935,024         |
| Refrigerator-Non-Mechanical         | 205                 | 1,271,410         |
| Flat-TOFC/COFC                      | 2,779               | 17,771,705        |
| Flat-Multi-Level                    | 4,831               | 65,822,375        |
| Flat-General Service                | 20                  | 127,900           |
| Flat-All Other                      | 31,744              | 203,002,880       |
| All Other Car Types-Total           | 4,755               | 27,445,860        |
| Average Railcar Cubic Feet          |                     | 6,309             |

| Freight Car Types (R1 Schedule 755) | Kansas City Southern |                   |
|-------------------------------------|----------------------|-------------------|
|                                     | Railcar Miles (x1K)  | Cu Ft Miles (x1K) |
| Box-Plain 40-Foot                   | 0                    | -                 |
| Box-Plain 50-Foot & Longer          | 3,383                | 24,279,791        |
| Box-Equipped                        | 39,792               | 285,587,184       |
| Gondola-Plain                       | 16,628               | 86,299,320        |
| Gondola-Equipped                    | 11,150               | 57,868,500        |
| Hopper-Covered                      | 50,346               | 210,849,048       |
| Hopper-Open Top-General Service     | 626                  | 2,641,720         |
| Hopper-Open Top-Special Service     | 943                  | 3,979,460         |
| Refrigerator-Mechanical             | 21                   | 130,242           |
| Refrigerator-Non-Mechanical         | 52                   | 322,504           |
| Flat-TOFC/COFC                      | 10,736               | 68,656,720        |
| Flat-Multi-Level                    | 629                  | 8,570,125         |
| Flat-General Service                | 12                   | 76,740            |
| Flat-All Other                      | 2,321                | 14,842,795        |
| All Other Car Types-Total           | 247                  | 1,425,684         |
| Average Railcar Cubic Feet          |                      | 5,938             |

| Freight Car Types (R1 Schedule 755) | Norfolk Southern    |                   |
|-------------------------------------|---------------------|-------------------|
|                                     | Railcar Miles (x1K) | Cu Ft Miles (x1K) |
| Box-Plain 40-Foot                   | 0                   | -                 |
| Box-Plain 50-Foot & Longer          | 7,622               | 54,703,094        |
| Box-Equipped                        | 136,745             | 981,418,865       |
| Gondola-Plain                       | 193,214             | 1,002,780,660     |
| Gondola-Equipped                    | 111,320             | 577,750,800       |
| Hopper-Covered                      | 116,848             | 489,359,424       |
| Hopper-Open Top-General Service     | 84,557              | 356,830,540       |
| Hopper-Open Top-Special Service     | 30,078              | 126,929,160       |
| Refrigerator-Mechanical             | 3,512               | 21,781,424        |
| Refrigerator-Non-Mechanical         | 5,392               | 33,441,184        |
| Flat-TOFC/COFC                      | 114,928             | 734,964,560       |
| Flat-Multi-Level                    | 20,349              | 277,255,125       |
| Flat-General Service                | 145                 | 927,275           |
| Flat-All Other                      | 24,563              | 157,080,385       |
| All Other Car Types-Total           | 212,408             | 1,226,018,976     |
| Average Railcar Cubic Feet          |                     | 6,065             |

| Freight Car Types (R1 Schedule 755) | Soo Line            |                   |
|-------------------------------------|---------------------|-------------------|
|                                     | Railcar Miles (x1K) | Cu Ft Miles (x1K) |
| Box-Plain 40-Foot                   | 0                   | -                 |
| Box-Plain 50-Foot & Longer          | 725                 | 5,203,325         |
| Box-Equipped                        | 17,972              | 128,985,044       |
| Gondola-Plain                       | 1,203               | 6,243,570         |
| Gondola-Equipped                    | 8,856               | 45,962,640        |
| Hopper-Covered                      | 94,146              | 394,283,448       |
| Hopper-Open Top-General Service     | 3,077               | 12,984,940        |
| Hopper-Open Top-Special Service     | 20                  | 84,400            |
| Refrigerator-Mechanical             | 159                 | 986,118           |
| Refrigerator-Non-Mechanical         | 742                 | 4,601,884         |
| Flat-TOFC/COFC                      | 11,178              | 71,483,310        |
| Flat-Multi-Level                    | 2,973               | 40,507,125        |
| Flat-General Service                | 12                  | 76,740            |
| Flat-All Other                      | 10,068              | 64,384,860        |
| All Other Car Types-Total           | 428                 | 2,470,416         |
| Average Railcar Cubic Feet          |                     | 5,667             |

| Freight Car Types (R1 Schedule 755) | Union Pacific       |                   |
|-------------------------------------|---------------------|-------------------|
|                                     | Railcar Miles (x1K) | Cu Ft Miles (x1K) |
| Box-Plain 40-Foot                   | 0                   | -                 |
| Box-Plain 50-Foot & Longer          | 12,311              | 88,356,047        |
| Box-Equipped                        | 238,241             | 1,709,855,657     |
| Gondola-Plain                       | 206,370             | 1,071,060,300     |
| Gondola-Equipped                    | 91,775              | 476,312,250       |
| Hopper-Covered                      | 370,929             | 1,553,450,652     |
| Hopper-Open Top-General Service     | 188,027             | 793,473,940       |
| Hopper-Open Top-Special Service     | 104,969             | 442,969,180       |
| Refrigerator-Mechanical             | 82,874              | 513,984,548       |
| Refrigerator-Non-Mechanical         | 27,009              | 167,509,818       |
| Flat-TOFC/COFC                      | 1,026,251           | 6,562,875,145     |
| Flat-Multi-Level                    | 46,889              | 638,862,625       |
| Flat-General Service                | 350                 | 2,238,250         |
| Flat-All Other                      | 72,371              | 462,812,545       |
| All Other Car Types-Total           | 16,769              | 96,790,668        |
| Average Railcar Cubic Feet          |                     | 6,248             |

| Freight Car Types (R1 Schedule 755) | Total (for Industry Average) |                   |
|-------------------------------------|------------------------------|-------------------|
|                                     | Railcar Miles (x1K)          | Cu Ft Miles (x1K) |
| Box-Plain 40-Foot                   | 1                            | 4,555             |
| Box-Plain 50-Foot & Longer          | 42,485                       | 304,914,845       |
| Box-Equipped                        | 790,717                      | 5,674,975,909     |
| Gondola-Plain                       | 940,900                      | 4,883,271,000     |
| Gondola-Equipped                    | 382,728                      | 1,986,358,320     |
| Hopper-Covered                      | 1,588,265                    | 6,651,653,820     |
| Hopper-Open Top-General Service     | 428,890                      | 1,809,915,800     |
| Hopper-Open Top-Special Service     | 341,531                      | 1,441,260,820     |
| Refrigerator-Mechanical             | 123,267                      | 764,501,934       |
| Refrigerator-Non-Mechanical         | 78,233                       | 485,201,066       |
| Flat-TOFC/COFC                      | 1,812,221                    | 11,589,153,295    |
| Flat-Multi-Level                    | 144,251                      | 1,965,419,875     |
| Flat-General Service                | 1,058                        | 6,765,910         |
| Flat-All Other                      | 244,806                      | 1,565,534,370     |
| All Other Car Types-Total           | 274,614                      | 1,585,072,008     |
| Industry Average Railcar Cubic Feet |                              | 6,091             |

## BLACK CARBON EMISSIONS ESTIMATION

Air, rail, barge, and truck carrier black carbon (BC) emissions are estimated using either emission factors (e.g., grams of BC per mile for truck carriers) or by scaling from PM emission estimates (e.g., for air carriers). BC emissions are also estimated for logistics business units assuming BC emission rates scale directly with PM (e.g., tons BC = scaling factor x tons PM). Average scaling factors for logistics business units are estimated for each selected carrier's mode/SmartWay Category combination, based on the following:

- The BC/PM<sub>2.5</sub> ratios for air and rail carriers are constant for each mode and are the same as those used to estimate BC emissions in the SmartWay Air and Rail Tools, respectively. Estimates assume jet fuel use for air carriers, and ultra-low sulfur diesel for rail carriers.
- Factors for barge carriers are based on the average BC/PM<sub>10</sub> ratio across all propulsion engine age groups and sizes in EPA's 2020 Port Emission Inventory Guidance.<sup>13</sup> Estimates assume ultra-low sulfur diesel fuel use.
- Factors for each Truck/SmartWay Category combination are based on average BC/PM<sub>2.5</sub> ratio for SmartWay truck carrier submissions for Data Year 2019.
- Factors for logistics business units are determined by calculating a weighted average of the BC/PM ratios for all other modes/SmartWay Categories. First, the ton-miles attributed to the air, rail, barge, and truck carriers selected by SmartWay logistics business units for the 2019 data year were summed by mode.<sup>14</sup> Then the fraction of ton-miles for each mode were applied to the BC factors for each mode to estimate a weighted average BC/PM ratio for all logistics carriers. The resulting weighting factors are as follows:
  - Air – 0.04%
  - Barge – 0.06%
  - Rail – 4.07%
  - Truck (all Categories) – 88.99%

Table 11 presents the average scaling factors used to estimate logistics business unit BC emissions. The table also presents the minimum and maximum BC/PM ratios observed in the various data sources to provide a measure of the potential variability associated with a logistic business unit's carrier selections. BC estimates are particularly uncertain for truck carriers selected by logistics business units, due to the large variation in BC/PM ratios across engine model years and truck classes.

<sup>13</sup> See Table H-6. <https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P10102U0.pdf>. Accessed 5-8-2024.

<sup>14</sup> Logistics business units selected by other logistics business units were excluded to simplify the analysis. This exclusion adds an unspecified degree of uncertainty to the final BC/PM ratio estimate.

**Table 11. BC/PM Ratios for Logistics Business Units**

| Mode/Category      | Basis | Average | Min   | Max   | Range | Data Source/Basis                            |
|--------------------|-------|---------|-------|-------|-------|----------------------------------------------|
| Rail               | PM2.5 | 0.677   | N/A   | N/A   | N/A   | SmartWay Rail Tool                           |
| Air                | PM2.5 | 0.130   | N/A   | N/A   | N/A   | SmartWay Air Tool                            |
| Barge              | PM10  | 0.746   | 0.733 | 0.754 | 0.021 | 2020 EPA Port Emissions Inventory Guidance   |
| Truck/Auto         | PM2.5 | 0.366   | 0.088 | 0.760 | 0.671 | 2019 Data Year Truck Partner submissions     |
| Truck/Dray         | PM2.5 | 0.442   | 0.085 | 0.782 | 0.697 | 2019 Data Year Truck Partner submissions     |
| Truck/Expedited    | PM2.5 | 0.295   | 0.071 | 0.720 | 0.649 | 2019 Data Year Truck Partner submissions     |
| Truck/Flatbed      | PM2.5 | 0.366   | 0.083 | 0.815 | 0.732 | 2019 Data Year Truck Partner submissions     |
| Truck/Heavy-Bulk   | PM2.5 | 0.335   | 0.088 | 0.764 | 0.676 | 2019 Data Year Truck Partner submissions     |
| Truck/LTL          | PM2.5 | 0.330   | 0.063 | 0.746 | 0.684 | 2019 Data Year Truck Partner submissions     |
| Truck/Mixed        | PM2.5 | 0.355   | 0.077 | 0.785 | 0.708 | 2019 Data Year Truck Partner submissions     |
| Truck/Moving       | PM2.5 | 0.361   | 0.077 | 0.673 | 0.596 | 2019 Data Year Truck Partner submissions     |
| Truck/Package      | PM2.5 | 0.162   | 0.088 | 0.576 | 0.488 | 2019 Data Year Truck Partner submissions     |
| Truck/Refrigerated | PM2.5 | 0.330   | 0.090 | 0.799 | 0.710 | 2019 Data Year Truck Partner submissions     |
| Truck/Specialized  | PM2.5 | 0.353   | 0.077 | 0.733 | 0.656 | 2019 Data Year Truck Partner submissions     |
| Truck/Tanker       | PM2.5 | 0.330   | 0.088 | 0.767 | 0.680 | 2019 Data Year Truck Partner submissions     |
| Truck/TL-Dry Van   | PM2.5 | 0.295   | 0.059 | 0.826 | 0.768 | 2019 Data Year Truck Partner submissions     |
| Truck/General      | PM2.5 | 0.329   | 0.059 | 0.826 | 0.768 | Average across all SmartWay Truck Categories |
| Logistics          | PM2.5 | 0.355   | 0.130 | 0.746 | 0.616 | Weighted average of all category ratios      |

## % SMARTWAY VALUE

The % SmartWay screen presents the portion of goods that logistics business units move with SmartWay Partners (expressed as a percentage between 0 and 100). Partners select the basis for calculating the percentage shipped with SmartWay Partners including:

-  Total annual miles (the Tool will automatically populate the % SmartWay screen with any carrier activity data that partners entered in the freight Activity Data screen). Miles corresponds to truck-miles for trucks, aircraft-miles for air, barge-miles for barge, and railcar-miles for rail;
-  Total annual ton-miles (the Tool will automatically populate the % SmartWay screen with any carrier activity data that partners entered on the freight Activity Data screen);

Note the Tool will automatically populate the % SmartWay screen with any carrier activity data entered in the Activity Data screen. In addition, the metric selected for your first business unit will be chosen as the basis for your other business units as well, so that a Partner-level % SmartWay Value can be calculated. The Partner-level % SmartWay Value is used to determine Excellence Award eligibility in the SmartWay program. To see your Partner-level % SmartWay Value, calculated across all companies, go to the % SmartWay Report in the Reports Menu via the Home page.

### Adjusted % SmartWay Value

The SmartWay Carrier breakout for the Logistics category includes an additional column for "Adjusted %SmartWay" values. The adjusted value reflects the % SmartWay score for each logistics business unit hired accounting for the portion of activity that business unit allocates to other SmartWay carriers.<sup>15</sup> If logistics business units are used, Adjusted % SmartWay values are also displayed in the "%SmartWay" summary table at the bottom of the screen.

## PUBLIC DISCLOSURE REPORTS

The Logistics Tool provides a report summarizing Scope 3 emissions for public disclosure purposes. Mass emissions are presented in metric tons for CO<sub>2</sub> (biogenic and non-biogenic), NO<sub>x</sub>, and PM<sup>16</sup> for all carriers listed on the Tool's Activity screen. The percent of CO<sub>2</sub> attributable to SmartWay Carriers is also provided. Biogenic CO<sub>2</sub> emissions estimates are assumed to equal approximately 2 percent of total CO<sub>2</sub> emissions, as per U.S. requirements for biomass-based diesel from the EPA Renewable Fuel Standard program final volume requirements.<sup>17</sup>

### CO<sub>2</sub>e

CO<sub>2</sub> equivalent (CO<sub>2</sub>e) emissions are also provided in the Public Disclosure report, and are calculated by multiplying carrier CO<sub>2</sub> values by scaling factors which vary by mode:

- Truck and Logistics-Truck carrier emissions:  $\text{CO}_2\text{e} = \text{CO}_2 \times 1.02271$

<sup>15</sup> At this time SmartWay logistics partners are assigned full credit when calculating their % SmartWay Value, regardless of the amount of business logistics partners do with SmartWay carriers. SmartWay may adopt the Adjusted % SmartWay Value for scoring purposes in the future, but as of now the adjusted values are for information purposes only.

<sup>16</sup> Emissions from CH<sub>4</sub>, N<sub>2</sub>O, HFC's, PFC's, SF<sub>6</sub> and NF<sub>3</sub> have been deemed immaterial, comprising less than 5% of overall GHG emissions and are therefore EXCLUDED for reporting purposes.

<sup>17</sup> As stated in the [Final Rule](https://www.govinfo.gov/content/pkg/FR-2018-12-11/pdf/2018-26566.pdf) (Table I.B.7-1 – see <https://www.govinfo.gov/content/pkg/FR-2018-12-11/pdf/2018-26566.pdf>, Accessed 5-8-2024.), the volume requirements for biomass-based diesel are rounded to equal 2% for calculation purposes. The percentage is updated annually in the Tool.

- Rail and Logistics-Rail carrier emissions:  $\text{CO}_2\text{e} = \text{CO}_2 \times 1.01420$
- Air and Logistics-Air carrier emissions:  $\text{CO}_2\text{e} = \text{CO}_2 \times 1.00970$
- Barge and Logistics-Barge carrier emissions:  $\text{CO}_2\text{e} = \text{CO}_2 \times 1.10560$
- Logistics-Mixed carrier emissions:  $\text{CO}_2\text{e} = \text{CO}_2 \times 1.04554$

The above scaling factors are based on data for the year 2020 from Table 2-13 in the [EPA Emissions and Sinks Report](#).<sup>18</sup> The Truck and Logistics-Truck factor was derived by dividing the medium and heavy-duty truck emissions for each greenhouse gas excluding  $\text{CO}_2$  ( $\text{CH}_4$ ,  $\text{N}_2\text{O}$ , and HFCs) by the total emissions including  $\text{CO}_2$ , and then summing the ratios to obtain the total adjustment factor. The factors for the other modes were calculated similarly for the appropriate mode types (Rail, Commercial Aircraft, and Ships/Boats), with the exception of the factor for Logistics-Mixed carriers which is a simple average of the other factors.

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<sup>18</sup> U.S. EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2020, <https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2020>, accessed 5-8-2024.

## 2.0

# Payloads and Data Validation

The Logistics Tool contains data validation checks designed to identify missing and potentially erroneous data. At this time the only validation involves payload checks and total ton-mile checks.

## PAYLOAD VALIDATION

Validation cut points are set in the Logistics Tool to identify payloads that are somewhat outside typical industry values (yellow flag warnings) and those that are far outside industry averages (red flag warnings). The payload check only applies to Data Availability selections where payloads are either entered by the user or calculated based on other inputs. Checks are applied at the carrier (row) level.

Payload checks are specific to the truck carrier fleet's SmartWay Category/mode, which is available for each carrier category from the Carrier Data Table. Red payload ranges require explanations. For yellow ranges explanations are optional.

Validation ranges are based on payload values reported by SmartWay Logistics partners for the 2018 calendar year. Minimum values are set to zero, requiring all payload entries to be greater than zero. Red and yellow ranges were determined based on visual identification of apparent inflection points in the payload distribution curves, corresponding to "natural" groupings where possible. Maximum, not-to-exceed values are based on those used in the SmartWay Truck Tool.

**Table 12. Logistics Business Unit Payload Validation Ranges**

| SmartWay Truck Category  | Low Red   | Low Yellow | High Yellow | High Red     |
|--------------------------|-----------|------------|-------------|--------------|
| LTL Dry Van              | 0.0 - 1.0 | 1.0 - 2.5  | 15.0 - 20.0 | 20.0 - 83.7  |
| Package                  | 0.0 - 0.1 | 0.1 - 2.5  | 15.0 - 20.0 | 20.0 - 83.7  |
| TL Dry Van               | 0.0 - 5.0 | 5.0 - 10.0 | 20.0 - 22.5 | 22.5 - 150.0 |
| Refrigerated             | 0.0 - 5.0 | 5.0 - 15.0 | 21.0 - 22.5 | 22.5 - 82.5  |
| Flatbed                  | 0.0 - 5.0 | 5.0 - 10.0 | 24.0 - 26.0 | 26.0 - 99.9  |
| Tanker                   | 0.0 - 5.0 | 5.0 - 15.0 | 23.5 - 25.0 | 25.0 - 103.8 |
| Moving                   | 0.0 - 2.5 | 2.5 - 4.0  | 17.5 - 19.5 | 19.5 - 150.0 |
| Specialized/Utility      | 0.0 - 2.0 | 2.0 - 10.0 | 22.5 - 25.0 | 25.0 - 111.0 |
| Dray                     | 0.0 - 5.0 | 5.0 - 10.0 | 22.0 - 30.0 | 30.0 - 73.5  |
| Auto Carrier             | 0.0 - 5.0 | 5.0 - 7.5  | 20.0 - 22.5 | 22.5 - 73.5  |
| Heavy-Bulk               | 0.0 - 5.0 | 5.0 - 10.0 | 22.5 - 25.0 | 25.0 - 120.0 |
| Mixed                    | 0.0 - 5.0 | 5.0 - 11.5 | 22.0 - 32.0 | 32.0 - 99.3  |
| Expedited                | 0.0 - 1.0 | 1.0 - 2.5  | 20.0 - 22.5 | 22.5 - 83.7  |
| General (all categories) | 0.0 - 5.0 | 5.0 - 10.0 | 23.0 - 25.0 | 25.0 - 150.0 |

| SmartWay Truck Category | Low Red    | Low Yellow  | High Yellow  | High Red      |
|-------------------------|------------|-------------|--------------|---------------|
| <b>Logistics</b>        | 0.0 – 12.0 | 12.0 – 16.7 | 21.0 – 27.2  | 27.2 – 150.0  |
| <b>Rail</b>             | 0.0 – 9.4  | N/A         | N/A          | 125.0 – 200.0 |
| <b>Air</b>              | N/A        | N/A         | 55.0 – 110.0 | > 110.0       |

Validation cutoffs for rail payloads are based on the distribution of average values estimated for all Class 1 carriers, and only include red flags. The absolute upper bound for rail carriers has been set at 200 tons.

Air carriers have their maximum average payload set to 110 tons, corresponding to the maximum payload capacity for the largest aircraft make/model specified by SmartWay partners in 2017. Payloads above this amount trigger a “red” out of range error that must be explained by the partner to proceed, although no value has been set for a maximum allowable payload at this time. Payloads between 55 and 110 tons receive a “yellow” warning which may be explained if the partner chooses.

Barge carrier payloads are flagged for verification if their density is greater than 0.6 tons per cubic foot or less than 0.003 tons per cubic foot, consistent with the payload validation used in the SmartWay Barge Tool.

## TON-MILE VALIDATION

2011 Logistics Partner data was evaluated to establish absolute upper bounds for ton-mile inputs. The ton-mile validation applies at the carrier (row) and total fleet (summation of rows) level, with the same values applied to both. The maximum allowable ton-mile value was set to twice the observed maximum value in the 2011 data set: 209,207,446,000 ton-miles.

# Appendix A - Background on Industry Average U.S. Rail Factors

Industry average freight rail grams per mile and grams per ton-mile factors were developed using data released in August of 2019 for EPA's 2017 National Emission Inventory (NEI).<sup>19</sup> The factors were developed using emission estimates specifically for Class I (line-haul and yard switching) locomotives. These data were then divided by railcar-mile and ton-mile data for 2017 Class I rail carriers to obtain the corresponding performance metrics. Table A-1 presents the industry average freight rail emissions factors used in the Tool.

**Table A-1. U.S. Freight Rail Industry Average Factors (2017)**

| Performance Metric  | CO <sub>2</sub> | NO <sub>x</sub> | PM <sub>10</sub> | PM <sub>2.5</sub> |
|---------------------|-----------------|-----------------|------------------|-------------------|
| gram/short ton-mile | 20.72           | 0.2897          | 0.0085           | 0.0082            |
| gram/railcar mile   | 980             | 14.38           | 0.418            | 0.405             |

Note that NO<sub>x</sub> and PM emission factors are not available at the carrier level for the rail mode. Accordingly, the industry average emission factors are assumed to apply equally for all rail carriers.

<sup>19</sup> Emissions Modeling Platform Collaborative, Specification Sheet: Rail 2017 National Emissions Inventory, August 2019 – Table 1. See [https://gaftp.epa.gov/air/nei/2017/doc/supporting\\_data/point/2017Rail\\_main\\_21aug2019.pdf](https://gaftp.epa.gov/air/nei/2017/doc/supporting_data/point/2017Rail_main_21aug2019.pdf). Accessed 5-8-2024.



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