Final Report
Research Project T2695, Task 48
Evaluation of FAME

EVALUATION OF OIL REBATE EXPENDITURES UNDERTAKEN IN ASSOCIATION WITH THE FREEWAY AND ARTERIAL MANAGEMENT EFFORT (FAME)

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16. ABSTRACT

Oil Rebate funds have allowed the Freeway and Arterial Management Effort (FAME) to spearhead technological breakthroughs in communication that both decrease the duration of congestion, and allow travelers to avoid the congestion as it occurs, thus decreasing energy used for travel, and pollutants generated by travel. Oil rebate funds have allowed FAME to perform a number of groundbreaking studies that have improved the state's ability to control and manage traffic. Further, the $1.4 million in Oil Rebate funding for FAME has been used to leverage or match almost $7.7 million from other funding sources.

The majority of the 23 projects that have been partially or wholly funded by Oil Rebate monies have been very successful; meanwhile, projects with unsatisfactory outcomes were frequently terminated before completion, and rebate monies were re-allocated to other, more promising opportunities. The use of Oil Rebate funding has decreased the risks associated with investigating non-traditional approaches to traffic flow improvements, and allowed WSDOT to begin quantifying benefits that could be gained from new approaches to dealing with congestion problems.

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EXECUTIVE SUMMARY

The objectives of this report are 1) to document the benefits obtained through the use of Oil Rebate funds, and 2) to provide guidance to WSDOT in using and accounting for future programmatic funds.

The Freeway and Arterial Management Effort (FAME) is a broad program that oversees research and deployment of new and more effective methods of reducing traffic congestion in the Washington State. FAME projects are funded through a variety of sources, including the Oil Rebate Program. Twenty-three FAME projects received at least partial funding from the Oil rebate Program between 1988 and 2004. These projects are listed at the end of this Executive Summary in Table 1.

FAME qualifies for Oil Rebate Program funding by meeting the program's requirements to: 1) reduce the energy required for travel, and to 2) lower the amount of pollutants that travel creates. Oil generated energy is minimized by reducing congestion and speeding the flow of traffic. This can be accomplished by improved traffic management actions and improved communications with agencies and travelers. Reduced congestion also results in lowered pollutant emissions, as vehicles spend less time idling, and have fewer "high emission" acceleration/deceleration driving cycles. Oil Rebate funds have allowed FAME to spearhead technological breakthroughs in communication that both decrease the duration of congestion, and allow travelers to avoid the congestion as it occurs. Oil Rebate funded FAME projects have provided benefits including the following:

- Increased the speed with which congestion-causing incidents are identified.
- Improved communications with the Washington State Department of Transportation and Washington State Patrol about the location and the composition of traffic incidents so that the appropriate equipment and staff can be more quickly dispatched to clear them.

- Improved the techniques used to investigate and clear the incidents.
- Improved the quality and quantity of information passed to travelers so that they can avoid congested incident locations.

The result is a quicker response to traffic incidents, a faster removal of incidents, a decrease in total delay, and an increased ability for travelers to avoid congestion and delays. All these improvements result in smoother, less congested vehicle flow, which in turn results in decreased fuel use. These same improvements decrease the amount of pollutant emissions that are generated by cars and trucks.

Oil rebate funds have also allowed FAME to perform a number of ground breaking studies that have improved the state's ability to control and manage traffic, as well as to plan, implement and operate facilities that provide travelers with transportation modes that lower energy use, such as high occupancy vehicle (HOV) lanes. FAME-supported projects also include testing and adopting new automatic vehicle detection systems that provide the data needed for improved planning and programming decisions.

The use of Oil Rebate funding decreased the risk associated with investigating non-traditional approaches to traffic flow improvements, and allowed WSDOT to begin quantifying both the extent of the problem and the size of the benefits that could be gained from new approaches to dealing with the congestion problem.

Finally, the Oil Rebate program funding for FAME has encouraged the State and other agencies to further support these efforts. The $1.4 million in Oil Rebate funding for FAME has been used to leverage or match almost $7.7 million from other funding sources. Additionally, several million dollars has been spent by WSDOT to implement technologies and/or procedures initially tested or demonstrated by FAME.

Table 1 summarizes the FAME projects that have received Oil Rebate funding. More details are provided in the narrative report that follows.

Table: Summary of FAME Projects Funded (at least in part) Using Oil Rebate Funds

Project Name (ending date)	Oil Rebate Funds used	Other Funds Used	Project Summary
Improving Motorist Information Systems (1990)	$75,000		Helped created early WSDOT traffic information policy, and was an early project in continuing improvement of travel information
Incident Management Strategies (1991)	$25,000	$80,000 (WSDOT) $60,000 (TransNow)	Helped shape and guide WSDOT's early incident management efforts
Detector Data Validity (1990)	$50,000	$30,000 (TransNow)	Testing of data from congestion detectors. Findings still used for data quality control for freeway loop archives
Arterial Control and Integration (1990)	$20,000	$42,000 (WSDOT)	Investigated potential for multi-agency control systems for arterial roads. Findings shaped WSDOT policy and development plans
HOV Compliance Monitoring (1990)	$20,000	$30,000 (WSDOT/TransNow)	Developed sample plan for monitoring HOV lane use. The basic plan is still used.
Real Time Motorist Information (1992)	$100,000	$80,000 (TransNow)	Developed a PC based graphic real time traffic information system. System still active.
Evaluation of Home End Transportation Management Programs (1991)	$14,000	$17,000 (TransNow) $8,000 (Metro)	Research on feasibility of home end based commute trip reduction, showed focus of effort should remain at employer end.
Freeway Incident Management for Medium-Sized Urban Areas (1991)	$28,000	$22,000 (TransNow)	Helped develop plans for incident management (I.M.) teams in medium size urban areas
Accident Investigation Tools Demonstration (1992)	$40,000		Testing on new WSP equipment. Led to adoption of Total Stations by WSP.
Incident Detection and Truck Congestion Alleviation Demonstration (1992)	$50,000	$30,000 (TransNow)	Investigate the uses of automatic vehicle identification systems. Results reflected in current surveillance system.
Vehicle Occupancy Forecasting (1994)	$28,000	$22,000 (TransNow)	Incorporate transportation models with new behavioral studies. Results used in policy development
Forecasting Freeway and Ramp Data for Improved Real-Time Control and Data Analysis (1993)	$35,000	$55,000 (WSDOT) $60,000 (TransNow)	Create ability to predict traffic data in failed detector areas. Incorporated into ramp metering algorithm

Arterial HOV Improvements (1993)	$28,000	$36,000 (TransNow) $8,000 (Metro) $10,000 (Cities of Redmond & Kirkland)	Investigate the possibility of HOV Improvements on major arterial roads. Contributed to current HOV policy
Incident Management Tools Demonstration (1993)	$180,000		Demonstration and delivery of new accident investigation tools. Resulted in guidelines used by WSDOT.
Incident Management Equipment Demonstration (1994)	$19,000		Evaluation of new accident investigation tools. Led to adoption of new I.M. equipment
State Force Work (1994)	$14,000		Upgraded WSDOT I.M. hardware and software
North Seattle Advanced Traffic Management System (2002)	$272,000 (through WSDOT) $145,000 (from City of Seattle)	$4,101,000 (FHWA) $255,000 (Private Sector)	Project to centralize traffic signal data sharing. Database system was unsuccessful, lessons learned currently being applied
Options for Monitoring Traffic Congestion in Washington's Urban Areas (1994)	$43,000	$20,000 (WSDOT)	Investigated alternative methods of congestion information gathering. Early task in current monitoring effort.
Demonstration of New Variable Message Sign Technologies (1996)	$28,000		Demonstrated new variable sign systems. Led to upgrading of WSDOT VMS signs
Tacoma Mobility Improvements (1996)	$202,000		Deployed of new traffic monitoring devices in Tacoma. Led to expanded IR system in Tacoma
Incident Response Technology Upgrade (2002)	$20,000		Evaluated new equipment used by incident response teams and implemented a management database
Statewide CARS Deployment (2003)	$50,000	$200,000 (WSDOT) $2,528,000 (other pooled fund study)	Began the CARS development and deployment process
CARS/CAD Integration (ongoing)	$63,000	$20,000 (WSDOT)	Integrates the WSP's CAD system with the national CARS system to speed incident response & improve motorist information

INTRODUCTION

The Oil Rebate program was created as a result of a dispute settlement between the federal government and major US oil companies concerning pricing irregularities for domestic oil. The settlement conditions specified that the settlement funds be used to reduce energy use and/or pollution. Funds were allocated to each state based on the oil sales of each oil company participating in the settlement. Consequently, the State Oil Rebate program was designed to provide funds to projects that would increase energy savings or decrease pollution.

The Freeway and Arterial Management Effort (FAME) was initiated by the Washington State Department of Transportation (WSDOT) in the early 1990's to address congestion issues related to rising traffic levels in the Puget Sound region. FAME was primarily designed to find ways to alleviate congestion and allow for additional mobility without additional road construction. A secondary objective was to study the growth and characteristics of suburb-to-suburb traffic so that transportation solutions that addressed the changing travel patterns emerging in the region could be crafted. Lastly, FAME was designed to create an ongoing information system that enabled the collection and reporting of the data needed to measure the effectiveness of congestion relief and mobility enhancement efforts, as well as to allow effective management of the transportation systems within the congested urban environment.

All of these objectives result in continuing efforts to decrease congestion, which in turn decreases fuel use and lowers pollutant emissions. As a result, FAME is eligible to receive Oil Rebate funding.

The FAME program performs the research, development, and testing required to help plan, design, and implement systems that lead to improved traffic flow. Specific FAME projects were designed to:

- Improve motorist information systems.
- Develop incident management systems.
- Help implement traffic management systems.
- Design and implement real-time freeway and arterial management systems.
- Integrate the arterial and freeway management systems.
- Analyze the potential effects of new technologies for relieving congestion.
- Develop improved treatments for High Occupancy Vehicles (HOVs).
- Improve methods for managing traffic demand of new developments.

Over time, FAME has helped create a many different projects, with a wide variety of funding sources, including the Oil Rebate program.

REPORT OBJECTIVES

The objectives of this report are 1) to document the benefits obtained through the use of Oil Rebate funds, and 2) to provide guidance to WSDOT in using future programmatic funds. Because of the diversity of WSDOT projects funded by Oil Rebate money, this study will not try to compute definitive, numeric, energy savings attributable to the Oil Rebate contributions to the FAME program. Instead, it will discuss how Oil Rebate funds were expended and whether the programs met the basic objective of the Oil Rebate program. Neither a strict benefit / cost study nor a definitive calculation of energy savings will be performed as part of this report because of the cost and complexity of such studies.

FUNDING

FAME receives funding from a variety of sources. Two of the major sources are the WSDOT and the Oil Rebate program. From 1988 through the end of 2003, the Oil Rebate program has contributed a total of $1.4 million to FAME, spread over 23 projects. A total of over $7,600,000 in matching or leveraged funds was contributed by other sources to FAME projects that used Oil Rebate funding.

FAME OIL REBATE PROJECT DESCRIPTIONS

FAME began with five major projects at its inception in 1988, all of which were funded, in part, by Oil Rebate money. All the projects were designed to provide information, whether for traffic control decisions that would ease traffic congestion, travel routing to avoid congestion, or policy adoption that result in reduced energy consumption. As the early projects were finished, new projects based on the results of the initial projects, began. The general success of the FAME program also facilitated an expansion of funding sources. While many FAME projects continued to be funded with Oil Rebate money, many others are now funded by WSDOT entirely without Oil Rebate funds. The research and development enabled by FAME has provided the information needed to create and implement some of the most effective traffic management systems in use today.

Initially, five FAME projects were funded wholly or partially through Oil Rebate Funds. The findings from these projects spawned numerous additional projects, also funded, in part, by Oil Rebate funds. The following narrative provides a sequential description each project.

1. Improving Motorist Information Systems

This project led to the creation of a WSDOT departmental policy for guiding the use of the Variable Message Sign (VMS) system. This policy directed that VMS be coordinated with local radio stations to create a system of reporting information to commuters who were in transit. This project also led to the creation of a telephone call-in system that travelers could use to obtain traffic reports when they were needed.

Energy savings occur when travelers are provided with up-to-date travel condition information that will help them make smart travel decisions by avoiding congestion whenever possible. Total project cost was $75,000. All of the funding came from Oil Rebate Funds.

Reports:

Haselkorn, M., W. Barfield, and L. Conquest. *Improving Motorist Information Systems: Towards a User-Based Motorist Information System for the Puget Sound Area.* Final Technical Report, WA-RD 187.1, Apr 1990, and Final Report, WA-RD 187.2, Apr 1990.

2. Incident Management Strategies

This effort was supported by three separate funding sources, separated into three separate projects. The initial portion of the effort studied potential modifications to current operational responses to incidents. This study resulted in five separate volumes of reports that suggested a variety of improvements to WSDOT's incident response process. One of the early recommendations was the formation of WSDOT's Incident Response Teams. The findings of the study also allowed the project team to design a framework document that could be used for guiding the creation of incident response programs elsewhere in the state. This effort was so well received, that the project was extended to create the Incident Management Framework report. This report is now the primary text used by the Federal Highway Administration to teach incident management, and is the guide used to design of incident response programs around the country. Finally, the project team developed a specific handbook for use in training for WSDOT's Incident Response Teams and agency working with them.

WSDOT's incident response teams succeeded in decreasing response time and increasing the effectiveness of the region's ability to significantly reduce the amount of time incidents block

roadways. The material incorporated into the Incident Management Framework allowed local jurisdictions to learn about options to optimize their own approach to incident response.

This project received $25,000 in Oil Rebate funds. It was matched by $80,000 in funding from WSDOT, and $60,000 in Transportation Northwest Regional Center (TransNow) funding. It also allowed additional federal funds to be leveraged to start and support the $150,000 Incident Management Framework project.

Reports:

Mannering, F. L., L. Janssen, B. Sebranke, and B. Jones. Generation and Assessment of Incident Management Strategies -Volume II: Analysis of Freeway Incidents in the Seattle Area. WA-RD 204.3. Final Technical Report. Jan 1990.

Mannering, F. L., and B. Jones. Generation and Assessment of Incident Management Strategies - Volume I: Management, Surveillance, Control, and Evaluation of Freeway Incidents: A Review of Existing Literature. WA-RD 204.2. Final Technical Report. Jan 1990.

Mannering, F. L., B. Jones, D. Garrison, B. Sebranke, and L. Janssen. *Generation and Assessment of Incident Management Strategies - Summary Report.* WA-RD 204.1. Final Summary Report. Jan 1990.

Mannering, F. L., B. Jones, D. Garrison, B. Sebranke, and L. Janssen.. Generation and Assessment of Incident Management Strategies-Volume IV: Seattle-Area Incident Management: Assessment and Recommendations. WA-RD 204.5. Technical Report. Jan 1990.

Mannering, F. L., B. Jones, D. Garrison, B. Sebranke, and L. Janssen.. Generation and Assessment of Incident Management Strategies, Volume III. WA-RD 204.4. Technical Report. Jan 1990.

Tanemura, L., and F. L. Mannering. *Incident Management Guide-Office Reference & Field Guide.* WA-RD 225.1. Final Guide. Sep 1991

Koehne, J., F. L. Mannering, and M. E. Hallenbeck. *Framework for Developing Incident Management Systems.* WA-RD 224.1. Executive Summary. Aug 1991.

3. Detector Data Validity

At the time of FAME's inception, the accuracy of some of the traffic measurement tools being used had come into question. As a result, FAME sponsored a project totally funded by Oil Rebate money called Detector Data Validity, which sought to identify problems in the data collection equipment and processes being used to measure roadway performance. Once the accuracy and reliability of the data gathering tools had been verified, the data were available for use in a number of later projects, including the Real Time Motorist Information and North Seattle Advanced Traffic Management System. These measurement tools now serve WSDOT by providing detailed measures of changing levels of congestion and delay.

This project received approximately $50,000 in Oil Rebate funding. These funds were matched by an additional $30,000 in TransNow funds.

Report:

Nihan, N. L., L. N. Jacobson, J. Bender, and G. Davis. *Detector Data Validity*. WA-RD 208.1. Final Report. Mar 1990.

4. Arterial Control and Integration

Designed as a basis for later projects, the Arterial Control and Integration project focused on the potential for creating an improved control system for Puget Sound's arterial roads. This project investigated the feasibility of, and the potential benefits from new traffic signal timing efforts, with special emphasis on the ability to integrate or coordinate the traffic control systems of neighboring jurisdictions.

The investigation proved to be successful, and resulted in the creation of the Integrated Freeway and Arterial Control System Project to further explore this subject. The study results also proved invaluable to the Arterial HOV and Tacoma Mobility Improvement projects.

Funding for this project was set at $62,000, of which $28,000 was to be Oil Rebate funds. However, WSDOT contributed an additional $8,000 to the project, reducing the need for Oil Rebate money to $20,000, and allowing the "extra" Oil Rebate funds to be used for other projects.

Report:

Rutherford, G. S., M. Schroeder, L. N. Jacobson, and M. E. Hallenbeck. *Arterial Control and Integration.* WA-RD 188.2. Final Report. Mar 1990.

5. HOV Compliance Monitoring

As its name suggests, the HOV Compliance Monitoring project entailed the development and use of a data sampling technique to determine HOV lane use levels, as well as the percent of violations occurring on specific facilities. The project also included a public survey to gauge public support and help guide HOV policy decisions, since increasing carpool use and decreasing single occupant vehicle use is a key state policy objective for reducing congestion and lowering fuel use while maintaining mobility in the region.

As a result of the study, The HERO violator hotline was moved from WSDOT's Traffic Systems Management Center to Metro Transit, an agency that was better suited to manage the hotline. The data acquired about public support for HOV lanes helped make the construction of additional HOV lanes a priority. Vehicle occupancy data collection continues to this day using the sampling techniques developed by the HOV Compliance Monitoring Program.

Originally proposed as a purely Oil Rebate funded program, the project was expanded in scope, but only used $20,000 of the originally proposed $30,000 in Oil Rebate funding. The remaining $30,000 came from a combination of WSDOT and TransNow funds.

Reports:

Kinchen, R. K., M. E. Hallenbeck, G. S. Rutherford, L. N. Jacobson, and A. O'Brien. *HOV Compliance Monitoring and the Evaluation of the HERO Hotline Program.* WA-RD 205.2. Final Technical Report. Feb 1990.

Kinchen, R. K., L. N. Jacobson, G. S. Rutherford, M. E. Hallenbeck, and A. O'Brien. *HOV Compliance Monitoring and the Evaluation of the HERO Hotline Program.* WA-RD 205.1. Final Summary Report. Feb 1990.

6. Real Time Motorist Information

This project was to be the beginning of a fully integrated traveler information system. Comprised of a series of motorist surveys and technology demonstrations, the Real Time Motorist Information project explored the effectiveness of different methods of getting real-time traffic information to travelers. One of the most significant outcomes from this project was the development, testing, and demonstration of a user friendly, PC based, real time, graphically-rich traffic information system. This system, the precursor of the current WSDOT Internet traffic congestion display, was demonstrated as one way to significantly improve the quality and timeliness of data available to travelers about freeway congestion. The final system was used as part of the Bellevue Smart Traveler project and is still available online through the University of Washington's ITS research program in Electrical Engineering (See TrafNet within the web site found at http://www.its.washington.edu/index.html.).

A side benefit of this project was research findings concerning commuter behavior showing that commuters exhibit four distinctly different behavioral patterns as they react to news

about current traffic congestion. They range from extreme flexibility—meaning a willingness to change their mode, time of travel or route—to unwillingness to change any aspect of their travel—meaning strict adherence to the same time, the same mode, and the same route, regardless of conditions.[1]

This knowledge of different types of commuter behavior helped permit more accurate projections of commuter reaction to events that affect their commuting routes. It has been instrumental in helping WSDOT understand the ramifications and responses of the public to different types of traveler information.

The total project cost was $180,000, of which Oil Rebate funds contributed $100,000 and TransNow contributed $80,000.

Reports:

Haselkorn, M., W. Barfield, J. Spyridakis, L. Conquest, D. J. Dailey, P. Crosby, B. Goble, and M. Garner. Real-Time Motorist Information for Reducing Urban Freeway Congestion: Commuter Behavior, Data Conversion and Display, and Transportation Policy. WA-RD 240.1/TNW 91-04. Final Technical Report. Apr 1992.

Haselkorn, M., W. Barfield, J. Spyridakis, L. Conquest, D. J. Dailey, P. Crosby, B. Goble, and M. Garner. Real-Time Motorist Information For Reducing Urban Freeway Congestion: Commuter Behavior, Data Conversion and Display, and Transportation Policy. WA-RD 240.2/TNW 91-04. Final Report. Jun 1992.

7. Evaluation of Home End Transportation Management Programs

It was hoped that the development and implementation of home end transportation management programs would assist traffic management in the Seattle area by creating a few dense trip origin points that could be easily and efficiently served by transit and other shared-ride transportation modes. This project was designed to validate the concept of home end

[1] The remaining two groups exhibit in-between levels of flexibility. One group is willing to change route, but not their time or mode of travel, while the other group is willing to change both route and time, but not mode.

transportation by evaluating the effectiveness of Transportation Demand Management (TDM) programs oriented toward residential areas, and designed to reduce the number of vehicle trips generated on to local arterials and freeways.

The project's methodology primarily relied on residential focus groups for information. From these focus groups it was found that, while residential TDM programs were beneficial, they were expensive when evaluated in the context of their limited results. The project discovered that the administrative difficulties and an apparent negative cost/benefit ratio of the home end transportation program meant residentially oriented solutions were not practical for the Seattle area at the time.

As a result, government sponsored efforts in trip reduction were shifted back to corporate site management. These efforts included such tasks as the passage of commute trip reduction regulations.

The budget for the project was $38,800, with $14,000 of Oil Rebate money being matched by $17,300 by Transportation Northwest Regional Center funds and $7,500 in King County Metro funds.

Report:

Ulberg, C., and C. Wolf. Evaluation of Transportation Demand Management Programs at Residential Developments. WA-RD 263.1. Final Report. Mar 1991.

8. Freeway Incident Management for Medium-Sized Urban Areas

The success of the incident response program in the Seattle area indicated that a similar system would also be effective in medium-sized urban areas. This project combined the task of creating an incident management program for Spokane with building a set of guidelines for

medium-sized urban areas. Additionally, a variable message sign system was installed in the Spokane area to assist in rapid incident response efforts.

Oil rebate funds of $28,000 were matched by $22,400 from the Transportation Northwest Regional Center to fund this project.

Report:

Khisty, C. J., and M. Wong. *Freeway Incident Management for Medium-Sized Urban Areas (Phase II).* WA-RD 223.1. Final Report. Jun 1991

9. Accident Investigation Tools Demonstration

The Washington State Patrol received new equipment to reduce the amount of time needed for highway accident investigations. The Accident Investigation Tools Demonstration project tested and documented this new equipment to measure the increase in efficiency actually achieved. For example, by using modern equipment—Total Stations—in place of the procedures used at that time by the Washington State Patrol (WSP), the time it took to investigate major accident sites was reduced by an average of 51 minutes. When major accident investigations are done much faster, lane closures are much shorter, and travel delay is significantly reduced. In fact, the value of traveler time saved during one peak-period incident as a result of using Total Stations when compared to the traditional procedures used by WSP officers exceeds the cost of the equipment.

Upon completion of the testing, WSP phased the equipment in statewide. Copies of the final report and other project documentation were subsequently requested by other state patrol agencies across the country, as well as internationally.

The cost of testing and documentation was $40,000, funded entirely by Oil Rebate money.

Reports:

Jacobson, L. N., B. Legg, and A. O'Brien. *Incident Management Using Total Stations.* TRB 920367. TRB Paper. Jan 1992.

Jacobson, L. N., B. Legg, and A. O'Brien. *Incident Management Using Total Stations* . WA-RD 284.1. Final Report. Aug 1992.

Mannering, F. L., and J. Koehne. *Development of Incident Management Systems: The Seattle Case Study*. WA-RD 221.2 WA-RD 244.1 10/01/91. Case Study. Jul 1991.

10. Incident Detection and Truck Congestion Alleviation Demonstration

An automatic vehicle identification (AVI) system was investigated to assist in tracking truck movements. It was also considered as an additional method of locating congestion points and determining their frequency and magnitude by tracking truck movements through an area, noting when shipments were delayed. The AVI system was also used to speed the passing of trucks through port-of-entry processing.

All objectives were met with some degree of success. The AVI system's initial success caused the project to be extended, with an additional $10,550 being redirected from the Incident Management Equipment Demonstration project (see project #15 in this report) to this effort, to supplement the $60,000 of Oil Rebate funds originally budgeted for this project. However, TransNow funding support was also obtained, and thus only a total of $50,000 in Oil Rebate funds were required.

The study finally concluded that while AVI technology offered a viable method for measuring travel times and detecting incidents on urban freeways, there were an insufficient number of AVI-equipped vehicles using the Puget Sound freeway system to make deployment of such a system cost effective at that time.

Reports:

Hallenbeck, M. E., T. Boyle, and J. Ring. Use of Automatic Vehicle Identification Techniques for Measuring Traffic Performance and Performing Incident Detection. WA-RD 273.1. Final Report. Oct 1992

11. Vehicle Occupancy Forecasting

In this project, new psychological and demographic data were collected from travelers through the use of surveys. The intention was to use survey information to develop a better model for planning and prioritizing HOV improvements on existing facilities.

The new data significantly improved our understanding of the factors that affect mode choice decisions. Unfortunately, the survey data also showed that there were a large number of unpredictable and independent variables that affected mode choice. In addition, these variables often worked together to affect mode choice decision. The result was that it was not possible, within the project, to create a more accurate discrete mode choice model, although a framework for creating such a model was developed.

Specific problems that hinder our ability to accurately model commuter behavior included:

- Changing personal circumstances: For instance, is there a need for daycare in the household, and if so, where is the daycare facility located relative to the work trip's origin and destination? Changes in daycare location can easily result in the need for a specific mode choice, or conversely, allow new mode choices.
- Attitudes and perceptions that are influenced by experience: For instance., does the traveler feel safe while waiting for a bus?
- Household composition: For instance, increases in the number of workers located in a household increases the likelihood that shared ride modes will be used, while the presence of family members with uncertain health, such as the elderly, can significantly increase the likelihood that personal vehicles will be used.

- The type of job and its location greatly effects the ability of the traveler to carpool: For instance, jobs with unusual start/end times or that are located in low density settings are less amenable to shared ride transportation modes.

The project was terminated because a successful prediction program could not be created within the time and scope of the project. However, the project did break new ground in understanding the complexity of mode choice decisions, which is key to creating successful new approaches to increasing the use of shared ride modes of travel.

Originally slated to receive $40,000 in Oil Rebate funds, the project's early termination allowed $12,000 of those funds to be redistributed. The final project cost for this effort was $50,000, with $28,000 coming from oil rebate funds. The remaining $22,000 was supplied by the Transportation Northwest Regional Center.

Report:

Ulberg, C. *Vehicle Occupancy Forecasting.* WA-RD 298.1. Final Technical Report. Feb 1994.

12. Forecasting Freeway and Ramp Data for Improved Real-Time Control and Data Analysis

The basic thrust of this project was to explore ways to improve the performance of the Puget Sound Region's ramp metering algorithm. The intent was to improve the metering algorithms by both improving the volume and lane occupancy values used in place of missing data points when loop detectors fail; and by predicting values of volume and occupancy for time periods in the near future so that these predictions could be used by the algorithm to anticipate future conditions—e.g., if current volume equals 1,000 vehicles per hour in this part of the peak period, what will it be in five minutes?

The initial task of this research project investigated a series of methods to predict short-term traffic data, including both volume and lane occupancy. The best methods identified in this

task were then tested using data on the I-5 North corridor. A second project task was to test using these same basic techniques for providing estimates that could be used to replace bad data from failed detectors.

The research project successfully developed and tested the desired analytical procedures in the lab. However, field implementation was not successful, as limitations in the functionality of the hardware and software used to operate the ramp metering system hindered the system's performance.

While the algorithm developed was not successfully implemented, the research findings from this project where incorporated into the design of the next generation of WSDOT's ramp metering control algorithm. This new generation algorithm was designed and implemented after a major upgrade of the traffic control system's hardware was undertaken.

The original $35,000 in Oil Rebate funds budgeted for this project was matched initially with by $55,000 from WSDOT. This money was matched by $60,000 in funding from TransNow. An additional $15,000 from WSDOT was later added to fund implementation efforts.

Reports:

Nihan, N. L. Forecasting Freeway and Ramp Data for Improved Real-Time Control and Data Analysis Volume I-Summary Report. WA-RD 288.1NTIS No. PB94-106531. Final Report. Nov 1992.

Nihan, N. L., and M. D. Babla. Application of Pattern Recognition to Forecast Congested Conditions on the Freeway for Use in Ramp Metering-Volume II. WA-RD 288.2. Final Technical Report. Jun 1993.

Nihan, N. L., and I. Cabrera-Gonzalez. Evaluation of a Prediction Algorithm for A Real-Time Ramp Control System-Volume III. WA-RD 288.3. Final Technical Report. Jun 1993.

Nihan, N. L., and K. L. Knutson. Short-Term Forecasts of Freeway Traffic Volumes and Lane Occupancies Phase 2-Volume V. WA-RD 288.5. Final Technical Report. Jun 1993.

Nihan, N. L., and J. Zhu. Short-term Forecasts of Freeway Traffic Volumes and Lane Occupancies Phase 1-Volume IV. WA-RD 288.4. Final Technical Report. Nov 1992.

13. Arterial HOV Improvements

The Arterial HOV Improvements study examined the potential benefits obtained from HOV improvements on arterials as the region explored alternative solutions for dealing with growing suburb-to-suburb traffic. The potential for adding HOV improvements to major arterial roads was studied in the hope that the mobility gained from HOV facilities would replace lost mobility due to increasing congestion. More specifically, this project examined two case studies of HOV improvements on arterials:

1. a queue jump implemented on NE Pacific Street in the University District of Seattle
2. a potential HOV corridor on NE 85th/Redmond Way between Kirkland and Redmond

From these two case studies, the project attempted to:

1. Develop tools to help evaluate the flow improvements that might be achieved with arterial HOV improvements.
2. Provide general guidelines that described what street systems and land use characteristics were necessary to make arterial HOV facilities successful.

As part of this project, enhancements to two existing computer models were written so that more accurate predictions could be made of how arterial flow conditions would change if HOV lanes were implemented. While the performance of the enhanced traffic flow models was judged to be satisfactory, concerns remained about the ability to accurately predict the magnitude of any shift from single occupant vehicles to HOVs as a result of the HOV improvements and the consequent impact on traffic volumes observed as a result of that mode shift.

A literature search performed for this project, along with the findings from the Vehicle Occupancy Forecasting study, called into question the ability of available forecasting techniques and data to accurately predict the mode shift caused by arterial HOV improvements. There

simply was not enough data, or basic research, to accurately predict potential mode shifts caused by improvements the size of most arterial HOV projects. Arterial HOV projects tend to generate modest average travel time improvements, but periodically save large amounts of travel time (e.g., when they allow HOVs to by pass large queues generated in one of our case studies by a drawbridge opening.) The mode choice effects of these improvements in travel reliability are not well understood.

The conclusions from the two case studies indicated that adding HOV lanes to arterials can provide travel time benefits to transit and carpool modes, and thus mode shifts may occur. However, in many cases, these improvements will not significantly decrease average person travel time through the project corridor. Furthermore, HOV improvements can create potentially hazardous traffic situations if the movements to/from lanes adjacent to the new facilities cannot be easily integrated into the HOV facility.

While concerns emerged about the reliability of mode split forecasts, the study found that enhanced models were useful tools for examining the performance of arterials retrofitted with HOV facilities.

The total project cost was $81,900 with $28,000 coming from Oil Rebate funds, $10,000 from the cities of Kirkland and Redmond, $7,500 from Metro Transit, and $36,000 from the Transportation Northwest Regional Center.

Reports:

Nihan, N. L. HOV Improvements on Signalized Arterials in the Seattle Area--Volume I: 2 Case Studies. WA-RD 301.1/TNW 92-10.1. Final Report. Feb 1993.

Nihan, N. L., and H. Chen. HOV Improvements on Signalized Arterials in the Seattle Area--Volume IV: Simulation Planning and Evaluation. WA-RD 301.4. Technical Report. Feb 1993.

Nihan, N. L., and J. E. Davis. Improvements on Signalized Arterials in the Seattle Area Volume II: State of the Art Review. WA-RD 301.2. Technical Report. Feb 1993.

Nihan, N. L., and L. O. Rubstello. HOV Improvements on Signalized Arterials in the Seattle Area--Volume III: NE 85th HOV Study. WA-RD 301.3/TNW 92-10.3. Technical Report. Feb 1993.

14. Incident Management Tools Demonstration

New tools for handling incident management that have been used successfully across the country were brought in for testing in all WSDOT districts. The most significant tools evaluated were portable Variable Message Signs (VMS), and portable Highway Advisory Radio (HAR) systems. While both VMS and HAR have been used for a number of years in Seattle, less urban districts were not familiar with these technologies and their uses in incident management.

In this project, outlying WSDOT regions were given the opportunity to evaluate WMS and HAR. As a result, portable VMS and HAR are now used throughout the state. Over the course of the project, guidelines were written to train staff and to ensure the appropriate use of the devises.

The total project cost was $180,000, all of which was oil rebate money.

Report:

Zeller, S. R., and F. L. Mannering. *Incident Management System Demonstration.* WA-RD 311.2. Final Report. Nov 1993.

15. Incident Management Equipment Demonstration

In coordination with the Incident Management Tools Demonstration project above, the Equipment Demonstration was created to purchase and test new equipment that would improve incident response. This project started by gathering input from each WSDOT Region's incident response team about tasks that might benefit from new technology.

The ensuing project tested equipment to collect and distribute streaming video from and incident site to a traffic management center. It was determined that the technology did not perform acceptably due to the costs and limited performance of the wireless communications technologies available at that time. However, findings from the project did result in WSDOT's outfitting incident response vehicles with laptop computers and still cameras.

Because of the unsatisfactory results from the streaming video test, the project was terminated early, and $10,550 of the original $30,000 in oil rebate funds was redistributed to the Incident Detection and Truck Congestion Alleviation Demonstration project. (See Project #10.)

Report: No formal report was printed for this project.

16. State Force Work

As technologies were selected for implementation in the Incident Management Equipment Demonstration, Incident Management Tools Demonstration, and Accident Investigation Tools Demonstration projects (project numbers 15, 14, 9 respectively), it became apparent that resources were needed to integrate the new technologies into existing WSDOT operations and management systems. This project provided funding for both minor labor expenses and incidental equipment costs required to perform the integration. These costs included tasks such as modifying existing management software to allow transmission of VMS messages to portable devices, and purchasing supplies needed to maintain the portable devices.

Originally funded with $14,000 of oil rebate funds, the project was supplemented by $13,000 transferred from the HOV Compliance Monitoring Project (project #5).

Report: No formal report was printed for this project.

17. North Seattle Advanced Traffic Management System (ATMS)

North Seattle ATMS (NSATMS) was funded by WSDOT based on the success of two previous projects: the Arterial Control and Integration project and the Integrated Freeway and Arterial Control Systems project. The two projects had demonstrated the potential of a large-scale software deployment designed to minimize congestion delays by the coordinating the freeway and arterial management systems operated by neighboring jurisdictions.

The intent was to allow each jurisdiction to continually adjust traffic signal timing patterns as required by changing traffic volume patterns. The result would be less congestion and delay (and consequently less oil consumption) for travelers. For example, the City of Seattle could change their traffic signal timing patterns based on real-time information showing that congestion had occurred on arterials in northern King County. Thus, traffic flows could be improved by changing the timing parameters on Seattle's signals in anticipation of "unusual" traffic volumes generated by the congestion in King County.

The system required developing and deploying software to automatically transfer data between proprietary traffic control systems operated by the participating jurisdictions. Sadly, the private sector partner selected to develop and implement the project was unable to deliver software that met the participating jurisdiction's needs and expectations. The NSATMS software simply did not achieve the benefits desired.

The NSATMS project cost $4.6 million, but included only $271,922 in State Oil Rebate funds. Another $144,989 in Oil rebate funds was contributed by the City of Seattle, which received Oil Rebate funds through WSDOT's Local Programs office. USDOT contributed over $4,100,000 to the effort. The private partner contributed $255,000 in direct contributions, and considerable additional internal software development funding. WSDOT also contributed

considerable in-kind labor time, as well as some equipment and computer and communications resources.

Report:

Ishimaru, J., and Hallenbeck M. E. *North Seattle Advanced Traffic Management System (NSATMS) Project Evaluation.* WA-RD 555.1. Final Report. Dec 2002

18. Options for Monitoring Traffic Congestion in Washington's Urban Areas

Because energy use is directly tied to traffic congestion levels in urban areas, and because all agencies that operate urban roadways are interested in tracking congestion levels on their facilities, there is strong interest in finding methods to monitor the size and scope of congestion so that accurate up-to-date information is available for traffic management. Concurrently, jurisdictions are under increased financial pressure to limit their expenditure on data collection efforts.

Consequently, this project was designed to investigate alternative technologies, procedures, and methodologies for collecting information, and to advise roadway agencies about them. The project had three overall objectives:

1. Define the congestion monitoring needs of relevant agencies.
2. Define alternative methods for performing the monitoring actions.
3. Develop cost and staffing estimates in a decision package form.

The project also included appraisals and recommendations for testing of technologies that were in an experimental stage at the time. In total, the project cost $63,000, of which $43,000 came from Oil Rebate funds. The remainder came from WSDOT funds.

Reports:

Hallenbeck, M. E. *Congestion Monitoring Options for WSDOT.* WA-RD 317.1. Final Phase I Summary Report. Sep 1994

Hallenbeck, M. E. *Congestion Monitoring Options for WSDOT.* WA-RD 317.2. Final Report. Sep 1994

19. Demonstration of New Variable Message Sign (VMS) Technologies

VMS systems that provide motorists with critical information while they are en-route to their destination have been successfully utilized for many years. However older VMS signs suffer from a number of limitations including visibility and maintenance requirements. This project was funded in order to determine whether newer VMS models were more easily read by motorists than older models, and if the new models actually proved to be more cost efficient than the older models.

The evaluation determined conclusively that the new light emitting fiber optic modules were much more efficient than the older flip disk signs, and were easier for motorists to read. As a result, WSDOT updated all older model VMS.

This project was funded entirely by Oil Rebate money. The total cost for the demonstration and report was $27,814. The updating and replacement of existing signs was a separate effort that did not use Oil Rebate funds.

Report: No formal report was printed for this project.

20. Tacoma Mobility Improvements

The Tacoma Mobility Improvement project involved placing a closed circuit television monitoring system and incident response hardware on SR 16 and I-5 in Tacoma to improve incident response times. Both roadways are heavily traveled, have restricted roadway shoulders, and are subject to considerable congestion as a result of incidents. The improvements proved successful at reducing the amount of time each traffic incident affected congestion. A secondary

benefit was a significant reduction in the number of secondary incidents which occurred in the backup caused by the initial incident. The reduction in secondary incidents not only provided congestion relief, but a much safer roadway environment as well.

As a result of the increased understanding about the size and scope of incident-caused congestion, WSDOT has expanded incident response efforts in the area by providing quick response service patrols.

The total project cost was $202,320, funded entirely with Oil Rebate money. These funds do not include the cost of the ongoing WSDOT incident response program which is funded entirely with WSDOT resources.

Report: A formal report has not been produced for this project at this time.

21. Incident Response Technology Upgrade

WSDOT deploys new technology throughout the state when it has been proven effective at clearing roadway incidents by the Northwest Region Incident Response Program Technology Upgrade Project. This project was designed to enhance existing incident response efforts. Specifically, it deployed the first stage of a statewide real-time incident response database, and it provided additional funding for the purchase of laptop computers placed in incident response trucks. These technology upgrades allowed the entire statewide incident response system to record incident occurrences and response data in a single database that was incorporated into the online travel-planning site. The database is used to manage and improve incident response activities throughout the state.

This project used $20,000 of Oil Rebate funds to complete the work already begun, and was completed in late 2002.

Report: No formal report was printed for this project.

22. Statewide Condition and Accident Reporting System (CARS) Deployment

The CARS system is a multi-state, pooled fund project designed as a travel planning resource for the general public. CARS has been initially deployed in Minnesota, Iowa, Missouri and Washington. It allows input of data from a variety of reporting systems and agencies from across the state into a single data repository. Accessible from a web page, the CARS database provides access to real-time data about traffic incidents, congestion, and road conditions. This project contributed to WSDOT's participation in the development and implementation of CARS. Over the course of the project, data from CARS was also made available via phone using the 511 travel information telephone number.

The Oil Rebate program supplied $50,000 for this effort, while WSDOT contributed over $200,000. Additional funding was provided by the other states participating in the national CARS development effort. This aspect of the CARS development effort was completed in mid-2002. The total cost of the development of CARS through the pooled fund effort is $2,758,000.

Report:

Legg, Bill. *CARS Reference Manual, Version 3.1*, electronically published only, available at http://wwwi.wsdot.gov/cars/

23. Condition and Accident Reporting System/Computer Aided Dispatch Integration (CARS/CAD Integration)

WSP is currently updating their Computer Aided Dispatch (CAD) program. This project supplemented the effort by funding the development of a software integration module that allows the WSP CAD system to output incident location and status data directly to WSDOT's CARS program. This allows CARS to automatically post and update the incident data it uses for providing traveler information and WSDOT traffic management support.

The WSP CAD enhancement supplement was initially funded primarily by $63,167 of Oil Rebate money, which was augmented by $20,000 of WSDOT funds. However, the project was then awarded federal funding, which supplanted the need for Oil Rebate funding. The project is still underway and, as of the writing of this report, no additional work has been proposed that would use the (now available) original Oil Rebate funding.

Report: Project still underway at the time this document was written.

SUMMARY OF OIL REBATE BENEFITS

The FAME projects that received oil rebate funds over the years consisted mostly of research and demonstration efforts. These projects produced some direct benefits in terms of reductions in fuel use and the air pollutant emissions associated with fuel use. They also produced significant indirect benefits, mostly by providing a proving ground for new technologies and ideas. In fact, many transportation facilities and support services taken for granted by commuters in the Puget Sound region are the direct result of FAME projects from more than ten years ago. Projects and improvements assisted by Oil Rebate funds include the following:

- more variable message sign systems on the freeways
- WSDOT's web based online travel information systems
- an emphasis on HOV lane construction that exists in the Seattle
- new communication methods between the Washington State Patrol and the Department of Transportation that enable faster response times to traffic incidents and easier routing of additional congestion around those incidents
- new traffic models that enable WSDOT to predict where congestion areas are likely to occur so that mitigation efforts to reduce the amount of travel time spent in pockets of congestion can be taken

The results successfully achieve the objective of the Oil Rebate program by reducing oil-based energy expenditures and its related pollution.

CONCLUSIONS

In addition to the specific programs described in this evaluation, it can be safely said that the Oil Rebate program has had positive effects within the broader state transportation community. The availability of Oil Rebate funds allowed WSDOT to enter the arena of improved traffic management and traveler information far more quickly and effectively than would have been possible without the Oil Rebate program. As a result, WSDOT and the State of Washington are viewed as being among the nation's leaders in traffic management, traveler information, and other programs intended to improve traffic flow, lower fuel use, and reduce transportation related emissions. It also allowed WSDOT to begin quantifying both the extent of the problem and the size of the benefits that could be gained from new approaches to dealing with the congestion problem.

By making new, flexible funds available, the Oil Rebate program was able to raise the priority of WSDOT projects that were of special importance to the State Energy Office, without forcing WSDOT to sacrifice its other needs and interests. Oil Rebate money simply allowed FAME to push important, existing, "early start" programs up the WSDOT priority list. The fact that Oil Rebate funds increased the total funding available also meant that more projects could be funded, increasing the Department's ability to find, test, and implement those programs and technologies which significantly improve travel. At the same time, shared funding decreases the risks associated with investigating non-traditional approaches to traffic flow improvements.

Programmatically, the flexibility allowed in how Oil Rebate program could be used allowed WSDOT to take advantage of emerging opportunities. Over the course of the Oil Rebate program, these opportunities included leveraging both programmed and unanticipated

federal funds, testing of technologies recently brought to market, and partnering with other public agencies to achieve better transportation system efficiency.

By allowing its funding to be used to develop and test new technologies and approaches, the Oil Rebate program performed the base work needed to:

- Advance the state-of-the-art.
- Prove the basic concepts being explored.
- Determine when, where, how, (and if) new technology and procedures should be adopted.
- Prioritize the deployment of new technologies and procedures based on the benefits they can be expected to provide.
- Test and debug those technologies and procedures so that they work as intended when fully implemented.
- Create buy-in and support for these new ideas and technologies among agency staff that need to implement and use them.
- Set up a culture where agency staff is open to new ideas.

Oil rebate funds have allowed all of these things to happen. While many congestion improvements would have happened without the Oil Rebate funding, Washington State would be much further behind in adopting and implementing its on-going congestion relief efforts had the Oil Rebate program not been actively supporting its early stages. Without the Oil Rebate program many of the above projects would never have begun.