# INCORPORATING THE EFFECT OF OPERATIONAL TREATMENTS – 101 URBAN AREAS

Many state and local transportation agencies, as well as the federal transportation program, have invested substantial funding in operational treatments and the future will include more of these programs in more cities. Technologies, operating practices, programs and strategies provide methods to get the most efficiency out of the road or transit capacity that is built, typically for relatively modest costs and low environmental effects. In some cases, the operational improvements are some of the few strategies that can be approved, funded and implemented.

For the Urban Mobility Report database, the operational treatments were assessed for the delay reduction that results from the strategy as implemented in the urban area. A separate report, *Six Congestion Reduction Strategies and Their Effects on Mobility* (*25*), describes the process of estimating the delay reduction in more detail. The ITS deployment analysis system (*26*) model was used as the basis for the estimates of the effect of the operational treatments. The ITS deployment database (*4*) and the Highway Performance Monitoring System (*1*) include data on the deployment of several operational improvements. These two databases provide the most comprehensive and consistent picture of where and what has been implemented on freeways and streets in urban areas.

The delay reduction estimates are determined by a combination of factors:

- extent of the treatments
- congestion level of the location
- density of the treatment (if it applies)
- effect of the treatment

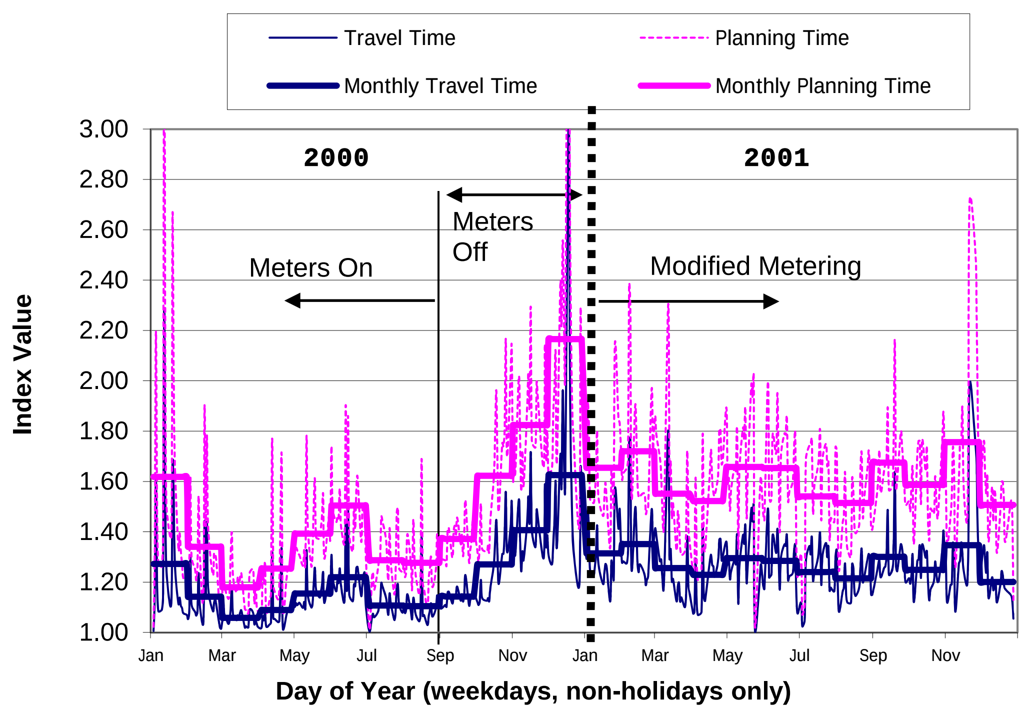
These factors are estimated from the databases, the inventory information found and applied within the existing Urban Mobility Report structure, and the delay reduction has been incorporated into several of measures calculated in the study.

### *Freeway Entrance Ramp Metering*

Entrance ramp meters regulate the flow of traffic on freeway entrance ramps. They are designed to create more space between entering vehicles so those vehicles do not disrupt the mainlane traffic flow. The signals, just as traffic signals at street intersections, allow one vehicle to enter the freeway at some interval (for example, every two to five seconds) They also somewhat reduce the number of entering vehicles due to the short distance trips that are encouraged to use the parallel streets to avoid the ramp wait time.

The effect of ramp metering was tested in Minneapolis-St. Paul in October 2000 when the extensive metering system was turned off and the freeway operated as it does in most other cities. The basic system was relatively aggressive in that ramp wait times of five minutes were not uncommon. The results of this systemwide experiment are clearly visible in the peak period data in Exhibit B-13. The Travel Time Index (average travel time) and the Planning Time Index (travel time that includes 19 out of every 20 trips) are plotted with each monthly average highlighted. Except for snowstorms, the highest values are during the shut-off experiment period. The metering experiment report produced by Cambridge Systematics (*27*) refers to a 22 percent increase in freeway travel time and the freeway system travel time becoming twice as unpredictable without the ramp meters. Congestion reductions are seen in January 2001 when a modified, less aggressive metering program was implemented. It might be interpreted that turning off the ramp meter system had the effect of a small snowstorm.

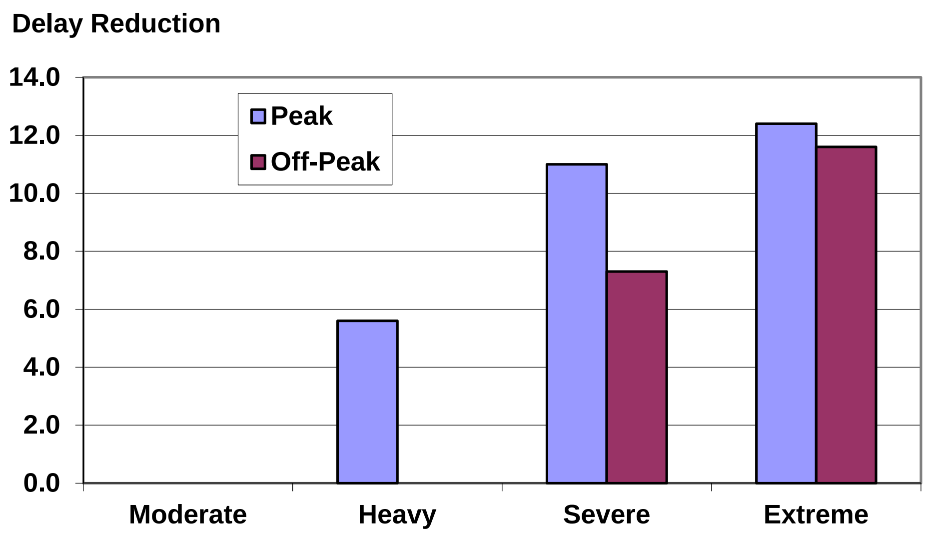
**Exhibit B-13. Minneapolis-St. Paul Freeway System Congestion Levels**



## Delay Reduction Effects

The results of the Minneapolis experiment and simulation modeling performed for the Intelligent Transportation System Deployment Analysis System (IDAS) (*26*) have been combined into a relatively simple delay reduction estimation procedure for use in the Urban Mobility Report. Exhibit B-14 illustrates the delay reduction percentage for each of the four congestion ranges. More delay is subtracted from the more congested sections because there is more effect, particularly if the metering program can delay the beginning of stop-and-go conditions for some period of time.

**Exhibit B-14. Ramp Metering Delay Reduction**




Twenty-eight of the urban areas reported ramp metering on some portion of their freeway system in 2010 (*1*,*4*). The average metered distance was about one-quarter. The effect was to reduce delay by 38.7 million person hours (Exhibit B-15). This value is combined in the operational effects summary at the end of this section.

- Los Angeles has the largest delay reduction estimate in the Very Large group.
- Minneapolis-St. Paul has the most extensive metering benefits in the Large group.
- Of the 55 areas studied with under one million population, only three reported any metering.

**Exhibit B-15. Freeway Ramp Metering Delay Reduction Benefits - 2010**

| Population Group | Percentage of Covered Freeway Lane-miles | Freeway Hours of Delay (million) |
|---|---|---|
| | | Reduction |
| Very Large (15) | 35 | 33.7 |
| Large (32) | 20 | 6.2 |
| Medium (33) | 2 | 0.2 |
| Small (21) | 0 | 0 |
| 101 Area Average | 25 | 0.4 |
| 101 Area Total | 25 | 39.5 |

Source: HPMS, IDAS, and TTI Analysis

Note: This analysis uses nationally consistent data and relatively simplistic estimation procedures. Local or more detailed evaluations should be used where available. These estimates should be considered preliminary pending more extensive review and revision of base inventory information obtained from source databases.

### *Freeway Incident Management Programs*

Freeway Service Patrol, Highway Angel, Highway Helper, The Minutemen and Motorists Assistance Patrol are all names that have been applied to the operations that attempt to remove crashed and disabled vehicles from the freeway lanes and shoulders. They work in conjunction with surveillance cameras, cell phone reported incident call-in programs and other elements to remove these disruptions and decrease delay and improve the reliability of the system. The benefits of these programs can be significant. Benefit/cost ratios from the reduction in delay between 3:1 and 10:1 are common for freeway service patrols (*28*). An incident management program can also reduce "secondary" crashes—collisions within the stop-and-go traffic caused by the initial incident. The range of benefits is related to traffic flow characteristics as well as to the aggressiveness and timeliness of the service.

Addressing these problems requires a program of monitoring, evaluation and action.

- Monitoring—Motorists calling on their cell phones are often the way a stalled vehicle or a crash is reported, but closed circuit cameras enable the responses to be more effective and targeted. Shortening the time to detect a disabled vehicle can greatly reduce the total delay due to an incident.

- Evaluation—An experienced team of transportation and emergency response staff provide ways for the incident to be quickly and appropriately addressed. Cameras and on-scene personnel are key elements in this evaluation phase.

- Action—Freeway service patrols and tow trucks are two well-known response mechanisms that not only reduce the time of the blockage but can also remove the incident from the area and begin to return the traffic flow to normal. Even in states where a motorist can legally move a wrecked vehicle from the travel lanes, many drivers wait for enforcement personnel dramatically increasing the delay. Public information campaigns that are effective at changing motorists' behavior (that is, move vehicles from the travel lanes when allowed by law) are particularly important.

An active management program is a part of many cities comprehensive strategy to get as much productivity out of the system as possible. Removing incidents in the off-peak periods may also be important particularly in heavily traveled corridors or those with a high volume of freight movement. Commercial trucks generally try to avoid peak traffic hours, but the value of their time and commodities, as well as the effect on the manufacturing and service industries they supply can be much greater than simple additional minutes of travel time.

## Delay Reduction Effects

The basic Urban Mobility Report methodology includes an estimate of the delay due to incidents. This estimate is based on roadway design characteristics and incident rates and durations from a few detailed studies. These give a broad overview, but an incomplete picture of the effect of the temporary roadway blockages. They also use the same incident duration patterns for all urban areas. Incidents are estimated to cause somewhere between 52 and 58 percent of total delay experienced by motorists in all urban area population groups. A more complete understanding of how incidents affect travelers will be possible as continuous travel speed and traffic count monitoring equipment is deployed on freeways and major streets in U.S. cities. Unfortunately, that equipment is in place and recording data in only a few cities. These can, however, give us a view of how travel speeds and volumes change during incidents.

The results of incident management program evaluations conducted in several cities and simulation modeling performed for the Intelligent Transportation System Deployment Analysis System (IDAS) (*26*) have been used to develop a delay reduction estimation procedure. The process estimates benefits for monitoring cameras and service patrol vehicles (Exhibits B-16 and B-17) with the cameras receiving less benefit from the identification and verification actions they assist with than the removal efforts of the service patrol. As with the ramp metering programs, more delay is subtracted from the more congested sections because there is more effect.

**Exhibit B-16. Benefits of Freeway Service Patrols**

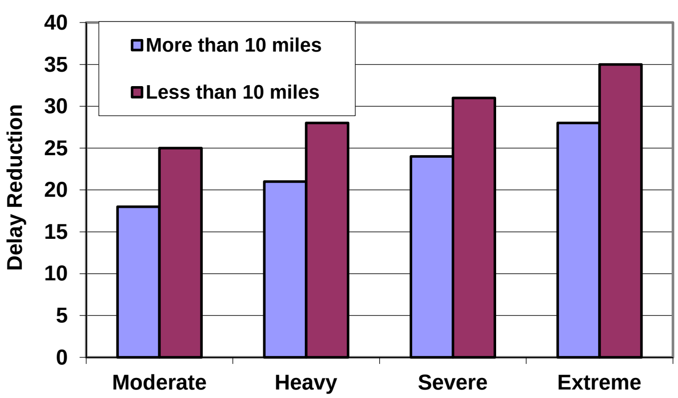
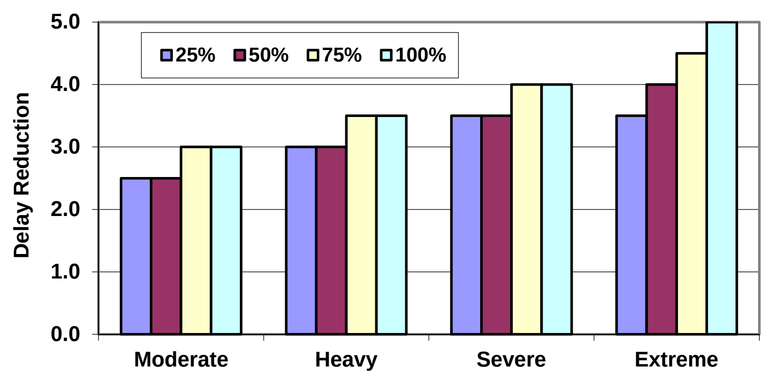



**Exhibit B-17. Benefits of Freeway Surveillance Cameras**




More than 85 areas reported one or both treatments in 2010, with the coverage representing from one-third to two-thirds of the freeway miles in the cities (*1*,*4*). The effect was to reduce delay by 135 million person hours (Exhibit B-18). This value is combined in the operational effects summary at the end of this section.

## Incident Management

- The New York City and Los Angeles regions are estimated to derive the most benefit from incident management.
- Minneapolis-St. Paul and Baltimore are estimated to have the most benefit in the Large group.
- Bridgeport is the area within the Medium group with the highest delay reduction benefit.

**Exhibit B-18. Freeway Incident Management Delay Reduction Benefits**

| Population Group | Percentage of Miles Covered Freeway Lane-miles | Freeway Hours of Delay (million) Delay Reduction |
|---|---|---|
| **Surveillance Cameras** | | |
| Very Large (15) | 59 | Delay Reduction Included Below |
| Large (32) | 51 | |
| Medium (33) | 30 | |
| Small (21) | 39 | |
| 101 Area Average | 52 | |
| 101 Area Total | 52 | |
| **Service Patrols** | | |
| Very Large (15) | 82 | 101.9 |
| Large (32) | 67 | 28.0 |
| Medium (33) | 35 | 4.0 |
| Small (21) | 46 | 1.0 |
| 101 Area Average | 70 | 1.3 |
| 101 Area Total | 70 | 134.9 |

Source: HPMS, IDAS, and TTI Analysis
Note: This analysis uses nationally consistent data and relatively simplistic estimation procedures. Local or more detailed evaluations should be used where available. These estimates should be considered preliminary pending more extensive review and revision of base inventory information obtained from source databases.

### *Traffic Signal Coordination Programs*

Traffic signal timing can be a significant source of delay on the major street system. Much of this delay is the result of the managing the flow of intersecting traffic, but some of the delay can be reduced if the streams arrive at the intersection when the traffic signal is green instead of red. This is difficult in a complex urban environment, and when traffic volumes are very high, coordinating the signals does not work as well due to the long lines of cars already waiting to get through the intersection.

There are different types of coordination programs and methods to determine the arrival of vehicles, but they all basically seek to keep moving the vehicles that approach intersections on the major roads, somewhat at the expense of the minor roads. On a system basis, then, the major road intersections are the potential bottlenecks.

## Delay Reduction Estimates

Some of the delay reduction from signal coordination efforts that have been undertaken in the U.S. is the attention that is given to setting the signal timing to correspond to the current volume patterns and levels and to recalibrate the equipment. It is often difficult to identify how much of the benefit is due to this "maintenance" function and how much is due to the coordination program itself. The Urban Mobility Report methodology draws on the evaluations and simulation modeling performed for the Intelligent Transportation System Deployment Analysis System (IDAS) (*26*) to develop the delay reduction estimation procedure shown in Exhibits B-19 and B-20. There is less benefit for the more heavily congested sections of the street system due to the conflicting traffic flows and vehicle queues. The benefits of an actuated system (where the signals respond to demand) are about one-third of the benefits of a centrally controlled system that monitors and adapts the signals to changes in demand.

All 101 areas reported some level of traffic signal coordination in 2010, with the coverage representing slightly over half of the street miles in the cities (*1,4*). Signal coordination projects, because the technology has been proven, the cost is relatively low and the government institutions are familiar with the implementation methods, have the highest percentage of cities and road miles with a program. The evolution of programs is also evident in the lower percentage of advanced progressive systems. These systems require more planning, infrastructure, and agency coordination.

**Exhibit B-19. Signal Coordination Benefits (actuated)**

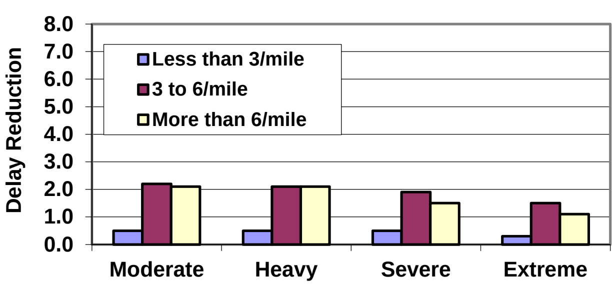
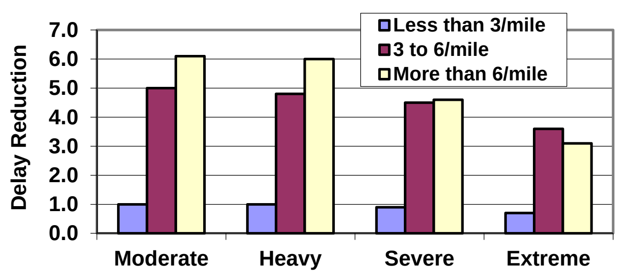



**Exhibit B-20. Signal Coordination Benefits (progressive)**




The effect of the signal coordination projects was to reduce delay by 21.7 million person hours, approximately one percent of the street delay (Exhibit B-21). This value is combined in the operational effects summary at the end of this section.

While the total effect is relatively modest, the relatively low percentage of implementation should be recognized, as should the relatively low cost and the amount of benefit on any particular road section. The modest effect does not indicate that the treatment should not be implemented—why would a driver wish to encounter a red light if it were not necessary? The estimates do indicate that the benefits are not at the same level as a new travel lane, but neither are the costs or the implementation difficulties or time. It also demonstrates that if there are specific routes that should be favored—due to high bus ridership, an important freight route or parallel route road construction—there may be reasons to ignore the system or intersecting route effects.

- Los Angeles and New York are the Very large areas with the highest benefits.
- Denver and Baltimore are the Large areas with the most hours of delay benefit from signal coordination in areas between one and three million population.
- Honolulu and Richmond in the Medium areas and Cape Coral in the Small areas lead their population group.

**Exhibit B-21. Principal Arterial Street Traffic Signal Coordination Delay Reduction Benefits - 2010**

| Population Group | Percentage of Mileage Covered Lane-miles | Principal Arterial Hours of Delay (million) Reduction |
|---|---|---|
| Very Large (15) | 66 | 13.8 |
| Large (32) | 57 | 45.2 |
| Medium (33) | 53 | 2.2 |
| Small (21) | 52 | 0.5 |
| 101 Area Average | 61 | 0.2 |
| 101 Area Total | 61 | 21.7 |

Source: HPMS, IDAS, and TTI Analysis

Note: This analysis uses nationally consistent data and relatively simplistic estimation procedures. Local or more detailed evaluations should be used where available. These estimates should be considered preliminary pending more extensive review and revision of base inventory information obtained from source databases.

### *Arterial Street Access Management Programs*

Providing smooth traffic flow and reducing collisions are the goal of a variety of individual treatments that make up a statewide or municipal access management program. Typical treatments include consolidating driveways to minimize the disruptions to traffic flow, median turn lanes or turn restrictions, acceleration and deceleration lanes and other approaches to reduce the potential collision and conflict points. Such programs are a combination of design standards, public sector regulations and private sector development actions. The benefits of access management treatments are well documented in National Cooperative Highway Research Program (NCHRP) Report 420 (*29*).

**Delay Reduction Estimates**

NCHRP Report 395 analyzed the impacts of going from a TWLTL to a raised median for various access point densities and traffic volumes (*30*). Tables produced in NCHRP Report 395 were used in the Urban Mobility Report methodology to obtain delay factors for both recurring and incident delay.

There is an increase in recurring delay for through and left-turning traffic when going from a TWLTL to a raised median. This increase is primarily due to the storage limitations of select turn bay locations with the raised median treatments. As the turn bays become full, traffic spills out into the through lanes and increases the delay of through vehicles. This situation worsens with increased congestion levels and increased signal density (*31,32*). The percent increase factors shown in Exhibit B-22 are applied to the recurring delay on the principal arterial streets to account for this increased delay.

Raised medians can increase roadway safety by reducing the number of conflict points and managing the location of the conflict points. The reduction in conflict points equates to a reduction in crashes. This benefit of the raised medians was included in the methodology. The delay factors were generated for roadways going from a TWLTL to a raised median.
Exhibit B-23 shows the percent reduction factors that range from 12 percent at low signal density (≤ signals/mile) and the lowest congestion level to 22 percent at high signal density (>3 signals/mile) and the highest congestion level (*30*). These percent reduction values are applied to the incident delay on the principal arterial streets in the methodology.

All 101 areas reported some level of access management in 2010, with the coverage representing about 33 percent of the street miles in the cities (*1,41*). The effect of access management was to reduce delay by 77 million person hours (Exhibit B-24). The percent reduction drops as the size of the urban area gets smaller.

**Exhibit B-22. Access Management**
**Recurring Delay Effects**

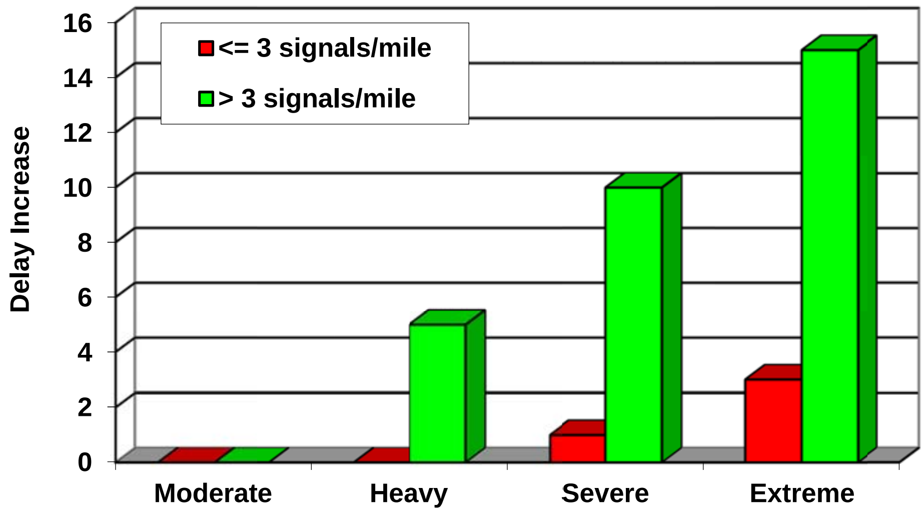
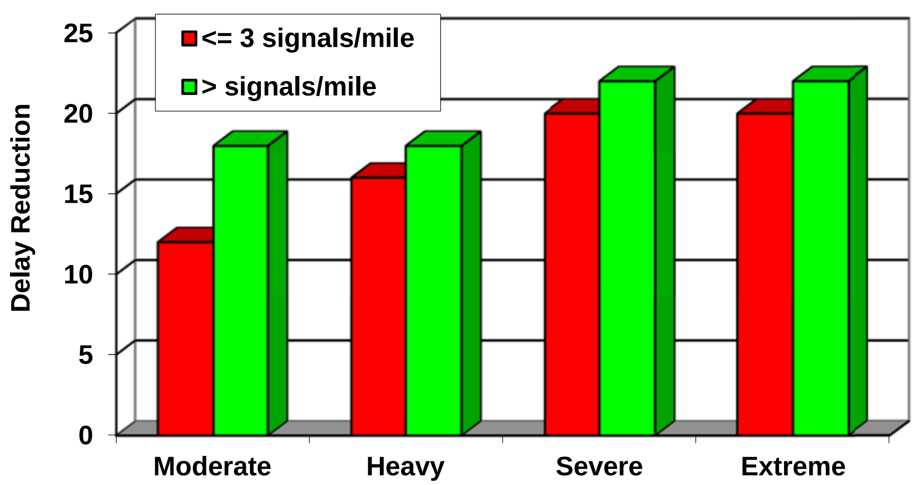



**Exhibit B-23. Access Management**
**Incident Delay Effects**




Source: (1) and Texas Transportation Institute Analysis

**Exhibit B-24. Principal Arterial Street Access Management Delay Reduction Benefits**

| Population Group | Percentage of Mileage Covered Lane-miles | Principal Arterial Hours of Delay (million) Reduction |
|---|---|---|
| Very Large (15) | 37 | 49.7 |
| Large (32) | 32 | 20.2 |
| Medium (33) | 26 | 5.8 |
| Small (21) | 19 | 1.4 |
| 101 Area Average | 33 | 0.8 |
| 101 Area Total | 33 | 77.1 |

Source: HPMS and TTI Analysis

Note: This analysis uses nationally consistent data and relatively simplistic estimation procedures. Local or more detailed evaluations should be used where available. These estimates should be considered preliminary pending more extensive review and revision of base inventory information obtained from source databases.

### *Combined Effect of Operational Treatments*

The delay reduction benefits of four operational treatments analyzed in this edition of the Urban Mobility Report are combined into an estimate of the total effect of the deployed projects in the 101 urban areas. The inventory of all projects is identified in Exhibit B-25 by the percentage of miles on freeways and streets that have one of the programs or projects implemented.
Exhibit B-25 shows the relatively low percentage of not only cities that have some treatments but also the low percentage of roads that have any treatment.

The total effect of the delay reduction programs represents about 6 percent of the delay in the 101 cities. Again, the value seems low but when the low percentage of implementation is factored in, the benefit estimates are reasonable. The programs are also important in that the benefits are on facilities that have been constructed. The operating improvements represent important efficiencies from significant expenditures that have already been made.

**Exhibit B-25. Total Operational Improvement Delay Reduction**

| Operations Treatment | Number of Cities | Percent of System Covered | Delay Reduction Hours (millions) |
|---|---|---|---|
| Ramp Metering | 28 | 25 | 40 |
| Incident Management | 85 | 52-70 | 135 |
| Signal Coordination | 101 | 61 | 22 |
| Access Management | 101 | 33 | 77 |

Note: This analysis uses nationally consistent data and relatively simplistic estimation procedures. Local or more detailed evaluations should be used where available. These estimates should be considered preliminary pending more extensive review and revision of base inventory information obtained from source databases.