# *8.0 BENEFIT-COST ANALYSIS*

## 8.1 OVERVIEW

This section identifies the benefits associated with the recommended programs and projects of the Miami Valley area ITS Strategic Deployment Plan, organized according to the top 12 prioritized user services which are recommended for implementation. One difficulty in developing benefits of the regional ITS program is that there is very little actual experience with the benefits of ITS in the region. This analysis utilizes nationally accepted empirical data made recently available by the federal government to quantify regional benefits and benefit/cost ratios to the extent possible based on the assumption that this national data can be applied in the Miami Valley. A listing of the documents consulted in this analysis is presented at the end of this section. The B/C analysis also relies upon qualitative measures in many program areas, these benefits can not be associated with a cost saving but certainly create a benefit to operators and users.

The benefit-cost ratios presented in Section 8.4 are not intended to provide the "justification" for implementing the projects recommended in Section 6.0 of this report. Rather, they are intended to assist in establishing the cost-effectiveness of ITS improvements relative to the types of projects against which ITS projects must compete for funding, e.g., traditional capacity expansion projects.

Given the current significance of air quality issues in portions of the Miami Valley, a note regarding the appropriate interpretation of air quality benefits is appropriate. As described in the sections which follow, ITS can provide benefits which can have significant positive air quality impacts. However, ITS improvements are not advocated as a replacement of emission control measures currently practiced in the Miami Valley or contemplated for the future. Implementation of ITS should be seen as a way to compliment other measures to improve air quality.

## 8.2 BACKGROUND INFORMATION

The projects and programs recommended in this plan focus on improving ***mobility, accessibility*** and safety. Generally, the benefits of the recommended programs and projects include the following:

- reduction in delay;
- operating costs;
- mobility;
- improved safety; and
- reduced emissions and fuel consumption

Benefits are typically presented in terms of equivalent monetary values so that comparisons can be made against costs. A recent report published by the U.S. Department of Transportation provides benefits associated with the national ITS Investment. This analysis results in estimates of benefits for basic metropolitan ITS infrastructure for all 227 metropolitan areas of the nation. It is estimated that with 15% of our ITI in place, we will receive a total estimated benefit of $227 billion by the end of 2015. Time and accident savings will account for 82% of the total savings. This report analyzes national benefits in three broad categories of traffic management, transit benefits and railroad crossing benefits. We will use this most recent data along with our other published sources to calculate regional B/C Ratios for the Miami Valley region for each program area.

To the extent feasible, benefits are identified for each of the twelve Miami Valley area highest priority user services. However, it is important to recognize that the quality of data, experience and research findings in some areas is relatively limited. As these projects proceed, it is important that their success be evaluated in quantitative terms.

The ITE Mobility Facts document indicates that nationally, congestion in 2005 will be five times that of 1984. In large measure, this tremendous growth in congestion has been due to increased travel brought about by continued suburban development, increases in disposable incomes and increased labor participation rates as women increasingly move into the work force. Furthermore, the number of passengers per vehicle continues to decline. The sum of these developments has been that the number of vehicle miles of travel increased by 98.5% between 1969 and 1989 while the number of road mileage only increased by 4.5%.

In quantifying the costs associated with the benefits, certain parameters will need to be defined. These are:

- fuel consumption
- air quality
- accident costs
- delay savings

## 8.2.1 Fuel Consumption

Fuel savings is an indirect benefit resulting from the reduction of delay and stops. A major portion of fuel consumption can be attributed to stop-and-go situations.

A report prepared for the FHWA by Frederick Wagner gives an equation for the total fuel consumed expressed as a function of vehicle-miles-traveled and vehicle hours of travel.

$$FTOT = 0.0425 * VMT + 0.6 * VHT$$

where: FTOT = total fuel consumed
VMT = vehicle miles traveled
VHT = vehicle hours of travel

Using an assumed baseline traffic data , total fuel consumption can be calculated. Assuming the average fuel cost of $1.60 per gallon and baseline figures for VMT and VHT, the total fuel consumption can then be determined in monetary value per million vehicle mile. USDOT estimates that 6% of the total ITS benefit will result from fuel consumption savings and reduced emissions.

## 8.2.2 Air Quality

Three major air pollutants arising from vehicular emissions are Carbon Monoxide (CO), Hydrocarbons (HC) and Nitrogen oxide (NOx). The generation of these pollutants is determined in terms of pounds per 1000 vehicle hours (due to idling of vehicles) or pounds per 1,000 vehicle miles of travel.

Table 8.1 shows the quantities of emissions for every 1,000 vehicle hours of stopped delay (due to idling of vehicles). The table also indicates an equivalent dollar value accounting for the impact of each pound of chemical compound released into the atmosphere. These dollar values are very approximate and are based on property damage and health costs.

It should be noted that carbon monoxide is not currently a pollutant of concern in the Miami Valley since CO levels are well below Federal standards. For illustrative purposes, however, CO impacts of ITS deployment have been included in this analysis where applicable.

It should also be noted that in Section 8.3, where national experience with various ITS benefits is summarized, not all ITS improvements are shown to affect all types of pollutants (e.g., CO, HC and NOx). As a result, the benefit-cost calculations in Section 8.4 (which utilize the results presented in Section 8.3), do not always show benefits associated with all three pollutants.

The differential impact of ITS improvements on emissions is due in part to the fact that some strategies/projects impact different pollutants (e.g., reducing signal delay affects only those pollutants associated with running vehicles and does not impact emissions associated with vehicle start-ups). However, the primary reason that emission benefits for different ITS areas are not always expressed in terms of the same three pollutants in this analysis is because the *anecdotal evidence underlying the calculations often does not provide comprehensive information.* For example, the results of a specific ITS deployment may not document impacts to a specific pollutant if that pollutant is not of concern in the area where the project was implemented. Because the number of quantified examples of real world examples of ITS benefits are still relatively limited (despite generally widespread agreement on the benefit of ITS strategies), complete information on benefits is not always available. This analysis does not hypothesize improvements which have not been documented in actual studies.

**TABLE 8.1**
**EMISSION QUANTITIES FROM STOPPED VEHICLES**

| Compound | Quantity for 1,000 vehicles-hours of stopped delay | Unit Cost per pound | Cost per 1000 vehicles-hours of delay |
|---|---|---|---|
| CO | 2,430 lbs. | $0.026 | $ 63.18 |
| HC | 160 lbs. | $0.40 | $ 64.00 |
| NO, | 50 lbs. | $1.32 | $ 66.00 |

Using a total stopped time delay of 6 million vehicle hours (estimated baseline), the quantity of emissions (per year) are as follows:

**TABLE 8.2**
**ANNUAL COST QUANTITIES FOR EMISSIONS**

| Compound | Total Quantity of Emissions (lbs) | Total Cost for Each Compound |
|---|---|---|
| CO | *14,600,000* | *$379,600* |
| HC | *960,000* | *$284,000* |
| NOx | *300,000* | *$396,000* |

## 8.2.3 Accidents

Accident costs are based on data published by the NHTSA in 1991. According to the study, the full cost of a fatality is $320,000 while an injury accident costs $10,000 and an average PDO accident costs $3,000. Nation wide, ITS deployment is estimated to cut accidents by 15% on freeways and 8.5% on arterials. The USDOT study estimates that national ITS deployment will reduce fatalities by 17,921 lives by 2015. Overall, the total value of accidents reduced by ITS nation wide will be approximately $50 billion.

## 8.2.4 Delay Savings

ITS applications hold the potential to reduce the delays experienced by travelers. In many analyses of transportation projects, travel delay reductions are expressed as a dollar value. This analysis also equates potential Miami Valley area ITS delay reductions with dollar savings. The sorts of delay reduction savings described in this analysis are realized by individual travelers rather than by the operators of the transportation system (ODOT, for example). In the case of work travel, delays are often equated with productivity losses and are described as a "societal cost".

Delay savings are highly dependent upon the value travelers place on the time they spend traveling. Obviously, these values vary widely depending upon who is traveling, when and why. For example, delay reductions would probably be valued higher by a highly paid business person on business travel than by an unemployed adult on a pleasure trip.

This analysis uses the value of $10.66 per *vehicle* hour to estimate the dollar value of delay savings. This figure is based on the value of 84% of the average wage rate ($11.90 per *person* hour used by the U.S. Department of Transportation in their Traffic Management Systems program). The increase in the value from $10.00 to $10.66 reflects an adjustment to convert the measure from *people* to *vehicles* and assumes a Miami Valley area average work trip vehicle occupancy of 1.11 persons per vehicle. An hourly delay value specific to the Miami Valley area was unavailable for this analysis.

A final note is appropriate regarding the way dollar values have been ascribed to delay savings in this analysis. It is a traditional criticism of benefit-cost analyses that it is inappropriate or misleading to combine small delay savings realized by many travelers into a single regional total with an associated high dollar value.

The argument is that to reduce a specific individual's commute time by a small amount may have no economic value to that person or may have a lower value than assumed given the relationship between time and money described above. For example, if a person's 30 minute commute is reduced by 3 minutes (10 percent), is this savings actually worth $1.07 ($10.66 x 0.10) to anyone?

Whereas small individual emissions or fuel savings do logically "add up" regionally, it has been questioned whether individual time savings can be meaningfully added up in the same manner. In its own assessments of ITS and other transportation benefits, the USDOT has taken the approach of "adding up" small time savings. The analysis presented here does the same and the results of the analysis should be viewed with this assumption in mind.

## 8.2.5 Miami Valley Region Travel Patterns

Existing traffic data was collected from the Miami Valley Regional Planning Commission related to the amount of traffic and accidents which occur and are projected at build out of the region. It is estimated that motorists will log in 18,435,825 vehicle-miles traveled daily. The corresponding vehicle hours of travel (VHT) are 507,098 vehicle hours daily. The increase in overall congestion levels is evident in the increase of 17% overall in person-trips on average from 1990 to projected 2015 volumes in the region's long range plan.

'Table 8.3 summarizes regional trips and auto occupancy rates for the region. The average trip lengths are summarized in Table 8.4. Table 8.5 shows the emissions data for the Miami Valley Region.

**TABLE 8.3**
**MIAMI VALLEY REGION DAILY PERSON TRIPS**

| Trip Choice | Trips | % | Occupancy |
|---|---|---|---|
| Home-based-work (HBW) | 590,685 | 18.5% | 1.074 |
| Home-based-shopping (HBShop) | 456,670 | 14.3% | 1.661 |
| Home-based-school (HBSchool) | 324,216 | 10.1% | 1.422 |
| Home-based-other (HBO) | 937,606 | 29.4% | 1.541 |
| Non-home-based (NHB) | 885,152 | 27.7% | 1.420 |
| TOTAL | 3,194,329 | 100.0% | |

**TABLE 8.4**
**MIAMI VALLEY REGION AVERAGE TRIP LENGTHS**

| Trip Choice | Trips | Trip-Hr (hr) | Ave Length (min) |
|---|---|---|---|
| HBW | 590,685 | 89,965 | 6.56 |
| HBShop | 456,670 | 32,719 | 13.96 |
| HBSchool | 324,216 | 54,845 | 5.91 |
| HBO | 937,606 | 110,961 | 8.45 |
| NHB | 885,152 | 93,746 | 9.44 |
| Total | 3,194,329 | 382,236 | 8.36 |

**TABLE 8.5**
**MIAMI VALLEY REGION EMISSIONS**

| Compound | Emissions (lb/day) |
|---|---|
| HC | 33,429 |
| CO | (1) |
| NOx | 36,782 |

(1) Cabon monoxide is not at this time a pollutant of concern in the Miami Valley since CO levels are well below Federal standards.

Table 8.6 summarizes the accident data for the Miami Valley Region for the years 1992 through 1994.

**TABLE 8.6**
**MIAMI VALLEY REGION HIGHWAY ACCIDENT STATISTICS**

| Year | Accident Type | | | Yearly Total |
|---|---|---|---|---|
| | Fatality | Personal Injury | Property Damage | |
| 1992 | NA | NA | NA | NA |
| 1993 | NA | NA | NA | NA |
| 1994 | 40 | 2308 | 4485 | 6833 |

## 8.2.6 User Services Bundling

Although it may be possible to deploy a system that provides a single user service, in many cases, there are combinations of user services that can be considered related. These combinations of user ***services*** have been termed ***bundles*** ". The commonality among user services in a bundle may relate to a number of different factors. In some cases, the institutional perspectives of organizations that will deploy the services provide the basis for arriving at a rationale for bundling. In other cases, the determination of bundles centers around common technical functionalities.

The bundles and user services are shown below in Table 8.3. The numbers to the left of the user service represents its rank in the initial user service prioritization. Only the top thirteen user services are included in this report. These 13 user services were formally acknowledged as those which would be utilized to guide the preparation of the Strategic Deployment Plan. A fourteenth user service, On-board Safety Monitoring, has not been analyzed for general benefits due to the lack of evaluation of actual deployment. It should be noted however, that the other 17 user services defined in the ITS National Program Plan will not necessarily be ignored. In the following sections, the bundled user services may be interrelatedly discussed.

**TABLE 8.7**
**USER SERVICES BUNDLES**

| BUNDLE | USER SERVICES |
|---|---|
| 1. Travel and Transportation Management | 2. Incident Management<br>1. Traffic Control<br>5. Traveler Service Information<br>3. En-Route Driver Information<br>4. Route Guidance |
| 2. Travel Demand Management | 7. Pre-Trip Travel Information<br>13. Demand Management and Operations |
| 3. Public Transportation Operations | 6. Public Transportation Management<br>14. En-Route Transit Information |
| 4. Commercial Vehicle Operations | 9. Hazardous Materials Incident Response |
| 5. Emergency Management | 11. Emergency Vehicle Management<br>10. Emergency Notification and Personal Security |

You will notice that one of the services, No. 8 - Highway-Railroad Intersection, is not included in this list because it is not associated with a bundle and is a relatively new service. It is analyzed for benefits utilizing some new data that has been made available from ITS America.

## 8.3 OVERVIEW OF BENEFITS BY PRIORITY USER SERVICE

This section presents a synthesis of benefits data in each of the 12 highest priority user services for the Miami Valley, as determined by the project Technical Committee at the workshop Intensive (see the User Service Plan report).

### 8.3.1 Traffic Control Services

Included in the Travel and Transportation Management bundle, traffic control services are responsible for managing the movement of traffic on streets and highways. It provides for the integration and adaptive control of the freeway and surface street system to improve the flow of traffic, give preference to public safety, transit or other high occupancy vehicles and minimize congestion while maximizing the movement of people and goods. Through appropriate traffic controls, the service also promotes the safety of non-vehicular travelers, such as pedestrians and bicyclists.

Transportation authorities have been installing more flexible traffic signal systems since the first computerized systems were commissioned in the early 1960s. Benefits have been reported in areas including:

- travel time
- travel speed
- vehicle stops
- delay
- fuel consumption
- emissions
- accident reduction

Among the earliest reported benefits, a 1966 project in Wichita Falls, Texas, reported a 16% reduction in stops, a 3 1% reduction in vehicle delay, an 8.5% reduction in accidents, and an increase in speeds of over 50%. This analysis compared the computerized system to the single-dial system it replaced.

The Fuel Efficient Traffic Signal Management (FETSIM) and the Automated Traffic Surveillance and Control (ATSAC) programs in California showed benefit/cost ratios of 58:l and 9.8: 1 respectively. ATSAC, which includes computerized signal control, reported a 13% reduction in travel time, a 35% reduction in vehicle stops, 14% increase in average speed, 20% decrease in intersection delay, 12.5% decrease in fuel consumption, 10% decrease in HC, and a 10% decrease in CO.

Similar studies in other parts of the country including:

- Traffic Light Synchronization (TLC) in Abilene, Texas, which provided for the installation of a closed-loop signal system with hardware interconnect and modem link back to a shop computer, showed a benefit/cost ratio of 62: 1.

- FAST-TRW program which provided for the installation of a traffic management system and the SCATS adaptive signal control system, in Detroit, Michigan.

- SCOOT signal control system, implemented on two corridors and the CBD network, totaling 75 signals, in Toronto, Canada. This study reported normal time savings of 6 to 1 I percent and up to 34% during special events.

- Katella Avenue in Anaheim, California, have yielded beneficial results as well. In general, the benefits fiom traffic signal control systems can be summarized as shown below.

It is important to point out that the magnitude of benefit received from ITS signal improvements will depend in part upon the sophistication and performance of the technology being replaced. Larger improvements can be expected when ITS technology replaces poorly functioning, antiquated equipment. More modest, or marginal improvements are likely when ITS technology is added to an existing sophisticated, effective traffic signal. The benefit-cost calculations shown in Table 8.8 are typical reported benefits reflected a variety of circumstances. When deployed in the Miami Valley area, it will be important to consider that the expected benefits of ITS signal improvements will depend in large part on the technology being replaced.

**TABLE 8.8**
**TRAFFIC SIGNAL CONTROL SYSTEMS BENEFITS**

| | |
|---|---|
| Travel Time | Decrease 7% - 15% |
| Travel Speed | Increase 14% - 22% |
| Vehicle Stops | Decrease 0% - 35% |
| Delay | Decrease 17% - 37% |
| Fuel Consumption | Decrease 6% - 12% |
| Emissions | Decrease 5% - 13% for CO emissions<br>Decrease 4% - 10% for HC emissions |

**Benefit Savings**

The traffic control services, applied to the Miami Valley Region, could yield a range of benefits. Expected benefits include:

*Reduction in Delay*

Responsive or adaptive signal control responds to the varying demand patterns by adopting flexible timing plans. This type of dynamic response reduces the intersection delay and number of stops by implementing optimal signal coordination for the major streets. An 8% reduction in travel time could provide a B/C Ratio of as high as 5: 1.

*Fuel Savings*

According to Wagner's approach, the 8% reduction in travel time and 6% reduction in fuel consumption would save approximately $30,000 in fuel costs daily for an average urban area. This is equivalent to an annual savings of $7.8 million.

*Air Quality*

According to the USDOT, we can expect a 5% decrease in CO emissions and 4% decrease in HC emissions which would correspond to a savings of $5.72 per 1000 vehicle-hours.

*Accident Reduction*

Effkient traffic management reduces congestion by reducing demand. Such situations avoid the formation of long queues which in turn reduce the probability of secondary accidents. An Orange County TOS Study (OCTA) indicates that the implementation of a Traffic Operations Center (TOC) reduces the accident rate by 35%. A more conservative national value based on urban systems suggests a 9 - 15% decrease in the accident rates for the average urban area.

## 8.3.2 Incident Management Services

The Travel and Transportation Management User Service bundle, which includes Freeway/Incident Management Service, share information about the surface transportation system. These services collect and process information about the surface transportation system and provide commands to various traffic control devices. The information gathered is then disseminated to the traveler.

Aimed at quickly identifying incidents and implementing a response to minimize effects on traffic, incident management programs follow an evolutionary route to full deployment. Frequently, incident management programs become part of the mission in expanding freeway management centers. Many of the existing incident management systems such as the Highway Helper Program in Minneapolis, the Incident Management component of the CHART program in Maryland and the Emergency Traffic Patrol in Illinois began as "eyes and ears" of motorists, incorporating technology such as cellular call-in, loop detectors, video monitoring and video detectors as technology and budget constraints allowed. Incident management programs show benefits in incident clearance times and are expected to reduce fatalities.

Incident management programs show concrete promise of reducing the 50% - 60% of traffic congestion attributable to incidents. The Institute of Transportation Engineers has estimated 1 0%-42% decrease in travel time for incident management programs included in freeway management systems. The Maryland CHART program is in the process of expanding to more automated monitoring with lane sensors and video cameras. CHART funding comes from a variety of sources including the state budget process and application for federal programs such as Congestion Management/Air Quality funding and Interstate Discretionary funding. This program is expected to have about a 10: 1 benefit/cost ratio according to draft analyses. The Minnesota Highway Helper Program reduces the duration of a stall (the most frequent type of incident, representing 84% of service calls) by 8 minutes. Using representative numbers, annual benefit through reduced delay totals $1.4 million for a program that costs $600,000 to operate. The reduction in secondary collisions attributable to the incident management program is difficult to estimate due to the coordinated freeway management program in the area. National figures show that fatalities can be reduced by 10% in urban areas.

**TABLE 8.9**
**TYPICAL NATIONAL INCIDENT MANAGEMENT PROGRAM BENEFITS**

| | |
|---|---|
| Incident Clearance Time | Decrease 8 minutes for stalls<br>Decrease wrecker response time 5 - 7 minutes |
| Travel Time | Decrease 10% - 42% |

The video imaging system has several quantifiable and unquantifiable benefits associated with it. The surveillance cameras placed at critical intersections can:

- Reduce the incident response time and also help operations personnel assess the severity of the incident before implementing the appropriate response (e.g. dispatch of ambulance, tow truck, etc.)

- Evaluate signal timing characteristics such as:

  - operational performance plans,
  - progression and platoon arrival patterns, and
  - changes in the intersection performance resulting from changes in signal plans.

- Be used to investigate equipment failure like high occupancy rate recorded by a specific loop detector. This type of monitoring can augment the performance of the Traffic Control Services.

- Help analyze certain types of accidents.

- Reduce the cost associated with traffic data collection.

Using video monitoring can also aid the clearance of an incident. The City of Richardson, Texas, tied the operator of the city's towing concession into the roadway monitoring network with an investment of roughly $200. Using the information provided by the camera, the tow truck dispatcher can position appropriate equipment near the collision site prior to the request for service from the police department. This advance notice reduces the response time for incident clearance by 5 - 7 minutes on average and greatly improves the ability to send equipment that will handle the active incident.

**A** study based on the Gardiner-Lake Shore Corridor identified that camera surveillance reduces the incident detection time on an average 5 - 7.5 minutes. This has significant impact during peak periods with high V/C ratios. Another study evaluated attributed delay savings of 10 vehicle-hours per incident to the video surveillance system.

A typical analysis was done by applying queuing theory techniques for an intersection with the following features:

V/C ratio between 0.8 - 0.9
Number of lanes in the approach: 4
Typical G/C ratio for the approach: 0.5
Number of lanes affected due to an incident: 1.4

Traffic conditions were simulated with and without the video surveillance. The presence of surveillance equipment is assumed to decrease the incident duration by about 6 minutes per incident. This information is summarized in the following table.

**TABLE 8.10**
**DELAY SAVINGS DUE TO VIDEO SURVEILLANCE**

| Incident Duration Without Video Surveillance | Incident Duration With Video Surveillance | Delay Savings per Incident Due to Video Surveillance |
|---|---|---|
| 15 minutes | 9 minutes | 11 vehicle hours |
| 25 minutes | 19 minutes | 20 vehicle hours |

A study was conducted in the city of Santa Ana (CA) where accident statistics for the year 1991 indicated about 62 accidents occurred in the area of coverage of the surveillance cameras. Assuming that the actual lane blocking incidents are about 6 times more than the reported accidents, the total number of incidents would be about 372 per year. From the calculated delay range per incident, the delay savings for 372 incidents annually will be in the range of 37 vehicle hours.

In addition to delay reduction benefits, incident management programs are expected to benefit safety and emission reduction efforts. An analysis of the accident statistics on several California arterials and expressways shows that secondary accidents represent an increase in accident risks of over 600%, without controlling for climatic or other conditions. According to draft analysis based on data from the Fatal Accident Reporting System, reduction of incident notification times on urban freeways from the current average of 5.2 minutes to 3 minutes would result in a fatality reduction of 10% annually, or a national total of 212 lives if all freeways nationwide were under such a program. A reduction to 2 minutes would reduce fatalities by 308 annually. For comparison, the San Antonio TransGuide project has an incident detection goal of 2 minutes.

**Benefit Savings**

The Miami Valley region stands to benefit from the implementation of Incident Management Services. With the installation of lane detection and video monitoring, the region stands to experience a benefit/cost ratio of 30 to 1.

## 8.3.3 En-Route Driver Information Service

En-Route Driver Information Service provides driver advisories and in-vehicle signing for convenience and safety. Driver advisories are similar to pre-trip planning information , but they are provided once travel begins. Part of the Travel and Transportation Management bundle, en-route driver information conveys real-time information about traffic conditions, incidents, construction, transit schedules and weather conditions to drivers of personal, commercial and public transit vehicles. This information allows a driver to either select the best route, or shift to another mode if mid-trip if desired.

In-vehicle signing, the second component of en-route driver information, provides the same types of information found on physical road signs, directly in the vehicle. The service could be extended to include warnings of road conditions and safe speeds for specific types of vehicles, such as autos, buses and large trucks, but potential users include drivers of all types of vehicles. This service might be especially useful to elderly drivers, in rural areas with large number of tourists, or in areas with unusual or hazardous roadway conditions.

Traffic and traveler information are popular with consumers. Systems that provide such information are producing data that anticipate system benefit when wider deployment occurs. Traveler information programs using variable message signs (VMS) and highway advisory radio (HAR) are funded out of highway operations budgets. Programs using kiosks and in-vehicle devices are in the pilot project stage and are funded through operational testing programs. Telephone information is making the transition from pilot to operational status. Studies have produced benefits in reducing travel delay and travel time and predict benefits in reducing emissions and fuel consumption.

INFORM (Information for Motorists) is an integrated corridor on Long Island, New York, including information via variable message signs and control using ramp meters on parallel expressways and some coordination on arterials. The program stretches back to concept studies in the early 1970s and a major feasibility study performed from 1975 to 1977. The implementation progressed in phases starting with VMSs, followed by ramp meters in 1986 and 1987, and completed implementation by early 1990.

Estimates of delay savings due to motorist information reach as high as 1900 vehicle-hours for a peak period incident and 300,000 vehicle-hours in incident related delay annually. Drivers will divert from 5% - 10 % of the time when passive (no recommended action) messages are displayed and twice that when message include diversion message. Convenient alternate routes also impact diversion. Drivers will divert starting several ramps prior to the incident, with any one exit ramp carrying 3% - 4% of the total approaching volume. This higher volume represents an increase in ramp usage of 40% - 70%. Accident frequency decreased slightly during the study, but data were insufficient to claim a significant trend.

**TABLE 8.11**
**DRIVER INFORMATION SYSTEM BENEFITS**

| | |
|---|---|
| Travel Time | Decrease 17 minutes (20%) in incident conditions<br>Decrease 8% - 20% for equipped vehicles |
| Delay | Decrease up to 1900 vehicle-hours per incident |
| Fuel Consumption | Decrease 6% - 12% |
| Emissions | Decrease VOC 5% from affected vehicles<br>Decrease HC emissions 33% corn affected vehicles<br>Decrease NO, emissions 1.5% from affected vehicles |

**Benefit Savings**

Implementation of En-Route Driver Information Service in the Miami Valley Region would result in savings in delay, fuel consumption and emissions with expected B/C Ratios of 2 to 1.

## 8.3.4 Route Guidance Service

Part of the Travel and Transportation Management bundle, Route Guidance Service provides travelers with simple instructions on how to best reach their destination. The expectation here is that increasing driver navigational effectiveness will increase the capacity of the system by minimizing "wasted miles" while searching for the trip destination point. It should also reduce the overall travel time for the trip. Early route guidance systems are based on static information about the roadway network or transit schedules. When fully deployed, route guidance systems will provide travelers with directions to their destinations based on real-time information about the transportation system. The route guidance service will consider traffic conditions, status and schedule of transit systems and road closures in developing the best route. Directions will generally consist of simple instructions on turns or other upcoming maneuvers. Users of the service include not only drivers of all types of vehicles, but also non-vehicular travelers, such as pedestrians or bicyclists, who could get specialized route guidance from a hand-held device.

According to the Pathfinder Evaluation Report, drivers perceived that their trip was less stressful using Pathfmder and their travel times were lower. Drivers also were 40% more likely to divert using Pathfinder. For networks with congestion causing increases of up to a factor of 3 for free flow travel time, but before saturation, equipped vehicles (with navigational aids allowing fixed and dynamic route guidance) experienced a 8% - 16% reduction in travel time for all types of trips.

Field studies performed during the TravTek project in Orlando, Florida, showed that vehicles with an active TravTek device experienced a decrease in travel time of 19% if the route is followed properly, a 20% decrease in travel times if turns are missed (i.e. when turns are missed by both TravTek and the unequipped control vehicle, TravTek provides time savings in regaining the desired route), and a decrease in probability of missing a given turn from 5.4% to 3.6%.

## 8.3.5 Traveler Services Information Service

Included in the Travel and Transportation Management bundle, the Traveler Services Information Service provides a business directory, or "yellow pages" of service information. Traveler Services Information Service provides quick access to travel-related services and facilities. Examples of information that might be included are the location, operating hours, availability of food, lodging, parking, auto repair, hospitals and police facilities. Traveler service information would be accessible in the home, office or other public locations to plan trips and would also be available en-route. When fully deployed, this service will connect users and providers interactively to request and provide needed information. A comprehensive, integrated service could support financial transactions, such as automatic billing for purchases.

Insufficient data is available to attempt to quantify the benefits of implementing a traveler services information service in the Miami Valley area. However, based on the intended function of such a program, such information could result in increased convenience to unfamiliar travelers and help to promote the attractiveness of the Miami Valley area as a tourist destination; could provide health and safety benefits by making it easier to locate emergency services; and could help reduce some of the travel and congestion associated with unfamiliar travelers attempts to locate their destinations. A study performed in Las Vegas, Nevada showed a B/C ratio of 20 to 1 for a Cable TV traveler information system.

## 8.3.6 Public Transportation Management Service

The Public Transportation Operations bundle reflects the commonality of the transit authority as the most probable provider of these services. The transit authority is responsible for implementing systems that are capable of better managing the public transportation system and providing improved transit and mode choice information.

The Public Transportation Management Service provides computer analysis of real-time vehicle and facility status to improve transit operations and maintenance. The analysis includes deviations from schedule and provides potential solutions to dispatchers and drivers. Accurate information on bus location helps maintain transit schedules and assure transfer connections intermodal transportation.

For nearly a decade, transit properties and emergency vehicle operators have been installing and using vehicle location systems based on signpost, triangulation, LORAN and GPS technologies. A recent study found 24 US transit systems operating more than 10,000 vehicles under AVL supervision and another 31 in various stages of procurement. This represents a doubling of the number of deployed systems, with most new systems using a GPS-based location process. Five Canadian operators are using AVL on fleets totaling 3,700 buses, including a 2,300 vehicle fleet in Toronto. Coupled with computer-aided dispatching systems, vehicle location technologies are producing benefits in security, travel time, service reliability and cost effectiveness. Additionally, several operators have reported incidents where AVL information assisted in resolving their disputes with employees and patrons.

AVL/CAD provides precise position of the bus along its route and reports this to the central computer at the dispatch headquarters. This data is used to determine the on-time performance and provides the driver and the dispatcher with a visual indication of where the bus is (if desired) and schedule adherence (ahead of schedule or behind schedule). The systems also provide run times on routes and a covert "mayday" message capability. AVL is also the basic ingredient for providing real-time schedule information to the public to make transit easier to use and more reliable. Some benefits identified by transit agencies are listed below.

Safety and security are major factors in decisions to install transit management systems. Situations benefitting from AVL and from communication systems installed as part of transit management systems include medical emergencies as well as threats and crimes involving passengers and those observed by bus drivers. Some agencies report response time of as little as 1 to 2 minutes while others report reductions of about 40%. Agencies have reported improved cooperation with police after being able to precisely locate a bus involved in an incident and having a transit dispatcher assist in apprehending criminals using bus location information. Bus operators also report an increase sense of security with silent alarm and vehicle location capabilities.

**TABLE 8.12**
**VEHICLE MANAGEMENT SYSTEM BENEFITS**

| | |
|---|---|
| Travel Time | Decrease 15% - 18% |
| Service Reliabilitv | Increase 12% - 23% in on-time performance |
| Security | Decrease incident response time to as little as one minute |
| Cost Effectiveness | 45% annual return on investment<br>Operating cost savings of 9% |

AVL and dispatching systems have most directly improved schedule adherence. Some agencies that have experienced these benefits are:

- The Mass Transit Administration in Baltimore reported a 23% improvement in on-time pefiormance by AVL-equipped buses. The Baltimore MTA initially installed the system on 50 buses in 199 1 and conducted a schedule performance test on buses with and without the equipment. They are now in the process of installing AVL on the remainder of their 850 buses.

- The Kansas City Area Transportation Authority improved on-time performance by 12% in the first year of operation using AVL, compared to a 7% improvement as the result of a coordinated effort between 1986 and 1989.

- Preliminary results from Milwaukee indicate a 28% decrease in the number of buses more than one minute behind schedule.

- Coordination between transit systems and traffic signal systems has also demonstrated operational benefits. Allowing buses to either extend green time or shorten red time by only a few seconds reduced bus travel time on a test route in Portland by 5% to 8%.

An AVL system provides a rich source of data for analyzing bus operations. Examining AVL data collected in Kansas City led to a schedule revision that reduced the 200-vehicle fleet by 7 buses while reducing scheduled travel times by up to 10%. The Kansas City Area Transportation Authority reported an annual operating expense reduction of $0.5 million based on a $1.1 million investment.

Other transit systems have reported reductions in fleet size of 2% to 5% due to efficiencies of bus utilization. Toronto, Canada has had an AVL system operating for several years and has resulted in a 4% reduction in the number of buses required to serve the existing routes.

Alternatively, the efficiency gains could be used to increase frequency by the same amount. Using AVL data for analysis purposes also reduces the need for staff to perform schedule adherence and travel time surveys. Estimates of savings range from $40,000 per survey to $1.5 million annually.

## 8.3.7 Pre-Trip Travel Information Service

Part of the Travel Demand Management bundle, Pre-Trip Travel Information Service is designed to increase the use of high occupancy vehicles and transit by providing intermodal information to travelers prior to the beginning of a trip, and by making ride sharing and transit more convenient and easier to use.

Aimed at providing information for selecting the best transportation mode, departure time and route, Pre-Trip Traveler Information Service allows travelers to access a complete range of intermodal transportation information at home, work and other major sites where trips originate. Real-time information on transit routes, schedules, transfers, fares and ride matching services area available to encourage the use of alternatives to the single occupancy vehicle. Real-time information on accidents, road construction, alternate routes, traffic speeds along given routes, parking conditions, event schedules and weather information is also included. Based on these information, the traveler can select the best route, modes of travel and departure time, or decide not to make the trip at all.

Several traveler information projects are showing popularity and usage growth. The Los Angeles Smart Traveler project deployed 78 information kiosks in locations such as office lobbies and shopping plazas. The number of daily accesses ranged from 20 to 100 in a 20-hour day, with the lowest volume in offices and the greatest in busy pedestrian areas. The most frequent request (83% of users) was for a freeway map. Over half of the users requested MTA bus and train information. Users, primarily upper middle class in the test area, were overwhelmingly positive in response to a survey.

An automated transit information system implemented by the Rochester-Genesee Regional Transportation Authority resulted in an increase in calling volume by 80%, while a system installed by New Jersey Transit reduced caller wait time from an average of 85 seconds to 27 seconds and reduced caller hang-up rate from 10% to 3% while increasing the total number of callers. The Boston SmarTraveler has experienced 138% increase in usage from October 1994 to October 1995 to a total of 244,182 calls monthly, partly due to a partnership with a local cellular telephone service provider.

The Travlink test in the Minneapolis area distributed PC and videotext terminals to 3 15 users and made available transit route and schedule information, including schedule adherence information as well as traffic incidents and construction information. For the month of July 1995, users logged on to the system a total of 1660 times, an average of slightly more than one access per participant per week. One third of the accesses to the system requested bus schedule adherence; another 3 1% examined bus schedules. Additionally, three downtown kiosks offering similar information averaged a total of 71 accesses per weekday between January and July of 1995 real-time traffic data were more frequently requested than bus schedule adherence.

Surveys performed in the Seattle, Washington and the Boston, Massachusetts areas indicate that 30% - 40% of travelers frequently adjust travel patterns based on travel information. Of those that change travel patterns, about 45% change route of travel and another 45% change time of travel. An additional 5% - 10% change travel mode.

Assuming that 30% of 96,000 daily callers change travel plans according to this breakdown, the impact of SmarTraveler in Boston on emissions has been estimated using a MOBILE5a model. On a daily basis, this adjustment of travel behavior nets an estimated reduction of 1,100 pounds of volatile organic compounds, 55 pounds of oxides of nitrogen, and 11070 lbs of carbon monoxide representing reductions of 25%, 1.5% and 33%, respectively of these pollutants from traveler changing travel plans. While only 28,800 daily trips are expected to be affected in a metropolitan area with 2.9 million registered drivers, this represents significant reductions for participating travelers.

Simulations performed using an urban scenario produced more encouraging indications of potential benefits. For networks with congestion causing increase of up to a factor of 3 from free flow travel time but before saturation, equipped vehicles experience a 8% - 20% advantage in travel time. As the network becomes saturated and before congestion significantly affects travel time the advantage of equipped vehicles is smaller. For experienced commuters, the simulation predicts an aggregate travel time benefit of 7% - 12%. The relative benefit to longer trips is more significant than to shorter trips, consistent with a greater opportunity for advantageous diversion. The simulations were performed using a market penetration level of 5%. A separate simulation study predicted that pre-trip information on roadway conditions could result in a delay reduction of 15% when a capacity reducing incident occurs and off-road travel options are present.

Studies also indicate interest in traffic information on the part of the traveler as well as willingness to react to avoid congestion and delay. In focus groups for the Atlanta Advanced Traveler Information Kiosk Project, 92% - 98% of participants found the current information on accidents, alternate routes, road closures and traffic congestion to be useful and desirable. A survey in Marin County, California showed that if regular commuters had been presented with alternate routes including travel time estimates, 69% would have diverted and would have saved an average of 17 minutes. A pilot program in the Netherlands found a 40% increase in route diversions based on traffic information by the 300 vehicles equipped with FM sideband data receivers.

**TABLE 8.13**
**PRE-TRIP TRAVELER INFORMATION BENEFITS**

| | |
|---|---|
| Travel Time | Decrease 7% - 12%<br>Decrease travel time by 17 minutes |
| Emissions | Decrease 33% of CO<br>Decrease 1.5% of NO, |

## 8.3.8 Highway-Railroad Intersection Service

The highway-railroad intersection service was created to provide the economic benefits of advanced technology deployments at grade crossings to improve safety by reducing accidents caused by infringements at rail grade crossings. An FRA study showed that passive warning devices can reduce accidents by 65%. Grade crossing deployment will be extensive reaching 20% of the crossings nationally due to the economic infeasibility of the grade separation of rail crossings. Technologies which may be deployed under this service include photo enforcement, advanced vehicle detection systems, vehicle location systems and wayside warning devices. Applications which are deployed to reduce congestion and delay include adaptive signal control and advanced signal pre-emption and are typically included in the traffic control systems service area.

### **8.3.9 Hazardous Materials Incident Response Service**

The use of advanced computers and communications technologies to improve the safety and productivity of the motor carrier industry supports the goal of improving the efficiency and safety of commercial fleet operations. From a technical perspective, the foundation is information systems. Each service will require some set of information on the motor carrier, the vehicle, the driver and the cargo.

The Hazardous Material Incident Response Service enhances the safety of shipments of hazardous materials by providing enforcement and response teams with timely and accurate information on cargo contents to enable them to react properly in emergency situations. The materials or combinations of materials involved when an incident involving a truck carrying hazardous materials occurs would be provided electronically to emergency responders and enforcement personnel at the scene so that the incident can be handled properly.

### **8.3.10 Emergency Notification and Personal Security Service**

Part of the Emergency Management Services bundle, the Emergency Notification and Personal Security Service provides immediate notification of an incident and an immediate request for assistance.

The Emergency Notification and Personal Security Service includes two capabilities: driver and personal security, and automatic collision notification. Driver and personal security capabilities provide for user-initiated distress signals for incidents such as mechanical breakdowns or car-jackings. When activated by an incident, automatic collision notification transmits information regarding location, and severity of the crash to emergency personnel.

### **8.3.11 Emergency Vehicle Management Service**

Police, fire and rescue operations use services in the Emergency Management Services bundle to improve their management of and response to emergency situations. Common functional elements are vehicle location, communications and response.

The Emergency Vehicle Management Service is responsible for reducing the time it takes for emergency vehicles to respond to an incident. It provides public safety agencies with fleet management capabilities, route guidance and signal priority an/or preemption for emergency vehicles. Fleet management improves the display of emergency vehicle locations and help dispatchers send the units that can most quickly reach an incident site.

Automated Vehicle Location (AVL) systems have been installed in emergency vehicles for the past decade. Of the deployed systems, the most commonly used is the GPS based location process. Other systems deployed also use the signpost, triangulation and the LORAN technologies. Coupled with computer-aided dispatching systems, vehicle location technologies are producing benefits in security, travel time service reliability and cost effectiveness.

The major factors in the decision to install these management systems are safety and security. Situations benefiting from AVL and from communications systems installed as part of transit and emergency management systems include medical emergencies.

### 8.3.12 En-Route Transit Information Service

The En-Route Transit Information Service provides information to assist travelers once public transportation travel begins. Real-time, accurate transit service information on-board the vehicle helps travelers make effective transfer decisions and itinerary modifications as needed while a trip is underway.

Traffic volumes and the associated delay and congestion can be expected to grow over the life of any system. As such, the estimate of current benefits are very conservative, representing the minimum benefits if the system features were in place at the present time. A more realistic assessment would be to accrue the benefits averaged over the life of the individual system configuration to derive annual benefit.

### 8.3.13 Demand Management and Operations Service

Part of the Travel Demand Management User services bundle, the Demand Management & Operations Service supports policies and strategies that are aimed at reducing demand by developing and encouraging mode of travel other than the single occupant vehicle. The services in this bundle are designed to increase the use of high occupancy vehicles and transit by providing intermodal information to travelers prior to the beginning of a trip, and by making transit more convenient and easier to use.

These services are also aimed at decreasing congestion by altering the timing of location of trips, or eliminating vehicle trips all together. Demand Management services also interact with the Travel and Transportation Management services in terms of implementing control strategies that can provide incentives, or disincentives, to change travel behavior. For example, disincentives such as increased tolls and parking fees could be applied during pollution alerts or peak travel periods, while transit fares would be lowered to accommodate the increase in number of travelers changing modes from driving alone. Such strategies will reduce the negative impacts of traffic congestion on the environment and improve overall quality of life.

Some programs aimed at reducing congestion by altering the timing of location of trips or eliminating trips all together are:

- compressed work week
- ridesharing/ridematching
- transit subsidies/parking restrictions
- telecommuting

### Compressed Work Week

The surest way to keep employees from driving to work alone is not to have them come to work at all. This can be accomplished by implementing a compressed work week (CWW) schedule at the work site. CWW schedules are very popular with employees since it gives employees an extra 26 to 50 or more days off work per year. Common CWW schedules include the following:

- 4/l 0 - where employees work four 10-hour days during the week
- 3/36 - where employees work three 12-hour days during the week
- 9/80 - where employees work 80 hours in 9 working days over a two week period

### Ridesharing/Ridematching

Ridesharing is one of the most effective and most popular ways of reducing single occupant vehicle trips. It encourages employees living in the same or neighboring zip codes to drive to work together. Many companies including Sun Microsystems in Mountain View, CA and Apple Computer in Cupertino organize employee zip code meetings or provide in-house ridematching to form carpools among employees who live in the same areas.

### Transit Subsidies/Parking Restrictions

One highly effective incentive program is a transportation allowance linked to on-site parking charges. Employees who drive to work must pay for parking. In turn, all employees receive a monthly transportation allowance that they can apply toward the parking fee, an alternative commute mode or use as they please. The allowance can be equal to or less than the parking charge. A study based upon data from downtown Los Angeles predicted that a parking cash-out program would reduce the number of cars per 100 employees from 75 to 62, a 17% decline.

### Telecommuting

Telecommuting allows employees to work at home. Home-based telecommuting is growing in popularity with an estimated 2.4 million employees nationwide in 1992, working at home during business hours as part of regular work. This program typically involves employees working at home one or more days per week on a regular basis. As such it works for many types of jobs and tasks and at all levels of a company.

An estimated 45% of the labor force are potential telecommuters. A nationwide survey found that 4 1% of telecommuters work at home one day a week and 3 8% work at home 2 days per week. Some of the job tasks suitable for telecommuting include: writing, research, editing, data processing, phone work, data entry, data coding, etc.

## 8.4 BENEFITS-COST ANALYSIS

This section evaluates the benefit cost ratios associated with the four program areas identified as part of the Implementation Plan. Program Areas are broken into distinct areas of deployment which as a whole provide specific benefits to the users and stakeholders of the region. One difficulty in determining the benefits of the program areas is that there is little actual field data on ITS benefits in the Miami Valley region. Many of the proposed ITS benefits have not been implemented in the area. Therefore, empirical data based on experience in other parts of the country for similar programs are referenced. We have developed the assessment based on these experiences, the existing traffic characteristics and benefits by user service discussed in this section and the proposed implementations identified by program areas including:

- Freeway/Incident Management Systems
- Advanced Traffic Signal Control Systems
- Public Transportation Systems
- Multimodal Traveler Information Systems

Each of these projects will support a number of ITS services. The experience of these ITS services as derived in other regions were applied to the regions travel characteristics. This provided an estimate of the potential benefits that could be derived in each of the program areas. However, the maturity of these ITS services would vary between regions and the degree of benefits that could be realized depends on how mature the ITS deployment of a program area is in the region. For the purpose of this analysis, we have assumed that no deployment has taken place within the region. The following sections discuss the regional benefit/cost assessment for each of the program areas.

Since the various ITS projects in this report are phased in over time, ranging from one to twenty years, our calculation of the benefits of each project attempted to account for this phasing. The benefits were calculated for each area based on what could be expected at “full implementation.” Once this benefit value was established, the yearly benefits were “scaled” over years l-5 based on the percentage of the system employed each year. For example, if an ITS program, when fully deployed, generated an annual benefit of $2,000,000 but it took five years for the system to be fully deployed, the benefits in years one through five were scaled down, based on the percentage of costs incurred each year. So in this example, if the ITS system took $500,000 to implement ($100,000) each year, year one benefits would be $200,000 (20% of total). Year two benefits would be $800,000 (represents 20% benefit from year one activities plus additional benefit from year 2). This simplified approach to “scaling” the benefits was applied to each of the four program areas discussed below. Some general assumptions and statistics that will be used throughout the benefits calculations are:

- Total Vehicle Miles Traveled (VMT) equals 18,435,825 miles daily.
- Total Vehicle Hours Traveled (VHT) equals 507,098 hours daily.
- 80% of travel (and thus 80% of VMT and VHT) occurs on arterial streets, 20% on freeways.
- Delay savings were calculated using an hourly rate of $10.66 per hour for traveler’s time.
- Fuel costs were estimated at $1.60 per gallon.
- Benefits calculated on a daily basis, will be converted to annual benefits by multiplying them by 260 (52 weeks per year X 5 days per week), assuming the vast majority of benefits will be realized during weekday commutes.
- For air quality calculations, it was assumed that 20% of all emissions were generated from freeway travel and 80% were generated from arterial travel.

The costs utilized in these calculations include those presented in Table 7.6, which include implementation (design/study and construction) as well as non-labor annual operating and maintenance costs. Labor costs are also included in these calculations, based on the average of the annual full-time staff equivalents (FTE's) presented in Table 7.6. A labor cost was derived by calculating an average FTE over the first five years of deployment and assuming an annual cost of $45,000 per FTE.

### 8.4.1 Freeway/Incident Management System

Aimed at quickly identifying incidents and implementing a response to minimize negative impacts on traffic, incident management programs have followed an evolutionary route to full deployment. Frequently, IMS have become a part of the mission in expanding freeway management systems (FMS). This is the case in Miami Valley where we have developed a program area which incorporates incident management into the FMS function. This program area includes:

- Freeway Management System
- Freeway Service Patrols
- Incident Management Program
- Ramp Metering
- Portable TMS
- Local ATIS

The F/IMS in the region is expected to yield the following benefits:

**Delay Savings**

Assuming 20% of VHT are freeway hours and will be impacted by the FMS, a daily VHT of 101,420 in the Valley, the FMS will result in an 8% decrease in VHT totaling a reduction of 8,114 vehicle-hours. The reduction in VHT of 10% during peak hours due to non-recurrent delays is expected due to the deployment of an Incident Management System. Assuming a 10% reduction in non-recurring delay, the corresponding savings in VHT would be 10,142 for a total delay savings of 18,256. Based on a cost of $10.66 per hour for the value of time, the equivalent to a cost of travel time savings of $194,609 daily or annual savings of $50.6 million.

**Fuel Savings**

Using Wagner's calculation for total fuel consumption discussed earlier in Section 8.2.1, it was estimated that the region consumed approximately 1,087,78 1 gallons of fuel daily. Applying a 6% decrease in fuel consumption assumed from previous analysis to the percent of freeway VMT will yield a savings of 13,053 gallons daily or 3.4 million gallons annually. This would represent an annual savings of $5.4 million.

**Air Quality**

Based on daily emission levels of 36,782 pounds of NO, and 33,429 pounds of HC for the region, 20% could be attributed to freeway travel. Assuming a 1.5% reduction of NO, emissions (110 pounds per day) and a 33% reduction of HC emissions (2,206 pounds per day) would correspond annual reductions of 28,600 pounds and 573,560 pounds respectively. Based on the unit costs per pound of emission from Table 8.1, these reductions would represent annual benefits of $37,700 for No, reductions and $229,400 for HC, for a total annual air quality benefit of approximately $267,100.

**Accident Reduction**

Using the NHTSA statistics for the costs of accidents (Section 8.2.3) and the accident statistics in Table 8.6, in 1994, the accident related costs on regional transportation facilities were estimated to be $49.3 million. A 10% reduction in accidents will result in an estimated savings of $4.9 million per year.

Adding the benefits associated with delay savings, fuel savings, reduction in emissions, and accident savings, provides an average annual benefit from freeway/incident management of approximately $61,195,100 However, this is based on the implementation of a freeway/incident management system on the entire freeway system. This will not be completed until year 20, according to the strategic plan. By the end of year 5, approximately 46 of the 139 miles of freeway in the Miami Valley Area will be covered by a freeway/incident management system. This represents one-third (33%) of the freeway miles. However, the implementation approach is geared to implementing the freeway/incident management system fist in the areas with the biggest problems. So, to say that covering one-third of the freeway would generate one-third of the total expected benefits would be underestimating the benefit. As a result, we have assumed that covering the first one-third of the freeway will generate two-thirds of the expected benefits. The remaining one-third coming with the full-scale implementation. Applying these percentages to the numbers above, generates an expected benefit of approximately $41,000,000 by the end of year 5. Table 8.14 below presents the calculation of the costs and benefits for years l-5 and the calculation of the benefit/cost ratio for the freeway/incident management program area.

**TABLE 8.14**
**BENEFIT/COST ASSESSMENT**
**FREEWAY/INCIDENT MANAGEMENT SYSTEM**

| | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Total |
|---|---|---|---|---|---|---|
| Deployment Cost | $949,400 | $3,217,400 | $2,726,800 | $3,336,900 | $5,129,900 | $15,360,400 |
| Labor Cost | $45,000 | $292,500 | $382,500 | $495,000 | $630,000 | $1,845,000 |
| Total Cost | $994,400 | $3,509,900 | $3,109,300 | $3,831,900 | $5,759,900 | $17,205,400 |
| Percentage Total (Year 1-5) | 5.78 | 20.40 | 18.07 | 22.27 | 33.48 | |
| Cumulative Percentage (Year 1-5) | 5.78 | 26.18 | 44.25 | 66.52 | 100.00 | |
| Benefit by Year | $2,369,800 | $10,733,800 | $18,142,500 | $27,273,200 | $41,000,000 | $99,519,300 |
| **5-Year Benefit/Cost Ratio:** | | | | | | **5.8:1** |

Source: BRW, Inc., July 1997

## 8.4.2 Advanced Traffic Signal Control System (TSCS)

This program area will give traffic operations engineers the ability to control and operate the signal systems from a central location and develop advanced strategies for the management of traffic congestion. The program area includes the following projects:

- Traffic Signal Timing Plan Updates
- Traffic Signal System Improvements and Coordination
- Highway/Railroad Intersection Improvements
- Diversionary Timing Plans

The ATSCS in the region is expected to yield the following benefits:

**Delay Savings**

Assuming 80% of VHT are arterial street hours and will be impacted by the ATSCS, a daily VHT of 405,678 in the Valley, the TSCS will result in an 8% decrease in VHT totaling a reduction of 32,454 vehicle-hours. Based on a previously calculated cost of $10.66 per hour for the value of time, the equivalent to a cost of travel time savings of $346,000 daily or annual savings of $90.0 million.

### Fuel Savings

As discussed earlier in this chapter, it was estimated that the region consumed approximately 1,087,781 gallons of fuel daily. Assuming 80% of the traffic volumes occur daily on arterial streets and are effected by TSCS, a 6% decrease in fuel consumption assumed from previous analysis will yield a savings of 52,214 gallons daily or 13.6 million gallons annually. This would represent an annual savings of $21.7 million.

### Air Quality

Based on daily emission levels of 36,782 pounds of NO, and 33,429 pounds of HC for the region, 80% could be attributed to freeway travel. Assuming a 5% reduction of NO, emissions (1,471 pounds per day) and a 4% reduction of HC emissions (1,070 pounds per day) would correspond annual reductions of 382,460 pounds and 278,200 pounds respectively. Based on the unit costs per pound of emission from Table 8.1, these reductions wouId represent annual benefits of $505,000 for NO, reductions and $111,000 for HC, for a total annual air quality benefit of approximately $616,000.

### Accident Reduction

In 1994, the accident related costs on regional arterial (assumes 80% of accidents are on arterials) facilities were estimated to be $39.5 million. A 9% reduction in accidents on arterial streets will result in an estimated savings of $3.5 million per year.

Adding the benefits associated with delay savings, fuel savings, reduction in emissions, and accident savings, provides an average annual benefit from traffic signal control systems of approximately $115,849,000 However, this is based on the implementation of a traffic signal control system on the entire arterial system. This will not be completed until year 10, according to the strategic plan. By the end of year 5, approximately 50% of the signals in the Miami Valley Area will be upgraded as part of this effort. However, the implementation approach is geared to implementing the traffic signal control system first in the areas with the biggest problems. Applying similar logic as before, we have assumed that approximately two-thirds of the overall benefit from the traffic signal control systems will be realized by the end of year 5. Applying these percentages to the numbers above, generates an expected benefit of approximately $77,619,000 by the end of year 5. Table 8.15 below presents the calculation of the costs and benefits for years l-5 and the calculation of the benefit/cost ratio for the traffic signal control systems program area.

**TABLE 8.15**
**BENEFIT/COST ASSESSMENT**
**TRAFFIC SIGNAL CONTROL SYSTEM**

| | **Year 1** | **Year 2** | **Year 3** | **Year 4** | **Year 5** | **Total** |
|---|---|---|---|---|---|---|
| Deployment Cost | **$1,082,500** | **$1,132,500** | **$1,245,000** | **$1,120,000** | **$1,133,000** | **$5,713,000** |
| Labor Cost | **$67,500** | **$67,500** | **$67,500** | **$67,500** | **$67,500** | **$337,500** |
| Total Cost | **$1,150,000** | **$1,120,000** | **$1,312,500** | **$1,187,500** | **$1,200,500** | **$6,050,500** |
| Percentage Total (Year l-5) | 19.01 | 19.83 | 21.69 | 19.63 | 19.84 | |
| Cumulative Percentage (Year 1-5) | 19.01 | 38.84 | 60.53 | 80.16 | 100.00 | |
| 5-Year Benefit by Year | $14,755,000 | $30,147,000 | $46,983,000 | $62,219,000 | $77,619,000 | $231,723,000 |
| **Benefit/Cost Ratio:** | | | | | | **38.3:1** |

Source: BRW, Inc., July 1997

### 8.4.3 Public Transportation Systems (PTS)

PTS provide improved management and information dissemination capabilities to improve transit operations and provide real time transit information to the public. Accurate information can enhance ridership and improve schedule adherence and transfer connections. The program area includes the following proposed projects:

- AVL and CADS Capabilities using MDT's
- Connection Protection Program
- Route Deviation Transit Service
- Electronic Fare Collection
- Mobility Management
- Electronic Station Signs
- Transit Priority Systems

The PTS in the region is expected to yield the following benefits:

**Delay Savings**

For transit management improvements, based on the assumption that travel time reduction translates into delay reduction experienced by the commuters, assuming an average trip length for transit riders of 30 minutes and an annual ridership of 8,003,000, the PTS will result in a 15% decrease in commute time totaling a reduction of 600,000 hours. Based on a previously calculated cost of $10.66 per hour for the value of time, the equivalent to a cost of travel time savings of $6,396,000 annually.

### Equipment Savings

As discussed earlier in this chapter, investment in the advanced transit management capabilities will translate into reduction in travel times and an associated improved efficiency and the more effective use of equipment.

The RTA has 250 vehicle fleet. A reduction of 15% in fleet size due to increased efficiency would provide transit operators with approximately $3.75 million in operating and capital cost savings (assuming approximately $100,000 per year, per bus for capital and operating costs). With an additional 45% return on annual investment expected from experience by other transit agencies, the savings would total $5,646,000 annually for this program.

Adding the benefits associated with delay savings and equipment savings, provides an average annual benefit from public transportation systems of approximately $12,042,000 Table 8.16 below presents the calculation of the costs and benefits for years l-5 and the calculation of the benefit/cost ratio for the public transportation systems program area.

**TABLE 8.16**
**BENEFIT/COST ASSESSMENT**
**PUBLIC TRANSPORTATION SYSTEM**

| | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Total |
|---|---|---|---|---|---|---|
| Deployment Cost | $1,006,250 | $2,476,875 | $6,130,800 | $6,387,380 | $5,868,210 | $21,869,515 |
| Labor Cost | $22,500 | $51,750 | $103,500 | $105,750 | $108,000 | $391,500 |
| Total Cost | $1,028,750 | $2,528,625 | $6,234,300 | $6,493,130 | $5,976,210 | $22,261,015 |
| Percentage Total (Year 1-5) | 4.62 | 11.36 | 28.00 | 29.17 | 26.85 | . |
| Cumulative Percentage (Year 1-5) | 4.62 | 15.98 | 43.98 | 73.15 | 100.00 | |
| Benefit by Year | $556,530 | $1,924,950 | $5,297,830 | $8,811,650 | $12,046,000 | $28,636,960 |
| **5-Year Benefit/Cost Ratio:** | | | | | | **1.5:1** |

Source: BRW, Inc., July 1997

### 8.4.4 Multimodal Traveler Information System (ATIS)

ATIS is a form of several traveler information related user services which we have discussed previously in this section. It provides information for travelers before and during the tip related to the transportation options of the traveler, allowing them to choose mode of transportation and route of choice. The ATIS program area includes:

- A Regional ATIS
- CATV Channel
- Internet Access to traveler information
- Kiosks
- Paging System

Although the ATIS will benefit all travelers throughout the Miami Valley area, on both freeways and arterials, the vast majority of the benefits are expected to apply to freeway travel. The ATIS in the region is expected to yield the following benefits:

**Delay Savings**

Assuming 20% of VHT are freeway hours and will be impacted by the ATIS, a daily VHT of 101,420 in the Valley, the ATIS will result in an 7% decrease in VHT totaling a reduction of 7,099 vehicle-hours. Based on a previously calculated cost of $10.66 per hour for the value of time, the equivalent to a cost of travel time savings of $75,675 daily or annual savings of $19.7 million.

**Fuel Savings**

Fuel savings is an indirect benefit of an ATIS. As discussed earlier in this chapter, it was estimated that the region consumed approximately 1,087,781 gallons of fuel daily. Assuming 20% of the traffic volumes occur daily on freeways and are candidate to utilize an ATIS for more efficient travel, a 7% decrease in fuel consumption assumed from previous analysis will yield a savings of 15,229 gallons daily or 4.0 million gallons annually. This would represent an annual savings of $6.3 million.

**Air Quality**

Based on daily emission levels of 36,782 pounds of NOx, 20% could be attributed to freeway travel. An assumed 1.5% reduction of NO, emissions (110 pounds per day) would correspond to annual reductions of 28,600 pounds. Based on the unit costs per pound of emission from Table 8.1, this reduction would represent an annual benefit of $38,000.

Adding the benefits associated with delay savings, fuel savings, and reduction in emissions provides an average annual benefit from the multi-modal traveler information system of approximately $26,049,000. All ATIS systems discussed in this report will be deployed and operational by the end of year 5, though some continuing upgrading and operational activities will continue in years 6 through 20. Table 8.17 below presents the calculation of the costs and benefits for years l-5 and the calculation of the benefit/cost ratio for the multi-modal traveler information systems program area.

**TABLE 8.17**
**BENEFIT/COST ASSESSMENT**
**MULTI-MODAL TRAVELER INFORMATION SYSTEM**

| | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Total |
|---|---|---|---|---|---|---|
| Deployment Cost | $647,760 | $648,940 | $928,040 | $1,047,840 | $637,840 | $3,910,420 |
| Labor Cost | $103,500 | $58,500 | $110,250 | $110,250 | $54,000 | $436,500 |
| Total Cost | $751,260 | $707,440 | $1,038,290 | $1,158,090 | $691,840 | $4,346,920 |
| Percentage Total (Year 1-5) | 17.28 | 16.27 | 23.89 | 26.64 | 15.92 | |
| Cumulative Percentage (Year 1-5) | 17.28 | 33.55 | 57.44 | 84.08 | 100.00 | |
| Benefit by Year | $4,501,000 | $8,739,000 | $14,963,000 | $1,902,000 | $26,049,000 | $76,154,000 |
| **5-Year Benefit/Cost Ratio:** | | | | | | **18.5:1** |

Source: BRW, Inc., July 1997

## 8.4.5 Summary of Benefits and Costs by Program Area

Table 8.18 provides a summary of the overall program costs and benefits calculated by program area and a benefit-cost ratio for the entire ITS implementation in the Miami Valley Area.

| | Years l-5 | | |
|---|---|---|---|
| **Program Area** | **Total Benefit ($000)** | **Total Cost ($000)** | **B/C Ratio*** |
| Freeway/Incident Management | **$99,519** | **$17,205** | **5.8:1** |
| Advanced Traffic Signal Control | **$231,723** | **$6,051** | **38.3:1** |
| Public Transportation System | **$28,637** | **$22,261** | **1.3:1** |
| Multi-Modal Traveler Information | **$76,154** | **$4,347** | **17.5:1** |
| **Total ITS Program:** | **$436,033** | **$49,864** | **8.7:1** |

Source: BRW, Inc., July 1997

## 8.5 REFERENCES CONSULTED

The data and assumptions presented and utilized in this analysis have been drawn from a number of sources, including the following:


1. Final Report, ITS America, U.S. Department of Transportation, ITS National Investment and Market Analysis, Apogee Research, Inc., Wilbur Smith Associates, May 1997

2. Mobility Facts, 1992

3. ITS National Program Plan (First Edition, March 1995; U.S. Department of Transportation)

4. Meyer, M. ed., *A Toolbox for Alleviating Traffic Congestion*, Institute of Transportation Engineers, Washington, DC, 1989

5. Points-du-Jour, J., Maryland State Highway Administration, telephone interview, November 1995

6. Kuciemba, S., Maryland State Highway Administration, telephone interview, April 1995

7. *Highway Helper Summary Report* - Twin Cities Metro Area, Minnesota Department of Transportation, Report #TMC 07450-0394, July 1994

8. Edwards, M., Lewis Wrecker Service, telephone interview, December 1995

9. Intelligent Transportation Systems Impact Assessment Framework: Final Report, Volpe National Transportation Systems Center, September 1995

10. Evanco, W., *The Benefits of Rapid Incident Detection on Accident Fatalities*, The MITRE Corporation, unpublished paper

11. McGowan, P., and Irwin, P., *TransGuide Transportation Guidance System: Technology in Motion*, Texas Department of Transportation, November 1995

12. Wilshire, R.L., *The Benefits of Computer Traffic Control*, Traffic Engineering, April 1969

13. Institute of Transportation Studies, University of California, *Fuel-efficient Traffic Signal Management: Three Years of Experience*, 1983-1985, Berkeley, CA: ITS Publications, 1986

14. Shahrzad Amiri of LACMTA, telephone interview quoting earlier studies, April 1995

15. Benefits of the Texas Traffic Light Synchronization Grant Program I; Volume I, Texas Department of Transportation/TTI Report #0258-l, Texas Department of Transportation, Austin, Texas, October 1992

16. *Overview of the FAST-TMC IVHS Program: Early Results and Future Plans,* Brent Bair, **James** Barbaresso, and Beata Lamparski *in Towards an Intelligent Transport System, Proceedings of the First World Congress on Applications of Transport Telematics and Intelligent Vehicle-Highway Systems,* December 1994

17. Siemens Automotive, USA, *SCOOT in Toronto,* Traffic Technology International, Spring 1995

18. Jones, W., ITS Technologies in Public Transit: Deployment and Benefits, USDOT ITS Joint Program Office, November 1995

19. Casey, R., et al., Advanced Public Transportation Systems: The State of the Art - Update '96, USDOT FTA, January 1996

20. Jones, W., ITS Technologies in Public Transit: Deployment and Benefits, November 1995

21. Jones, W., ITS Technologies in Public Transit: Deployment and Benefits, November 1995

22. Kloos, W., et al., Bus Priority at Traffic Signals in Portland, ITS Annual Meeting, March 1995

23. Jones, W., ITS Technologies in Public Transit: Deployment and Benefits, November 1995

24. USDOT, FTA, APTS Benefits, November 1995

25. Giuliano, G., Golob, J., and Hall, R., *Los Angeles Smart Traveler Information Kiosks,* presented at the 74th Transportation Research Board Annual Meeting, January 1995

26. USDOT, FTA, APTS Benefits, November 1995

27. *NJ Transit's Customer Information Speeded Up by* New *System,* Passenger Transport, January 24,1994

28. SmartRoute Systems Memorandum, *SmarTraveler Update,* November 6, 1995

29. Remer, M., Atherton, T., and Gardner, W., ITS Benefits, Evaluation and Costs: Results and Lessons from the Minnesota Guidestar Travlink Operational Tests, Draft, November 1995

30. Air Quality Benefit Study of the SmarTraveler Advanced Traveler Information Service, Tech Environmental, Inc., July 1993

31. Wunderlich, K., *Congestion and Route Guidance Benefits Assessment, The* MITRE Corporation, letter ITS-L- 13 1, October 1995

32. Wunderlich, K., *Trip Planning User Service Benefits Assessment,* the MITRE Corporation, letter ITS-L- 13 1, November 1995

33. *Advanced Traveler Information Kiosk Project: Summary Report - Focus Groups,* Catherine Ross and Associates, Inc., undated

34. Khattak, A., Kanafani, A., and Le Colletter, E., *Stated and Reported Route Diversion Behavior: Implications on the Benefits of* ATIS, University of California - Berkeley, UCB-ITS-PRR-94-13, 1994

35. Broeders, W.P.B., *RDS/TMC as Traffic Management Tool and Commercial Products,* Proceedings of the Second World Congress on Intelligent Transportation Systems, Yokohama, Japan, November 1995

36. Smith, S., and Perez, C., *Evaluation of INFORM- Lessons Learned and Application to Other Systems,* presented at 7 1 st Transportation Research Board Annual Meeting, January 1992

37. Bay Area Air Quality Management District, *BAAQMD Guide to Employer Trip Reduction Programs,* November 1993 (Revised 2/94)

38. U.S. Department of Transportation (DOT), *Transportation Implications of Telecommuting,* April 1993

39. RIDES, *Facts About Telecommuting,* January 1992, citing *Urban Transportation Monitor*

40. U.S. Department of Transportation (DOT), *Transportation Implications of Telecomuting,* April 1993

# MIAMI VALLEY ITS

## MANAGEMENT PLAN

Management Plan