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TRAQ Technical Overview

Transportation Air Quality Center

Transportation Control Measures: Traffic Flow Improvements

EPA's main strategy for addressing the contributions of motor vehicles to our air quality problems has been to cut the tailpipe emissions for every mile a vehicle travels. Air quality can also be improved by changing the way motor vehicles are used—reducing total vehicle miles traveled at the critical times and places, and reducing the use of highly polluting operating modes. These alternative approaches, usually termed Transportation Control Measures (TCMs), have an important role as both mandatory and optional elements of state plans for attaining the air quality goals specified in the Clean Air Act. TCMs encompass a wide variety of goals and methods, from incentives for increasing vehicle occupancy to shifts in the timing of commuting trips. This document is one of a series that provides overviews of individual TCM types, discussing their advantages, disadvantages, and the issues involved in their implementation.

Getting There with Clean Air

Traffic Flow Improvements

Contents

Traffic flow improvements include a range of strategies that enhance the capacity and efficiency of a roadway system, without adding extra lanes or new roads. As roadways become less congested, congestion-related emissions tend to fall. However, reducing congestion may encourage motorists to make more trips causing vehicle miles traveled (VMT) and associated emissions to rise. These strategies can be grouped into three main types: traffic signalization, traffic operations, and enforcement and management. Traffic signalization represents the most common traffic management technique applied in the U.S. Traffic signal improvements can include the following:

- **Updating** traffic signals to include new, more modern hardware, allowing for the planning of more sophisticated traffic flow strategies.
- **Timing** traffic signals to correspond to current traffic flows, reducing unnecessary delays.
- **Coordinating and interconnecting** signals to better interface pre-timed and traffic actuated signals, actively managed timing plans, and master controllers to minimize the number and frequency of stops necessary at intersections.
- **Removing** signals at intersections no longer requiring signalized stop control to reduce vehicle delays and unwarranted stops.

Traffic operations describe several types of roadway improvement projects, including:

- **Converting** two-way streets to one-way operation to improve corridor travel times and increase roadway capacity.
- **Restricting** left turns on two-way streets as a means of eliminating conflicts with left turn movements, thereby reducing congestion and delay.
- **Separating** turning vehicles from through traffic with continuous median strip turn lanes.
- **"Channelizing"** roadways and intersections (i.e., clearly marking travel lanes and paths with striping and signage to reduce motorist confusion and uncertainty by channeling traffic in the proper position of the street) to improve vehicular flow and capacity.
- **Widening and reconstructing** roadways and intersections to reduce bottlenecks along sections where traffic capacity is below that of the adjacent street (e.g., traffic islands, turning lanes, and signage).

Finally, several types of programs fall under enforcement and management:

- **Incident management systems**, consisting of roving tow or service vehicles, motorist aid call boxes, incident teams, detectors in the roadway lanes to monitor traffic volumes, signage systems, traffic operations centers, contingency planning, and improved information availability to consumers through radio and television.
- **Ramp metering**, a technique to improve traffic flow on freeways by using signals to regulate traffic entering the highway so that it enters only at pre-timed intervals or at times determined by traffic volumes on the ramp or on the highway.
- **All other enforcement of traffic and parking program regulations** necessary when individuals are required to change or adhere to a particular travel and parking behavior.

1. Background

Traffic flow improvements have been in existence for decades, growing increasingly more complex as congestion on U.S. roadways has worsened. One prominent early application was the Chicago Incident Management Program. The program was initiated in 1960 when the newly opened Kennedy Expressway began to reach near-capacity volumes during peak periods. To manage the crisis, the Illinois Department of Transportation assigned twenty people in pick-up trucks to patrol the expressway during the morning and afternoon peak commuter periods. The emergency patrol, eventually named the "Minuteman Patrol," was charged with keeping the Kennedy Expressway open by clearing travel lanes of disabled vehicles. Today the program employs 60 people, covers 80 miles of the 150-mile expressway system, and operates 24 hours a day. It has an annual operating budget of $3.5 million funded from state motor fuel taxes.

Also in Chicago, in 1963, the first metered ramp in the U.S. was installed on the Eisenhower Expressway. The system featured a police officer, stationed on the entrance ramp, who stopped traffic and released vehicles one at a time at a rate determined by a pilot detection program. Currently, traffic flow improvements are widely applied by both state and municipal transportation agencies, primarily to reduce congestion and improve travel times at specific locations. Other factors motivating their implementation include financial difficulties in supporting new major transportation projects, and the environmental and physical constraints associated with new infrastructure construction.

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2. Costs and Benefits

Traffic flow improvements generally provide a cost-effective method to reduce congestion, although the effects on vehicular emissions can be difficult to quantify. The cost to implement traffic flow improvements can range considerably, however. Strategies involving local traffic operations or signal improvements can be implemented at a low cost. Actions involving right-of-way acquisition or construction have relatively high capital costs. System-wide traffic operation improvements that involve many sites can be very expensive to implement.

- ➥ **Traffic signalization** costs vary depending on the type of improvement and number of signals affected. Updating a signalized intersection requires a new traffic controller or traffic control software strategy. Timing plan improvements entail a labor-intensive data collection effort to determine new signal timings and subsequent re-timing of signals at each location. Signal coordination and interconnection requires cable installation, as well as a series of controllers or a centralized computer-based master control system. To remove signals, a field survey must be performed to substantiate the elimination of the signals; field work is also necessary to remove the equipment.
- ➥ **Traffic operation improvements** include a wide array of actions with varying costs, although they are typically inexpensive when compared to actions such as constructing new lanes. Converting streets to one-way operations or implementing left-turn restrictions at intersections involves installing new signage and possibly removing or relocating existing signs and traffic signals. Implementing a continuous left-turn median lane requires new signage and lane markings and modifications to existing signage and signals. Similarly, improving the channelizing of a roadway or intersection requires pavement striping, markings, and signage.
- ➥ **Enforcement and management activities** impose capital, operating, and maintenance costs. A facility enforcement program includes the labor costs associated with traffic control officers providing patrols and surveillance of the facility during its operation. A traffic and parking enforcement program requires meter readers, uniformed police officers, and tow trucks. However, the revenue generated by the fines issued as part of an enforcement program generally exceed costs by a factor of at least seven or eight. An incident management system entails costs for embedded traffic detectors, changeable message signs, closed-circuit televisions, and some type of central computer control. Metered ramps require additional signals and signage.

The air quality benefits from these three types of traffic flow improvements are difficult to predict. Because signal improvements reduce travel times and stop-and-go driving conditions, they can produce measurable reductions in carbon monoxide and hydrocarbon emissions. Although system – or region wide – air quality benefits are likely to be low, measurable local benefits to air quality and congestion relief can be seen within downtown and other major activity areas. However, motorists might be diverted from alternative modes of transportation, or at a minimum, the signal improvements might induce more and longer trips during peak and off-peak travel periods. The subsequent increase in VMT along a roadway with improved traffic flow would at least partially offset any short-term air quality improvements generated by faster, more consistent travel speeds.

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Traffic operations are similar to signalization improvements in that they are primarily orientated towards reducing congestion on local and arterial streets by improving the efficiency of the system. Their system – or region wide – air quality benefits are probably low. However, in conjunction with their proven effectiveness to improve traffic bottlenecks and flow, they probably provide measurable reductions in localized carbon monoxide and hydrocarbon emissions.

Enforcement and management programs provide a variety of tools that, alone or in combination with other measures such as traffic operations and signalization improvements, can provide an additional means to improve traffic flow conditions, both locally and at the corridor-wide level. Travel speeds can be increased by installing ramp metering, thereby lowering emissions, although there could be increases in localized carbon monoxide concentrations in the areas of individual ramps if excessive queues develop. In addition, it is important to take into account the excess emissions that may occur during rapid-ramp acceleration.

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Finally, along with the travel speed improvements brought about by ramp metering, there can be measurable increases in traffic volumes, raising the possibility that metering may induce additional traffic or increase VMT. Where large-scale metering is implemented and results in substantial improvements to travel speed, it is likely that some percentage of any additional traffic or VMT detected would reflect a shift from another mode of travel. This shift would at least partially offset any air quality improvements generated by faster, more consistent travel speeds on the highway system.

3. Implementation

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Traffic flow improvements typically are implemented by city and county public works departments, with financial assistance usually provided by state and federal funding sources. Because these actions facilitate urban driving, they usually generate little public opposition, with the exception that local residents may object to the disruption caused by construction and to such actions as street reversals.

Many traffic flow improvements involve changes in the attitude and behavior of local residents and commuters. As a result, the most successful programs are likely to be those that provide the greatest incentives or disincentives to change. Strict enforcement of such traffic flow improvements as restricted left turns and parking limitations, for example, discourages violations of these measures. With enough effort early-on, the initial level of enforcement can be reduced later. Overly restrictive measures, however, should be avoided. Very high fines, for instance, could be considered unacceptable by the majority of users and could foster resentment of the program.

Factors that can negatively impact the implementation of traffic flow improvements include the relatively long amount of time necessary to complete some improvements and the scarcity of available funding. Enforcement and management strategies typically involve a substantial amount of time and planning to implement. Implementation of highway information management systems, ramp metering from conceptual planning to a complete system, for example, may require five to ten years. Traffic signalization and traffic operation improvements are generally less time-intensive.

Many small jurisdictions and even some large central cities have limited traffic engineering capabilities and budgets. In these cases, traffic signal management and roadway maintenance and design are often limited to the most basic or rudimentary installation and maintenance functions. In addition, state DOTs have a strong influence over the allocation of federal roadway aid funds. Many states have priorities that stress capital-intensive road and bridge building rather than traffic operations and signal control systems.

4. Summary of Recent Examples

Traffic flow improvements are becoming increasingly common across the U.S. Ramp metering programs, for example, are currently operating in 23 metropolitan areas in 18 states. Since 1989, the number of operating meters in North America has increased from about 1,600 to over 2,300, an increase of about 45 percent. [1] Two recent examples of comprehensive traffic flow improvement programs are discussed below.

Traffic flow improvements are becoming increasingly common across the U.S. Ramp metering programs, for example, are currently operating in 23 metropolitan areas in 18 states.

Over the past several years, the City of Sacramento has initiated a series of systematic programs to improve its signalized traffic control systems. [2] The programs have included changing signals that are primarily located in outlying areas from a system of interconnected, pre-timed signals to a system consisting of traffic-actuated signals operated by computer-based control. To improve the 220 fixed-time signal intersections located mainly within the downtown area, the City received direct financial and technical assistance through the California Fuel Efficient Traffic Signal Management program to re-time and optimize the signal phasing to minimize delay and increase overall arterial travel speeds. A future program is envisioned by the City to install a master computer network that will allow the traffic system to be more thoroughly monitored and controlled from a central site.

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Post-implementation surveys identified several positive results. The arterials located in areas outside the downtown area all experienced reductions in vehicle delay averaging about five percent (as measured in vehicle-hours of travel). These benefits were derived throughout the day, not just at peak travel periods. For signalized roadways within the downtown area, the data indicated that the signal timing optimization program has led to an overall travel-speed improvement of ten percent, with a comparable reduction in vehicle delay. Vehicle counts show that the "preferential signal timing" strategy has likely caused traffic to increase on these roadways, along with a higher travel speed during peak periods. Whether this induced demand represents trips diverted from other streets or if the additional vehicles represent new trips was not determined conclusively. Air quality effects were not estimated.

In the fall of 1987, the City of Boston Transportation Department initiated a comprehensive study of the City's historic Back Bay district to develop a short – and long range – transportation management policy plan. [2] The plan primarily focused on two major arterials. The traffic operational measures implemented included the following:

- Left-turn restrictions at several intersections that currently experience a poor level of service
- Left-turn bays at several other locations to reduce conflicts
- Street widening of a few feet along several segments to gain an additional travel lane or allow for a left turn lane

Management measures that were implemented involved on-street parking and included establishing new no-stopping zones at selective locations either for the peak period or throughout the day; relocation and consolidation of cab stands, tour bus stops, loading zones and handicapped parking spaces; and removal of short-term parking meters. Enforcement activities featured a highly visible program that included meter readers, motorcycle police officers, and two trucks.

The benefits derived from the traffic plan on area mobility were significant. Illegal long-term parking at on-street meters was reduced considerably. Double parking was almost eliminated. Average travel speeds on the arterials increased from as low as 6 mph to over 12 mph. Travel time reductions of over 30 percent were seen for both roadways. Significantly, arterial travel times after implementation remained relatively constant throughout the day, rather than deteriorating significantly by the afternoon peak period, as was the case before the plan was implemented. These travel time reductions were realized despite traffic counts that indicated the arterials were carrying 30 to 40 percent more traffic during the peak hours. Analogously, traffic counts indicated that other roadways, and particularly several streets located in residential areas, had experienced a corresponding reduction in vehicle use, ranging from five percent to more than 40 percent of the peak hour traffic. The impact of the plan on air quality was not estimated.

6. Sources

[1] U.S. Department of Transportation. *Ramp Metering Status in North America (1995 Update)*. DOT-T-95-17. Washington, D.C. (June 1995).

[2] U.S. Environmental Protection Agency, Office of Air and Radiation. *Transportation Control Measure Information Documents*. 400-R-92-006. Washington, D.C. (March 1992).

7. On-line Resource

The Environmental Protection Agency's Office of Mobile Sources has established the TCM Program Information Directory to provide commuters, the transportation industry, state and local governments, and the public with information about TCM programs that are now operating across the country. This document and additional information on other TCMs and TCM programs implemented nationwide can be found at:

http://www.epa.gov/omswww/transp/traqtcms.htm