# MOBILITY BENEFITS FROM PUBLIC TRANSPORTATION SERVICE

Buses and trains carry a significant number of trips in many large areas, and provide important benefits in many smaller ones. Peak period public transportation service during congested hours can improve the transportation capacity, provide options for travel mode and allow those without a vehicle to gain access to jobs, school, medical facilities, and other destinations. In the case of public transportation lines that do not intersect roads, the service can be particularly reliable as they are not affected by the collisions and vehicle breakdowns that plague the roadway system and are not as affected by weather, road work, and other unreliability-producing events. Early versions of the Urban Mobility Report included examples of the amount of public transportation improvements needed to address congestion. Later versions included public transportation service in the general measures and analysis. This paper provides an estimate of the mobility benefits associated with general public transportation service.

## Public Transportation Service

The Urban Mobility Report methodology for roadways uses person volume and speed as the two main elements of the measurement analysis (*6*). While this is consistent with the goals of the public transportation service, there are differences between several aspects of road and transit operations. Regular route bus transit service stops frequently to allow riders to enter and leave the vehicles. Train service in many cases also makes more than one stop per mile. The goal of the service is to provide access to the area near the stops as well as move passengers to other destinations. A comparison with road transportation systems, therefore, cannot use the same standards or comparison methods.

The data sources for this type of analysis are a combination of locally collected and nationally consistent information. The nationally consistent public transportation data is supplied by the American Public Transportation Association (APTA) and includes ridership, passenger miles of travel, service mileage and hours (*2*). Consistent roadway data, in the form of the Highway Performance Monitoring System (HPMS) from Federal Highway Administration (FHWA) is available for similar statistics, but the relationship between volume and speed on the roadway side is more studied and more easily estimated than for the transit service (*1*). Some simplifying assumptions have been made to initiate the analysis. There is an ongoing effort to improve the data and statistics in order to reduce the number of assumptions that are needed, as well as improving the estimates that are made.

## The Mobility Measures

### *Travel Delay Savings*

The delay benefits associated with public transportation service were calculated using the "what if many of the transit riders were in the general traffic flow" case. Additional traffic on already crowded road networks would affect all the other peak period travelers as well. This is an artificial case in the sense that the effects of a transit service shutdown would be much more significant and affect more than just the transit riders or roadway travelers. Public transportation patrons who rely on the service for their basic transportation needs would find travel much more difficult, making jobs, school, medical, or other trip destinations much harder to achieve. Businesses that count on the reliable service and access to consumers and workers that public transportation provides would suffer as well.

### *Travel Time Index*

The method used in this analysis to estimate a revised Travel Time Index focuses on "similar expectations". Transit service is operated according to a schedule. When buses and trains stop to pick up and discharge passengers, their average speed is generally slower than vehicles on the road. Riders and potential riders evaluate the service and make choices according to either the departure and arrival times or in the case of operations that run very frequently, the travel time to the destination with the expectation that the departure time will be relatively soon after arrival in the station. In transit operations this can be thought of as similar to an uncongested roadway trip. Public transportation service that operates on-time according to the schedule, then, would be classified by the patrons as uncongested roadway travel.

It may seem odd to disregard travel speed in this sense, but the service differences are important. Attempting to estimate the slower speeds on transit routes and incorporating them into the analysis would, in essence, double penalize the service. Many travelers already use the longer travel times to make their decision to not use transit and the longer times are one of the reasons ridership is relatively low during off-peak hours. Transit routes could gain speed by decreasing stops, but at the risk of losing ridership. This relationship between speed and convenience is constantly adjusted by transit agencies seeking to increase transit performance and ridership. Our approach to defining a different standard for transit routes is similar to the different speed threshold used for surface streets and freeways.

The "reward" for public transportation in this revised Travel Time Index estimate comes from gain in ridership and on-time operation. If the route travel times become unreasonably long, ridership will decline, and the amount of "uncongested" passenger-miles contributed by public transportation will also decline. The beneficial effects of faster route times, better access or improved service from interconnected networks or high-speed bus or rail links would result in higher ridership values, which would increase the amount of "uncongested" travel in the mobility measure calculations.

# Revisions to Public Transportation Methodology

Since the release of the *2003 Urban Mobility Report* (UMR) (*33*) the Texas Transportation Institute (TTI) has included several statistics that show the estimated reduction in traffic congestion attributed to public transportation. Following the release of the *2007 Urban Mobility Report* (*34*)*,* the decision was made to take an in-depth look at the public transportation methodology to determine if any improvements could be made to the statistics produced in the analysis. The American Public Transportation Association (APTA) was helpful in supplying support and industry contacts to this effort in addition to the transit statistics necessary to produce the congestion estimates. Three key items were identified for improvement.

- Incorporate transit modal share—determine the percentage of transit travel associated with bus, light rail, heavy rail, and commuter rail in each urban area.
- Transit ridership in the peak periods—determine the amount of daily transit travel occurring in the peak commuting periods.
- Account for location of transit routes on the roadway network—determine how to account for the fact that transit routes often operate in congested roadway corridors.

## *Incorporate Transit Modal Share*

The purpose for this addition to the methodology is to allow the ridership from the different public transportation modes to be assigned to specific roadway functional classes based on the type of service provided by the mode. The modal share information is obtained from the public transportation operating statistics (*2*) supplied annually by APTA for inclusion into the Urban Mobility Report analysis. The passenger-miles of travel for each urban area are classified as light rail, heavy rail, commuter rail, or bus. No differentiation is made between service that is owned by the company and service that is purchased. Any other mode is placed in the bus category. These other modes include service such as vanpools and taxis. The reason for placing these into the bus category is that the service uses the surface streets and provides a similar type of service as buses.

- The transit vehicle-miles of travel from commuter rail are assigned to freeways because commuter rail typically travels longer distances into centrally located activity centers similar to freeway commuting. Arterial streets tend to handle shorter commutes than the freeway system, therefore, none of the commuter rail travel is assigned to the arterial streets.
- Travel from the remainder of the modes—light rail, heavy rail, and bus—is assigned to the roadway system in the same proportions that already exist on the roadway. For example, if 60 percent of the roadway travel in a city occurs on the freeway system, then 60 percent of the light rail, heavy rail, and bus travel is added to the freeway system and 40 percent of the transit travel is assigned to the arterial streets.

# Public Transportation Ridership in the Peak Periods

The peak period transit ridership statistics were obtained from APTA who conducted a survey of the transit companies operating in approximately twenty urban areas across the U.S. APTA surveyed the majority of the Very Large urban areas—those with populations over 3 million—because the transit companies in these larger regions comprise a significant percentage of the public transportation usage in the U.S. Surveys were only sent to a sample of transit companies in the smaller urban area population groups to create a representative set of statistics that can be applied to all urban areas of similar size. Exhibit B-33 shows the results of the survey.

In some cases, an incomplete survey was returned to APTA by a transit agency. The transit agency may have reported a peak period modal share for one or two rail modes operating in their area but not all of the rail modes. In some areas, the survey was not returned by all transit operators. When this occurred, the urban area was assigned the average response for the modes from returned surveys. An area was assigned the population group average when no information was submitted.

**Exhibit B.33. Peak Period Ridership Percentages by Mode**

| **Urban Area** | **Percentage of Daily Modal Ridership in Peak Period** | | | |
|---|---|---|---|---|
| | **Bus** | **Commuter Rail** | **Heavy Rail** | **Light Rail** |
| **Very Large Area Average** | 60 | 75 | 65 | 60 |
| | 58 | -- | 59 | -- |
| Atlanta | 63 | 75 | 61 | 63 |
| Boston | 59 | 83 | 67 | -- |
| Chicago | 60 | 74 | -- | 68 |
| Dallas-Fort Worth | 65 | -- | 63 | 63 |
| Los Angeles | 56 | 65 | 73 | -- |
| New York | 70 | -- | 68 | -- |
| Philadelphia | 62 | 68 | 81 | 58 |
| San Francisco-Oakland | 63 | 75 | -- | 60 |
| Seattle | -- | -- | 59 | -- |
| Washington DC | | | | |
| **Large Area Average** | 55 | 75 | 65 | 60 |
| Denver | 55 | -- | -- | 60 |
| San Jose | 55 | -- | -- | 55 |
| **Medium and Small Area Average** | 55 | 75 | 65 | 55 |
| Charleston | 54 | -- | -- | -- |
| Colorado Springs | 54 | -- | -- | -- |
| Grand Rapids | 55 | -- | -- | -- |

Notes: -- denotes data is unavailable
Very Large Areas have populations over 3 million
Large Areas have populations between 1 and 3 million
Medium and Small Areas have populations under 1 million

## Location of Public Transportation Routes

Many of the public transportation routes either utilize or run parallel to congested roadway corridors. In the prior version of the methodology, transit travel was assigned to all roadways throughout the urban area rather than being placed onto more congested corridors. Areas of a city that had little or no transit service were assigned some of the transit travel from portions of the city which had significant transit service. In reality, if transit service were eliminated, some traffic would shift to other corridors but much of it would continue to use the same corridor because of proximity to homes and jobs. In order to account for the location of transit routes along these congested corridors, researchers used two steps to alter the approach from “spread the transit travel like the road travel” to “peak period travel is more concentrated on highly traveled and congested corridors to major job centers.”

*Transit Travel on Congested Roads*

Exhibit B-34 shows how the additional travel is added in urban areas with a range of congested roadways. For example, Urban Area 2 has roadway travel in the moderate, heavy, and severe congestion levels. The additional transit travel would be added only in the heavy and severe congestion levels to replicate the heavier congestion levels on transit routes. The percentage of transit travel assigned to uncongested roadways would be the same as with existing road travel. Thus, the same amount of transit travel is assigned to the roadway network as the previous methodology, but now it is applied to some of the more congested roadways.

**Exhibit B-34. Accounting for Location of Transit Service on Roadway Network**

| Example Urban Area | Existing Roadway Travel by Congestion Level | | | | Roadway Travel Following Addition of Transit Travel by Congestion Level | | | |
|---|---|---|---|---|---|---|---|---|
| | Moderate | Heavy | Severe | Extreme | Moderate | Heavy | Severe | Extreme |
| Area 1 | X | X | X | X | X | X + T | X + T | X + T |
| Area 2 | X | X | X | | X | X + T | X + T | |
| Area 3 | X | X | | | X | X + T | | |
| Area 4 | X | | | | X + T | | | |

Note: ‘X’ denotes existing roadway travel, ‘T’ denotes transit travel that is added to roadway system

*Effect of Transit Travel*

Another change to the previous methodology was to adjust the way the transit travel is added to roadways in the various congestion levels. Exhibit B-35 shows the traffic densities associated with the five congestion levels—uncongested, moderate, heavy, severe, and extreme—for both the freeways and arterial streets (*6*). If the additional transit travel assigned to a level causes the traffic density to surpass the highest traffic density allowed in that level, the amount of the travel above the highest allowable traffic density is allowed to “spill over” into the next more congested level. For example, if the average VMT per lane-mile in the freeway heavy congestion level is 19,970 and the additional transit travel assigned to the heavy level increases this average to 20,050, the 50 VMT per lane-mile “spills” into the severe level to lower the heavy level average to 20,000 (the ceiling for the heavy freeway level). The effect of this “spillage” is that the travel that shifts into the severe bin would be subjected to lower speeds (more delay) than the travel in the heavy level.

**Exhibit B-35. Congestion Level Bins and Traffic Density**

| Functional Class and Traffic Density (VMT/Lane-mile) | Traffic Density by Congestion Level | | | | |
|---|---|---|---|---|---|
| | Uncongested | Moderate | Heavy | Severe | Extreme |
| Freeways | under 15,000 | 15,000 to 17,499 | 17,500 to 19,999 | 20,000 to 24,999 | over 25,000 |
| Arterial Streets | under 5,500 | 5,501 to 6,999 | 7,000 to 8,499 | 8,500 to 9,999 | over 10,000 |

Source: (*6*)

In a perfect world, the transit travel would be assigned to the corridors where the transit service was provided and the traffic volumes on the roadway would be adjusted accordingly. The methodology used to produce the Urban Mobility Report, however, does not function at such a microscopic level. The two changes that deal with location of transit service provide a first step at emulating where much of the transit travel occurs and what would happen if the additional travel was added to roadways that are already congested.

## Summary of Changes

Exhibit B-36 shows the steps for calculating the traffic delay reduction provided by public transportation. A comparison is made of the "old" methodology used in the *2007 Urban Mobility Report* (*34*) and the "new" methodology used in the *2009 Urban Mobility Report* (*6*). The changes to the methodology occur in Steps 2, 3, 6, and 7 of the calculation process.

- The Urban Mobility Report methodology has the following new features for calculating the delay reduction effects of public transportation.
- Public transportation ridership is assigned to the roadway system based on the travel in each of the existing transit modes.
- The percentage of the daily public transportation ridership that occurs in the peak periods is used in the roadway delay calculations.
- Public transportation ridership is assigned to more congested roadways to estimate the effect of public transportation routes that utilize congested roadway corridors.

### Exhibit B-36. Changes to the Urban Mobility Report Methodology

| Computation Step | 2007 Urban Mobility Report | 2009 Urban Mobility Report |
|---|---|---|
| 1. Convert annual transit passenger-miles of travel (pmt) to daily vehicle-miles of travel (vmt) | Passenger miles / 300 days / 1.25 persons per auto = transit daily vmt | Passenger miles / 300 days / 1.25 persons per auto = transit daily vmt |
| 2. Assign vmt from Step 1 to transit mode | Not used | Using mode splits in APTA transit ridership report, assign vmt to commuter rail, heavy rail, light rail, or bus |
| 3. Assign vmt to roadway facility | Assign transit vmt from Step 1 to freeways and arterials based on existing roadway vmt proportions | Assign modal vmt from Step 2 to freeways and arterials. Commuter Rail vmt is assigned entirely to freeways. The other 3 modes are assigned to freeways and arterials based on existing vmt proportions. |
| 4. Re-calculate percentage of travel occurring in peak periods | Re-calculate with additional transit travel added to roadways | Re-calculate with additional transit travel added to roadways (Unchanged) |
| 5. Calculate amount of transit vmt added to existing roadway vmt | Use recalculated percentage from Step 4. | Use results from survey of transit companies by APTA to determine percentage of ridership by mode occurring in peak periods |
| 6. Assign transit vmt to congestion levels (buckets) | Assign transit vmt in same proportions as existing roadway travel | Assign transit travel for moderate congestion category to more congested categories unless moderate is only current roadway congestion level. |
| 7. Add peak period transit vmt to existing roadway vmt | Add transit vmt in same proportions as existing roadway travel | Add transit vmt to road vmt based on results of Step 6 and allow for travel to spill over into more congested levels. |
| 8. Re-calculate peak period operating speeds | Use combined volumes from Steps 6 and 7 | Use combined volumes from Steps 6 and 7 |
| 9. Re-calculate delay | Use combined volumes and new speeds to calculate delay | Use combined volumes and new speeds to calculate delay |

Source: (*6*)

These changes have improved the methodology for analyzing the delay reduction benefits derived from public transportation. A comparison was made of the results of the “old” and “new” methodologies for the year 2005 (the latest year reported with the old methodology). The results of the comparison show that the delays savings from public transportation increased from the reported 540 million hours in all 439 urban areas under the “old” methodology to about 610 million hours under the “new” methodology. The improvements to the methodology show that public transportation has an even greater effect on delay savings than was reported in *2007 Urban Mobility Report* (*34*).

## Summary of the Mobility Effects of Public Transportation

The mobility effects from public transportation are shown for both of the key performance measures—travel delay and Travel Time Index. The differences between the two measures are important to understand:

- The travel delay shows an estimate of the amount of additional delay that would occur if public transportation did not exist and the transit riders were added onto the roadways.
- The Travel Time Index shows the effects of including the public transportation travel with the roadway travel, but assumes that all of the public transportation service is uncongested travel for purposes of calculating the benefits to the entire transportation system. Additional research and data collection are needed to develop a consistent "on-time reliability" measure for the public transportation industry.

### *Travel Delay*

Exhibit B-37 shows that in the 439 urban areas studied, there were approximately 56 billion passenger-miles of travel on public transportation systems in 2007 (*6*). The annual average ridership ranged from about 16 million passenger-miles in the Small urban areas to about 3 billion in the Very Large areas. Overall, if these riders were not handled on public transportation systems they would contribute an additional roadway delay of almost 646 million hours or about a 14 percent increase in the total delay. Some additional effects include:

- The range of benefits derived from public transportation in the 90 intensely studied urban areas ranged from about 18 percent in the Very Large Urban Areas down to about 3 percent in the Small Areas.
- Of the 646 million hours of potential extra delay, 630 million are in the 90 urban areas studied in detail.

**Exhibit B-37. Delay Increase if Public Transportation Service Were Eliminated – 439 Areas**

| Population Group and Number of Areas | Population Group Average Annual Passenger-miles of Travel (million) | Delay Reduction Due to Public Transportation | |
|---|---|---|---|
| | | Hours of Delay (million) | Percent of Base Delay |
| Very Large (14 ) | 2,972 | 557.0 | 17.9 |
| Large (29 ) | 213 | 58.8 | 5.6 |
| Medium (31 ) | 55 | 12.8 | 4.2 |
| Small (16 ) | 16 | 1.5 | 2.8 |
| | | | |
| 90 Area Total | 49,790 | 630.1 | 14.9 |
| Other Areas (349) | 6,032 | 15.8 | 2.8 |
| All Areas | 55,822 | 645.9 | 13.5 |

Source: (*6*)

### *Travel Time Index*

The Travel Time Index values are shown with and without the effects of public transportation in Exhibit B-38 for the 90 Urban Areas studied extensively in the Urban Mobility Report. In the 90 urban areas, the mobility effect of public transportation lowered the average TTI value by almost 2 points from approximately 1.31 to 1.29. The delay reduction was greatest in the Very Large urban areas which have the most extensive transit systems. The TTI values in the Very Large areas were lowered by almost 4 points.

**Exhibit B-38. Effects of Public Transportation Service on the Travel Time Index – 90 Areas**

| Population Group and Number of Areas | Travel Time Index | | |
|---|---|---|---|
| | Base (without public transportation) | With Public Transportation Effect | Reduction in TTI (Points) |
| Very Large (14 ) | 1.403 | 1.367 | 0.036 (4) |
| Large (29 ) | 1.248 | 1.243 | 0.005 (1) |
| Medium (31 ) | 1.145 | 1.143 | 0.002 (0) |
| Small (16 ) | 1.102 | 1.101 | 0.001 (0) |
| 90 Area Average | 1.309 | 1.291 | 0.018 (2) |

Note: A TTI “point” is 0.01 on the Travel Time Index
Source: (*6*)