APPALACHIAN DEVELOPMENT HIGHWAYS ECONOMIC IMPACT STUDIES

Prepared for the

APPALACHIAN REGIONAL COMMISSION

Prepared by
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Executive Summary Report
ECONOMIC IMPACT OF THE APPALACHIAN DEVELOPMENT HIGHWAY SYSTEM

Congress established the Appalachian Regional Commission (ARC) in 1965. The intent was to foster and promote the economic and social development of the Appalachian Region which includes all of West Virginia and portions of 12 other states from Mississippi to New York.

THE APPALACHIAN DEVELOPMENT HIGHWAY SYSTEM (ADHS)

In order to promote economic development in the Region, Congress authorized the Commis-sion to carry out a number of programs, including the development of the Appalachian Development Highway System. The ADHS is envisaged as a 3,440 mile network of highways (with 3,025 miles authorized for improvements by the ARC) providing essential transportation access for improving the Appalachian Region's economic position. The ADHS has 26 corridors and, to date, is 75% complete.

THIS ECONOMIC IMPACT STUDY

This study focuses on 12 of the 26 ADHS highway corridors that are largely complete and determines the extent to which these corridors have helped the Region's economy. By restricting the study to 12 of the 26 corridors, the counties impacted are limited to 165 counties of the total 399 counties in the Appalachia Region. These counties are most affected by improvements in the 12 corridors.

A primary objective of this study is to measure, in retrospect, the extent to which the completed portions of the ADHS have contributed to the economic well-being of Appalachia. If the completed corridor segments have succeeded, then it bodes well for the economic development potential of the remainder of the ADHS corridors that are not yet funded and/or built.

THIS EXECUTIVE SUMMARY

This brief report summarizes a study conducted by Wilbur Smith Associates in 1998 that included a comprehensive data collection effort and a thorough economic impact analysis. Highlighted in this report are the economic benefits created from the 12 ADHS corridor improvements, the benefit/impact-cost analysis, and a summary of the conclusions and implications. The full details of the analysis are documented in a study volume entitled "Appalachian Development Highways: Economic Impact Studies," dated June 11, 1998.

KEY STUDY ISSUES

The study focuses specifically on the ability of the ADHS highways to contribute economic value and development to the Appalachian Region. Based on transportation data and an economic model, which utilizes the trans-portation data, the study addresses the economic impact that the improved ADHS corridors have had and will have on the Appalachian Region.

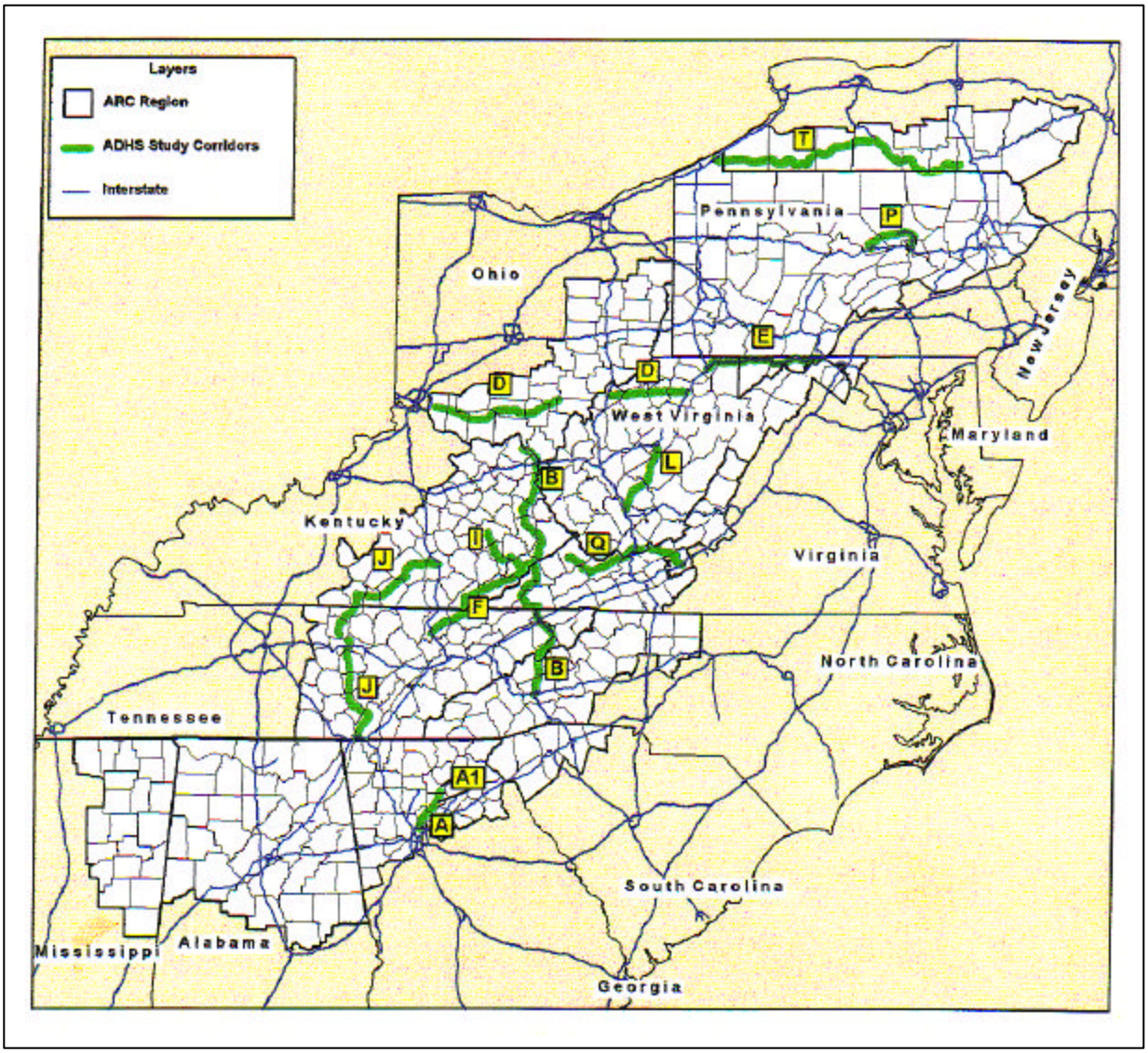
As part of this analysis, systematic economic benefits and economic costs are presented based upon the travel efficiencies created from the improved highways, which accrue to both automobile and truck users who utilize the improved facilities. These travel efficiencies are in the form of reduced travel time, reduced vehicle operating costs, and a reduced number of accidents. The improved travel efficiency along the ADHS corridors ultimately leads to an increase in economic production, job opportunities, wages, population, and travel benefits to the people and the communities the highways serve. A major objective is to quantify and present these impacts.

ADHS CORRIDORS INCLUDED IN THIS STUDY

This economic impact study focuses exclusively on those ADHS corridors and corridor segments that are already built and open to traffic. The 12 corridors included and evaluated in this study are illustrated on the following map and labeled as **A/A-1** (Georgia), **B** (North Carolina, Tennessee, Virginia, and Kentucky), **D** (Ohio and West Virginia), **E** (West Virginia and Maryland), **F** (Tennessee and Kentucky), **I** (Kentucky), **J** (Kentucky and Tennessee), **L** (West Virginia), **P** (Pennsylvania), **Q** (Virginia and West Virginia), and **T** (Pennsylvania and New York).

THE ECONOMIC EVALUATION PROCESS

The effectiveness of the ADHS in creating economic opportunity is estimated by the use of a regional economic model (the REMI model). The REMI model is a comprehensive economic forecasting and simulation model that has been employed in the evaluation of a wide array of issues, including investments in infrastructure. Travel efficiency benefits (shorter travel times and reduced vehicle operating costs) are inputs into the REMI model which generate the regionally specific economic development impact estimates, as measured by jobs, wages and value-added.



ECONOMIC EFFICIENCY RESULTS

The ADHS corridors were evaluated from both a travel efficiency perspective and a regional economic development perspective. The table at the bottom of the page displays the results of these evaluations. Included in the table is the net present value (NPV), the internal rate of return (IRR), and the benefit/cost ratio (impact/cost ratio for the economic development perspective) of the ARC's investment into the ADHS. From the perspective of travel efficiency, the table indicates that:

- The net present value created from the travel efficiencies is $755 million over the course of the study time frame.
- The constant dollar economic return is an attractive 7.87%.
- The life cycle economic travel efficiency benefits exceed the costs (benefit/cost is 1.18). For each $1.00 invested in the ADHS, the ADHS has yielded $1.18 in travel efficiency benefits.
- The corridors as a whole seem to have been reasonable investments from a travel efficiency perspective.

ECONOMIC DEVELOPMENT RESULTS

The evaluation of the corridors from the regional economic development perspective indicates that:

- The net present value created from the travel efficiency is $1.344 billion over the course of the study time frame.
- The constant dollar economic return is a very attractive 8.29%.
- The economic impacts exceed the costs (impact/cost is 1.32). For each $1.00 invested in the ADHS, the ADHS has yielded $1.32 in economic development impacts.

These impacts are also broken down in terms of the jobs, population, wages, and value added for the Region, and are displayed for three selected years in the following table:

Economic Development Impacts

Increases Due to ADHS	1975	1995	2015
Jobs	6,100	16,270	42,190
Population	14,690	30,420	84,480
Wages ($ million)	$68	$426	$1,178
Value Added ($million)	$271	$1,002	$2,975

ECONOMIC EVALUATION RESULTS

Perspective	Net Present Value	Internal Rate of Return	Benefit or Impact/Cost Ratio
Economic Efficiency	$755,743,000	7.87%	1.18
Regional Economic Development	$1,344,376,000	8.29%	1.32

Evaluation Rules: The Appalachian Development Highway System is economically justified (has an economic rationale) if:

- The Net Present Value is positive (+).
- The Internal Rate of Return is 7.0% or greater.
- The Benefit/Cost Ratio is 1.0 or greater.

SOURCE: Wilbur Smith Associates

STUDY CONCLUSIONS

1. **ADHS Has Created Jobs** – By 1995 a net increase of 16,000 jobs are estimated to have been created that would not have existed without the completed portions of the ADHS; it is estimated that these twelve corridors will, by the year 2015, have created a net increase of 42,000 Appalachian jobs. These jobs occurred because the ADHS made the Region a better place to invest, live, and work.

2. **ADHS Has Led to Increased Production** - The net increase in value added was $1 billion in 1995, and will increase to $2.9 billion by the year 2015. The total present value of this increased production is $6.9 billion (1965-2025). Therefore, the ADHS has been successful in increasing the Region's production, which results in increased job opportunities and increased wages.

3. **ADHS Has Created Efficiency** - The ADHS highway corridors have created travel efficiencies valued at $4.89 billion over the 1965-2025 period. Improved road conditions and access resulted in greater efficiency. By helping the Region to be more efficient and accessible, economic opportunity has been expanded.

4. **The Federal Investment is Warranted** - The economic rate of return from an efficiency perspective is 7.87 percent, and from an economic development perspective is 8.29 percent per year (in inflation adjusted terms, the rate of return would be higher). This is a solid return on the investment. Over the life cycle of the ADHS, for each $1 invested, the return is $1.18 in efficiency benefits, and $1.32 in economic impact benefits. These are indicative of a good use of tax payer funds.

5. **All ADHS Corridors Yielded Benefits** - All of the twelve completed ADHS corridors produce efficiency benefits, from a corridor-specific low of $59 million to a corridor high of $1.2 billion. The individual corridor efficiency returns on investment range from 5.44 percent per year to 10.06 percent. While some corridors are better than others, they all appear to have been reasonable investments.

6. **Many People Have Benefited** – While the most direct beneficiary of the ADHS is the highway user, non-users of the highways were also positively impacted—due to job creation, better jobs (wages), and other opportunities. Therefore, the ADHS highways have benefited the people of Appalachia, even those who do not use the specific highways.

7. **The ADHS Has Made Appalachia More Competitive** – The ADHS highways have helped the Appalachian Region to be better able to compete for economic opportunity. This competitiveness is valued at $2.7 billion over the 1965-2025 period. Clearly, the ADHS has helped the Region to make progress, even though the system is not yet complete.

The Appalachian Development Highway System, as conceived by the U.S. Congress, was intended to help the economy of the Appalachian Region. This study examined the ADHS, to determine whether the completed portions of the ADHS have attained their economic development objective.

The ADHS cannot take credit for all growth, or even a majority of the growth, in Appalachia's prosperity. But it can take credit for enough growth (42,000 jobs, 84,000 people, $2.9 billion wages, $6.9 billion value added) to demonstrate that the ADHS has been a good investment in Appalachia's, and America's, future.

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Chapter 1
INTRODUCTION AND OVERVIEW

In 1965, the U.S. Congress established the Appalachian Regional Commission (ARC). The overarching objective of the ARC is to promote economic and social development of the Appalachian Region. Since its beginning, the ARC has carried out a wide range of programs, intended to foster Appalachian Region economic development and well being.

The Appalachian Development Highway System (ADHS) is one of the key economic development programs of the Commission. That system of highways was conceived to comprise 26 corridors totaling 3,440 miles of highway, including 3,025 miles authorized by Congress for improvement. To date, some $4.6 billion has been spent on the ADHS, with approximately 75 percent complete.

Because additional funds will be needed to complete the ADHS, and because of the ADHS economic development objectives, it is appropriate to quantify what impact the completed portions of the ADHS have had on the Appalachian Region.

The ARC sponsored this study which quantifies the economic benefits and impacts attributable to the ADHS. The benefits comprise the economic efficiency benefits and the impacts comprise economic development effects that can be reasonably attributed to the completed portions of the ADHS.

The Appalachian Regional Commission is a federal-state partnership, comprised of all of West Virginia and portions of 12 other states from Mississippi to New York.

Since the enactment of the Appalachian Regional Development Act of 1965, a combination of federal, state, local and private funding in excess of $15 billion has helped provide highways, hospitals, land conservation, mine land restoration, flood control and water resource management, vocational education facilities, and sewage treatment works to the 21 million residents in the 399 counties of the Appalachian Region. Throughout the terms of seven US presidents, federal financial support has helped support the ARC to promote economic development in the Region.

THE APPALACHIAN DEVELOPMENT HIGHWAY SYSTEM

In its 1964 report to Congress, the President's Appalachian Regional Commission (PARC) indicated that "…economic growth in Appalachia would not be possible until the Region's isolation had been overcome." The PARC report indicated that "the Interstate Highway System has largely bypassed the Appalachian Region, going through or around the Region's rugged terrain as cost-effectively as possible." As a result, areas of Appalachia remained isolated, many roads were"…narrow, with sharp switchback curves, steep grades, and short sight

distances. These characteristics made driving hazardous and discouraged commerce and economic development. "[1]

In carrying out the intent of Congress, the ARC has stressed the importance of having good Appalachian Region transportation access. The idea is that, by providing access and efficient transportation, the residents of Appalachia will be better able to compete for economic activity, which in turn will improve living standards throughout the Region.

An important part of the ARC-administered program is the Appalachian Development Highway System. The ADHS is not intended to replace or duplicate the state or local highway programs or systems; rather, the ARC highway funds are intended to complement, or supplement, the state funds in building a system of highways to provide access to areas with development potential in the Region.

The ADHS – The Appalachian Development Highway System (ADHS) is planned to comprise 3,440-mile network of highways, with 3,025 miles authorized by Congress for improvement, serving the 13-state Appalachian Region, as shown on **Exhibit 1-1**. The letters on the ADHS corridors refer the official ARC corridor designations. More than 75 percent of the ADHS mileage is complete or under construction, mostly to four-lane standards, representing a public investment exceeding $4.6 billion. The system is part of an overall development strategy for the Appalachian Region initiated in the mid-1960s to help provide the transportation access essential to improving the Region's economic position. As established by the U.S. Congress, the Appalachian Regional Commission (ARC) is the institutional body responsible for developing the ADHS.

The cost of completing the ADHS is estimated to approach $8.5 billion, and ADHS advocates believe that completion of this highway system is vital to the Region. Sustaining financial support is crucial if the ADHS is to be completed. In the current environment of constrained public budgets, it becomes essential to evaluate the public benefit of each public program. Because the ADHS was established as an economic development tool, and because much of the ADHS is built, it is timely to measure what the completed portions of the ADHS have contributed to the program's economic development objectives.

[1] "Appalachian Development Highway System: Status Report," Appalachian Regional Commission, 1996.

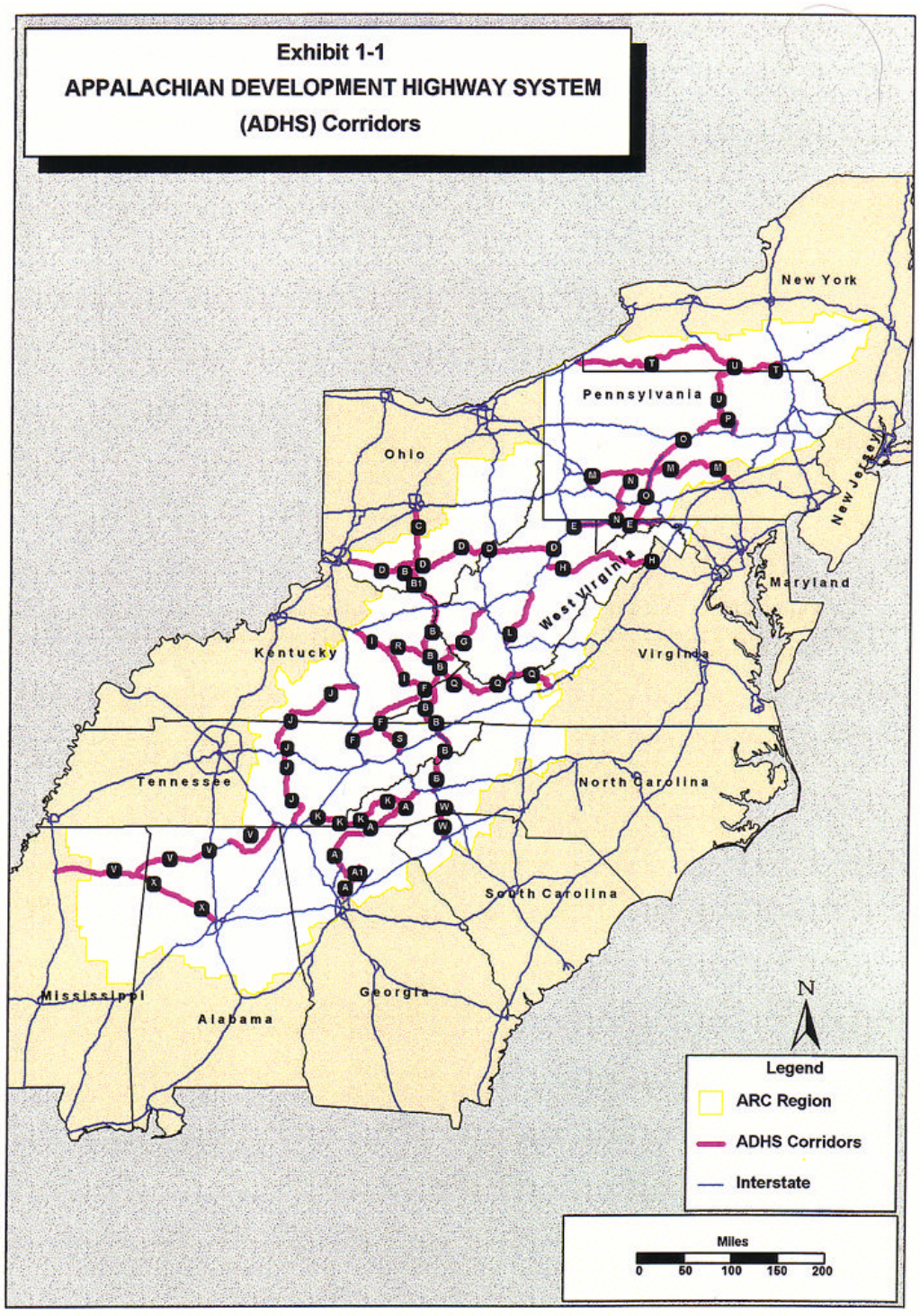
Exhibit 1-1
APPALACHIAN DEVELOPMENT HIGHWAY SYSTEM
(ADHS) Corridors
New York
Pennsylvania
Ohio
New Jersey
Maryland
West Virginia
Virginia
Kentucky
Tennessee
North Carolina
South Carolina
Georgia
Alabama
Mississippi
N
Legend
ARC Region
ADHS Corridors
Interstate
Miles
0 50 100 150 200

ADHS Objectives – Each of the 13 states involved in the Appalachian program have state highway systems that are planned, built, operated and funded by a combination of state and federal tax dollars. These state programs for the most part are intended to meet the travel needs in the state. State investment priorities typically depend on travel demand (as evidenced by traffic volumes), travel safety, roadway conditions and needs, etc.

The ADHS, as envisaged by Congress, is something different. The ADHS highways have economic development and social enhancement objectives which differ from the typical state program. The individual states of course are interested in economic development, but, given budgetary constraints, traffic safety, highway capacity deficiencies and highway maintenance often supercede economic development when difficult highway priorities are set.

The ADHS is somewhat unique as a highway in that its stated purpose is to stimulate economic development and opportunities for the residents of the Appalachian Region.

The ADHS Highway Corridors – In selecting and designating the 26 ADHS corridors, the Appalachian Regional Commission sought to approve a network of Development Highway corridors that would: (1) link key centers in the Region to national markets, thus helping to make the corridor areas competitive for growth; (2) provide for more efficient flows of commerce through the Region in order to enhance the development potential of isolated areas traversed by the new routes; (3) facilitate the commutation of people to new jobs and public services to be developed along the System; and (4) open up new sites for development.

To achieve this, each corridor was selected to accomplish one or more of the following:

(1) Major economic centers in Appalachia which were bypassed by the Interstate Highway System were to be linked to the Interstate System, restoring locational advantages which they had lost by being bypassed.

(2) Selected corridors were chosen to help “close the gap” between key markets on either side of Appalachia that were not linked by the Interstate System. The region could then capitalize on the alterations in flows of commerce which such additions to the national highway network might induce.

(3) Several corridors were selected to open up large areas of Appalachia with significant potential for recreation development.

(4) By constructing a new highway system through the more isolated sections of Appalachia, it was also anticipated that commuting fields for the major job centers in and around Appalachia would be enlarged because more people would be able to travel greater distances in less time to the jobs and services being developed.

In other words, the purpose of the ARC highway program is economic development.

STUDIES OF ADHS EFFECTIVENESS

A number of studies have examined and tracked economic development in Appalachia, including development that has occurred in counties served by the ADHS corridors.

- **1987 Survey** – An ARC survey of jobs in the Appalachian Region found that 81 percent of total job growth in Appalachia between 1980 and 1986 occurred in the 241 Appalachian counties served by an interstate highway and/or an ADHS corridor. Unemployment rates in interstate highway/ADHS corridor counties was 8.5 percent, in other Appalachian counties it was 10.0 percent. The implication is that highways and successful economic development go hand in hand.

- **1994 Professional Geographic Study** – A study by Tyrell Moore, University of North Carolina, "…found a strong correlation between income growth and the presence of improved highways in Northern and Southern Appalachia. Central Appalachia had a weaker, but still positive, correlation…" Again, the implication that highways assist in the economic development process.

- **1995 National Science Foundation Study** – This more rigorous study by Andrew Isserman, Professor of Economics and Geography at West Virginia University, analyzed population and income changes over a 20 year period in Appalachia and compared those changes with statistical "twin" counties elsewhere in the US. The study found that the Appalachian counties with ADHS corridors grew 69 percentage points faster in income, 6 percentage points faster in population, and 49 percentage points faster in earnings. The rural counties with ADHS corridors faired even better.

These three studies suggest that better economic growth occurred in counties with ADHS corridors than in counties without ADHS corridors. But, these previous studies were not able to address the questions "How much of this growth is due to the ADHS? Does the ADHS cause development, or are the highways and their counties' growth coincidental?"

KEY ISSUES ADDRESSED IN THIS STUDY

This study addresses the issue of the ADHS highways themselves, and specifically what the highways contribute to economic growth and economic development. The study does not imply that all Appalachian growth is due to the highways; rather, the study focuses specifically on the ability of the highways to attract economic value and development, and the quantified magnitude of that economic growth.

More specifically, this study seeks to address the following issues regarding the completed ADHS corridors:

- To what extent, and in what ways, do the ADHS corridors make the Appalachian Region more efficient?

- Has the ADHS directly or indirectly caused job opportunities retention and attraction in the Appalachian Region? How many job opportunities are believed attributable to the completed portions of the ADHS?

- Has the ADHS led to increased production in the Region? How much?

- Federal funds have been used to build the ADHS. Is the desired economic development occurring? What magnitude of development?

- Based on the portion of economic benefits that can be quantified, what is the economic rate of return on the federal investment? Is it sufficient to indicate that this was a good use of tax payer funds?

- How do the various ADHS completed corridors compare, one with the others? Do they all appear to have been sound investments?

- To what extent have the ADHS corridors benefited the highway users? The non-users? Do people have to use the ADHS corridors in order to benefit from them?

- Have the completed ADHS corridors helped the Appalachian Region to compete on a more equal basis with other regions of the US for economic development?

One reason for this study is to gauge, in retrospect, the extent to which the completed portions of the ADHS have contributed to the economic well being of Appalachia. Implicitly, if the completed corridor segments have succeeded, then it might logically follow that the remainder of the ADHS (the segments that are not yet funded and/or built) might similarly be successful with their economic development orientation.

ADHS CORRIDORS INCLUDED IN THIS STUDY

This study focuses exclusively on those ADHS corridors that are completely, or principally, built and open to traffic. The study does not include corridors that are 75% or less built. Twelve of the 26 ADHS corridors shown on **Exhibit 1-2** meet this criterion. The 12 corridors evaluated in this study are these colored green on Exhibit 1-2. By including and analyzing only those corridors that are principally complete, it is possible to address the question "What economic impacts have resulted from the ADHS corridors that are already built and open to traffic?"

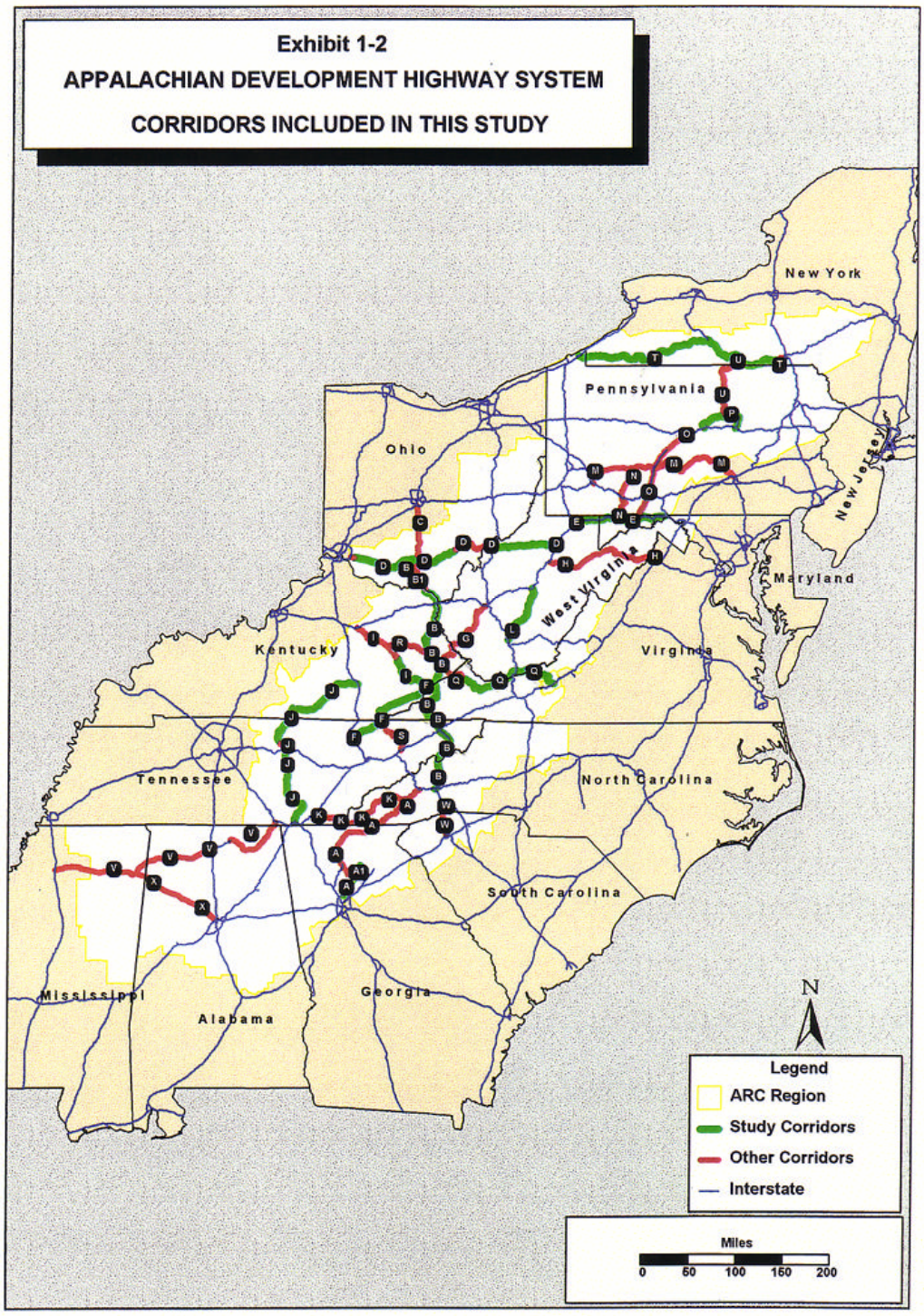
Exhibit 1-2
APPALACHIAN DEVELOPMENT HIGHWAY SYSTEM
CORRIDORS INCLUDED IN THIS STUDY
New York
Pennsylvania
Ohio
New Jersey
Maryland
West Virginia
Kentucky
Virginia
Tennessee
North Carolina
South Carolina
Georgia
Alabama
Mississippi
N
Legend
ARC Region
Study Corridors
Other Corridors
Interstate
Miles
0
50
100
150
200

Chapter 2
DESCRIPTION OF THE ECONOMIC EVALUATION METHODOLOGY

This is not a typical economic study of a highway. In a typical study, the road is not yet built, the economic impacts are estimated based on a planned highway, and the question being addressed is whether or not the highway should be built. In this study, the highways that are being studied are already built and are already open to traffic. The study measures what economic impacts and benefits have occurred as a result of the completion of the highway corridors that were studied.

This study focuses on the portions of the ADHS that have already been built (12 of the 26 corridors). Those ADHS highway segments that are not yet funded and/or not yet built are excluded from the analysis. Because the highways being studied are already built, the study analyses are much more certain than is typically the case with other highway studies. For example:

- The actual construction costs are known; they need not be estimated.
- The highway locations and alignments are known; they need not be planned.
- The highways are open to traffic and the traffic volumes are known; traffic need not be estimated.

Therefore, this study is conducted with much greater certainty than is the case with most other, more traditional studies.

The challenge in this study, in terms of estimating the economic contribution the highways make to the Appalachian Region, is to estimate what would have occurred in the areas of the Region impacted if these Appalachian Development Highway System (ADHS) corridors had not been built. The economic benefits and impacts analyzed in the study represent the economic differences between:

- The Appalachian economy with the ADHS highways having been built, compared with
- The Appalachian economy that would have existed if the ADHS highways had not been built.

The differences between these two scenarios comprise the net quantifiable economic contribution, which the completed portions of the ADHS highways have made to the Appalachian Region economy.

THE ECONOMIC ASSESSMENT PROCESS

A public investment in a series of highway corridors such as the ADHS is "economically feasible" if the economy is better off with the investment than without it. Without question highways are significant assets to the people who live and work along the corridors. But the key issues addressed in this study are (1) the magnitude of overall transportation efficiency benefits believed attributable to the highway improvements, and (2) whether such efficiencies induce economic development and/or economic productivity within the Appalachian Region.

Overall Economic Analysis Approach

Great care was taken in the selection of an economic impact methodology. Alternative methods were considered, but the one that was selected has been supported by FHWA.

Optional Approaches – A number of different approaches have been attempted in various studies, all with the goal of quantifying or otherwise depicting the economic gains believed attributable to highway construction. Some of these have been applied previously to the Appalachian Development Highway System.[1] Others have been applied nationally, to the national system of highways.[2] In addition, there are a number of technical approaches that are available to address the economic questions.[3]

Travel Efficiency/Economic Development Approach – What was ultimately decided was to use an economic approach that is described in two places.[4] FHWA in 1996 examined alternative approaches to highway corridor economic analysis, and developed its "Good Practices" report. That FHWA report states that the FHWA "…report is intended to supplement the Federal Highway Administration's (FHWA's) Procedural Guidelines for Highway Feasibility Studies to serve as a reference document on good practice. It provides a set of principles drawn from the best of recent highway and multimodal corridor studies, and directs attention to sources for more information on examples of good practice."[4]

"The audience for this (FHWA Good Practices) report is intended to be all persons involved in highway corridor feasibility studies, including those who are developing work programs or proposals, those who are performing the studies, and those who are overseeing the work as members of review committees. The primary audience is intended to be those involved in feasibility studies initiated as a result of Congressional action and administered by the FHWA. However, this report should also be useful to a secondary audience; namely, those involved in other highway corridor studies."[4]

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[1] "The Economic Effects of the Appalachian Regional Commission," Andrew Isserman and Terance Rephann, 1995.

[2] "Economic Impacts of Federal-Aid Highway Investment: Productivity Impacts of Highway Investment," 1996; and "Highway Infrastructure Investment and Job Generation," U.S. Department of Transportation, 1996; and "Productivity and the Highway Network: A Look at the Economic Benefits to Industry of the Highway Network," Federal Highway Administration, 1996.

[3] "AASHTO Red Book"—American Association of State Highway and Transportation Officials: *A Manual on User Benefit Analysis of Highway and Bus Transit Improvements*, 1977.
"HERS Manual"—Jack Faucett Associates, *The Highway Economic Requirements System*, Federal Highway Administration, US DOT, July 1991. (an update is scheduled for 1996-7.)
"Indiana Guide"—*Major Corridor Investment-Benefit Analysis System*, Cambridge Systematics and Bernardin Lochmueller for Indiana Dept. of Transportation, 1996.
"NCHRP 342"—D. Lewis: *Primer on Transportation, Productivity and Economic Development*, National Cooperative Highway Research Program, Transportation Research Board, August 1996.
"Road Investment to Foster Local Economic Development," University of Iowa Public Policy Center, 1990.
"NCHRP 7-12"—Texas Transportation Institute: *Microcomputer Evaluation of Highway User Benefits*, National Cooperative Highway Research Program, Report 7-12, Transportation Research Board, 1993.

[4] "Examples of Good Practice: Highway Corridor Feasibility Studies," Planning Programs Branch, FHWA, June 1996; and "Iowa Guide"—*Guide to the Economic Evaluation of Highway Projects*, Wilbur Smith Associates for the Iowa Dept. of Transportation, 1993.

"Most of the substance of this (FHWA Good Practices) report is drawn from five corridor feasibility studies which were selected by FHWA staff because portions of each of the studies include examples of the best of current practice. The five corridors and the reference documents, all of which were underway prior to development of FHWA's guidelines, are:[4]

1. Chicago to Kansas City: *Chicago/Kansas City Tollway Feasibility Study*: *Overview Report and Engineering Analysis;* Howard Needles Tammen & Bergendorff, et al.; January 1990; and *Financial Analysis*; Price Waterhouse, et al., March 1990; for Federal Highway Administration, Illinois Department of Transportation, and Missouri Highway and Transportation Department.[4]

2. St. Louis to St. Paul: *St. Louis to St. Paul Corridor Feasibility and Necessity Study; Consultant's Report to the States and Executive Summary*; Wilbur Smith Associates; March 1990; for Federal Highway Administration, Iowa Department of Transportation, Illinois Department of Transportation, Minnesota Department of Transportation, and Wisconsin Department of Transportation.[4]

3. U.S. Highway 20 in Iowa, from Sioux City to Fort Dodge: *U.S. Highway 20 Corridor Development Study; Final Report and Executive Summary;* Wilbur Smith Associates, et al,; December 1992; for Iowa Department of Transportation.[4]

4. Transamerica Transportation Corridor, from California to the Chesapeake Bay area: *Transamerica Transportation Corridor – Transportation Options for the 21st Century Feasibility Study – Final Report;* Wilbur Smith Associates and Howard Needles Tammen & Bergendorff; September 1994.[4]

5. Corridor 18, from Indianapolis to Houston: *Corridor 18 Feasibility Study; Final Report and Executive Summary*; Wilbur Smith Associates and HNTB Corporation; November 1995; for Arkansas State Highway and Transportation Department."[4]

The economic evaluation methodology described in the FHWA "Best Practices" study of 1996 was used in this assessment of the completed portions of the Appalachian Development Highway System.

Economic Principles

Government is often asked to make highway investments for "economic development" purposes. The rationale is that the area served by the highway will be better off due to greater transport efficiency, the possible attraction of new businesses, and the overall improved ability of the corridor(s) region to compete (with the rest of the country) for economic activity.

This study analyzes the completed portions of the ADHS, to determine what impact the improvements to the highways have had on the Appalachian Region.

Definition of Economic Development - For purposes of this study, economic development is defined as "an increase in the prosperity and incomes of people and institutions." Economic development of this nature in the Appalachian Region occurs when the incomes and products

generated in the Region increase. Improved highways can cause such increases to occur in either of two ways: more resources and/or greater efficiency.

- **More Resources** - If goods and services produced in the Appalachian Region (output) increase, more resources (land, labor, materials, capital) will be required which means that more people are employed, more incomes are earned and more profits are made. If the ADHS investment enables the retention of existing firms or the attraction of additional business to the Appalachian Region (new firms, or expanded firms), then the highway has aided the Region's economic development process.

- **Greater Efficiency** - Even if the improved highway does not help to create increased output (more resources) in the Appalachian Region, it can still help economic development by causing the Region's (and the Nation's) output to be achieved at less total cost. Reduced transportation costs due to the highway improvement in this way yields increased prosperity and income.

The study finds that the completed portions of the ADHS (the 12 corridors) have accomplished both: the federally funded highways have enabled the attraction of "more resources" and they have created greater "efficiency." As a result, the highway improvements have enabled/created some "economic development."

Economic Development Basis for a Feasible Highway Project - Highways are essentially "tools" used in transporting goods and people from one place to another. Investments in highways contribute to economic development in that they lower transportation and/or logistics costs and/or improve people's perceptions of the corridor thereby causing them to want to settle/invest there, and/or divert and induce traffic. Such changes may be realized in numerous ways, including improved safety, decreases in fuel and other vehicle operation costs, revised logistics or agricultural or mining patterns, and reductions in noise or air pollution.

Such changes that result from the ADHS may not only accrue to persons and businesses that use the highways. Lower transportation costs may be passed on to consumers as lower prices for consumer goods, to workers as higher wages, or to owners of businesses as higher net income. Persons may thus benefit from the ADHS highways without traveling on them.

It is important to keep in mind that for any of these benefits to occur, the highway must either have enabled significant reductions in transportation costs or cause revised perceptions of the region served by the highway. If the amount of these savings is small for each trip, if the number of vehicles using the highway is not sufficiently large, or if peoples' perceptions do not change significantly, the investment will not produce sufficient economic development impacts to make the investment worthwhile.

Treatment of "Transfer" Impacts - This study recognizes only "net" changes within the portion of the Appalachian Region impacted by the 12 study corridors. Transfers of economic value from one part of the Region to another part (from one group of people or firms to another group of people or firms within the Appalachian Region) are excluded from the calculations.

Under Investment vs. Over Investment - There are economic consequences of either under investing or over investing in highways. If the states or the Appalachian Regional Commission

under invest in highways, economic development will be inhibited because real and perceived travel costs will be greater; tourism and competitive position will be retarded, etc. There is, therefore, an economic cost associated with under investment in highways. If the states or ARC over-invest in highways, overall efficiency will suffer because those funds could have been put to better (more efficient) use elsewhere. There is therefore a net cost to society of either underinvesting, or overinvesting, in highways

Economic Model - The Regional Economic Models Incorporated (REMI) econometric model is used in this study to ascertain the magnitude of the economic development impacts believed attributable to the ADHS. Inputs into the model comprise cost savings to area businesses, increases in disposable income to area residents, increased roadside business revenues, increased tourism revenues and construction cost expenditures.

Travel Efficiency and Economic Development

The two ways that a highway can impact an area economically (greater efficiency and more resources) are both analyzed in this study. Greater efficiency is calculated as travel efficiency benefits, and more resources are calculated in the form of economic development impacts.

- **Travel Efficiency** - Automobile users benefit from better highways due to faster average travel speeds (time savings), reduced accident rates (safety), and improved traffic flow (vehicle operating costs). Truck travel similarly may be faster, cheaper and more reliable. These types of travel efficiency benefits are estimated in this study for the completed segments on each of the 12 ADHS study corridors.

- **Economic Development** – This impact type depicts how the highway improvements impact the region's economy in terms of creating economic opportunity, creating/retaining jobs, and creating value added. These are caused by:

  Improved Competitive Position - Highway improvements sometimes remove an impediment to economic development. Reduced transportation costs and/or better access can enable a region to better compete for economic activities, meaning that business activity is expanded in, or otherwise attracted to, the corridor's economy.

  Non-Business Travel – Vehicle operating cost savings for private personal travel result in an increase in disposable income (less spent on travel, more available to spend on other things).

  Roadside Service Industries - The highway improvements may induce traffic (trips that otherwise would not be made), which will increase local revenues of roadside businesses such as gasoline stations, motels, restaurants and others.

  Tourism - If the highway improvements cause additional visitors to be attracted to the region, the area's income and general prosperity will rise (over and above the Roadside Service Industries' impacts).

These types of economic development impact are presented for all 12 studied corridors combined. The economic development impacts are not presented on a corridor-specific basis.

The overall economic evaluation process as applied in this study is depicted in **Exhibit 2-1**. The chart shows that the traffic volumes and travel costs are tabulated both with and without the ADHS highways. For purposes of clarification, the travel efficiency improvements that result from the ADHS are referred to as *benefits*, and economic development improvements are referred to as *impacts*. The chart indicates that all the net highway improvements costs are compared with all quantifiable "net" travel efficiency benefits. These benefits and the overall traffic analysis provide the foundation for assessing the magnitude of economic development impacts that accrue to the Appalachian Region.

Another important distinction between the benefits and impacts is that the travel efficiency benefits are calculated from the national perspective, while the economic development impacts that are calculated from the Appalachian Region's perspective. The rationale for this distinction is that the travel efficiency gains are net gains to society (no one loses, there is no transfer effect) while the economic development impacts accrue to businesses and residents in the impacted portions of the Appalachian Region and may be transfers from elsewhere in the U.S.A. (not necessarily a net gain to the entire U.S.A.).

Life Cycle Analysis Time Period

To ensure evaluation consistency, a life cycle approach is used in this study. In most studies, travel efficiency benefit/cost analyses evaluate the project over a period of 20 to 30 years, which which is a suitable period of time over which to cover the construction and use of the road. Since the various segments of the 12 ADHS study corridors were authorized and built between 1965 and 1995, a single 30-year analysis period is not acceptable. To ensure that the benefits of each segment of the 12 corridors is evaluated over a period of at least 30 years, the study period was extended through 2025. All ADHS corridor segments are evaluated through the year 2025, regardless of when they were built, 1965, 1980 or 1995.

For these reasons, the analysis of the completed segments of the 12 study corridors begins in the year of funding authorization (between 1965 and 1992) and continues through the year 2025, which results in a 60-year analysis period, 1965 to 2025, for some highways.

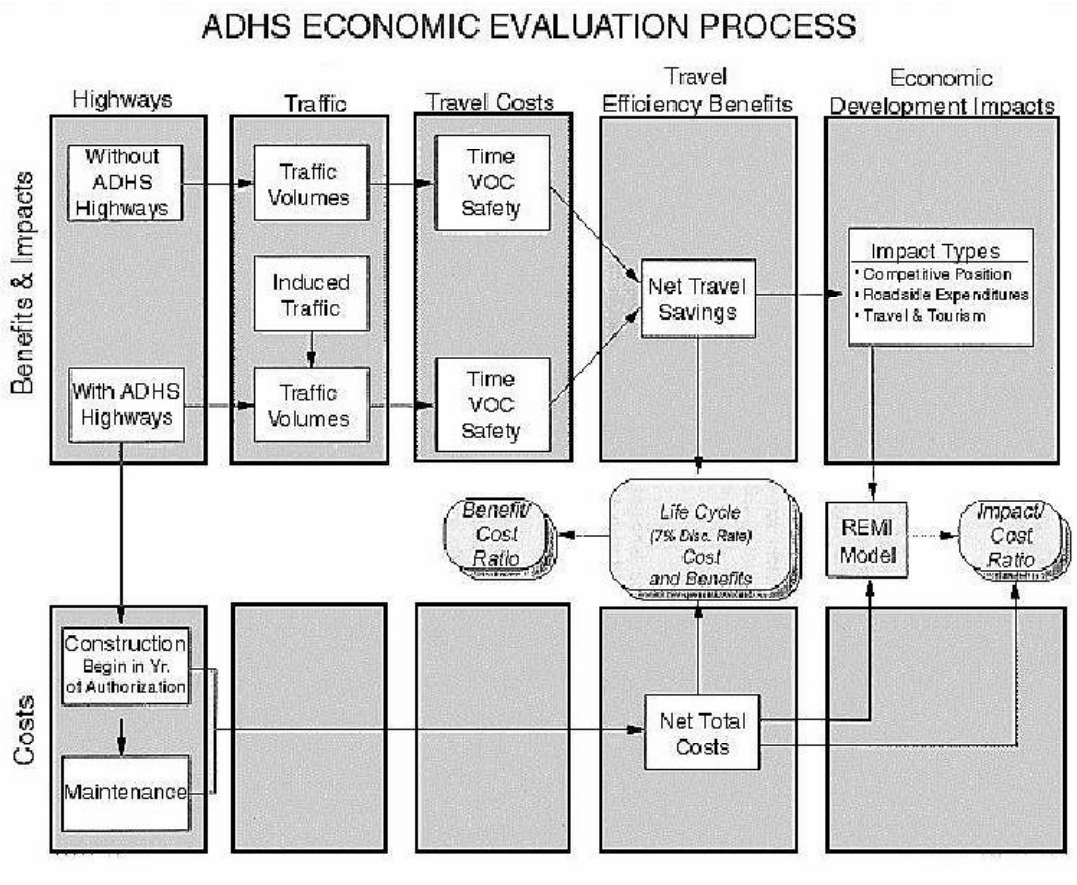
Quantifiable Economic Implications Only

It is important to stress that this study, in its estimates of benefits and impacts, only includes:

- Those implications that can be quantified, and
- Those implications that are economic in nature.

Therefore, this study examines only the quantifiable economic implications of the ADHS; it does not address the social, quality of life or other non-quantifiable impacts. There are likely many social and other positive ADHS impacts that are not included in this study.

Exhibit 2-1


ADHS ECONOMIC EVALUATION PROCESS
Highways
Traffic
Travel Costs
Travel Efficiency Benefits
Economic Development Impacts
Benefits & Impacts
Without ADHS Highways
With ADHS Highways
Traffic Volumes
Induced Traffic
Traffic Volumes
Time VOC Safety
Time VOC Safety
Net Travel Savings
Impact Types
• Competitive Position
• Roadside Expenditures
• Travel & Tourism
Benefit/ Cost Ratio
Life Cycle (7% Disc. Rate) Cost and Benefits
REMI Model
Impact/ Cost Ratio
Costs
Construction Begin in Yr. of Authorization
Maintenance
Net Total Costs

Social Benefits Not Examined – For example, the ADHS likely has increased access to health care, education, cultural amenities and otherwise improved access to other social needs. These types of access benefits cannot be measured in economic terms and therefore are not included in this study.

Import Substitution Effects Not Included – This study methodology assumes that travel efficiency is the only net gain to the USA, and that the economic development impact for the Appalachian Region is a transfer effect nationally. But this is not necessarily the case. There may be economic development impacts to the U.S.A. that are not included. For example, better access to tourist destinations in Appalachia might cause a net increase in tourism nationally, or better access to Appalachian hardwood products might create a net gain for American hardwoods (a benefit to the USA).

These are examples of ADHS implications that are not included as quantifiable economic benefits or impacts believed attributable to the ADHS. In this sense the benefit and impact estimates in this study could be viewed as conservative.

TRAVEL EFFICIENCY ECONOMIC BENEFITS

Transportation efficiency is a legitimate local corridor, regional, state and even national goal. If a road improvement creates road user cost savings that, over time, exceed the cost of the road improvement, then that road improvement should be implemented. Therefore, travel efficiency is relevant to the funding decision for Congress, the FHWA, the Appalachian Regional Commission, the individual state departments of transportation, and local agencies.

The highway travel efficiency benefits due to ADHS improvements are of three types: value of travel time savings, vehicle operating cost savings, and accident cost savings. Such benefits are calculated for two vehicle types: cars and trucks. Travel efficiency benefits are calculated by corridor beginning in the year the segment was opened to traffic through the year 2025.

The calculation itself compares travel costs in the built scenario (with the ADHS in place) with travel cost in the non-built scenario (if the ADHS were not built). For this reason, comparable road data were needed for both scenarios.

Travel Time Savings

Most highway investments enable motorists to travel more quickly. There are potentially three different ways to reduce travel time: (1) Reducing mileage to reach one's destination by offering a shorter route, (2) Increasing the speed at which one can travel by providing facilities with higher design standards, and (3) Reducing congestion by providing additional high capacity facilities. A methodology to take into account all three elements of time savings was developed. It uses the results of the corridor surveys, which describe the ADHS corridors the way they are today, and the way they were before the ADHS was implemented. In effect, for each vehicle using one of the ADHS segments, travel times with and without the new improved highway are calculated and summarized. Travel times are calculated for each segment using the Highway Performance Monitoring System (HPMS)[5] model methodology and data developed by FHWA. This methodology recognizes that travel time varies due to the design of the road, the speed limits in effect, and the level of congestion (expressed in terms of volume/capacity ratios). Travel

time also varies by type of vehicle (it takes longer for a truck to climb an upward grade or resume original speed when slowed down by congestion).

To include time savings in the transportation efficiency evaluation, it is necessary that a

purposes of this study, values of time based on average hourly wage rates, average occupancy and cargo values were developed using the FHWA methodology outlined in the Highway Economic Requirements System (HERS)[5]. The resulting values of time are:

- $16.59 per on-the-clock auto hour (travel while on business);
- $7.64 per off-the-clock auto hour (commuter and non-business travel);
- $21.48 to $28.95 per truck hour depending on the type of truck.[6]

These values are used in this study, and sensitivity analyses are also conducted.

Vehicle Operating Cost Savings

The costs of operating motor vehicles are a significant portion of the total cost of transportation. Vehicle operating costs include a number of components, some of which are variable costs (use related), and others are fixed costs (insurance and license fees which typically do not vary with use). Only use-related costs -- engine oil, gasoline, maintenance, and tires -- are directly affected by an improved highway. Vehicle operating costs, like travel time, vary with the characteristics of the trip being made including trip length, running speeds, and speed change cycles. Using the same data as for the travel time, vehicle operating costs with and without the ADHS were calculated. HPMS model data was used to develop the costs.[6] With this methodology, vehicle operating costs vary with the length of the segments, the various speeds on different portion of the segments, and the type of vehicle. Excess vehicle operating costs due to speed change cycles are also calculated by type of vehicle.

Accident Reduction Cost Savings

Improvements in highway safety comprise another reason for building highways with higher design standards. Because a higher standard 4-lane roadway is safer than an older 2-lane lower standard road, many of the ADHS roadways reduce accident risk. National average injury rates by type of accident (fatal, injury, property damage only) and by type of highway facility were used to calculate accidents savings in the various corridors under study.[7] These accident rates are shown on Exhibit 2-2.

[5] "Highway Performance Monitoring System (HPMS)," FHWA, 1994

[6] "Highway Performance Monitoring Systems Analytical Process (HPMS)," FHWA, 1987

[7] "Highway Statistics," FHWA, 1994 and 1995

Exhibit 2-2
ACCIDENT RATES BY HIGHWAY TYPE
Rate Per 100 Million Vehicle Miles of Travel

Accident Types:	Fatalities		Serious Injuries		Other Injuries	
Highway Lanes:	2	4	2	4	2	4
Rural Interstate	1.209	1.209	5.151	5.151	30.733	30.733
Rural Other Principal Arterial	2.458	2.300	12.211	10.990	73.822	66.439
Rural Minor Arterial	2.915	2.727	14.917	13.425	102.579	92.321
Rural Collector	3.285	3.038	17.367	15.338	135.354	121.305
Rural Local	3.855	3.607	19.331	17.398	198.845	178.960
Urban Interstate	0.626	0.626	4.858	4.858	67.177	67.177
Urban Other Freeway/Expressway	1.170	1.095	5.552	4.997	86.844	78.160
Urban Other Principal Arterial	1.494	1.397	17.281	15.553	214.497	193.048
Urban Minor Arterial	1.260	1.179	14.863	13.376	179.640	161.676
Urban Collector	1.070	1.001	14.334	12.901	142.775	128.497
Urban Local	1.741	1.628	18.198	16.378	286.084	257.431

Source: FHWA Highway Statistics and Consultant Calculations

To include the accident reduction benefits in the transportation efficiency evaluation, a monetary value was assigned to each type of accident. The accident monetary values used for this study are based on "The Economic Cost of Motor Vehicle Crashes," National Highway Traffic Safety Administration (NHTSA) 1994 data.[8]

- $2,854,000 per fatality.
- $654,000 per seriously injured person.
- $20,600 per other injured person
- $1,600 per property damage only (PDO) vehicle

Total Travel Efficiency Benefits

The total efficiency benefits quantified in this study comprise the sum of the travel time savings, vehicle operating cost savings, and accident savings. Under the efficiency category, economic development impacts (job creation, etc.) are excluded.

ECONOMIC DEVELOPMENT IMPACTS ON APPALACHIAN REGION

Highway improvements of the ADHS type make travel faster, easier and more efficient. These improvements divert traffic from other highways; they also generate traffic. Such events are most welcome, not only because of the travel efficiencies and the improved perception of the area served by the highway, but also because of what these travel efficiencies and perceptions could mean to the local economy that is served by the highway. Whereas the previous section explained the methodology behind the estimation of travel efficiencies, this section explains the methods used to estimate the economic development impacts that are of value to the Appalachian Region.

[8] "The Economic Cost of Motor Vehicle Crashes," National Highway Traffic Safety Administration (NHTSA), 1994

The REMI Economic Model

The economic development impact portion of the study relies on an inter-regional model of the US and the Appalachian Region referred to as "REMI." REMI is a private sector model owned by Regional Economic Models, Inc. of Amherst, Massachusetts. This model package, which has previously been applied to a number of corridor evaluations, has the advantage that it is dynamic in the sense that it allows the primary impact region to interact with the rest of the United States.

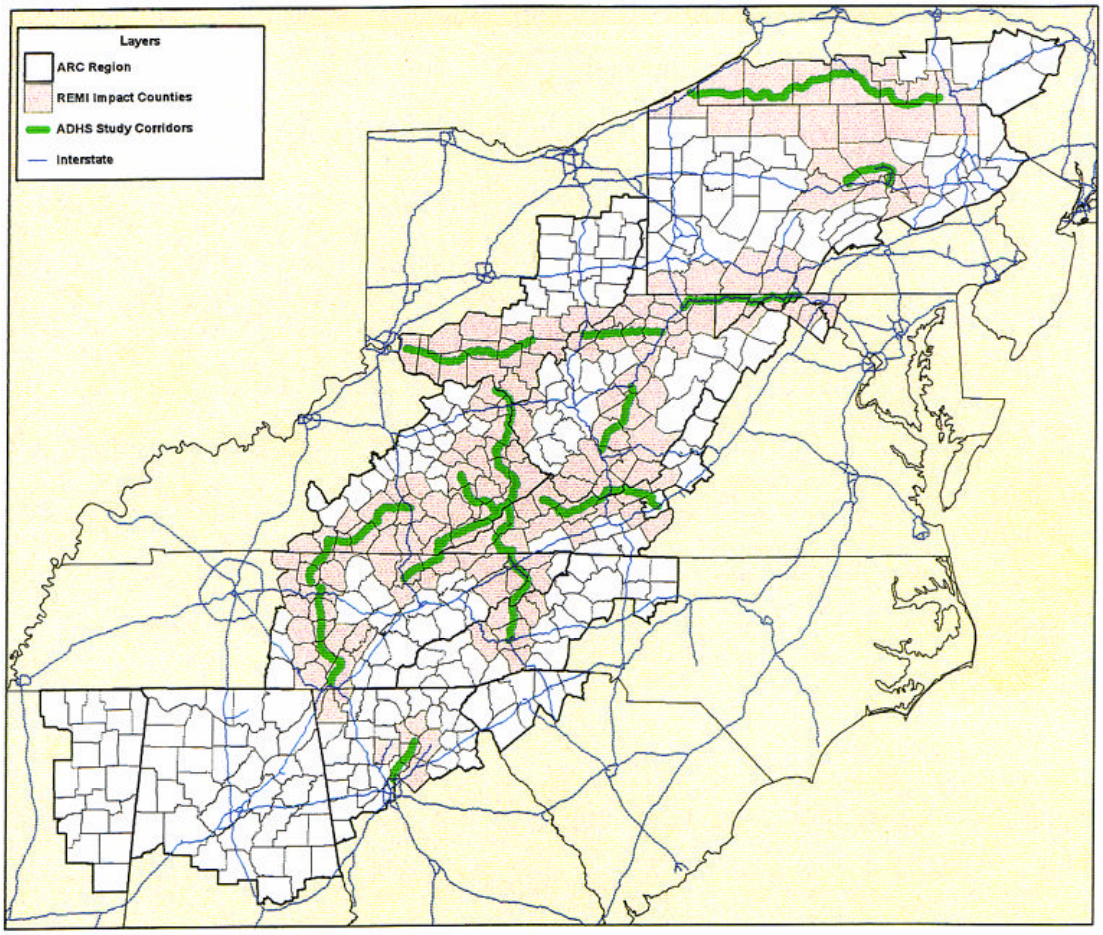
The REMI model is a comprehensive forecasting and simulation system useful for policy and investment analysis of a wide array of issues. While it does have some similarities to Input-Output models, it allows greater interaction of industries and it has the ability to estimate the proportion of an increase in demand for goods and services from a shock to the system that can be met by businesses within the region. Within the model, wages are responsive to changes in labor market conditions, migration is responsive to changes in expected income, and the share of local and export markets responds to changes in regional profitability and export costs.

From a highway investment feasibility perspective, the study was interested in the extent of economic development that has occurred as a result of the highway improvement. Moreover, the degree of economic development, which may result from the highway, varies depending on the stage of total socioeconomic development for the impact region. That is, a remote small rural community with a relatively undeveloped labor pool may not have the full range of socioeconomic conditions required to fully benefit from the economic development potential of a highway improvement. REMI accounts for this phenomenon in its estimates of economic impact.

Modifications to REMI Model - Simulations with the model can be used to estimate the economic and demographic effects of policy and investment interventions such as economic development programs, infrastructure investments such as new highway construction, energy and natural resource conservation programs, state and local tax changes, and other policies. The policy simulation compares the performance of the corridor region after a policy intervention with the projected performance of the region based on national forecasts of industry growth and estimates of the shifting competitive position of each industry in the corridor region compared to that industry elsewhere in the country and elsewhere in the primary impact area. Because REMI is primarily an economic forecasting model, alterations to the inputs and the outputs had to be made in order to reflect the historical nature of this study. A description of these alterations is discussed in **Appendix A**.

Primary Economic Impact Areas - The REMI model is compiled by county, which requires a clearly defined impact area. Although the ADHS spans a large geographic area, each study corridor is perceived to principally serve a primary impact area near the highway. For analysis purposes, the "principal impact" areas were defined as those counties through which one of the corridors passes plus those that lie within a ten-mile buffer of the new highways. These are included in the REMI primary impact study areas as shown in **Exhibit 2-3**. The selected impact area is mostly rural and excludes many of the major urban areas (Atlanta, Pittsburgh, and Cincinnati). Any area within the Appalachian Region that was not included in the primary impact area was considered a second region of non-primary impact counties. The REMI primary impact area includes 165 of the total 399 counties in the Appalachian Region. The other 234 counties comprise non-primary Appalachian Region counties.

Exhibit 2-3
REMI MODEL IMPACT REGIONS
Primary Impact Counties and Rest of Appalachian Region



REMI Model Inputs - In the following pages, the method in which the economic impacts are estimated is described. The impacts derived from an improved competitive position, increased roadside services, and additional dollars spent on tourist related businesses are based upon travel estimates derived from the traffic forecast model used in the study. The method used in the calculation of REMI model outputs for the ADHS system is displayed in **Exhibit 2-4**.

Indicators of Economic Development Impact

The ADHS investments are believed to impact the Appalachian Region economy in numerous "economic development" ways. In order to recognize these impacts in a consistent fashion, a single set of "impact indicators" were used. These are all produced by the REMI model, and are as follows:

- **Value Added** – Dollar value of increased Regional product believed attributable to the completed portions of the ADHS.
- **Employment** – Net change in Appalachian Region jobs believed attributable to the completed portions of the ADHS.
- **Wages** - Total increases in payroll costs (wages and salaries and benefits) paid to those increased jobs.
- **Population** - Total population dependent on the new jobs created by the completed portions of the ADHS.

All monetary calculations are expressed at constant 1995 price levels (unless otherwise stated).

Direct Measures of ADHS Economic Development Impact

The fact that the study's 12 ADHS corridors have been built and are operational has caused a number of "direct impacts" to have occurred. These direct impacts include those items that can be measured using available information. It is these direct impacts which are input into the REMI model to estimate the total economic development impacts believed attributable to the ADHS. Four such direct impacts were estimated in this study. These are:

- **Competitive Position** – Improved access, revised perceptions of an area, and reductions in transportation time and cost make the corridor areas more attractive, and can lead to reduced costs of production, which in turn lead to marginally reduced prices and/or increased profits, which can lead to increased production (firm expansion and/or attraction of new firms), which in turn generates economic impact value. Efficiencies of this type are input into the REMI model.
- **Roadside Service Industries** – Increased traffic due to the highway improvements generally increases local sales at roadside businesses (restaurants, gasoline stations, motels, and other businesses that cater to highway users). These increased sales are input into the REMI model, to the extent that they exist.

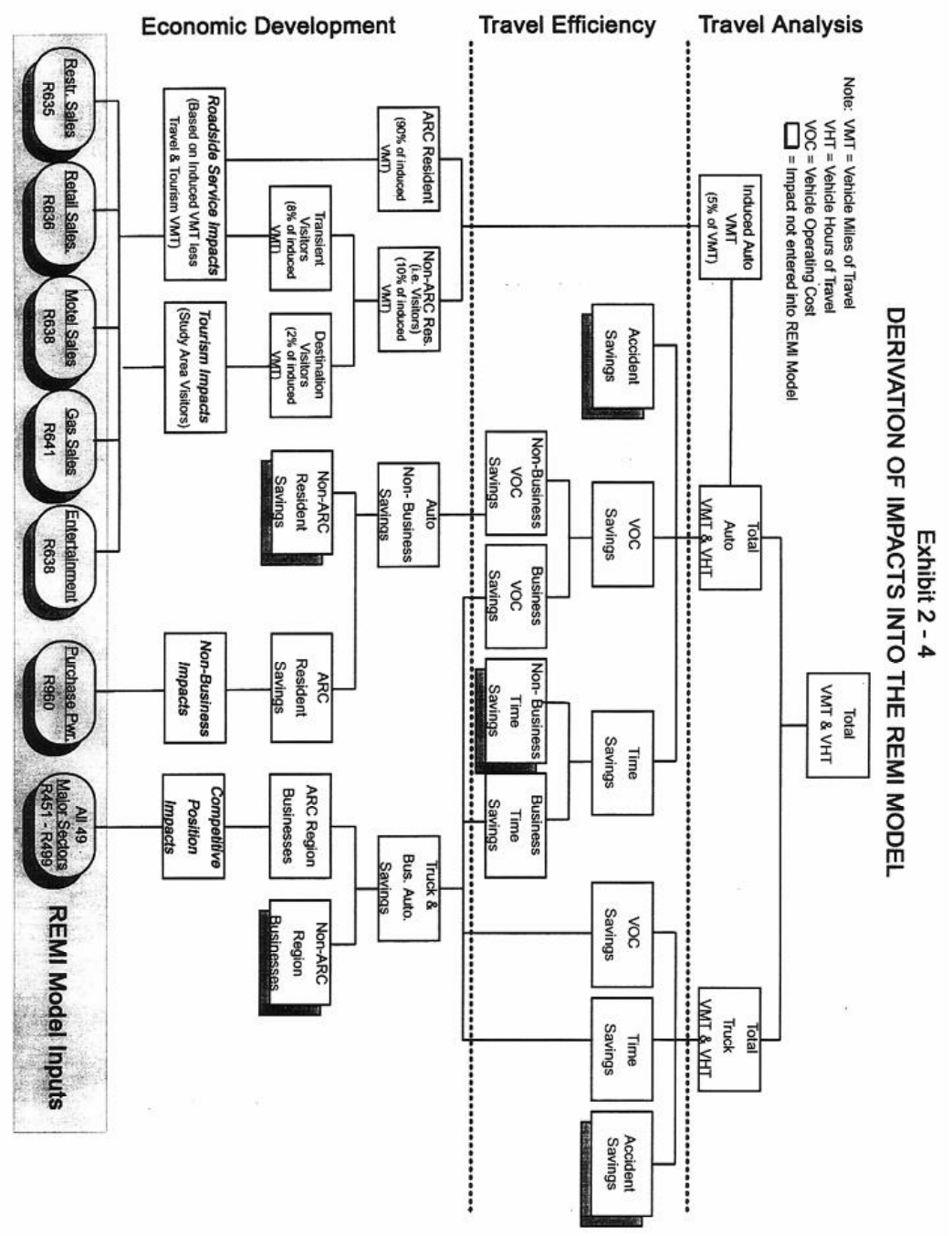


Exhibit 2 - 4
DERIVATION OF IMPACTS INTO THE REMI MODEL
Note: VMT = Vehicle Miles of Travel
VHT = Vehicle Hours of Travel
VOC = Vehicle Operating Cost
= Impact not entered into REMI Model
Travel Analysis
Travel Efficiency
Economic Development
Induced Auto VMT (5% of VMT)
Total Auto VMT & VHT
Total VMT & VHT
Total Truck VMT & VHT
Accident Savings
VOC Savings
Time Savings
Non-Business VOC Savings
Business VOC Savings
Non-Business Time Savings
Business Time Savings
Truck & Bus. Auto. Savings
ARC Resident (90% of induced VMT)
Non-ARC Res. (i.e. Visitors) (10% of induced VMT)
Auto Non-Business Savings
Transient Visitors (8% of induced VMT)
Destination Visitors (2% of induced VMT)
Non-ARC Resident Savings
ARC Resident Savings
ARC Region Businesses
Non-ARC Region Businesses
Roadside Service Impacts (Based on Induced VMT less Travel & Tourism VMT)
Tourism Impacts (Study Area Visitors)
Non-Business Impacts
Competitive Position Impacts
Restr. Sales R635
Retail Sales R636
Motel Sales R638
Gas Sales R641
Entertainment R638
Purchase Pwr. R960
All 49 Major Sectors R451 - R499
REMI Model Inputs

- **Tourism** - Highway improvements of the scale of the ADHS help to attract additional visitors to the area over and above the Roadside Service Industry impacts. Such travel and tourism impacts pertain to visitors who choose to visit the area after the road improvement because of the improved access. This direct increase in tourism expenditures is also input into the REMI model.

- **Highway Construction** - The act of spending money to build the highway is of immediate economic impact to the region. These impacts are temporary in nature, since they primarily exist during the construction period and dissipate after road construction (when the highway is open to traffic). These "direct" impacts of highway construction are calculated and are run through the REMI model, but they should not be used as evidence that the highway improvements are feasible. Therefore, these impacts are not included in the calculation of the impact/expenditure ratio.

All four of the above identified “direct impacts” are estimated in the study for each of the 12 corridors, based on the traffic models and on secondary data. However, they are not presented on a corridor-specific basis. Each is described in greater detail below.

Competitive Position Impacts

There is a desire for the Appalachian Region, and its individual corridor regions, to expand existing businesses, to attract new businesses, and to diversify the area's economic base. To attract business activity to the Appalachian Region, the Region must be competitive with other areas of the USA.

The question arises as to what extent the ADHS investments impact the businesses already in the Region. A related question is what the highways could do to help foster growth of other, emerging industries. It is clear that competition is great among regions of the USA to maintain as high a level of economic activity as possible and to attract activities demonstrating growth potential nationally. Keeping transportation costs as low as possible is one action government can take to make a region more competitive.

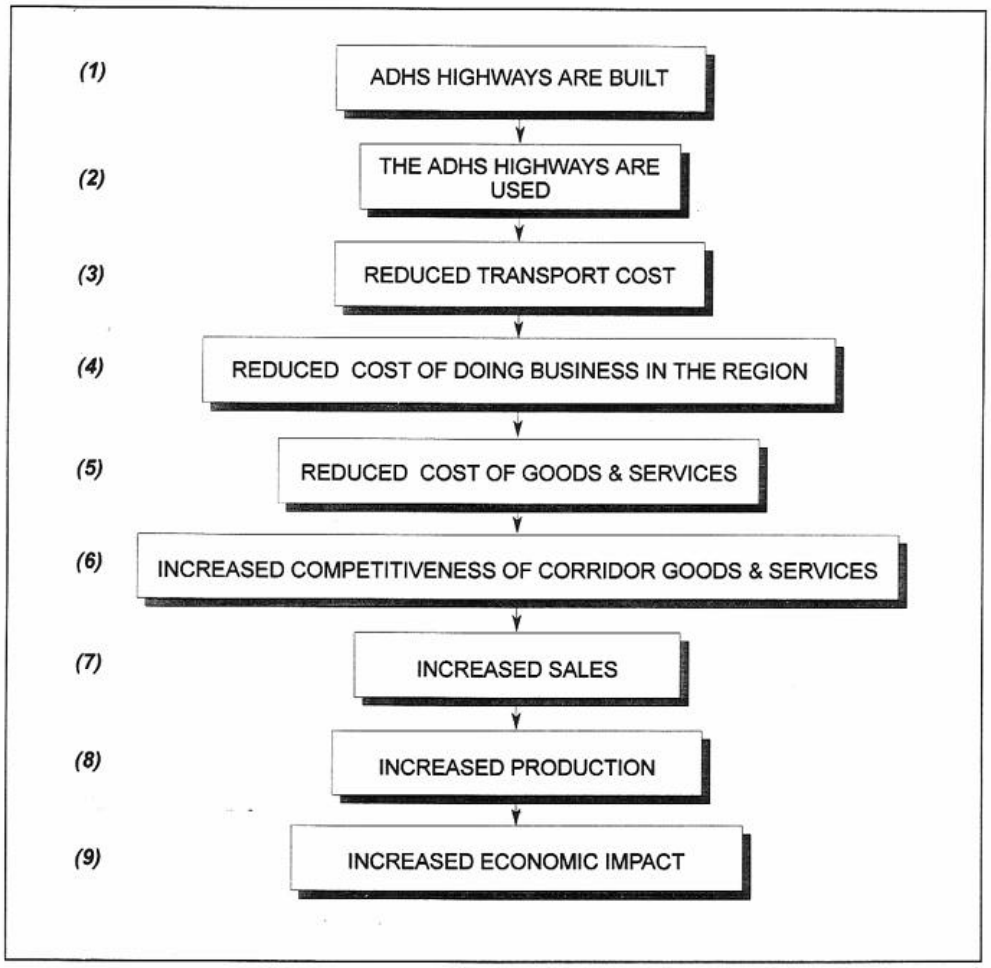
Exhibit 2-5 presents a sequential flow of activities involved in moving from the ADHS highway improvements to the associated economic impact in terms of what they do for competitive position. The activities are described as follows:

1. **The ADHS Highways Are Built** - The act of building the improved highways has a short-term economic impact; that impact is assessed in this study.

2. **The ADHS Is Used** - The improved highway is used by existing and induced traffic. Because the highways are already built, the extent of ADHS use is known.

3. **Reduced Transportation Cost** - The highway improvements lead to increased travel efficiency in the form of reduced travel time, increased travel reliability, reduced accidents and revised vehicle operating costs. The efficiencies themselves are quantified in the "Travel Efficiency Analyses" for cars and trucks.

Exhibit 2 - 5
COMPETITIVE POSITION PRINCIPLES



4. **Reduced Costs of Doing Business in Corridor** - Transportation cost is one factor in the cost of doing business in the Appalachian Region. If transportation costs, especially trucking costs and business travel costs, decline in the corridor, this means that the total cost of doing business in the corridor will also decline slightly.

5. **Reduced Prices of Goods and Services** - If costs of production in Appalachia decline due to transportation cost reductions, the result will be reduced prices of goods and services, or increased profits, or both. Such reductions apply to goods produced in the Appalachian Region as well as goods shipped into the Region.

6. **Increased Competitiveness of Appalachian Region's Goods and Services** - With slightly reduced costs, and therefore prices, the goods and services produced in the region should be slightly more competitive with the ADHS than without it.

7. **Increased Sales** - If the Appalachian Region's goods and services become more competitive due to price decreases, the region's businesses should be able to make additional sales of those goods and services.

8. **Increased Production** - If sales increase production of goods and services will increase by a like amount.

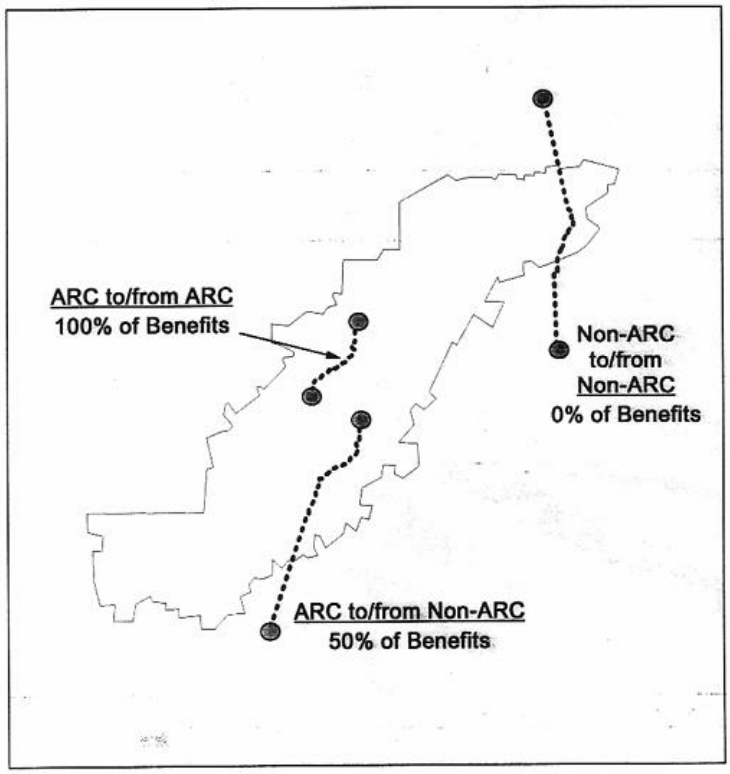
9. **Increased Economic Impact** - Increased production means that more of the Appalachian Region's people are employed, more income is earned, and economic activity expands.

These types of competitive position changes are calculated for the 12 corridors as a whole. To estimate these impacts, the vehicle operating cost and time savings of truck and business related automobile traffic for traffic that originates and/or terminates in the Region are estimated.

For purposes of the REMI analysis, the portion of cost savings, in terms of travel time savings and vehicle operating cost savings, for business related trips[9] are placed into the REMI model as cost savings across all of the different industries for the Appalachian Region. These cost savings must be broken down into benefits to the direct impact area (referred to as the ARC region) and benefits for indirect impact areas (referred to as the Non-ARC region). For example, when a business located in the Appalachian Region transports goods along an improved study corridor, any cost savings incurred help make the business more competitive. Conversely, when a business that is *not* located in the region ships goods through the region, travel efficiency benefits associated with the highway improvements *should not* be accounted for in the competitive position impacts because the savings accrue to businesses outside the region. The three trip type variations of Region and non-Region trip movements are diagrammed in **Exhibit 2-6.**

[9] While all truck trips can be considered business trips, only a portion of auto trips can be considered business trips. According to the *1990 Nationwide Transportation Survey*, 13.3 percent of all auto trips are for business purposes. This percent was used in this study.

Exhibit 2 - 6
ECONOMIC BENEFITS VARY BY TRIP TYPE



These cost savings are placed in the REMI model in the year that the cost savings occur. To distribute these costs savings across the different industries, a proxy is established for the importance of each of the industries represented in the Appalachia Region. The proxy is based upon the number of employees each of the industries has of the total employees for the region in a base year of 1995. Based on this proportion, each industry receives a portion of the cost savings as an input into the REMI model. For instance, mining has 2.2 percent of the total employees for the Appalachia Region. Therefore, mining receives 2.2 percent of the total cost savings for each of the years under examination.

- If a trip begins and ends in the Appalachian Region, 100 percent of the travel efficiency benefits accrue to residents of the Region and are input into the economic development analysis.

- If only one trip end is in the Appalachian Region, only 50 percent of the travel efficiency benefits are considered as input into the economic development analysis since it is assumed that half of these trip makers reside outside of the Appalachian Region.

- If a trip neither begins nor ends in the Appalachian Region, zero percent of the travel

efficiency benefits are considered as input into the economic development analysis because these benefits accrue to people who reside outside of the Region.

To estimate the distribution of these three types of trips, surveys from previous studies with similar road types were used.[10] It was established that 92.7 percent of all auto trips can be classified as ARC auto trips while 79.85 percent of all truck trips can be classified as ARC trips. Based upon these estimates of trips that are business related and can be classified as ARC trips, the values of travel time savings and VOC savings are placed into REMI as cost savings across the various industries of REMI.[11]

Once again, due to the historical nature of the study, savings had to be placed into REMI with some adjustments since REMI is usually a foreword-forecasting model. See **Appendix A** for details of the adjustments process.

Roadside Service Impacts

A safer and more travel efficient highway system in the Appalachian Region should lead to an increase in the volume of traffic by inducing traffic to these roads. An increased volume of traffic creates an increase in the volume of sales for roadside businesses including motels, restaurants, gasoline stations, and other businesses that cater to highway users. The impacts from the roadside expenditures are considered to be net benefits to the corridor region. The volume of traffic induced onto the roads is based upon the existing traffic volumes (in terms of VMT) and is assumed to be 5 percent of the total traffic (VMT). Of this induced traffic, it was estimated that 10 percent of the traffic is from non-residents and 90 percent is from resident traffic. To avoid double counting, 8 percentage points of the 10 percentage points of non-residents is considered transient visitors while the remaining 2 percentage points is considered destination visitors.[12] The VMT created by the 8 percent of non-resident visitors plus the 90 percent of resident visitors is the basis for deriving the roadside services REMI inputs.

[10] The estimate for the breakdown of trips was obtained from a survey of similar rural roads in the U.S Highway 20 Study Corridor Development Study, Iowa Department of Transportation. This breakdown of trips could be viewed as conservative for a number of reasons. First, the survey examined the proportion of trips that have origin and destination points within the State of Iowa, which is a much smaller area than is the Appalachian Region (Iowa has 55,965 square miles while the counties that make up the Appalachian Region have 185,268 square miles.) Second, the points at which the traffic was surveyed in this study are near the borders of Nebraska and South Dakota and presumably, would have a much higher percent of trips that either begins or ends outside the state than a road in the center of that state or the center of the Appalachian Region.

[11] The cost savings are appropriated to each of the industries in the REMI model based upon the importance of each of the industries to the Appalachian regional economy. A simple example might clarify this point. If it is determined that a new road could create $1000 of savings, and there were only five industries within a region each with 20 percent of the employment of the region, than each industry would receive $200 worth of cost savings. The importance of the industries is based on the proportion of total employment within each industry.

[12] The 2 percent is based on the *1990 Nationwide Personal Transportation Survey* which estimated that 2 percent of VMT is for the purpose of vacation.

To estimate the inputs for REMI from the roadside expenditures to the Appalachian Region, an expenditure per VMT mile was estimated. Data from surveys in previous studies were utilized to gain an estimate of the roadside expenditures per VMT. These surveys suggest that the roadside service impacts from road improvements is 0.193 cents per VMT.[13] These costs by expenditure type are shown in **Exhibit 2-7.**

Exhibit 2-7
ROADSIDE EXPENDITURE RATES

Expenditure Type	Expenditure per VMT
Motel	$0.023
Restaurant	0.021
Gasoline	0.072
Other Retail	0.077
Total	$0.193

VMT = Vehicle Miles of Travel

These direct impacts per VMT are multiplied by the induced VMT (from residents and non-residents) to gain a value of inputs for the roadside services impacts.

Tourism

The Appalachian Region is attractive to visitors for many reasons, including its ski areas, fishing opportunities, scenic vistas, mountains, and lakes that are part of a network of trails and scenic roads. Tourism can create a substantial impact on a region through money expended on hotels, summer homes, restaurants, gas stations, gift shops, etc. By creating safe and efficient roads, a region can enjoy greater accessibility and have an added economic impact through an increase in the volume of tourists. Based on the *1990 Nationwide Transportation Survey* produced by the FHWA, it is estimated that two percent of VMT is vacation related. Therefore, two percent of the induced VMT was assumed to be tourist related. To establish the impact that tourists have on an area, a regression was conducted to derive a multiplier per VMT for tourist

[13] These expenditures per VMT are based on an analysis from a previous study called St. Louis to St. Paul *Corridor Feasibility Study, 1990*. In this study, expenditures per VMT were estimated, and explained below. These values were inflated to 1995 levels.

- It was assumed that people stay at motels if they drive 500 miles. Motels cost $50, or 10 cents per VMT. Assume only 20 percent of diverted or induced traffic stays in a motel. Impact per VMT is therefore 2 cents per VMT.
- If people traveling spend $20 per person day, and there are 1.6 people per vehicle, and they travel 500 miles, the cost is 6 cents per VMT. If only 30 percent of the travelers stop for food (the other trips are shorter, not involving restaurants), the expenditure per VMT is 1.8 cents.
- If fuel costs $1.25 gallon, at 20-miles/ gallon, the gross expenditures is 6.2 cents per VMT.
- Vehicle drivers also pay other vehicle user costs (oil, tires, maintenance), and buy things (gifts, other retail). These expenditures are estimated at 6.7 cents per VMT.

traffic[14]. The tourist VMT was multiplied by this derived multiplier to gain the value of inputs for tourism. The output of this calculation was included in REMI as an input to derive an economic impact of tourism created by the improved roads.

Highway Construction Impacts

The very act of spending large sums of externally generated (federal) construction money in the Appalachian Region also is of economic value to the Region, since contractors and construction workers are hired, gravel is purchased, etc. Economic value created in the Appalachian Region due to the act of spending such construction funds in the ADHS corridors was estimated.

Data concerning each corridor's capital costs were examined in terms of construction cost and right-of-way cost. The construction costs were treated as increases in final demand and input into the REMI model. The right-of-way costs were treated as transfers and not included. The construction costs were assumed spent, initially, within the Appalachian Region. The economic impacts due to the act of construction comprise the monies spent in the corridor and the flow of those monies in terms of respending. The impacts include the labor and expenses associated with planning, design and construction, plus the respending of those funds to the extent that such respending occurs within the Appalachian Region.[15]

ADHS IMPROVEMENT COSTS

The cost side of the cost-benefit calculation includes two costs: 1) the "capital costs" of constructing each ADHS completed highway segment, and 2) the annual change in highway administration, operation, and maintenance costs due to the new ADHS highways.

- **Capital Cost** - Capital costs comprise the actual funding incurred by the Appalachian Regional Commission in improving the road sections. This includes all funds expended from the ARC budget relative to the planning, design, and construction.
- **Road Maintenance Cost** - Once the ADHS highway improvements were in place, there is more road to maintain than previously. The resulting net change in maintenance and operations cost is included as a net new cost attributable to the ADHS highway investments.

Capital Costs

[14] The regression analysis ran a series of regressions in which dollars spent on different tourist related service was the dependent variables, while the independent variable was the VMT of the 12 corridors. By using the regression analysis, a correlation between VMT and dollars spent on tourist services was established and this correlation is represented by the coefficients in the regression analysis. These coefficients were multiplied times the induced VMT on the 12 corridors to gain the value of inputs for tourism in REMI.

[15] The construction impacts should only be used to indicate the extent to which the region might benefit economically from the attraction of federal funding to the Region. They should not be used to try to justify that federal expenditure.

Exhibit 2-8 lists the ADHS costs used in this study. The construction costs (current) depict the total capital cost expenditures of the various years summed, at the price levels appropriate for the years when the expenditures were authorized (current price levels). The construction costs (Constant 1995) are the same costs expressed at Constant 1995 price levels. The current costs were converted to Constant 1995 price levels using the Highway Construction Cost Index.

Exhibit 2-8 also lists the number of traffic lanes before and after the ADHS. It indicates that many of the corridors were expanded from 2-lane highways to 4-lane highways. The exhibit then identifies the average ADHS construction costs per added lane mile and per total lane mile, all expressed at Constant 1995 price levels.

Exhibit 2-8
ADHS Construction Cost Comparisons

Corridor	Construction Costs ($000)1		Corridor Length (miles)	Average No. Lanes		Average Construction cost per2	
	Current	Constant 1995		Before	After	1995 Added Lane mile	1995 Lane Miles
A/A1	$54,989	$113,911	30.4	2.3	4.0	$1,150	$489
B	$927,866	$1,825,251	249.4	2.2	4.0	$2,013	$906
D	$308,346	$843,689	189.8	2.0	4.0	$1,417	$708
E	$430,702	$903,113	109.2	2.0	4.0	$2,209	$1,105
F	$147,539	$350,560	99.3	2.0	3.0	$1,954	$651
I	$100,432	$256,341	59.9	2.0	3.0	$9,137	$1,192
J	$379,704	$630,414	214.5	2.0	3.0	$1,228	$409
L	$167,165	$457,946	60.5	2.1	4.0	$2,349	$1,116
P	$207,228	$472,046	54.7	2.1	4.0	$2,482	$1,179
Q	$235,249	$579,656	129.8	2.0	4.0	$1,264	$632
T	$568,056	$1,256,350	220.3	2.2	4.0	$1,709	$769
All Corridors	$3,527,277	$7,689,277	1,417.8	2.1	3.7	$1,824	$789

1) Total capital investment in the ADHS corridor. "Current" dollars are the actual expenditures by year summed over the period 1965-1995. "Constant" dollars

2) Constant 1995 construction costs divided by number of new ADHS lane miles built and divided by total lane miles in the corridor.

Annual Maintenance Costs

The annual estimated increase in annual highway maintenance costs were also included in the ADHS evaluation. These annual maintenance costs were estimated based on maintenance costs per functional class reported in "Highway Statistics," FHWA. The average of 1993, 1994 and 1995 maintenance costs in $1995 were used. These unit costs are listed in **Exhibit 2-9**.

Exhibit 2-9
HIGHWAY MAINTENANCE COSTS PER LANE MILE
(1995$, Thousands)

Rural Interstate	$11.887
Rural Other Principal Arterial	3.957
Rural Minor Arterial	3.426
Rural Collector	3.557
Rural Local	2.949
Urban Interstate	6.834
Urban Other Freeway/Expressway	10.091
Urban Other Principal Arterial	4.916
Urban Minor Arterial	7.809
Urban Collector	3.957
Urban Local	3.957

Total Costs Present Value

The present value of the net cost increase for each corridor are listed in **Exhibit 2-10**. These are used in the study's economic benefit/cost analysis.

Exhibit 2-10
TOTAL PRESENT VALUE COSTS [(a)]
(1995$, Thousands)

Corridor	Construction Costs	Maintenance Costs	Total
A/A1	$ 55,318	$4,119	$59,437
B	879,597	23,972	903,569
D	517,035	20,711	537,746
E	444,194	38,331	482,524
F	189,274	4,729	194,003
I	161,546	2,645	164,191
J	251,514	11,865	263,380
L	264,599	5,460	270,059
P	245,423	12,507	257,930
Q	320,695	7,468	328,163
T	649,074	28,723	677,797
Total	$3,978,268	$160,530	$4,138,798

(a) See Appendix B for the tabulation of these costs.

ECONOMIC BENEFIT/COST AND IMPACT/EXPENDITURE ANALYSES

This study's methodology indicates that the ADHS could help the Appalachian Region economy in two quantifiable ways:

- **Benefits** – Monetary value of travel efficiencies (vehicle operating cost, travel time, and accident savings) accruing to the economy; and

- **Impacts** – Economic development impacts (jobs, value added, etc.) accruing to the Appalachian Region.

The totals for these two indicators of economic consequences should not be added together; adding these together would be to double count the economic consequences of the ADHS. Instead, only selected portions can be added together, as done in Chapter 5.

But the benefits and impacts by themselves only indicate that there were positive economic consequences due to the ADHS. To indicate whether or not the ADHS was a prudent use of federal dollars, it is necessary that the economic costs to society of building and maintaining the ADHS be compared with the economic benefits or impacts derived.

This comparison is accomplished in this study by conducting a benefit/cost comparison, initially by comparing the economic benefits (efficiencies) with the ADHS costs, then by comparing the economic impacts (value added) with the ADHS costs.

Excluded from the benefit/cost calculations are the road improvement implications that cannot be tabulated in monetary terms (environmental or social implications, impacts on other modes of transportation, etc.). As a result, the economic benefit/cost calculations should be important relative to interpretations of how well the ADHS has performed, but should not be viewed as the only criterion.

Travel Efficiency Benefit/Cost Ratio

A benefit/cost approach is used to compare the net economic costs with the net travel efficiency benefits, in the form of a benefit/cost ratio. This ratio is similar to those used in other conventional studies when the road is not yet built, but is superior to the normal ratios in three important ways:

1. The benefits are based on what has already actually occurred (since the study highways are built), rather than what is estimated to occur if the corridors were built;

2. The benefits are based on actual 1995 traffic, and therefore are more accurate than benefits based on forecasted traffic;

3. The costs are actual costs rather than estimates.

Other than these differences, the ADHS benefit/cost ratios are similar to other highway feasibility studies where the analysis is conducted before the highway is built.

Life Cycle Benefit/Cost Approach

The 30-year construction period and limited historical traffic data complicates the process of presenting the study findings. Typically, study results are presented over the life cycle of the project, 20 or 30 years. The life cycle method sums the constant dollar value of all costs and benefits by the year they were incurred and discounts them by the Office of Management and Budget (OMB) discount rate of 7.0 percent. The results are then presented by a number of feasibility indicators that include:

- **Net Present Value** – All costs and benefits in future years are discounted back to the base year using the adopted discount rate. The future stream of discounted costs are subtracted from the future stream of discounted benefits. If the sum of the discounted benefits is greater than the sum of the discounted costs, the "net present value" is positive and the highway improvement is deemed to be "economically feasible" in terms of travel efficiency.

- **Discounted Benefit/Cost Ratio** – After the future streams of costs and benefits are discounted, the sum of the discounted benefits is divided by the sum of the discounted costs. If the result is 1.0 or greater, the highway improvement is "economically feasible" from a travel efficiency perspective.

- **Internal Rate of Return** - This calculation determines that discount rate at which the net present value difference between costs and benefits is zero. If the rate of return, expressed as a percentage, is equal to or greater than the adopted discount rate, then the highway improvement is deemed to be "economically feasible" in terms of travel efficiency.

Economic Impact/Cost Ratio

The value-added impacts estimated to accrue to the Appalachian Region are also divided by the costs to obtain an "Impact/Cost Ratio." In effect, this divides Regional Impacts by National Costs. Therefore, it is not a true benefit/cost, since the numerator beneficiary is different than the denominator who is paying the cost. Nevertheless, this ratio is useful in visualizing the extent to which federal funds are helping the Appalachian Region.

Chapter 3
HIGHWAY AND TRAFFIC ANALYSIS

This study addresses the question "To what extent have the ADHS corridors that are already built and open to traffic attained their economic objectives? To answer this question, the study identified and documented those ADHS corridors that were principally complete.

This Chapter describes the corridors that are included in the study in terms of location, their physical and operational characteristics before and after the ADHS improvements, and the traffic which uses the ADHS highways. These physical and operational characteristics provide the basis for the economic analyses.

ADHS CORRIDORS INCLUDED IN STUDY

The 26 ADHS corridors are in various stages of completion, ranging from only partially complete to being almost complete. In other words, the study could not simply examine the entire system or those corridors that are complete. At the same time, a process was needed that would not unfairly distort the study results.

Corridor Selection Criteria

To determine which corridors were most appropriate for analysis, one single criterion was selected. That is:

Corridor Selection Criterion

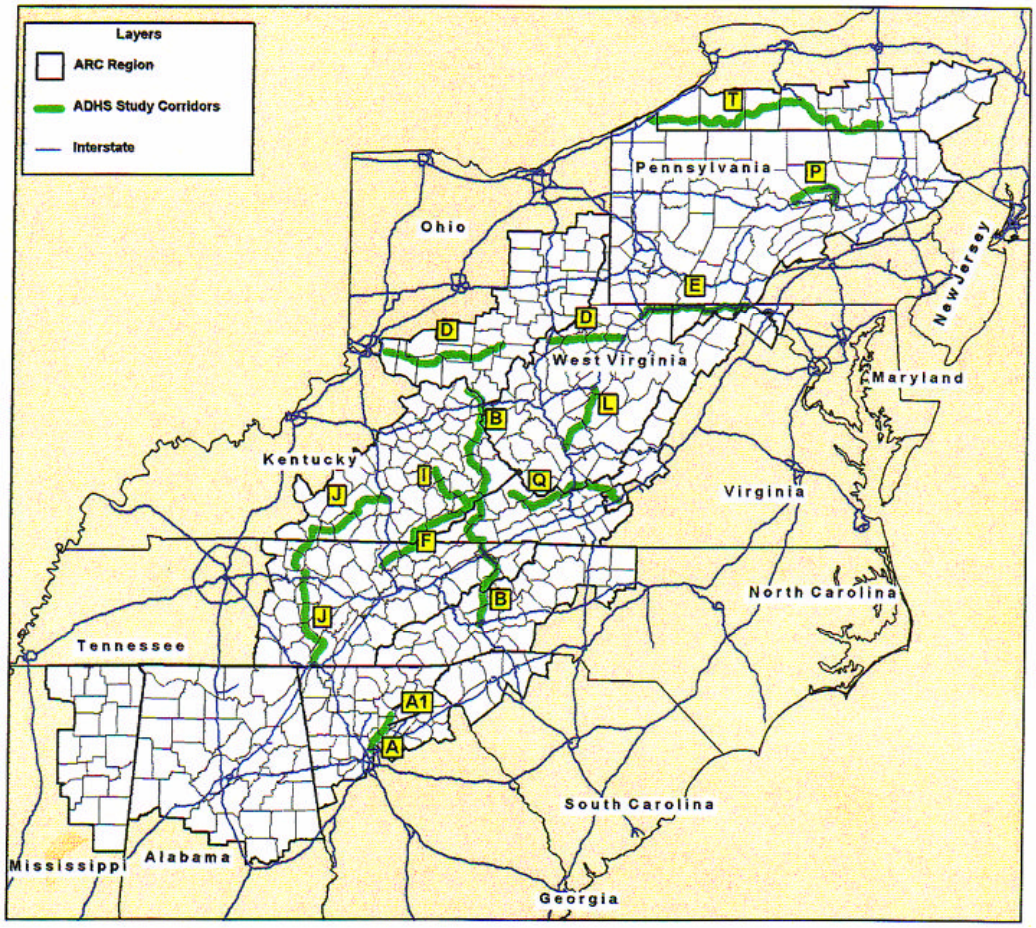
> Each ADHS highway corridor that, end-to-end, was 75% or more complete (in terms of total corridor length) as of January 1, 1995, was selected for inclusion in the study.

Within this criterion it is recognized that each corridor is not 100 percent complete. As a result, the highway sections that were not built prior to 1995 were also excluded from the analysis. In this way only the sections built and open to traffic by January 1, 1995, were included for both cost and economic evaluation purposes.

The Studied ADHS Corridors

Upon examination, it was determined that twelve of the 26 ADHS highway corridors met the 75 percent completion criterion. These are located in 10 of the 13 states in the ARC Region--Georgia, Kentucky, Maryland, New York, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia and West Virginia. The selected twelve ADHS corridors included in the study are shown on **Exhibit 3-1** and are as follows:

Exhibit 3-1
Study Corridors
Appalachian Development Highway Systems



Study Corridors

- A/A-1 in Georgia
- B in North Carolina, Tennessee, Virginia and Kentucky
- D in Ohio and West Virginia
- E in West Virginia and Maryland
- F in Tennessee and Kentucky
- I in Kentucky
- J in Kentucky and Tennessee
- L in West Virginia
- P in Pennsylvania
- Q in Virginia and West Virginia
- T in Pennsylvania and New York

But even these corridors are not completely built. Documentation review determined which sections of which corridors were built prior to 1995. Only these sections are included in the study. The final "Study Corridors" include only those portions of the selected ADHS corridors that were completed and open to traffic before 1995. **Exhibit 3-2** identifies the final Study Corridors in terms of beginning and ending points and mileage. This exhibit indicates that this study focuses on 1,417.8 miles (47%) of the total envisaged ADHS system of 3,025 miles.

Corridor Descriptions

The twelve ADHS corridors are depicted on **Exhibits 33** through **3-13**. Those segments colored green are the segments that are included in the cost and economic impact calculations. Those segments colored orange are in the corridor but were not included in the analysis either because they were not built prior to 1995 or because they were built using other than ARC funds. By making these exclusions, the study was able to focus only in those highway sections that were built prior to 1995 using Appalachian Regional Commission administered funds.

The With and Without ADHS Scenarios

In order to estimate the economic impacts due to the ADHS, it is necessary to compare the "with ADHS" situation to the "without ADHS" situation. In other words, what is quantified and measured in this study is the economic difference between what occurred with the ADHS compared with what would have occurred without the ADHS.

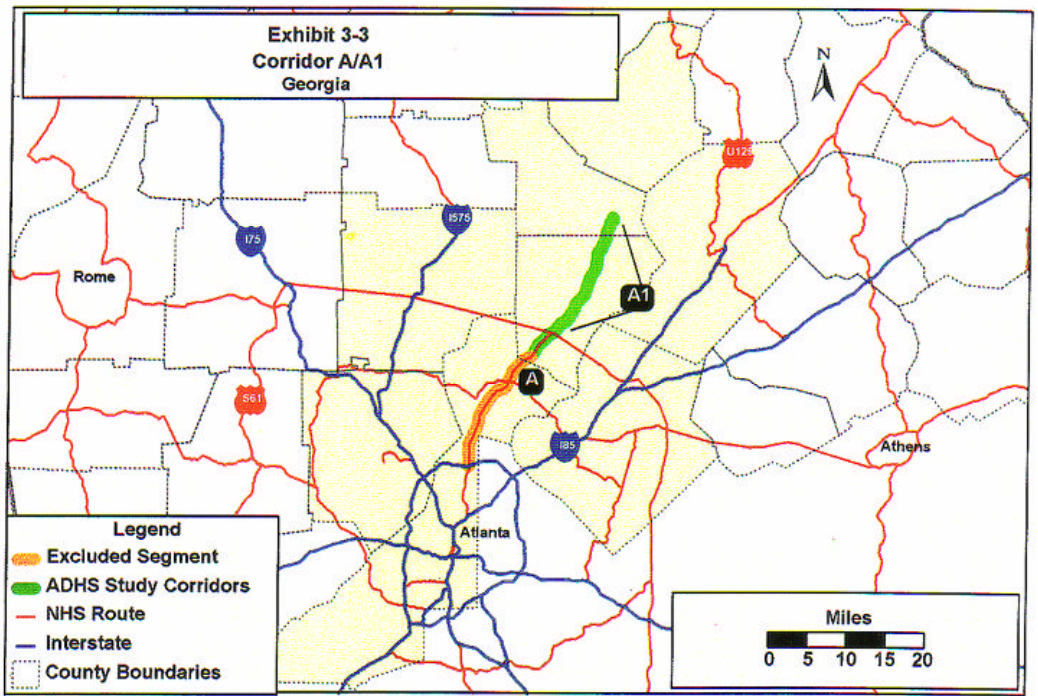
With ADHS Scenario - The highways are already built. Therefore, the "with ADHS" scenario is the 1995 existing highway system and that system's land use and traffic level. The with ADHS scenario includes the highways on **Exhibits 3-3** through **3-13** listed as "With ADHS Improvements."

Exhibit 3-2
ADHS CORRIDORS INCLUDED IN THIS ECONOMIC STUDY

Study Corridors	States	From	To	Miles Studied
A & A-1	Georgia	Forsyth County Line, GA	GA 60, South of Dahlonega, GA	30.4
B	North Carolina, Tennessee, Virginia and Kentucky	I-40, Asheville, NC	Ohio River Crossing South of Portsmouth, OH	249.4
D	Ohio and West Virginia	Batavia, OH	Meigs/Athens Co. Line, OH	189.8
		I-77, Parkersburg, WV	I-79 Clarksburg, WV	
E	West Virginia And Maryland	I-79, Morgantown, WV	I-70, Hancock, MD	109.2
F	Tennessee and Kentucky	I-75, Caryville, TN	Corridor B (US 23) at Jenkins, KY	99.3
I	Kentucky	Corridor F (US 119) at Whitesburg, KY	State Route 30 at Jackson, KY	59.9
J	Tennessee and Kentucky	I-124, Chattanooga, TN	Cookeville, TN Near I-40	214.5
		8 mi. South of Gainsboro, TN	I-75 at London, KY	
L	West Virginia	I-77 at Beckley, WV	I-79 at Sutton, WV	60.5
P	Pennsylvania	I-80, Near Lock Haven, PA	I-80 near Milton, PA	54.7
Q	Virginia and West Virginia	West of Grundy, VA	I-81 at Christiansburg, VA	129.8
T	Pennsylvania and New York	I-90 near Erie, PA	I-81 at Binghamton, NY	220.3
	Total Miles			1,417.8

"Without ADHS Scenario" – The more difficult challenge was to visualize the highway system and traffic levels that would exist today in each corridor region if the ADHS had never been built. This "without ADHS" scenario was deemed to be the existing 1995 regional highway system excluding the ADHS improvement. In other words, the old roads or highways prior to the ADHS, are suitably maintained. These are described on **Exhibits 3-3** through **3-13** as "Without ADHS Improvements." Considerable effort was expended to properly define the "old road" that existed prior to the ADHS.

This study's estimates of economic benefits and economic costs believed attributable to the ADHS represent the benefit and impact differences between the "With ADHS" and "Without ADHS" highway scenarios.

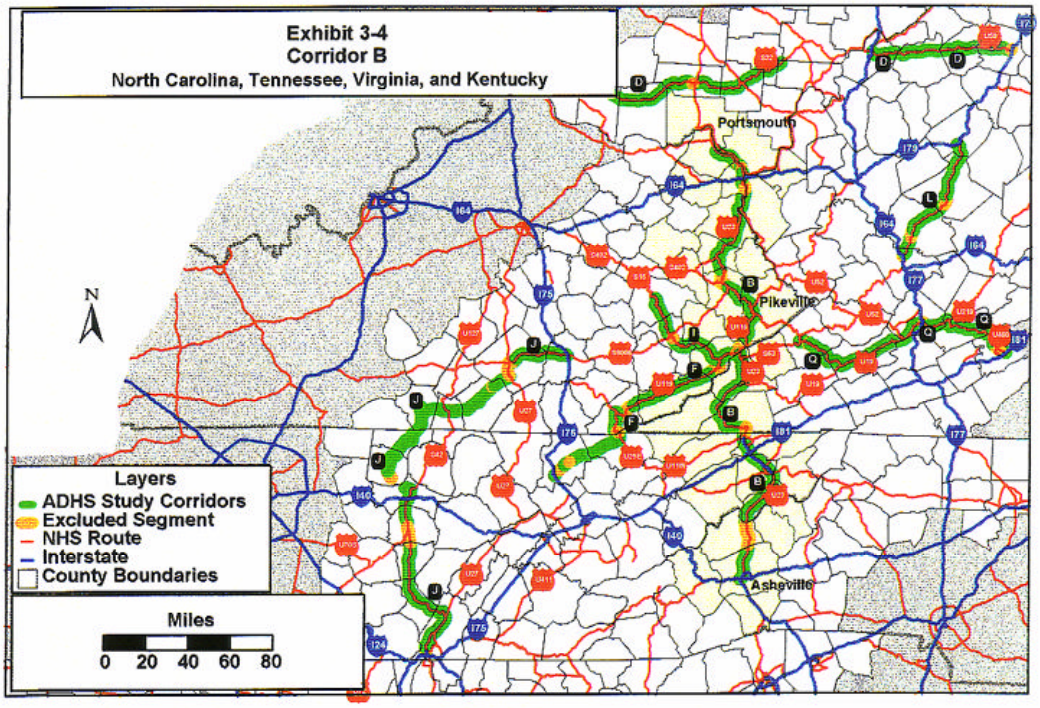


With ADHS Improvements

- Georgia: GA 400 from Forsyth Countyline north to GA 60 south of Dahlonega (includes a section constructed with APL funds as a local access road from GA 53 to GA60).

Without ADHS Improvements

- Georgia: Georgia Route 9 from Forsyth Countyline to Georgia Route 141 (junction with Corridor A1 south of Cumming); Georgia Route 9 from Georgia Route 141 (junction with Corridor A) north to Georgia Route 60.



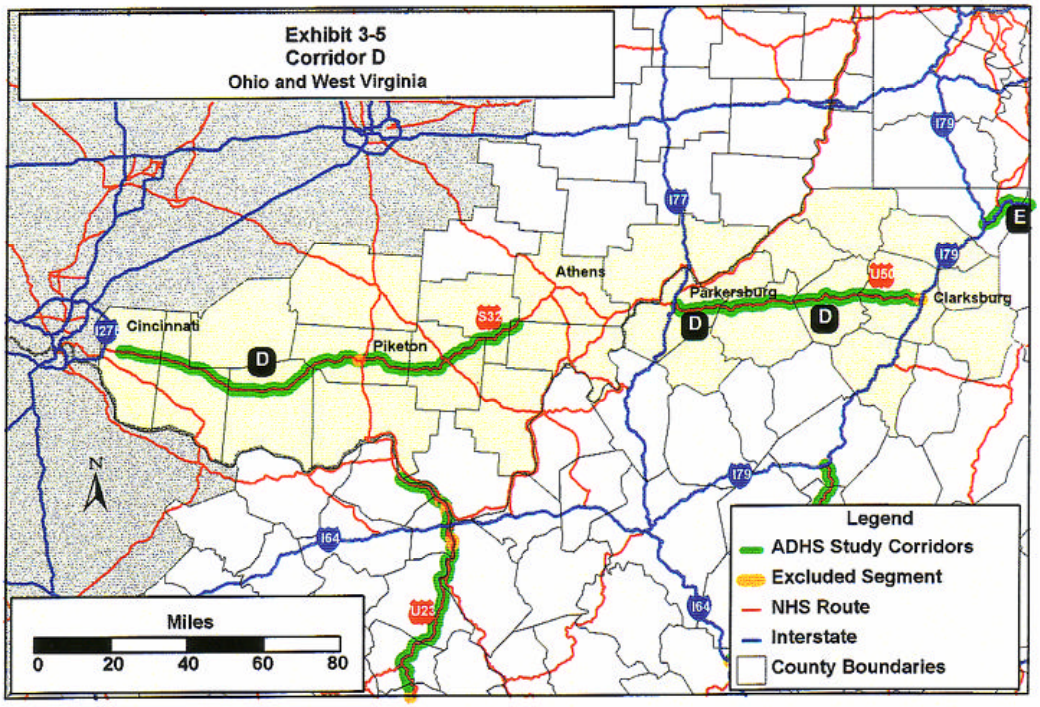
With ADHS Improvements

- North Carolina: US 19/23 From I-40 at Asheville, North Carolina north to Tennessee.
- Tennessee: US23 and I-181 at Johnson City-Kingsport to Virginia
- Virginia: US 23 to Kentucky.
- Kentucky: US23/119 through Pikeville, via KY 80 to Prestonburg, via US 23/460 to Paintsville, and via US 23 to Ohio River Crossing at Portsmouth, Ohio.

Without ADHS Improvements

- North Carolina: Business US 19/23 from I-40 at Asheville north to Mars Hill; US 23 from Mars Hill north to the Tennessee State line at Sam's Gap.
- Tennessee: US 23 from the North Carolina State line at Sam's Gap north to Kingsport at the Virginia State line.
- Virginia: US 23 from the Kingsport at the Tennessee State line north to Pound at the Kentucky State line.
- Kentucky: US 23/US 119 from Jenkins at the Virginia State line to the junction with US460/Ky Route 80 (Corridor Q) at Pikeville; US 460/US119/US23/Ky Route 80 from junction with corridor Q at Pikeville north to junction with US 119 (Corridor G) north of

Pikeville; US 460/US23/Ky Route 80 from Pikeville to junction with Ky. Route 80 at Prestonburg; US 460/US23 from Prestonburg north junction with US 460 at Paintsville; US 460 at Paintsville north to junction with Corridor B1 at Greenup at Ohio State line.



With ADHS Improvements

Study Corridor is divided into two segments: one in Ohio and another in West Virginia which are separated by a 25 mile gap between Athens, Ohio and Parkersburg, West Virginia.

- Ohio: From I-275 at Cincinnati, Ohio via Ohio Route 32 to Piketon then via Ohio Route 32/124 to jct. with US 50 west of Albany, Ohio and via US 50 to intersection with Ohio 56 at eastern limits of Athens, Ohio. (Includes a 6.5 mile section under construction at Piketon from Ohio Route 104 east to Ohio Route 220. Existing Ohio Route 32 provides alternative routing for continuity.

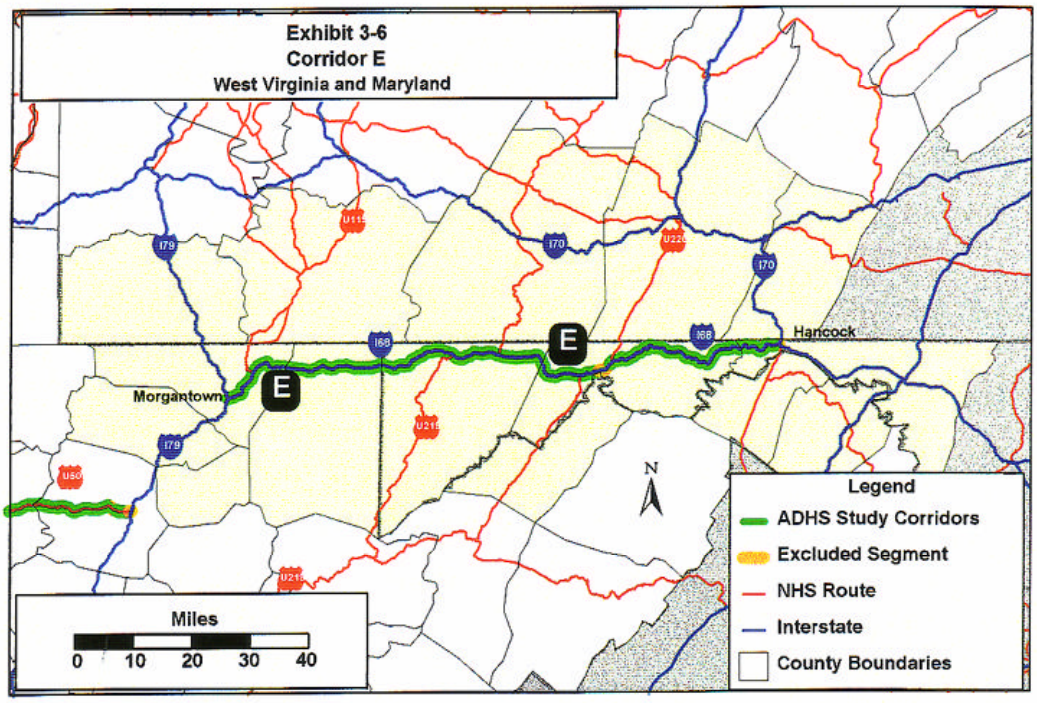
- West Virginia: From I-77 west of Parkersburg, West Virginia via US 50 to I -79 at Clarksburg, West Virginia.

Without ADHS Improvements

- Ohio: Ohio Route 32 from Ohio Route 132 at Batavia to Ohio Route 74 at Andersonville (this is identified as Route 74 on older maps and as Route 32 on more recent maps); Ohio Route 74 (Route 32 ?) From Andersonville eastward to Ohio Route 73 southeast of Locust Grove; Ohio Route 73 from Locust Grove to Ohio Route 772 at Rardon; Ohio Route 772 from Rardon to Ohio Route 112 at Jasper; Ohio Route 112 north to Ohio Route 124 west of Piketon; Ohio Route 124 east to junction with Ohio Route 689 at Wilkesville; Ohio Route 689 north to junction with Ohio Route 143 at Mt. Blanco (recent maps show Route 143 as Route 346); Ohio

Route 143 (Route 346 ?) northeast to junction with US 50 west of Albany; US 50 from Albany to Athens.

- West Virginia: US 50 from WV Route 47 at Parkersburg east to US 19 at Clarksburg.



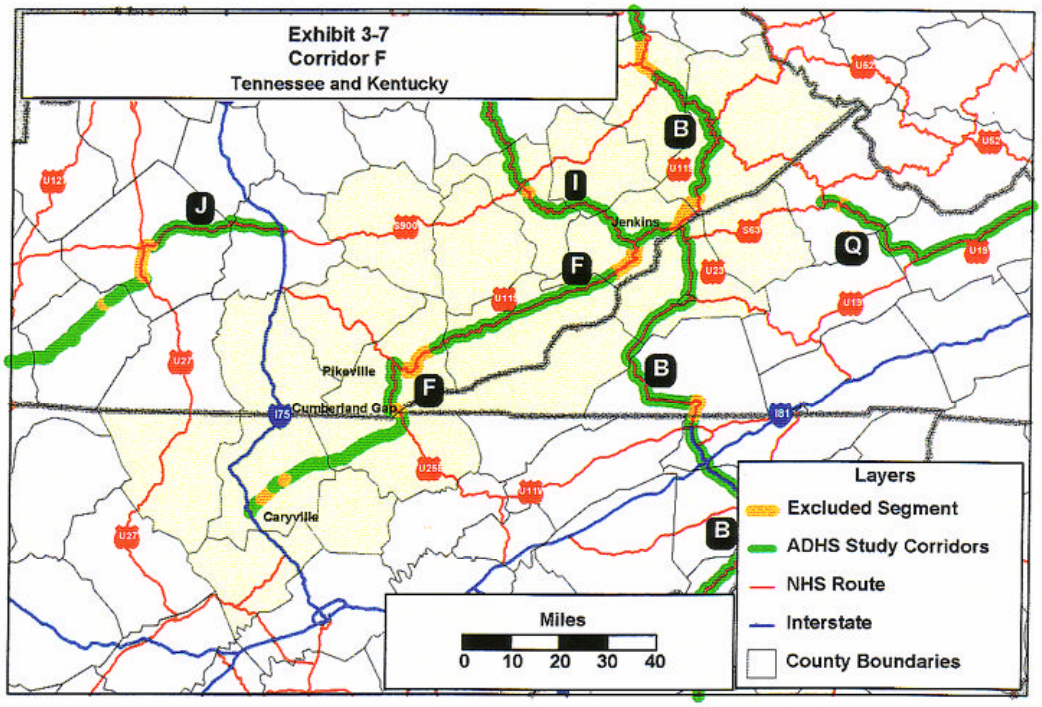
With ADHS Improvements

- West Virginia: From I -79 at Morgantown, West Virginia via I-68 (US 40) to I-70 at Hancock, Maryland.

Without ADHS Improvements

- West Virginia: US 119/ WV Route 73 from WV Route 92 at Morgantown east to junction with US 119 at Easton; WV Route 73 east to junction with WV Route 26 at Bruceton Mills; WV Route 26 north to WV Route 281 at Brandonville; WV Route 281 northeast to junction with US 40 in Pennsylvania; US 40 (in Pennsylvania) into Maryland.

- Maryland: US 40 from Pennsylvania State line east to junction with Maryland Route 522 at Hancock.



With ADHS Improvements

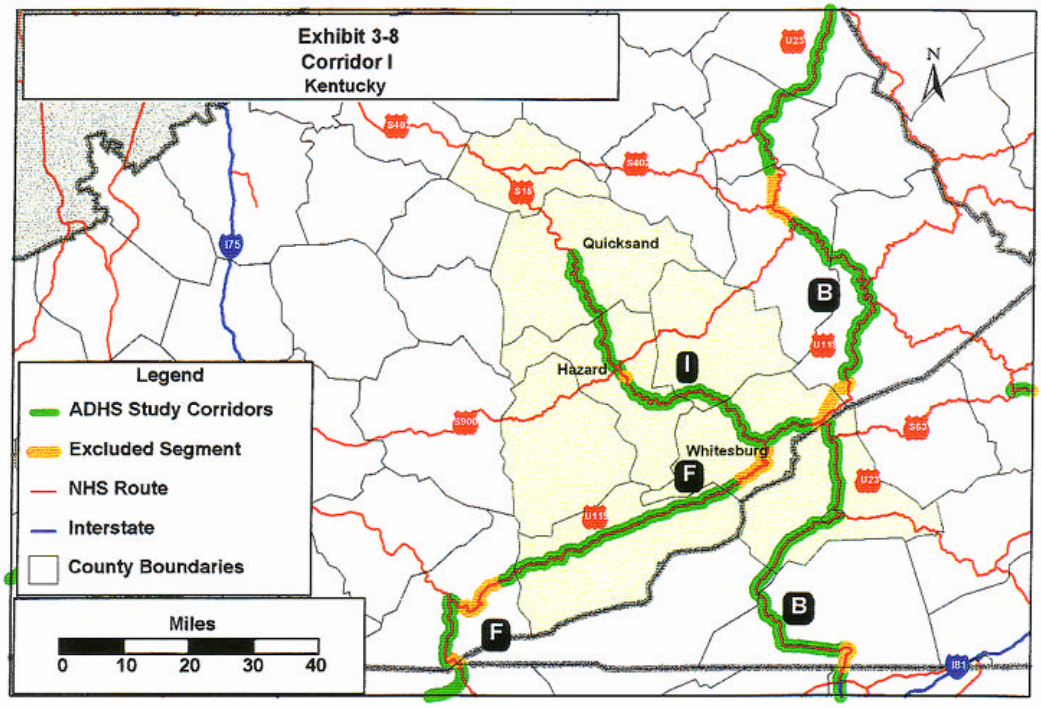
- Tennessee: From I -75 at Caryville, Tennessee via US 25W to Tenn. Route 63 @ LaFollette, via Tenn. Route 63 to Tenn. Route 32/US 25E and then via Tenn. Route 32/US 25E to Cumberland Gap at Kentucky State line. Projects in Tennessee from La Follette east to US 25E, a 30 mile section, have been built to 2 lanes with future widening planned to 4 lanes.

- Kentucky: From Cumberland Gap via US 25E to US 119 at Pineville, Kentucky and then via US 119 to Corridor B (US 23) at Jenkins, Kentucky. An unbuilt section for 14.5 miles from Pine Mountain to Whitesburg in Kentucky is planned for widening of shoulders and additions of climbing lanes along the existing US 119.

Before ADHS Improvements

- Tennessee: US 25 W from junction with Tennessee Route 63 in Caryville eastward to junction with US 25W at LaFollette; Tennessee Route 63 from LaFollette eastward to junction with US 25E at Patterson Crossroads; US 25E north to the Cumberland Gap at the Kentucky State line.

- Kentucky: US 25E from the Cumberland Gap at Middlesboro eastward to junction with US 119 at Pineville; US 119 east from Pineville to US 23 at Jenkins near the Virginia State line.

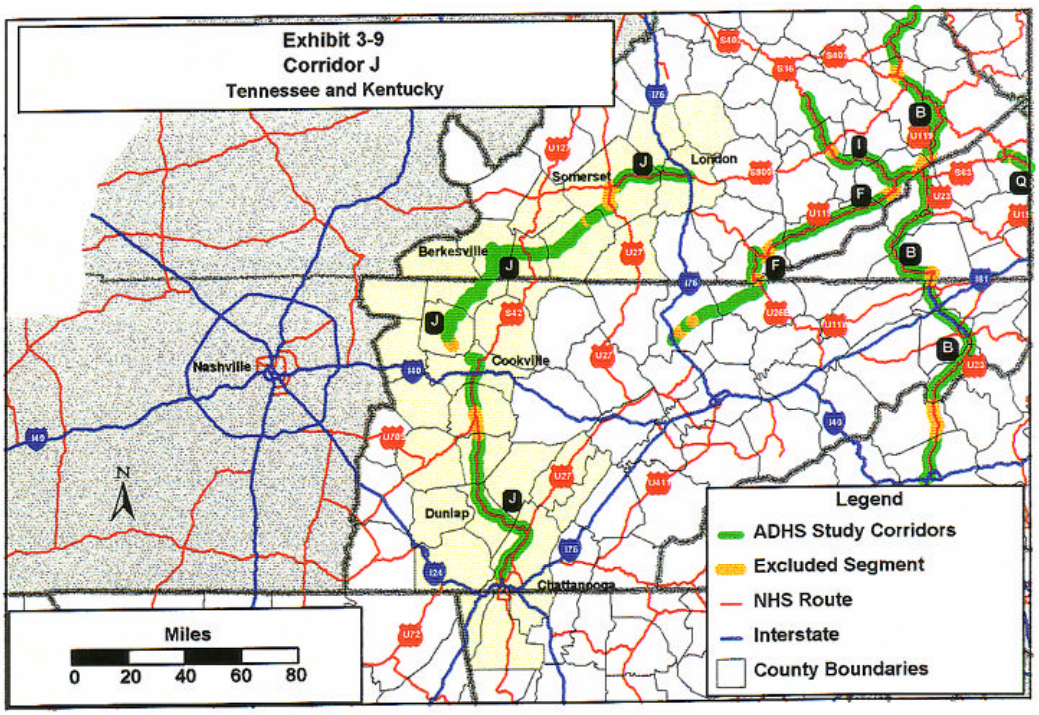


With ADHS Improvements

- Kentucky: From Corridor F (US 119) at Whitesburg, Kentucky via Kentucky Route 15 to Kentucky Route 30 south of Jackson, Kentucky. Length is 60.5 miles. Remainder of Corridor I in Kentucky is an "Adequate" section built with other funds from Jackson to I-64 at Winchester.

Before ADHS Improvements

- Kentucky: Kentucky Route 15 northwest to junction with Kentucky Route 28 at Darfork (north of Hazard); Kentucky Route 28 northwest to junction with Kentucky Route 267 at Clemons; Kentucky Route 267 north to junction with Kentucky Route 15 at Stacy; Kentucky Route 15 northwest to junction with Kentucky Route 30 at Jackson.



With ADHS Improvements

- Tennessee: From I-124 at Chattanooga, Tennessee north via US 27 to Soddy-Daisy, northwest via Tenn. Route 111 to Dunlap, and Tenn. Route 8/111 to Cookville north of I-40 (this segment includes sections with 2 of ultimate 4 lanes complete and open to traffic); From Tenn. Route 56 (north of Jackson County line) via Tenn. Route 56 to Gainsboro and Tenn. Route 53 to the Kentucky State Line. There is 9.7 mile gap on the corridor between north limit at Cookeville to Tenn. Route 56 north of Putnam-Jackson County Line where construction of corridor is planned on new location. This segment includes sections with 2 of ultimate 4 lanes complete and open to traffic.

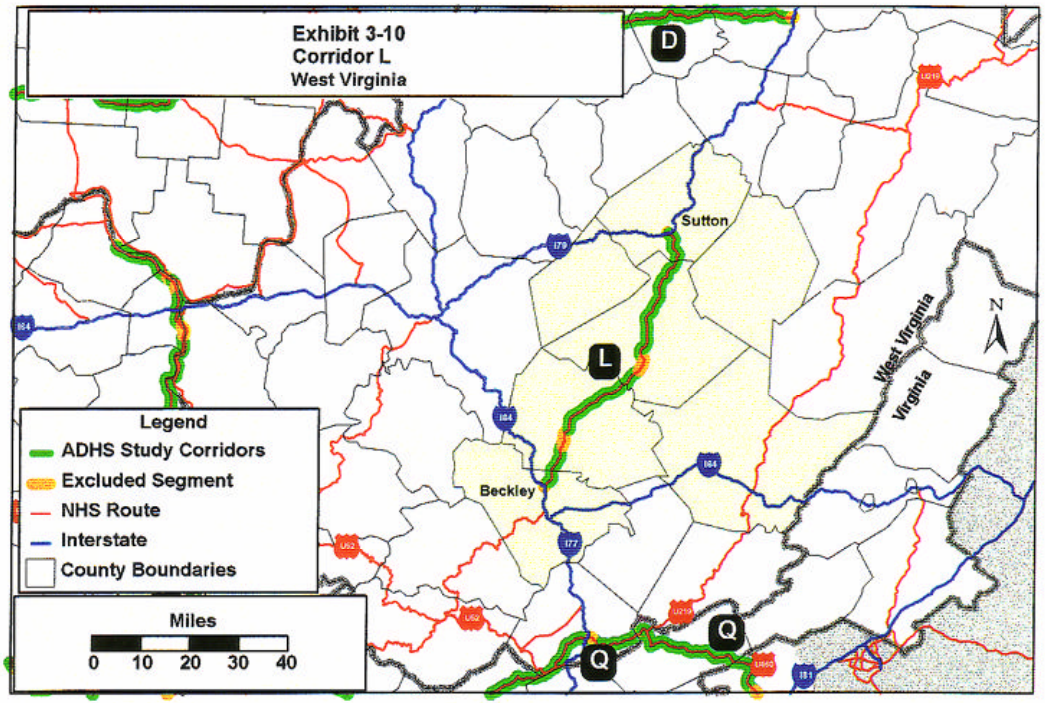
- Kentucky: From Tennessee State line via north Ky. Route 61 to Burkesville, east and north via Ky. Route 90 to Somerset, east via Ky. Route 80 to I-75 at London, Kentucky.

Without ADHS Improvements

- Tennessee (Southern Section): US 127/Tennessee Route 8 from junction with US 27 in Chattanooga north to junction with Tennessee Route 28 near Center Point; Tennessee Route 8/28 north to junction with Tennessee Route 8 north of Dunlap; Tennessee Route 8 north to junction with Tennessee Route 111 at Cagle; Tennessee Route 111 north to junction with Kentucky Route 30 at Spencer; Tennessee Route 111 north to junction with US 70S at Doyle (south of Sparta); US 70S north to Tennessee Route 42 at Sparta; Tennessee Route 42 north to Tennessee Route 136 at Cookeville; Tennessee Route 136 north to junction with Tennessee Route 290; Tennessee Route 290 northwesterly to Tennessee Route 56 (unbuilt section); Tennessee Route 56 north to McCoinsville, south of Gainsboro (unbuilt section).

- Tennessee (Northern Section): Tennessee Route 56 at McCoinsville north to junction with Tennessee Rout 53 at Gainsboro; Tennessee Rout 53 north to the Kentucky State line.

- Kentucky: Kentucky Route 61 north to Kentucky Route 90 at Burkesville; Kentucky Route 90 at Burkesville east to Kentucky Route 55 near Seminary; Kentucky Route 55 to US 127 (shown as Kentucky 35 on older maps) at Ida; US 127 (Kentucky Route 35) to Kentucky Route 90; Kentucky Route 90 to junction with US 27 near Burnside; US 27 north to junction with Kentucky Route 80 at Somerset; Kentucky Route 80 east to junction with US 150 near London.

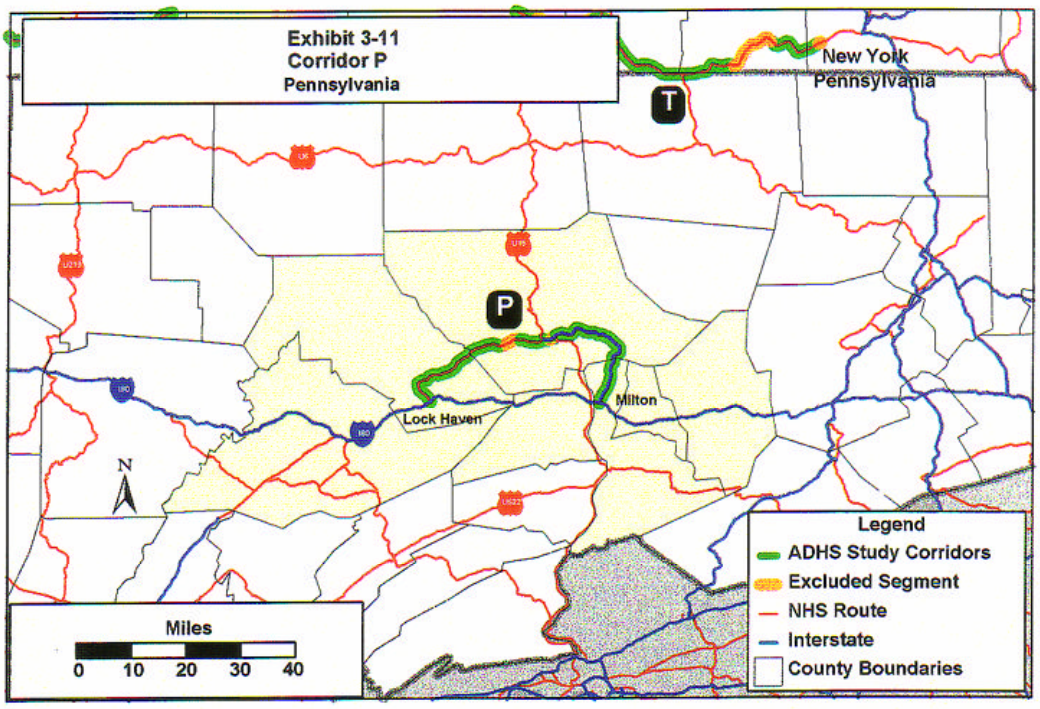


With ADHS Improvements

- West Virginia: From I-77 at Beckley, W. Virginia via US 19 to I-79 at Sutton, W. Virginia. Length - 69.9 miles.

Without ADHS Improvements

- West Virginia: WV Route 16 at Prosperity north to US 21 at Red Star; US 21 north to junction with US 60 at Kanawha River near Cotton Hill; US 60 east to WV Route 41/ US 19 southeast of Lookout; WV Route 41/US 19 north to US 19 at Summerdale; US 19 north to WV Route 4 near Sutton.

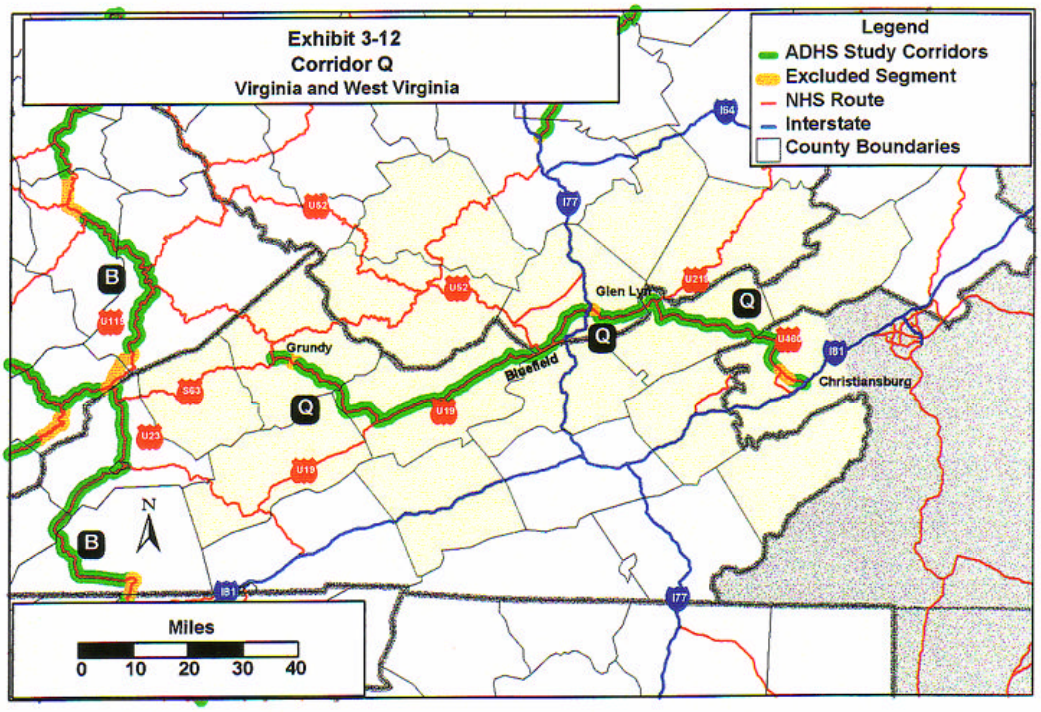


With ADHS Improvement

- Pennsylvania: From I-80 at Lock Haven, Pennsylvania eastward via US 220 and I-180 to I-80 and Milton, Pennsylvania. Length is 60.0 miles.

Without ADHS Improvements

- Pennsylvania: PA Route 880 north to PA Route 64 at Cedar Springs; PA Route 64 north to US 220 at Mill Hall; US 220 east to PA Route 147 at Pennsdale; PA Route 147 south to PA Route 405 near Milton.



With ADHS Improvement

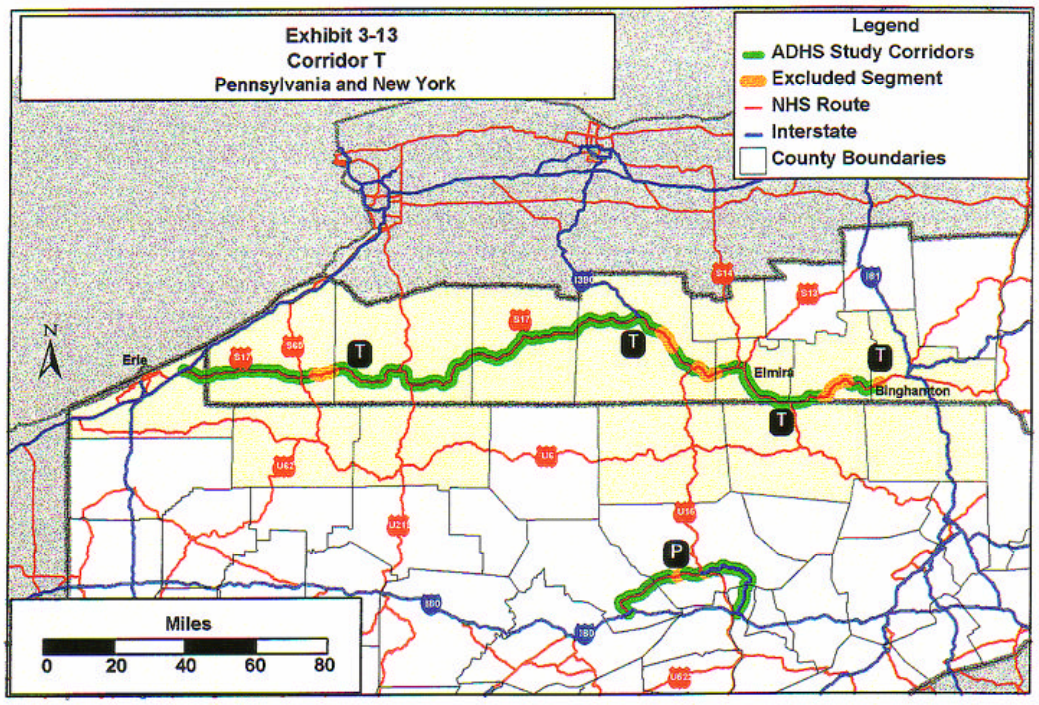
- Virginia: From Grundy, Virginia via US 19/460 to Bluefield at W. Virginia State line. From Glen Lyn at W. Virginia State line east via US 460 to I-81 at Christiansburg, Virginia.

- West Virginia: From Virginia State line at Bluefield via US 460 to Virginia State line at Glen Lyn.

Without ADHS Improvements

- Virginia: US 460 from Christiansburg to the West Virginia State line; US 460/19 from West Virginia State line to junction with US 19 at Claypool Hill; US 460 from Claypool Hill to junction with VA Route 83 at Grundy.

- West Virginia: US 460/WV Route 12 from Glen Lyn at the Virginia State line to junction with US460/219 at Oakvale; WV Route 12 to junction with US 19 (US 21 on old maps) southwest of Princeton; US 19 to Bluefield at the Virginia State line.



With ADHS Improvement

- Pennsylvania: From I-90 east of Erie Pennsylvania via Pa. Route 17 to New York State line (section was recently widened to 4 lanes with other than ADHS funds).

- New York: From Pennsylvania State line via New York Route 17 to I-81 at Binghamton, New York.

Without ADHS Improvements

- Pennsylvania: PA Route 430 to the New York State line.

- New York: NY Route 430 from Pennsylvania State line east to NY 302 at Sherman; NY 302 east to NY Route 94 at Chautauqua Lake; NY Route 94 across Chautauqua Lake to NY Route 17; NY Route 17 east to NY Route 16 at Olean; NY Route 16 to NY Route 408 at Hinsdale; NY Route 408 to NY 20 at Cuba; NY Route 20 to NY Routes 16/2 at Angelica; NY Route 2 to NY Route 70 at Hornell; NY Route 70 to NY Routes 15/415 at Avoca; NY Routes 15/415 to NY Route 17 at Painted Post; NY Route 17 to junction with NY Route 60 at Elmira; NY Routes 17/60 to US 11 at Binghamton.

CORRIDOR ANALYSES

Sources of Information

In order to assess the economic impacts resulting from the completed ADHS improvements, it is necessary to compare the physical and operational characteristics of the Study Corridors with and without the ADHS improvements. Three sources of information were used to develop data for each of the Study Corridors: (1) ARC's 1997 Cost-To-Complete Database and other data provided by ARC; (2) a questionnaire sent to State DOTs requesting before and after data for the Study Corridors; and (3) a travel model developed by Wilbur Smith Associates to estimate traffic and travel data not available from the other sources.

The ARC's 1997 Cost-To-Complete Database includes detailed information regarding the current (1995) status of the entire ADHS and the improvements necessary to complete the system. The ADHS is divided into more than 1,400 sections within the database. This database does provide useful information on the current physical characteristics of those Study Corridor sections that were completed before 1995. However, it contains very little historical information about the Study Corridors before any improvements were made.

To supplement the data available from ARC and, in particular, to obtain more data on the Study Corridors before the ADHS improvements were made, a survey questionnaire **(Exhibit 3-14)** was developed and sent to the State DOTs in the 10 states through which the Study Corridors pass. The State DOTs were very cooperative and responsive. All of the states had good and useful data on the existing (improved) Study Corridors. Most of the State DOTs, however, had little detailed historical data concerning the unimproved Study Corridors (the highways before the ADHS improvements were made). In those cases where detailed historical data was not available, the State DOTs were instructed to use professional judgment in estimating the missing data. Based on the experience of this study, it is recommended that the ARC collect information regarding the existing physical and operational characteristics of those ADHS corridor sections that have not yet been improved (for use in future studies).

Traffic Model

The two data sources described above provided traffic information for two points in time: 1965 and 1995. A travel model was developed by Wilbur Smith Associates to estimate the traffic and travel data required to analyze the economic impacts of the ADHS improvements to the Study Corridors, including:

- Opening year and 30th year auto and truck traffic for each Study Corridor section – the ADHS improvements within each Study Corridor were not all completed at the same time. To realistically compute economic benefits, auto and truck traffic estimates are needed for the year each Study Corridor section was first opened-to-traffic, and for the 30th year thereafter. The ADHS travel model estimates the opening year traffic volumes based on historical traffic counts. Traffic estimates for the 30th year are based on historical traffic growth, forecast future population growth, and forecast changes in vehicle-miles of travel per person.

Exhibit 3-14
Appalachian Development Highway System (ADHS)
Economic Benefit Study Questionnaire

State: **Corridor:** **Section:**
From: **To:**

Part 1: ***Description of the improved ADHS Corridor section in 1995***

(1)Area Type: ☐ Urban ☐ Rural
(2)Road Type: ☐ Freeway ☐ Prin Arterial ☐ Min Arterial ☐ Collector ☐ Local
(3)Access Control: ☐ Full Control ☐ Limited Access ☐ Controlled Access

(4)Length (x.x mi): ____ (5)Speed Limit (mph):
(6)Thru Lanes (#): ____ (7)Climbing Lanes (mi):
(8)Lane Width (ft): ____ (9)Median Width (ft): ____ (10)Shoulder Width (ft):

(11)Curvature (mi): ____ @0-2° ____ @3-6° ____ @7-9° ____ @10-14° ____ @>14°
(12)Grades (mi): ____ @0-5% ____ @6-7% ____ @8-9% ____ @10-11% ____ @>11%
(13)1995 AADT: ____ (14)1995 % Trucks:

(15)In what year was the last major ADHS roadway improvement to this section completed?
(16)Did the ADHS improvements to this section primarily involve: ☐ Improving an existing road, or
☐ Building a new road on new location?

Part II: ***Description of the road that 1995 traffic on the Corridor section described above would have used in 1995 if no ADHS improvements had been made:***

(17)Area Type: ☐ Urban ☐ Rural
(18)Road Type: ☐ Freeway ☐ Prin Arterial ☐ Min Arterial ☐ Collector ☐ Local
(19)Access Control: ☐ Full Control ☐ Limited Access ☐ Controlled Access
(20)Surface Type: ☐ Unpaved ☐ Paved

(21)Length (x.x mi): ____ (22)Speed Limit (mph):

(23)Thru Lanes (#): ____ (24)Climbing Lanes (mi):
(25)Lane Width (ft): ____ (26)Median Width (ft): ____ (27)Shoulder Width (ft):

(28)Curvature (mi): ____ @0-2° ____ @3-6° ____ @7-9° ____ @10-14° ____ @>14°
(29)Grades (mi): ____ @0-5% ____ @6-7% ____ @8-9% ____ @10-11% ____ @>11%

(30)1965 AADT: ____ (31)1965 % Trucks: ____ <-------- yes, we do want 1965 data here!

If the ADHS improvements for this section involved building a new road in a new location, please provide the following information for the **old road** through this corridor (ie, the road that 1995 section traffic would have used in 1995 if the new road had not been built):

(32)1995 Rte Num: ____ (33)1995 Rte Name:

(34)1995 AADT: ____ (35)1995 % Trucks: ____ Thank you very much for your help.

- Opening year and 30th year travel time/speed for each Study Corridor segment, with and without the ADHS improvements -- travel time/speed was estimated for each Study Corridor segment using the Highway Performance Monitoring System (HPMS) methodology and data developed by the FHWA. This methodology recognizes that travel time, due to congestion-induced speed change cycles, varies according to the level of congestion (expressed in terms of volume/capacity ratios) and varies by type of vehicle (that is to say, it takes longer for a truck to resume original speed).

Corridor Characteristics

The remainder of this chapter summarizes the physical and operating characteristics of the Study Corridors, with and without the ADHS improvements. For data collection and analysis, the Study Corridors were segmented into more than 500 sections. For the purposes of this report the data are summarized by Corridor and State.

Study Corridor Length and Opening Year -- **Exhibit 3-15** summarizes Study Corridor lengths with and without the ADHS improvements. As discussed earlier, these lengths exclude any Study Corridor segments that were not improved with ADHS funds, or were not open to traffic by 1995.

Altogether, the Study Corridors include approximately 1,417 miles of roadway that were constructed or improved using ADHS funds. The comparable roadway mileage in all Study Corridors without the ADHS improvements was about 1,478 miles. The ADHS improvements increased roadway mileage in some corridors and decreased mileage in others. As will be seen later, the major benefits of the ADHS improvements do not come from changes in overall corridor mileage, but from changes in number of lanes and design standards.

Exhibit 3-15 also shows the earliest year, the latest year and the average year that ADHS-improved road sections were opened to traffic within each Study Corridor. The open-to-traffic year is important in this study because it represents the first year that benefits can be generated for an improved roadway section. The earliest year improved sections were opened to traffic was 1967, while the latest were opened in 1995. Corridors F, I and P have been open to traffic the longest. Corridors B, E, L and T include sections that were opened very recently.

Number of Lanes and Lane Miles -- **Exhibit 3-16** shows the minimum, maximum and average number of roadway lanes for each Study Corridor with and without the ADHS improvements. Overall, the ADHS improvements increased the average number of lanes in the Study Corridors from 2.1 to 3.7. Most Study Corridor roadways were 2-lanes before the ADHS improvements, and 4-lanes after the ADHS improvements.

Also shown in Exhibit 3-16 is the mileage of climbing lanes with and without the ADHS improvements. Overall, the ADHS improvements increased the climbing lane mileage in the Study Corridors from 9 to 121 miles. In some cases (for example, Corridors B and P), climbing lanes that existed before the ADHS improvements were eliminated when the roadway section was widened.

Exhibit 3-15. Corridor Length With and Without ADHS Improvements and the Year Open to Traffic

		Studied Length (miles)		Year Open to Traffic		
Corridor	State	With	Without	Earliest	Latest	Average
A/A1	GA	30.4	28.5	1984	1984	1984
B	KY	116.2	129.3	1968	1992	1976
	NC	18.3	18.3	1968	1974	1971
	TN	57.4	55.9	1971	1995	1984
	VA	57.5	69.4	1968	1987	1976
	All of B	**249.4**	**272.8**	**1968**	**1995**	**1977**
D	OH	119.4	128.4	1969	1984	1976
	WV	70.4	75.0	1971	1978	1972
	All of D	**189.8**	**203.4**	**1969**	**1984**	**1975**
E	MD	77.0	77.3	1968	1993	1983
	WV	32.2	30.1	1974	1976	1975
	All of E	**109.2**	**107.4**	**1968**	**1993**	**1981**
F	KY	63.5	68.5	1973	1978	1975
	TN	35.8	36.6	1968	1977	1976
	All of F	**99.3**	**105.1**	**1968**	**1978**	**1975**
I	KY	59.9	63.4	1968	1972	1969
J	KY	93.7	99.4	1970	1984	1977
	TN	120.8	113.5	1973	1991	1983
	All of J	**214.5**	**212.9**	**1970**	**1991**	**1981**
L	WV	60.5	67.3	1971	1995	1980
P	PA	54.7	54.4	1969	1979	1973
Q	VA	103.0	108.8	1967	1986	1976
	WV	26.8	27.6	1967	1978	1975
	All of Q	**129.8**	**136.4**	**1967**	**1986**	**1976**
T	NY	213.5	218.4	1970	1994	1978

	PA	6.8	8.4	1986	1986	1986
	All of T	**220.3**	**226.8**	**1970**	**1994**	**1978**
Total (All Corridors)		**1,417.8**	**1,478.4**	**1967**	**1995**	**1977**

Exhibit 3-16. Number of Lanes and Lane Miles With and Without ADHS Improvements

		Number of Lanes With			Number of Lanes Without			Climbing Lanes (Miles)		Lane Miles	
Corridor	State	Min.	Max.	Avg.	Min.	Max.	Avg.	With	Without	With	Without
A/A1	GA	4	4	4.0	2	4	2.3	0.0	0.0	121.6	66.3
B	KY	2	4	4.0	2	2	2.0	0.0	1.1	463.2	258.5
	NC	4	8	4.2	2	4	3.7	0.0	0.0	76.0	66.9
	TN	4	4	4.0	2	4	2.5	1.9	0.4	229.6	138.7
	VA	4	4	4.0	2	4	2.1	0.0	2.4	230.0	146.8
	All of B	**2**	**8**	**4.0**	**2**	**4**	**2.2**	**1.9**	**3.8**	**998.8**	**610.8**
D	OH	4	4	4.0	2	2	2.0	0.0	0.0	477.6	256.9
	WV	4	4	4.0	2	2	2.0	0.0	0.0	281.6	149.9
	All of D	**4**	**4**	**4.0**	**2**	**2**	**2.0**	**0.0**	**0.0**	**759.2**	**406.8**
E	MD	4	4	4.0	2	2	2.0	51.7	0.0	308.0	154.5
	WV	4	4	4.0	2	2	2.0	10.0	0.0	128.8	60.3
	All of E	**4**	**4**	**4.0**	**2**	**2**	**2.0**	**61.7**	**0.0**	**436.8**	**214.8**
F	KY	2	4	2.4	2	2	2.0	6.0	0.0	155.0	136.9
	TN	4	4	4.0	2	2	2.0	0.0	0.0	143.2	73.3
	All of F	**2**	**4**	**3.0**	**2**	**2**	**2.0**	**6.0**	**0.0**	**298.2**	**210.2**
I	KY	2	4	2.3	2	2	2.0	17.0	0.0	140.4	126.7
J	KY	2	4	2.3	2	2	2.0	15.9	0.0	218.6	198.8
	TN	2	4	3.5	2	2	2.0	14.6	0.0	421.8	227.0
	All of J	**2**	**4**	**3.0**	**2**	**2**	**2.0**	**30.5**	**0.0**	**640.4**	**425.8**
L	WV	4	4	4.0	2	4	2.1	4.1	1.1	242.0	142.0
P	PA	4	4	4.0	2	4	2.1	0.0	4.1	218.8	115.1
Q	VA	4	4	4.0	2	2	2.0	0.0	0.0	412.0	217.6
	WV	4	4	4.0	2	4	2.1	0.0	0.0	107.2	58.9
	All of Q	**4**	**4**	**4.0**	**2**	**4**	**2.0**	**0.0**	**0.0**	**519.2**	**276.6**
T	NY	4	6	4.0	2	4	2.2	0.0	0.0	861.8	488.1
	PA	4	4	4.0	2	2	2.0	0.0	0.0	27.2	16.9
	All of T	**4**	**6**	**4.0**	**2**	**4**	**2.2**	**0.0**	**0.0**	**889.0**	**505.0**
Total (All Corridors)		**2**	**8**	**3.7**	**2**	**4**	**2.1**	**121.2**	**9.0**	**5264**	**3100.2**

The new lanes added by the ADHS improvements significantly increased the roadway lane-miles in the Study Corridors. As shown in Exhibit 3-16, total lane miles increased from 3,100 to 5,264, a 70% increase. The most significant increases occurred in Corridors A/A1, D, E, P and Q.

The ADHS improvements to the Study Corridor roadways are also reflected in the increased width of an average lane (**Exhibit 3-17**). Except for a portion of the Corridor T in New York, all Study Corridor roadways have been upgraded to a standard lane-width of 12 feet.

Roadway Classification -- Approximately 13% of the improved Study Corridor mileage is classified as urban, while 87% is rural. The overall mileage of urban and rural highways does not change much with and without the ADHS improvements. However, as shown in **Exhibit 3-18**, the ADHS improvements increased lane miles in urbanized areas from 478 to 752, or by 57%. Rural lane miles increased from 2,622 to 4,512, or by 72%.

Exhibit 3-19 describes the Study Corridors, with and without the ADHS improvements, in terms of roadway type. Most significant is the increase in freeway lane miles, which increases from 0 to 1,202 miles with the ADHS improvements. Arterial lane miles increased from 2,182 to 4,062, or by 86%.

Speed Limits -- A summary of minimum, maximum and average posted speed limits with and without the ADHS improvements is presented in **Exhibit 3-20**. Overall, the ADHS improvements have increased the average posted speed limit in the Study Corridors by 10 miles per hour, or more than 20%. This increase is the obvious result of the higher design standards used for the ADHS improvements.

Roadway Curvature and Grades -- The higher design standards used for the ADHS improvements also resulted in less severe curves and grades within the Study Corridors. **Exhibit 3-21** shows the percentage of Study Corridor roadway mileage by degree of curvature and the weighted average degree of curvature, with and without the ADHS improvements. Overall, the average degree of curvature for all corridors was reduced from 2.9 to 2.1.

Exhibit 3-22 shows the percentage of Study Corridor roadway mileage by percent grade and the average percent grade, with and without the ADHS improvements. Overall, the average grade for all corridors was reduced from 3.2% to 3.0%. In comparing the curvature and grade data, it appears that the grade problems were not as severe as the curvature problems. Consequently, the ADHS improvements should be expected to have more impact on the curvature problems.

Exhibit 3-21. Roadway Curvature With and Without ADHS Improvements

		Percent Roadway mileage by Curvature (degrees)										AverageCurvature (Degrees)	
		0-2°		3-6°		7-9°		10-14°		Over 14°			
Corridor	State	With	Without	With	Without	With	Without	With	Without	With	Without	With	Without
A/A1	GA	59.8	30.0	11.0	60.8	22.5	5.8	5.7	3.5	1.0	0.0	3.7	3.9
B	KY	91.4	87.3	6.2	6.3	1.5	2.9	1.0	1.8	0.0	1.6	1.4	1.9
	NC	71.1	71.1	28.9	28.9	0.0	0.0	0.0	0.0	0.0	0.0	2.0	2.0
	TN	50.5	55.2	0.5	0.2	9.5	4.0	6.9	1.4	32.4	39.2	7.3	7.3
	VA	82.3	87.7	15.5	3.9	2.3	5.8	0.0	0.0	0.0	2.6	1.7	1.9
	All of B	**78.4**	**79.7**	**8.7**	**6.0**	**3.4**	**3.7**	**2.0**	**1.2**	**7.5**	**9.5**	**2.9**	**3.0**
D	OH	96.1	84.3	3.9	8.7	0.0	1.4	0.0	0.7	0.0	4.9	1.1	2.2
	WV	79.1	58.1	20.7	28.3	0.3	6.7	0.0	4.5	0.0	2.4	1.7	3.3
	All of D	**89.8**	**74.6**	**10.1**	**15.9**	**0.1**	**3.4**	**0.0**	**2.1**	**0.0**	**4.0**	**1.4**	**2.6**
E	MD	52.7	44.9	31.9	31.3	15.4	8.5	0.0	6.1	0.0	9.3	3.2	4.8
	WV	87.2	69.9	12.8	22.0	0.0	3.0	0.0	2.7	0.0	2.3	1.4	2.6
	All of E	**62.9**	**51.9**	**26.3**	**28.7**	**10.9**	**7.0**	**0.0**	**5.2**	**0.0**	**7.3**	**2.7**	**4.2**
F	KY	93.3	89.4	5.3	7.1	1.3	2.0	0.1	0.9	0.0	0.5	1.3	1.6
	TN	64.4	62.5	19.6	8.4	6.5	8.1	4.3	5.4	5.3	15.6	3.4	4.8
	All of F	**82.9**	**80.1**	**10.5**	**7.5**	**3.1**	**4.1**	**1.7**	**2.5**	**1.9**	**5.8**	**2.1**	**2.7**
I	KY	75.9	67.5	14.7	14.2	7.5	10.6	1.3	2.8	0.6	4.8	2.3	3.3
J	KY	97.1	79.7	2.1	5.6	0.8	4.6	0.0	3.1	0.0	7.0	1.1	2.9
	TN	85.0	74.9	13.5	22.5	0.5	1.0	1.0	1.7	0.0	0.0	1.6	2.0
	All of J	**90.3**	**77.1**	**8.5**	**14.6**	**0.6**	**2.6**	**0.6**	**2.4**	**0.0**	**3.3**	**1.4**	**2.4**
L	WV	91.3	70.8	8.7	11.8	0.0	9.8	0.0	4.2	0.0	3.4	1.3	3.1
P	PA	96.3	89.4	3.7	5.3	0.0	3.7	0.0	0.5	0.0	1.0	1.1	1.7
Q	VA	86.3	84.2	11.7	9.4	0.9	3.1	1.1	1.7	0.0	1.7	1.6	2.0

	WV	73.8	84.8	25.5	3.9	0.7	4.6	0.0	4.2	0.0	2.4	1.9	2.3
	All of Q	**83.7**	**84.3**	**14.6**	**8.3**	**0.9**	**3.4**	**0.8**	**2.2**	**0.0**	**1.8**	**1.7**	**2.0**
T	NY	48.4	36.0	44.7	46.3	7.0	17.8	0.0	0.0	0.0	0.0	3.1	3.9
	PA	100.0	94.5	0.0	3.9	0.0	0.4	0.0	0.8	0.0	0.4	1.0	1.3
	All of T	**50.0**	**38.1**	**43.3**	**44.7**	**6.8**	**17.1**	**0.0**	**0.0**	**0.0**	**0.0**	**3.0**	**3.8**
All Corridors		**77.6**	**69.2**	**16.4**	**18.2**	**3.7**	**6.4**	**0.8**	**2.0**	**1.5**	**4.3**	**2.1**	**2.9**

Exhibit 3-22. Roadway Grades With and Without ADHS Improvements

		Percent Roadway Mileage by Grade (percent)										Avg. Grade (percent)	
		0-5%		6-7%		8-9%		10-11%		Over 11%			
Corridor	State	With	Without	With	Without	With	Without	With	Without	With	Without	With	Without
A/A1	GA	90.3	77.5	6.4	22.5	3.3	0.0	0.1	0.0	0.0	0.0	3.0	3.4
B	KY	95.4	95.2	4.6	3.0	0.0	1.8	0.0	0.0	0.0	0.0	2.7	2.7
	NC	96.3	93.2	3.7	6.8	0.0	0.0	0.0	0.0	0.0	0.0	2.6	2.8
	TN	100.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	2.5
	VA	86.6	84.3	10.4	6.2	3.0	9.0	0.0	0.4	0.0	0.0	3.1	3.3
	All of B	**94.5**	**93.3**	**4.8**	**3.5**	**0.7**	**3.1**	**0.0**	**0.1**	**0.0**	**0.0**	**2.7**	**2.8**
D	OH	97.5	85.3	2.5	7.8	0.0	6.0	0.0	0.1	0.0	0.8	2.6	3.3
	WV	100.0	93.2	0.0	6.7	0.0	0.2	0.0	0.0	0.0	0.0	2.5	2.8
	All of D	**98.4**	**88.2**	**1.6**	**7.4**	**0.0**	**3.9**	**0.0**	**0.0**	**0.0**	**0.5**	**2.6**	**3.1**
E	MD	65.7	64.3	21.9	23.6	6.8	7.2	5.6	4.9	0.0	0.0	4.2	4.3
	WV	92.8	70.5	7.2	23.7	0.0	5.7	0.0	0.0	0.0	0.0	2.8	3.8
	All of E	**73.6**	**66.1**	**17.6**	**23.6**	**4.8**	**6.7**	**4.0**	**3.6**	**0.0**	**0.0**	**3.8**	**4.1**
F	KY	88.4	86.5	11.6	11.3	0.0	2.2	0.0	0.0	0.0	0.0	3.0	3.1
	TN	100.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	2.5
	All of F	**92.6**	**91.2**	**7.4**	**7.4**	**0.0**	**1.4**	**0.0**	**0.0**	**0.0**	**0.0**	**2.8**	**2.9**
I	KY	74.9	66.8	16.7	16.1	8.3	13.9	0.0	3.2	0.0	0.0	3.7	4.2
J	KY	81.5	82.3	18.5	6.0	0.0	9.9	0.0	1.8	0.0	0.0	3.2	3.5
	TN	89.7	89.4	10.3	10.6	0.0	0.0	0.0	0.0	0.0	0.0	2.9	2.9
	All of J	**86.1**	**86.0**	**13.9**	**8.5**	**0.0**	**4.6**	**0.0**	**0.8**	**0.0**	**0.0**	**3.1**	**3.2**
L	WV	97.2	84.0	2.8	15.7	0.0	0.1	0.0	0.1	0.0	0.0	2.6	3.1
P	PA	99.8	96.7	0.2	2.8	0.0	0.5	0.0	0.0	0.0	0.0	2.5	2.6

Q	VA	88.8	86.6	10.4	12.3	0.4	0.8	0.0	0.3	0.4	0.0	3.0	3.1
	WV	98.5	98.2	1.5	1.8	0.0	0.0	0.0	0.0	0.0	0.0	2.6	2.6
	All of Q	**90.8**	**88.9**	**8.6**	**10.2**	**0.3**	**0.7**	**0.0**	**0.2**	**0.3**	**0.0**	**2.9**	**3.0**
T	NY	75.4	70.1	24.6	27.6	0.0	2.2	0.0	0.0	0.0	0.0	3.5	3.7
	PA	100.0	99.2	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	2.5	2.5
	All of T	**76.1**	**71.2**	**23.9**	**26.6**	**0.0**	**2.2**	**0.0**	**0.0**	**0.0**	**0.0**	**3.5**	**3.7**
All Corridors		**88.2**	**83.9**	**10.5**	**12.1**	**0.9**	**3.4**	**0.3**	**0.6**	**0.0**	**0.1**	**3.0**	**3.2**

Traffic Analyses

Exhibit 3-23 summarizes the minimum, maximum and average annual daily traffic (AADT) in the Study Corridors for: (1) 1965, before any ADHS improvements were made, (2) the first year each improved Study Corridor segment was open to traffic, and (3) for 1995, after all ADHS improvements were made. In almost every Study Corridor there are very significant differences between the minimum and maximum AADTs. The minimum AADTs typically occur on rural sections of the Study Corridors. The maximum AADTs typically occur on urban sections of the Study Corridors. The average AADT typically falls closer to the minimum because there are many more rural miles in each Study Corridor than there are urban miles.

As discussed earlier, the improved Study Corridor sections were opened to traffic at various times between 1967 and 1995. Consequently, the "first year open" AADT presented in Exhibit 3-23 does not represent traffic for a single year. Instead it represents the average of the first year open AADTs for all Study Corridor sections, whenever they were opened to traffic. Between 1965 and 1995, average AADT for all Study Corridors (except Corridor T for which 1965 data were not available) increased from 3,572 to 11,925, or by 233%. The 1995 average AADT for all corridors including Corridor T is about 11,931. Between opening year and 1995, average AADT for all Study Corridors increased from almost 7,000 to almost 12,000, or by 71%.

The AADTs discussed above are one, but not the only, measure of travel on the Study Corridors. Vehicle miles of travel (VMT) and vehicle hours of travel (VHT) are also useful measures because they take into account not only the amount of traffic, but also the distance and time that vehicles travel. VMT on a roadway section is calculated by summing the distance each vehicle on the section travels (for example, 1 vehicle traveling for 1 mile generates 1 vehicle mile of travel). VHT on a roadway section is calculated by summing the time each vehicle takes to travel on the section (for example, 1 vehicle traveling for 1 hour generates one vehicle hour of travel).

Exhibit 3-24 summarizes the estimated 1995 VMT and VHT for cars and trucks in the Study Corridors, with and without the ADHS improvements. The 1995 VMT for the Study Corridors with the ADHS improvements is 14,564,000 for cars and 2,353,000 for trucks. Without the ADHS improvements, the VMT would be about 14,928,000 for cars and 2,425,000 for trucks, or about 2.5-3.0% higher. The reduction in vehicle miles of travel is primarily due to the slight reduction in Study Corridor mileage with the ADHS improvements.

The 1995 VHT for the Study Corridors with the ADHS improvements is 292,000 for cars and 67,000 for trucks. Without the ADHS improvements, the VHT would be about 463,000 (about 60% higher) for cars and 94,000 (about 40% higher) for trucks. The very significant reduction in vehicle hours of travel is primarily due to the higher average travel speeds achieved through the ADHS improvements. In terms of VHT, trucks benefited somewhat less from the ADHS improvements than did cars because they are more affected by the remaining curves and grades on the improved Study Corridors than are cars.

Exhibit 3-23. Average Daily Traffic (AADT) Before and After ADHS Improvements

Average 1st	AADT for 1965			AADT for the 1st Year Open			AADT for 1995		
Yr. Open	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg
1984	1,300	2,300	1,836	4,085	18,679	10,948	16,250	45,000	29,351
1976	2,300	15,600	4,332	2,586	19,225	7,200	5,500	30,600	14,522
1971	3,900	20,200	10,930	5,439	27,841	10,504	10,000	52,400	18,650
1984	900	9,300	5,412	4,000	22,023	10,138	4,000	38,200	19,179
1976	2,000	6,300	3,461	3,656	12,627	5,615	5,910	22,100	10,335
1977	**900**	**20,200**	**4,774**	**2,586**	**27,841**	**7,620**	**4,000**	**52,400**	**14,931**
1976	2,100	4,600	3,400	2,265	12,427	3,985	1,900	30,300	7,274
1972	1,400	5,800	3,406	1,928	16,582	4,821	9,800	47,000	13,935
1975	**1,400**	**5,800**	**3,402**	**1,928**	**16,582**	**4,283**	**1,900**	**47,000**	**9,745**
1983	2,700	19,300	5,886	4,933	18,680	10,180	8,850	32,350	14,238
1975	1,700	1,700	1,700	3,785	8,587	5,481	9,900	27,500	16,029
1981	**1,700**	**19,300**	**4,711**	**3,785**	**18,680**	**8,861**	**8,850**	**32,350**	**14,766**
1975	2,200	5,600	3,011	1,733	10,772	4,756	2,300	21,000	8,037
1976	1,500	4,500	1,854	1,547	12,169	3,877	3,100	25,600	9,156
1975	**1,500**	**5,600**	**2,607**	**1,547**	**12,169**	**4,450**	**2,300**	**25,600**	**8,440**
1969	**1,600**	**2,800**	**2,026**	**2,171**	**4,515**	**2,833**	**6,000**	**13,400**	**8,986**
1977	800	4,600	1,592	619	6,423	2,921	1,600	14,100	5,524
1983	400	4,600	1,416	420	18,961	5,001	1,400	25,600	7,754
1981	**400**	**4,600**	**1,498**	**420**	**18,961**	**4,030**	**1,400**	**25,600**	**6,780**
1980	**2,100**	**5,200**	**2,941**	**2,411**	**14,800**	**6,625**	**7,800**	**23,200**	**13,233**
1973	**2,600**	**10,600**	**6,724**	**5,061**	**22,333**	**10,289**	**4,553**	**42,600**	**15,659**
1976	3,000	8,500	4,503	3,444	14,580	7,698	8,500	25,200	12,647
1975	4,100	6,800	5,177	4,830	10,680	7,351	9,200	24,500	15,351
1976	**3,000**	**8,500**	**4,639**	**3,444**	**14,580**	**7,628**	**8,500**	**25,200**	**13,206**
1978	N/A	N/A	N/A	5,150	39,423	11,377	5,150	39,700	12,185
1986	N/A	N/A	N/A	8,632	8,666	8,645	5,124	5,144	5,134
1978				**5,150**	**39,423**	**11,275**	**5,124**	**39,700**	**11,967**
1977	**400**	**20,200**	**3,572**	**420**	**39,423**	**6,984**	**1,400**	**52,400**	**11,931**

Exhibit 3-24. 1995 Daily Vehicle Miles and Hours of Travel With and Without ADHS Improvements (1,000's)

		Car VMT		Truck VMT		Car VHT		Truck VHT	
Corridor	State	With	Without	With	Without	With	Without	With	Without
A/A1	GA	**831.18**	**757.22**	**61.09**	**54.65**	**16.51**	**24.78**	**1.65**	**2.12**
B	KY	1442.10	1604.61	245.32	270.77	29.87	48.41	7.02	9.18
	NC	317.38	316.48	23.91	23.86	6.18	9.92	0.59	1.06
	TN	978.45	889.84	122.37	111.54	23.61	33.96	3.55	5.50
	VA	527.02	648.91	67.19	85.82	10.15	19.07	2.02	3.19
	Total	**3264.95**	**3459.84**	**458.79**	**491.99**	**69.81**	**111.36**	**13.18**	**18.95**
D	OH	781.73	816.65	86.87	90.75	14.01	20.68	2.32	2.90
	WV	826.13	869.79	154.84	164.81	17.59	30.23	4.50	6.34
	Total	**1607.86**	**1686.44**	**241.71**	**255.56**	**31.60**	**50.91**	**6.82**	**9.24**
E	MD	961.46	964.60	134.82	135.26	16.08	27.08	3.50	5.20
	WV	448.66	395.51	67.48	59.28	7.11	12.85	1.45	2.44
	Total	**1410.12**	**1360.11**	**202.30**	**194.54**	**23.19**	**39.93**	**4.95**	**7.64**
F	KY	450.85	486.82	59.52	65.02	8.77	11.38	1.71	2.05
	TN	288.49	293.48	39.29	40.03	7.19	10.00	1.25	1.51
	Total	**739.34**	**780.30**	**98.81**	**105.05**	**15.97**	**21.38**	**2.96**	**3.56**
I	KY	**463.87**	**495.04**	**74.38**	**79.24**	**9.64**	**13.77**	**2.29**	**2.93**
J	KY	437.26	462.01	80.38	85.09	8.52	12.47	2.35	2.83
	TN	835.36	769.70	101.27	94.11	16.11	25.04	2.64	4.06
	Total	**1272.62**	**1231.71**	**181.65**	**179.20**	**24.63**	**37.51**	**4.99**	**6.89**
L	WV	**695.59**	**766.42**	**105.05**	**114.90**	**12.63**	**22.44**	**2.84**	**4.05**
P	PA	**760.57**	**730.93**	**95.96**	**92.67**	**14.93**	**22.59**	**2.33**	**3.45**
Q	VA	1174.10	1245.60	128.61	135.79	24.31	40.50	3.94	5.57
	WV	367.59	374.16	43.81	45.88	7.47	11.93	1.28	1.72
	Total	**1541.69**	**1619.76**	**172.42**	**181.67**	**31.78**	**52.43**	**5.22**	**7.29**
T	NY	1948.27	2006.28	653.20	665.94	41.12	64.65	19.87	27.80
	PA	27.57	34.24	7.33	9.10	0.44	0.80	0.17	0.26
	Total	**1975.84**	**2040.52**	**660.53**	**675.04**	**41.57**	**65.45**	**20.04**	**28.06**
All Corridors		**14,563.63**	**14,928.29**	**2,352.69**	**2,424.51**	**292.26**	**462.56**	**67.27**	**94.19**

CORRIDOR AND TRAFFIC CONCLUSIONS

Without question, the ADHS improvements have had a significant and positive impact on the physical and operating characteristics of the Study Corridors:

- The average number of lanes has increased from 2.1 to 3.7, or by 76%.
- The total number of lane miles has increased from 3,100 to 5,264, or by 70%.
- The total lane mile of freeways has increased from 0 to 1,202.
- The average speed limit has increased from 47 to 57 miles per hour, or by 21%.
- The average degree of roadway curvature has been reduced from 2.9 to 2.1, or by 38%.
- Vehicle hours of travel for cars and trucks were reduced by 198,000 hours in 1995.

These types of roadway changes make travel more efficient. The economic efficiencies (benefits) that result from these improvements are discussed in the next Chapter.

Chapter 4
EFFICIENCY GAINS DUE TO THE ADHS

Economic efficiency is a legitimate local, regional, state and national goal. If an investment leads to a significant operational cost savings, then there is an economic efficiency rationale for making that investment. If a highway improvement is estimated to create significant efficiencies (road user cost savings), such savings should be considered in deciding whether or not the investment makes economic sense. Therefore, travel efficiency is a relevant criterion for FHWA, the Appalachian Regional Commission, the individual state departments of transportation, and local agencies in making highway investment decisions.

This study analyzed the costs of traveling on the ADHS, compared those costs with the costs of travel in the relevant corridors if the ADHS had not been built, and estimated the magnitude of the economic savings caused by the ADHS investments. These savings are viewed as "efficiency benefits," and these efficiency benefits are net gains to the economy.

The travel efficiency *benefits* comprise the dollar value of travel time savings, reduced vehicle operating costs, and accident savings that accrue to those who drive on the improved corridors. The *costs* consist of the public sector expenditures associated with building and maintaining the ADHS highway improvements. The travel efficiency *benefits* are compared to the travel efficiency *costs* using standard benefit-cost techniques described in Chapter 2. The results of the benefit-cost analysis, which include benefit-cost ratio, net present value, and internal rate of return indicators, are used to evaluate the various ADHS corridors.

ADHS CORRIDORS INFLUENCE EFFICIENCY

Americans spend great sums of money, time and lives in the act of traveling (or shipping) from one location to another. Investments that will allow them to travel more quickly, more safely or less expensively tend to create travel efficiencies.

The ADHS comprises highways that yield just such results – the ADHS highways are observed to yield faster, safer, and less expensive trips. **Exhibit 4-1** summarizes some of the key characteristics of each of the completed portions of the ADHS. The Exhibit shows that:

- Seven of the ADHS routes are shorter than the roadways they replaced;
- The ADHS investments included the widening of many 2-lane highways to 4-lane (4-lane highways yield considerable travel efficiencies);
- The ADHS investments raised the average speed limit in these corridors from 47 mph to 57 mph (indicating a much quicker trip on the ADHS).

These characteristics indicate that the ADHS has created better access, and considerably superior efficiency.

Exhibit 4-1. Corridor Characteristics

Corridor	States	Length (Miles) [1] Before	Length (Miles) [1] After	1995 [2] AADT	Average No. Lanes [3] Before	Average No. Lanes [3] After	Average Speed Limit [4] Before	Average Speed Limit [4] After
A/A1	GA	28.5	30.4	29,351	2.3	4.0	38	58
B	KY, NC, TN, VA	272.9	249.4	14,931	2.2	4.0	45	56
D	OH, WV	203.6	189.8	9,745	2.0	4.0	47	55
E	MD, WV	107.3	109.2	14,766	2.0	4.0	48	64
F	KY, TN	104.9	99.3	8,440	2.0	3.0	49	52
I	KY	63.3	59.9	8,986	2.0	3.0	43	54
J	KY, TN	212.9	214.5	6,780	2.0	3.0	46	57
L	WV	67.3	60.5	12,233	2.1	4.0	49	54
P	PA	54.4	54.7	15,659	2.1	4.0	49	61
Q	VA, WV	136.3	129.8	13,206	2.0	4.0	44	53
T	NY, PA	226.9	220.3	11,967	2.2	4.0	52	60
All Corridors		**1,478.3**	**1,417.8**	**11,931**	**2.1**	**3.7**	**47**	**57**

(1) The length of the corridor ADHS segments that have been completed and therefore were included in this study. "Before" length refers to length of the road before the ADHS highway was built; "After" refers to the length of the ADHS segments already built.

(2) AADT = "Average Annual Daily Traffic," which is the daily average traffic volume. It is calculated by dividing daily vehicle miles of travel on the corridor by the corridor length.

(3) Average number of lanes of highway in existence. 2.0 means a two-lane highway, 2.3 means most of the highway length is two lanes, some is three or four lanes. "Before" of 2.0 and "After" of 4.0 means a previously two-lane highway was widened to four lanes.

(4) Average speed limit is average end-to-end speed limit, weighted by traffic volume.

Vehicle Miles of Travel Saved

According to this study's calculations, and as shown on **Exhibit 4-2**, the completed portions of the 12 ADHS corridors combined to save 133,101,000 car miles of travel and 26,214,000 truck vehicle miles of travel annually. This represents a very significant increase in travel efficiency. Some corridors yield a net increase in vehicle miles of travel, due to the longer length of the ADHS (Corridors A/A1, E, J and P), and due to the traffic that is induced by the ADHS.

Exhibit 4-2. Annual Vehicle Miles of Travel [(1)]
(Thousand Vehicle Miles), 1995

	Corridor Length (Miles)		Car VMT			Truck VMT		
Corridor	Before	After	Before	After	Savings	Before	After	Savings
A/A1	28.5	30.4	276,385	303,381	-26,995	19,947	22,298	-2,351
B	272.9	249.4	1,262,842	1,191,707	71,135	179,576	167,458	12,118
D	203.6	189.8	615,551	586,869	28,682	93,279	88,224	5,055
E	107.3	109.2	496,440	514,694	-18,254	71,007	73,840	-2,832
F	104.9	99.3	284,810	269,859	14,950	38,343	36,066	2,278
I	63.3	59.9	180,690	169,313	11,377	28,923	27,149	1,774
J	212.9	214.5	449,574	464,506	-14,932	65,408	66,302	-894
L	67.3	60.5	279,743	253,890	25,853	41,939	38,343	3,595
P	54.4	54.7	266,789	277,608	-10,819	33,825	35,025	-1,201
Q	136.3	129.8	591,212	562,717	28,496	66,310	62,933	3,376
T	226.9	220.3	744,790	721,182	23,608	246,390	241,093	5,296
All Corridors	**1,478.3**	**1,417.8**	**5,448,826**	**5,315,725**	**133,101**	**884,946**	**858,732**	**26,214**

(1) "After" VMT includes traffic induced by the new highway, therefore, there is more traffic on the "After" ADHS highways than "Before" the ADHS highway. On Corridors B, D, F, I, L, Q and T there is less "After" VMT, meaning the ADHS is shorter than the "Before" road.

Vehicle Hours Saved

By shortening the travel distance, and by increasing the speed limit, and by reducing congestion and by making it easier to pass slow moving vehicles, the ADHS is estimated to save considerable travel time. **Exhibit 4-3** suggests that the studied corridors save 62.2 million car hours and 9.8 million truck hours annually. This is a huge efficiency gain attributable to the ADHS.

Exhibit 4-3. Annual Vehicle Hours of Travel (Thousand Hours) 1995

	Car Hours			Truck Hours		
Corridor	Before	After	Savings [1]	Before	After	Savings [1]
A/A1	9,044	6,027	3,018	774	603	171
B	40,646	25,482	15,164	6,915	4,812	2,103
D	18,583	11,532	7,051	3,373	2,490	883
E	14,575	8,466	6,110	2,790	1,806	984
F	7,806	5,828	1,977	1,301	1,080	222
I	5,027	3,519	1,508	1,069	835	234
J	13,690	8,990	4,700	2,515	1,820	695
L	8,189	4,609	3,580	1,479	1,038	440
P	8,246	5,449	2,797	1,258	849	409
Q	19,137	11,601	7,536	2,663	1,906	757
T	23,890	15,171	8,719	10,241	7,314	2,927
All Corridors	**168,834**	**106,675**	**62,159**	**34,379**	**24,554**	**9,825**

Savings in vehicle hours result from shorter trip distances on shortened ADHS highways, higher speed limits on ADHS, reduced congestion on ADHS, and increased ability to pass other vehicles on ADHS.

TRAVEL EFFICIENCY BENEFITS

These gains in travel efficiency attributable to the ADHS are assigned a monetary value, as described in Chapter 2. The values reflect three types of travel efficiency gains: travel time, travel cost, and accidents.

Travel Time Savings

The first gain of value to the trip maker is the economic benefit associated with the amount of time required to travel through the various corridors. There are potentially three different ways to reduce travel time: (1) reducing mileage to reach one's destination by offering a shorter route, (2) increasing the speed at which one can travel by providing facilities with higher design standards, and (3) reducing congestion (or making it easier to pass) by providing improved or additional facilities.

Each ADHS corridor was evaluated with respect to the estimated travel time savings between the year of opening of the various segments and 1995, as well as the projected savings between 1996 and 2024. Different values of travel time were assigned by trip purpose -- auto-business, auto-non-business, and truck trips (see Chapter 2).

Exhibit 4-4 identifies the expected annual monetary benefits estimated to be attributable to travel time savings for the years 1995 and 2024. In addition, both the mean and median annual benefits were estimated for each corridor. All twelve corridors provide positive annual time savings benefits. Improvements in ADHS Corridors B and T provide the largest overall travel time benefits, in part because these two corridors are the longest. Corridor I provides the lowest overall travel time benefit due to a combination of shorter corridor and lower average ADT. In total, the twelve corridor improvements are estimated to generate an average annual travel time savings of $1.0 billion.

Exhibit 4-4 also identifies the cumulative total time benefits from 1965 to 2024, and splits these time benefits to contrast those benefits accrued already (1965-1995) with those projected in the future (1996-2025). Overall only about 18 percent of travel time benefits have already occurred while 82 percent are yet to occur. The reasons for this disparity are: (1) few of these corridors actually opened in 1965 but several years later, (2) time savings are linked directly to the amount of traffic using the facilities, and since traffic is increasing in the corridors, time savings per year are also increasing.

Overall, one of the most quantifiable direct benefits to travellers is the time savings estimated to be attributable to the ADHS. Total annual time benefits of $785.8 million in 1995 and $2.4 billion by the year 2024 represent significant savings to the residents of and visitors to the Appalachian Region. As a proxy for accessibility, the time saved represents a considerable jump in travel efficiency.

Exhibit 4-4. Value of Travel Time Savings ($, Thousands)

Corridor	A/A1	B	D	E	F	I
Annual Travel Time Benefits						
Year 1995	$30,436	$184,198	$82,973	$78,232	$22,601	$18,921
Year 2024	66,817	556,498	150,983	177,254	53,203	34,399
Mean (1)	40,535	233,850	81,272	81,792	25,407	19,455
Median (2)	41,727	197,036	86,491	81,647	23,656	19,454
Total Undiscounted Benefits						
1965-1995	$233,573	$2,403,187	$1,124,873	$908,066	$333,716	$328,045
1996-2024	1,428,363	10,926,241	3,426,367	3,754,055	1,114,455	780,868
Total	$1,661,936	$13,329,428	$4,551,239	$4,662,121	$1,448,171	$1,108,913

Corridor	J	L	P	Q	T	Total
Annual Travel Time Benefits						
Year 1995	$58,319	$41,980	$34,648	$83,848	$149,656	$785,812
Year 2024	362,347	149,740	129,835	203,444	579,769	2,464,289
Mean (1)	125,355	60,388	54,168	94,561	240,859	1,011,766
Median (2)	79,287	51,270	39,572	85,910	179,319	814,751
Total Undiscounted Benefits						
1965-1995	$642,865	$427,108	$600,802	$1,259,018	$2,455,499	$10,716,750
1996-2024	6,251,675	2,833,818	2,432,603	4,225,534	10,791,723	47,965,703
Total	$6,894,540	$3,260,925	$3,033,405	$5,484,552	$13,247,222	$58,682,453

(1) Mean is the average value.

(2) Median is the value wherein half of the other values are above, and half below, the stated median value.

Vehicle Operating Cost (VOC) Savings

The costs of operating motor vehicles are a significant portion of the total cost of transportation. Vehicle operating costs include a number of components, some of which are variable costs (use-related), others of which are fixed costs (insurance and license fees which typically do not vary with use). Only use-related costs -- engine oil, gasoline, maintenance, and tires -- are directly affected by an improved highway. Vehicle operating costs, like travel time, vary with the characteristics of the trip being made including trip length, running speeds, and speed change cycles. Using the same data as for the travel time, vehicle operating costs with and without the ADHS were calculated.

In many cases, vehicle operating costs may increase after completion of a highway improvement; when this occurs it is usually because vehicles traveling at faster speeds are less efficient than vehicles traveling at slower speeds (it costs more to drive a car at 65 mph than it costs at 45 mph). Also, vehicle operating costs may increase if the new road is longer than the road it replaces. On the other hand, improvements completed on corridors with moderate to severe levels of congestion tend to improve vehicle operating costs as vehicles no longer experience a large number of speed change cycles. In addition, if improvements reduce the grades of a corridor, vehicle operating costs decrease, especially for trucks.

Seven (A/A1, D, E, F, L, P, and Q) of the twelve ADHS corridors are estimated to generate increased vehicle operating costs, while the remaining four corridors (B, I, J, and T) generate vehicle operating cost savings. **Exhibit 4-5** depicts both the annual and total vehicle operating cost savings for the twelve corridors under study.

Overall, improvements in the twelve corridors under study resulted in vehicle operating cost increases of $11 million in 1995 due to the increases in speed. However, as traffic increases, VOC savings due to the relief of congestion increase and by 2024 exceeds speed related VOC increases so that VOC benefits are estimated at nearly $72 million in 2024. Improvements in ADHS Corridor B result in the largest VOC benefits while corridor D generates the most VOC increases. The 9 percent reduction in corridor B length combined with high traffic explains the results for corridor B. The relatively low traffic on corridor D results in lower congestion reduction to counterbalance the increase in speed due to widening a 2-lane corridor to 4 lanes.

Exhibit 4-5. Vehicle Operating Cost Savings ($ Thousands)
1995

Corridor	A/A1	B	D	E	F	I
Annual Cost Benefits						
Year 1995	($7,564)	$15,633	($11,298)	($979)	($1,169)	$625
Year 2024	(11,449)	64,750	(16,690)	(10,492)	(2,105)	928
Mean (1)	(8,328)	23,756	(10,358)	(3,429)	(1,095)	595
Median (1)	(8,770)	17,326	(11,577)	(1,955)	(1,201)	635
Total Undiscounted Benefits						
1965-1995	($63,827)	$163,999	($171,541)	($24,352)	($14,490)	$11,247
1996-2024	(277,630)	1,190,106	(408,525)	(171,098)	(47,948)	22,669
Total	($341,456)	$1,354,104	($580,066)	($195,450)	($62,437)	$33,916

Corridor	J	L	P	Q	T	Total
Annual Cost Benefits						
Year 1995	$926	($4,270)	($754)	($5,429)	$3,101	($11,178)
Year 2024	23,281	(6,995)	(977)	(12,600)	43,892	71,541
Mean (1)	6,944	(4,135)	(4,135)	(5,976)	13,315	12,092
Median (1)	2,792	(4,505)	(904)	(5,552)	5,914	(1,143)
Total Undiscounted Benefits						
1965-1995	$19,765	($58,602)	($26,380)	($81,622)	$30,521	($215,282)
1996-2024	362,176	(164,707)	(25,205)	(265,000)	701,785	916,623
Total	$381,940	($223,309)	($51,586)	($346,622)	$732,306	$701,340

Note: *(1) Mean and Median calculated from earliest opening year of a corridor segment to year 2024.*

Accident Savings

Improvements in highway safety comprise another reason for building highways with higher design standards. Multilane roadways are generally safer than 2-lane highways, so many ADHS improved roadways have reduced accident risks. Also, reducing curves and grades makes highways safer by improving visibility.

National average injury rates by accident type (fatal, injury, property damage only) and by highway facility type (Interstate versus collector for example) were used, as described in Chapter 2. They were adjusted to account for the 2-lane multilane differences and used to calculate accident savings in the various corridors under study. However, they do not account for the likely accident risk reduction due to straightening a highway when no lanes are added. Therefore, the accident savings estimates due to the ADHS are likely underestimated.

Accident risk is measured in accidents per 100 million vehicle miles. As a result, improved corridors which are longer than the ones they replace may increase accidents if the decrease in accident risk, due to better design, cannot overcome the increase in exposure, due to increased vehicle miles.

Exhibit 4-6 identifies the expected annual safety benefits by corridor for the years 1995 and 2024, as well as the mean and median annual benefits. Improvements in ADHS Corridor B result in the largest overall benefit due to the combination of such factors as the length of the corridor, proportionally large reduction in corridor length, and high traffic volumes. Five ADHS corridors – A/A1, E, J, P - produce negative accident cost savings. In these cases, the improved corridor is longer than the original corridor. Corridor A/A1 shows the largest accident disbenefits because in addition to increased corridor length, a larger proportion of this corridor was already multilane before the ADHS improvements (in such case there is no improvement in accident risk unless the improvements resulted in a change in roadway type).

Overall , the corridor improvements are estimated to generate annual accident cost savings of $47 million in 1995, and $80 million in 2024. These translate into cumulative savings of $2.5 billion for the 1965-2024 time period (not discounted). As is the case with other benefits, the majority of these benefits, 76 percent, will occur in the future.

Exhibit 4-6. Accident Cost Savings ($, Thousands)
1995

Corridor	A/A1	B	D	E	F	I
Annual Accident Benefits						
Year 1995	($6,032)	$22,564	$9,753	($3,697)	$2,923	$1,217
Year 2024	(12,114)	43,035	15,300	(8,251)	5,337	1,727
Mean (1)	(7,742)	21,373	9,154	(3,891)	2,976	1,132
Median (1)	(7,920)	23,270	10,040	(3,854)	3,007	1,235
Total Undiscounted Benefits						
1965-1995	($45,218)	$234,264	$136,822	($42,573)	$45,712	$20,332
1996-2024	(272,190)	983,984	375,796	(179,218)	123,907	44,166
Total	($317,408)	$1,218,247	$512,618	($221,790)	$169,619	$64,498

Corridor	J	L	P	Q	T	Total
Annual Accident Benefits						
Year 1995	($1,256)	$6,235	($743)	$9,575	$6,909	$47,449
Year 2024	(12,648)	16,774	(1,558)	19,077	13,540	80,220
Mean (1)	(3,872)	7,240	(1,016)	9,770	7,501	43,553
Median (1)	(2042)	7,144	(982)	9,739	7,366	48,014
Total Undiscounted Benefits						
1965-1995	($4,403)	$45,807	($22,376)	$136,874	$105,805	$611,046
1996-2024	(208,561)	345,138	(34,514)	429,786	306,740	1,915,035
Total	($212,964)	$390,945	($56,891)	$566,660	$412,545	$2,526,080

Notes: *(1) Mean and Median calculated from earliest opening year of a corridor segment to year 2024.*

Total Travel Efficiency *Benefits*

The total travel efficiency benefits include the compilation of the dollar value of travel time saved, reduced vehicle operating costs, and accident savings that accrue to those who drive on the improved corridors. **Exhibit 4-7** summarizes the estimated annual travel efficiency benefits for the years 1995 and 2024.

Exhibit 4-7. Annual Travel Efficiency Benefits ($ Thousands)

	1995				2024			
Corridor	**Time**	**VOC**	**Accident**	**Total**	**Time**	**VOC**	**Accident**	**Total**
A/A1	$30,436	-$7,564	-$6,032	$16,840	$66,817	-$11,449	-$12,114	43,255
B	184,198	15,633	22,564	222,394	556,498	64,750	43,035	664,283
D	82,973	-11,298	9,753	81,428	150,983	-16,690	15,300	149,593
E	78,232	-979	-3,697	73,556	177,254	-10,492	-8,251	158,511
F	22,601	-1,169	2,923	24,356	53,203	-2,105	5,337	56,434
I	18,921	625	1,217	20,763	34,399	928	1,727	37,054
J	58,319	926	-1,256	57,989	362,347	23,281	-12,648	372,980
L	41,980	-4,270	6,235	43,946	149,740	-6,995	16,774	159,518
P	34,648	-754	-743	33,152	129,835	-977	-1,558	127,300
Q	83,848	-5,429	9,575	87,994	203,444	-12,600	19,077	209,922
T	149,656	3,101	6,909	159,666	579,769	43,892	13,540	637,201
All Corridors	**$785,812**	**-$11,178**	**$47,449**	**$822,083**	**$2,464,289**	**$71,541**	**$80,220**	**$2,616,050**

Exhibit 4-8 summarizes the total present value of the efficiency gains, 1965-2024. From these two exhibits a number of conclusions are apparent regarding the ADHS and its ability to create economic efficiency.

Exhibit 4-8
PRESENT VALUE OF TOTAL TRAVEL EFFICIENCY BENEFITS
($Thousands)

Corridor	Travel Time Savings	Vehicle Operating Cost Savings	Accident Savings	Total Efficiency Gains
A/A1	$105,069	($24,497)	($21,244)	$59,328
B	1,049,252	83,937	102,100	1,235,290
D	430,767	(63,663)	54,341	421,445
E	387,641	(12,623)	(18,653)	356,366
F	131,034	(5,318)	18,125	143,841
I	130,097	4,440	8,353	142,891
J	386,875	17,518	(8,721)	395,672
L	222,867	(20,963)	28,459	230,363
P	261,422	(10,412)	(10,354)	240,656
Q	501,308	(31,755)	55,153	524,706
T	1,072,564	31,299	40,120	1,143,984
Total	$4,678,898	($32,037)	$247,680	$4,894,541

ECONOMIC EFFICIENCY FINDINGS

1. Every ADHS corridor that has been completed to date has created economic efficiency benefits.

2. These benefits range from $16.8 million annually in 1995 (Corridor A/A1) to $664.3 million annually in 2024 (Corridor B).

3. Travel time savings comprise the largest single form of efficiency gain attributable to the ADHS.

4. The cost savings (vehicle operating costs) are generally not yet occurring, but are estimated to occur in the future on four corridors.

5. Accident savings occur on seven of the corridors, with total annual savings of $47 million in 1995.

6. The total annual efficiency gains in 1995 for the twelve corridors are $822 million annually, increasing to over $2.6 billion annually by 2024. These are very significant efficiency gains.

7. The total present value of the efficiency gains for the twelve corridors combined are valued at $4.89 billion. Clearly the ADHS is contributing to the efficiency of the Appalachian Region.

ECONOMIC EFFICIENCY BENEFIT/COST RESULTS

To gauge the extent to which the completed portions of the ADHS may have constituted a good investment from the efficiency perspective, the efficiency gains (cost savings) were compared with the costs (construction plus maintenance) in the form of a benefit/cost analysis.

An example (Corridor B) of the way in which the life cycle costs and benefits were handled 1965-2025, is shown on **Exhibit 4-9**. This exhibit depicts the flow of costs and benefits, by year. It shows, for example:

- **Construction Costs** – Incurred every year 1965-1995, at 1995 price levels.
- **Maintenance Costs** – The net increase in costs incurred by the state departments of transportation responsible for maintaining the roads.
- **Time Savings** – The increase in time savings, as traffic builds up on the highway. These are at constant 1995 values of time, and comprise the largest form of direct efficiency gain attributable to the ADHS.
- **VOC Savings** – Vehicle Operating Cost Savings which are true net savings in this corridor. These also increase over time, in real terms.
- **Accident Savings** – The monetary value of the lives saved and the accidents reduced, due to the Corridor B improvements.
- **Total** – The total "not discounted" benefits or costs over the analysis period.
- **Discounted Total** – The sum of the discounted costs and benefits 1965-2025. All are discounted at 7% per year. It is the discounted numbers that are used in the benefit/cost evaluation.

Exhibit 4-9 is an example (Corridor B). Similar tabulations for all corridors are contained in Appendix B.

Exhibit 4-9. Travel Efficiencies Benefit Cost Analysis
Corridor B - KY, NC, TN, VA
Undiscounted 1995 $1,000

Year	Construction Costs	Maintenance Costs	**TOTAL COSTS**	Time Savings	VOC Savings	Accidents Savings	**TOTAL SAVINGS**	NET BENEFITS
1965	5,984	0	**5,984**	0	0	0	**0**	(5,984)
1966	33,033	0	**33,033**	0	0	0	**0**	(33,033)
1967	63,167	0	**63,167**	0	0	0	**0**	(63,167)
1968	93,052	(110)	**92,942**	4,043	686	370	**5,099**	(87,844)
1969	125,380	(6)	**125,373**	4,416	693	412	**5,521**	(119,852)
1970	86,661	47	**86,708**	10,919	(484)	1,098	**11,533**	(75,175)
1971	133,986	450	**134,436**	17,563	605	488	**18,656**	(115,780)
1972	139,398	771	**140,169**	22,928	736	2,020	**25,685**	(114,484)
1973	141,786	1,212	**142,998**	26,351	864	2,862	**30,078**	(112,920)
1974	94,710	1,410	**96,120**	35,379	1,767	3,384	**40,530**	(55,590)
1975	75,728	1,591	**77,319**	42,094	2,005	3,410	**47,509**	(29,810)
1976	64,509	1,825	**66,333**	44,991	2,047	3,576	**50,614**	(15,719)
1977	64,854	2,021	**66,874**	49,149	1,343	3,712	**54,203**	(12,671)
1978	68,621	2,187	**70,808**	52,100	1,354	3,876	**57,329**	(13,479)
1979	63,946	2,267	**66,214**	56,664	1,783	4,770	**63,216**	(2,998)
1980	75,310	2,258	**77,569**	64,120	826	5,752	**70,698**	(6,871)
1981	45,543	2,396	**47,939**	68,334	1,153	6,546	**76,032**	28,093
1982	70,822	2,561	**73,383**	75,170	1,041	7,718	**83,929**	10,546
1983	149,357	2,858	**152,215**	92,826	5,645	8,320	**106,791**	(45,425)
1984	59,264	3,130	**62,394**	103,499	7,086	9,454	**120,039**	57,645
1985	26,260	3,422	**29,681**	111,711	7,271	10,702	**129,684**	100,002
1986	33,775	3,686	**37,461**	117,178	7,571	11,162	**135,912**	98,451
1987	34,177	3,831	**38,008**	129,782	10,855	14,931	**155,568**	117,560
1988	13,964	3,917	**17,881**	136,034	11,427	15,714	**163,175**	145,294
1989	20,890	3,956	**24,846**	142,286	11,999	16,498	**170,783**	145,937
1990	10,166	3,995	**14,161**	148,539	12,571	17,281	**178,391**	164,230
1991	9,803	3,995	**13,798**	154,791	13,143	18,064	**185,998**	172,200
1992	14,077	4,013	**18,090**	163,052	14,215	19,911	**197,178**	179,088
1993	3,677	4,031	**7,708**	169,375	14,793	20,715	**204,882**	197,174
1994	2,000	4,049	**6,049**	175,698	15,371	21,518	**212,587**	206,538
1995	1,351	4,126	**5,477**	184,198	15,633	22,564	**222,394**	216,918
1996	0	4,184	**4,184**	197,036	17,326	23,270	**237,632**	233,448
1997	0	4,242	**4,242**	209,874	19,020	23,976	**252,869**	248,627
1998	0	4,300	**4,300**	222,712	20,714	24,682	**268,107**	263,807
1999	0	4,300	**4,300**	235,550	22,407	25,388	**283,344**	279,044
2000	0	4,300	**4,300**	248,387	24,101	26,093	**298,582**	294,282
2001	0	4,300	**4,300**	261,225	25,795	26,799	**313,820**	309,519
2002	0	4,300	**4,300**	274,063	27,488	27,505	**329,057**	324,757
2003	0	4,300	**4,300**	286,901	29,182	28,211	**344,295**	339,995
2004	0	4,300	**4,300**	299,739	30,876	28,917	**359,532**	355,232
2005	0	4,300	**4,300**	312,577	32,570	29,623	**374,770**	370,470
2006	0	4,300	**4,300**	325,415	34,263	30,329	**390,007**	385,707
2007	0	4,300	**4,300**	338,253	35,957	31,035	**405,245**	400,945
2008	0	4,300	**4,300**	351,091	37,651	31,741	**420,482**	416,182
2009	0	4,300	**4,300**	363,929	39,344	32,447	**435,720**	431,420
2010	0	4,300	**4,300**	376,767	41,038	33,152	**450,957**	446,657
2011	0	4,300	**4,300**	389,605	42,732	33,858	**466,195**	461,895

2012	0	4,300	**4,300**	402,443	44,426	34,564	**481,433**	477,132
2013	0	4,300	**4,300**	415,281	46,119	35,270	**496,670**	492,370
2014	0	4,300	**4,300**	428,119	47,813	35,976	**511,908**	507,608
2015	0	4,300	**4,300**	440,957	49,507	36,682	**527,145**	522,845
2016	0	4,300	**4,300**	453,795	51,200	37,388	**542,383**	538,083
2017	0	4,300	**4,300**	466,633	52,894	38,094	**557,620**	553,320
2018	0	4,300	**4,300**	479,470	54,588	38,800	**572,858**	568,558
2019	0	4,300	**4,300**	492,309	56,281	39,505	**588,095**	583,795
2020	0	4,300	**4,300**	505,146	57,975	40,211	**603,333**	599,033
2021	0	4,300	**4,300**	517,984	59,669	40,917	**618,570**	614,270
2022	0	4,300	**4,300**	530,822	61,363	41,623	**633,808**	629,508
2023	0	4,300	**4,300**	543,660	63,056	42,329	**649,046**	644,746
2024	0	4,300	**4,300**	556,498	64,750	43,035	**664,283**	659,983
2025	(456,568)	0	**(456,568)**	0	0	0	**0**	456,568
Total	1,368,683	194,415	**1,563,098**	13,329,428	1,354,104	1,218,247	**15,901,780**	14,338,682
Discounted Total	879,537	23,972	**903,569**	1,049,252	83,937	102,100	**1,235,290**	331,721

Net Present Value($1000)	**331721**
IRR (%):	**8.66**
Benefits/Costs Ratio:	**1.37**

The results of the benefit/cost analysis for all corridors are shown on **Exhibit 4-10**. The key indicators are the NPV (Net Present Value), IRR (Internal Rate of Return), and B/C (discounted Benefit/Cost Ratio). These should be interpreted as follows:

- An efficient project has a positive Net Present Value (NPV), an Internal Rate of Return (IRR) equal to or greater than the discount rate (7 percent), and a Discounted Benefit/Cost Ratio (B/C) of 1.0 or higher.

- The higher the NPV, IRR and B/C the more efficient the project.

The benefit/cost analyses suggest a number of conclusions regarding the completed portions of the ADHS and their role in aiding the efficiency and productivity of the Appalachian Region. These conclusions include the following:

1. The corridors combined have a constant dollar (exclusive of inflation) annual rate of return of 7.87%. This is really quite good, and is indicative of a good investment.

2. In efficiency terms, the economy is better off by some $755 million (the NPV), as a result of the ADHS.

3. A combined benefit/cost ratio of 1.18 is good, given that the "economic development" implications of the ADHS are not included in this calculation.

4. Five of the corridors have positive economic efficiency results. This is excellent, given that the real purpose of these highways was economic and social development, rather than efficiency.

5. Even the corridor ranking last in terms of return on investment (Corridor E) has a constant dollar return of 5.44% which is pretty good (if inflation were 5% and were included, the return would be 10.44%).

6. The total 1995 price level present value cost of these ADHS corridors is $4.1 billion; the total efficiency benefits are $4.9 billion. This is indicative of a prudent investment in Appalachia's future.

Exhibit 4-10. Travel Efficiencies Benefit Cost Benefits

Corridor	Present Value [1] Total Costs (3) (1995 $1,000)	Present Value [1] Total Benefits (1995 $1,000)	Net Present Value [1] (1995 $1,000)	IRR [2]	Benefit/Cost Ratio
A/A1	$59,437	$59,328	-$109	6.99%	1.00
B	903,569	1,235,290	331,721	8.66	1.37
D	537,746	421,445	-116,301	5.83	0.78
E	482,524	356,366	-126,158	5.44	0.74
F	194,003	143,841	-50,162	5.50	0.74
I	164,191	142,891	-21,300	6.20	0.87
J	263,380	395,672	132,292	8.84	1.50
L	270,059	230,363	-39,696	6.34	0.85
P	257,930	240,656	-17,274	6.64	0.93
Q	328,163	524,706	196,543	9.82	1.60
T	677,797	1,143,984	466,187	10.06	1.69
All Corridors	$4,138,798	$4,894,541	$755,743	7.87%	1.18

(1) Present values in 1965 calculated using 7% discount rate.

(2) IRR: Internal Rate of Return.

(3) Total Costs include construction costs, residual values and maintenance costs.

NOTE: An "economically justified" investment, when using these benefit/cost results, exists when:

* The Net Present Value is positive
* The Internal Rate of Return is 7% or greater
* The Benefit/Cost Ratio is 1.0 or greater

Sensitivity Tests

This study's calculations suggest that the ADHS sections that have been completed overall comprise a good, economically based investment. Based on travel efficiency alone, the ADHS investments yielded $1.18 for each $1.00 invested (a 7.87% return on the ADHS investment).

While every attempt was made in this study to be realistic and even conservative, the calculations are in part based on assumptions, any of which could be open to question. Therefore, to depict the possible effect of these assumptions on study conclusions, five sensitivity tests were conducted. The sensitivity of study conclusions to variations in discount rate, travel time savings, and accident calculations were all analyzed.

Discount Rate – Exhibit 4-11 compares study results at 4%, 7%, and 10% discount rate. At 7% (the constant dollar discount rate called for by OMB), the highways are economically justified. At 4%, the highways are even more justified (benefit/cost of 2.35). At 10% the benefit/cost is .7. A 10% real discount rate is unusually high, however, and perhaps unrealistic. Study results are therefore shown to be sensitive to the discount rate selected. However, since the study used the 7% discount rate required by the Office of Management and Budget, study conclusions based on the discount rate appear to be appropriate.

Exhibit 4-11. Travel Efficiencies Benefit Cost Sensitive Results
Variation in Discount Rates

	Net Present Value [1]				Benefit/Cost Ratio		
Corridor	4%	7%	10%	IRR [2]	4%	7%	10%
A/A1	$99,627	-$109	-$22,748	6.99%	2.20	1.00	0.49
B	2,059,397	331,721	-138,489	8.66	2.73	1.37	0.80
D	357,141	-116,301	-239,154	5.83	1.54	0.78	0.46
E	242,279	-126,158	-199,585	5.44	1.36	0.74	0.46
F	101,912	-50,162	-84,110	5.50	1.41	0.74	0.45
I	111,929	-21,300	-60,424	6.20	1.57	0.87	0.57
J	845,811	132,292	39,200	8.84	3.23	1.50	0.79
L	305,749	-39,696	-117,847	6.34	1.90	0.85	0.46
P	270,435	-17,274	-84,620	6.64	1.79	0.93	0.57
Q	862,674	196,543	-6,670	9.82	3.09	1.60	0.97
T	2,034,674	466,187	4,995	10.06	3.30	1.69	1.01
All Corridors	$7,353,361	$772,829	-$979,143	7.88%	2.35	1.18	0.70

(1) Thousands of 1995 dollars discounted at 7 percent.

(2) IRR: Internal Rate of Return.

Variations in Value of Travel Time – Although both the values of time and the methods of calculating the amount of time saved are based on conventional techniques, other values and techniques could have been used. To test study conclusions sensitivity to travel time, benefit/cost calculations were run using a 20% reduction and then a 20% increase in travel time benefits. The results are presented on **Exhibit 4-12**.

At the time values used in the study, the ADHS is economically justified. If the time savings or values were 20% greater, the benefit/cost would increase from 1.18 to 1.41. If values of 20% less were used, the benefit/cost would be 0.96. In other words, time values of 20-50% less would be needed in order for the ADHS to have questionable travel efficiency value. This is unlikely.

Exhibit 4-12. Travel Efficiencies Benefit Cost Sensitivity Results
Variation in Time Savings

	Net Present Value [1]			IRR [2]			Benefit/Cost Ratio [3]		
Corridor	**-20%**	**Base**	**20%**	**-20%**	**Base**	**20%**	**-20%**	**Base**	**20%**
A/A1	-$21,123	-$109	$20,905	5.33%	6.99%	8.24%	0.64	1.00	1.35
B	121,871	331,721	541,572	7.64	8.66	9.61	1.13	1.37	1.60
D	-202,455	-116,301	-30,148	4.83	5.83	6.71	0.62	0.78	0.94
E	-203,687	-126,158	-48,630	4.29	5.44	6.43	0.58	0.74	0.90
F	-76,369	-50,162	-23,955	4.59	5.50	6.32	0.61	0.74	0.88
I	-47,319	-21,300	4,720	5.15	6.20	7.17	0.71	0.87	1.03
J	54,917	132,292	209,667	7.83	8.84	9.73	1.21	1.50	1.80
L	-84,269	-36,696	4,878	5.51	6.34	7.08	0.69	0.85	1.02
P	-69,558	-17,274	35,010	5.47	6.64	7.71	0.73	0.93	1.14
Q	96,282	196,543	296,805	8.46	9.82	11.09	1.29	1.60	1.90
T	249,509	466,187	674,550	8.74	10.06	11.29	1.37	1.69	2.01
All Corridors	($160,957)	$755,743	$1,706,616	6.80%	7.88%	8.86%	0.96	1.18	1.41

(1) Thousands of 1995 dollars discounted at 7 percent.
(2) IRR: Internal Rate of Return.
(3) Discounted at 7 percent.

Sensitivity to Accidents – The final sensitivity test questioned results in four corridors where the number of accidents were estimated to increase due to the ADHS. In **Exhibit 4-13** no

accident increases were included in the analysis. As shown, study results are not sensitive to this accidents issue.

Exhibit 4-13. Travel Efficiencies Benefit Cost Sensitivity Results
Excluding and Including Negative Accident Values

Corridor	Net Present Value [1]		IRR[2]		Benefit/Cost Ratio[3]	
	Including Negative Accident Values	Excluding Negative Accident Values	Including Negative Accident Values	Excluding Negative Accident Values	Including Negative Accident Values	Excluding Negative Accident Values
A/A1	-$109	$21,135	6.99%	8.27%	1.00	1.36
B	331,721	331,721	8.66	8.66	1.37	1.37
D	-116,301	-116,301	5.83	5.83	0.78	0.78
E	-126,158	-107,506	5.44	5.69	0.74	0.78
F	-50,162	-50,162	5.50	5.50	0.74	0.74
I	-21,300	21,300	6.20	6.20	0.87	0.87
J	132,292	141,690	8.84	8.95	1.50	1.54
L	-39,696	-39,696	6.34	6.34	0.85	0.85
P	-17,274	-6,920	6.64	6.85	0.93	0.97
Q	196,543	196,543	9.82	9.82	1.60	1.60
T	462,030	463,529	10.06	10.08	1.69	1.69

(1) Thousands of 1995 dollars discounted at 7 percent.
(2) IRR: Internal Rate of Return.
(3) Discount at 7 percent.

Chapter 5
ECONOMIC IMPACTS DUE TO THE ADHS

The travel efficiencies of Chapter 4 are one of the key components for documenting and measuring the economic gains attributable to the ADHS and provide critical data for estimating the economic development benefits of the ADHS. The ADHS as envisaged by Congress was intended to stimulate economic development in the Appalachian Region by making the Region more accessible, and better able to compete with other regions of the US. This chapter develops an estimate of the economic development impacts on Appalachian Region believed attributable to the completed portions of the ADHS. Specifically, this section of the report analyzes the jobs, wages and value-added from new production that can be quantified as impacts of the ADHS.

In order to measure how the ADHS has helped promote economic development in the Appalachian Region, this chapter implements the methods that were explained in Chapter 2 for estimating the job creation, wages and value-added that are attributable to the ADHS. The value-added estimates are then divided by the ADHS life cycle costs, and an economic impact/cost ratio is thereby derived.

ECONOMIC DEVELOPMENT OVERVIEW

The effectiveness of the ADHS in creating economic opportunity in the Appalachian Region is quantified by the use of the REMI regional economic model. The direct efficiency benefits that arise from shorter travel times, reduced vehicle operating costs for business and non-business uses, and improved safety of the ADHS provide the data input into REMI model. In turn, the REMI model generates detailed, regionally specific, estimates of the economic development impacts, as measured by jobs, wages and value-added by industries within the impact region.

Do Not Add Economic Benefits and Economic Impacts

A note of caution: the economic benefits (efficiencies) of Chapter 4 should not be added to the economic development impacts of Chapter 5. The limited extent to which some of the benefits and impacts can be properly added together is already done in the Chapter 5 impact/cost analysis. No further adding of benefits and impacts should be made—any such summation would be to double count the implications of the ADHS.

Four Indicators of Economic Development Impact

The economic development impacts of the ADHS investments are measured in four ways. Use of these four measures allows ADHS diverse impacts to be documented in a consistent fashion. The following "impact indicators" are used. These should not in any way be added together.

- **Value Added** – The dollar value of increased economic production in the Appalachian Region because of the ADHS. It is the value of the region firms' output minus the value of the inputs they purchase from other firms. In this study it is the value added by firms located in the defined impact region(s), including employee compensation, proprietary income, indirect business taxes, and other property income. This value can be thought of as the net increase in gross regional product (GRP) for the Appalachian Region.

- **Wages** – Total increases in payroll costs (wages, salaries, and benefits) paid by local industries to employees who owe their jobs, directly or indirectly, to the ADHS.

- **Employment** – Employment impacts are net changes in number of jobs due to the ADHS expressed as "full-time equivalents" (FTE's). These FTE's include the number of jobs directly attributable to ADHS highway use, plus the share of those employed in sectors that indirectly support the road users, and the firms that might expand in or locate to the Appalachian Region. In addition, the people in the new jobs will spend much of their income in the Region and this respending will in turn create additional jobs, which are also included in the study.

- **Population** – Total population dependent on the new jobs created by the ADHS.

These four statistics are the best available measures for the economic impact derived from the improved corridors. Each of the impact statistics is presented based on the impact the corridors have had or will have on the Appalachian economy in the past, present, and in the future. In order to do so, the economic impact statistics are presented for the years 1975, 1995, and 2015. All monetary calculations are expressed in constant 1995 price levels. The full results for each of the tables are presented in Appendix C.

ECONOMIC DEVELOPMENT IMPACTS

The economic development impacts are calculated for each year 1965-2025, by impact type and cause. For impact/cost evaluation purposes, the impacts are discounted by seven percent per year, and summed. The total sum of the discounted economic impacts are shown on **Exhibit 5-1**.

Exhibit 5-1
ADHS TOTAL LIFE CYCLE ECONOMIC DEVELOPMENT IMPACT
Discounted at 7%
1965-2025

	Economic Impact on Appalachian Region
Competitive Advantage	$2,699,500,000
Roadside Services	253,070,000
Tourism	235,968,000
Total ADHS Operations Impacts	$3,188,538,000
Construction Impacts [(a)]	1,457,585,000
Total Appalachian Region Impacts	$4,646,123,000[(b)]

(a) The Region impacts due to the act of spending the federal construction funds in the Region should be excluded from any analysis that attempts to justify the use of these funds.
(b) Excludes accident savings and some other travel efficiencies.

The total net life cycle economic development impacts discounted at 7 percent per year indicate that the completed sections of the ADHS as operating is worth $3.2 billion to the Appalachian economy (excluding the impacts attributable to the expenditure of the federal funds). When the

state and federal fund expenditures are included, the impacts total an estimated $4.6 billion. Clearly the ADHS has created sizable economic value for the Appalachian Region. A summary of these impacts by type and year follows.

Estimated Competitive Advantage Impacts

A major ARC objective is to create economic development for the Appalachian Region by expanding existing businesses, by attracting new businesses, and by diversifying the area's economic base. To expand and attract businesses, the Region must be competitive with other areas of the US and the world. It has been clear in recent years that there is a high level of competition among regions of the US for economic development. Keeping transportation costs as low as possible is one way that the ARC can help the Appalachian Region to be more competitive and to strengthen its business climate. Facilitating faster and more efficient travel along the corridors represents a logical means for increasing the competitive advantage of communities along the corridors. These lower transportation costs may be passed on to consumers as lower prices for consumer goods, to workers as higher wages, or to owners of businesses and firms as higher net income. Therefore, individuals can benefit from the improved corridors without even traveling on them.

To estimate the economic impact attributable to making the Region more competitive, the efficiencies are distributed across a number of industries within REMI as cost savings based on the importance of each of the industries to the total Appalachia Region. The importance of each industry is based upon the number of employees each industry has as a percentage of the total employees of the Appalachia Region. Once the values are placed into REMI as an input, the REMI model calculates the effect of reinvestment of these savings into the corridor region and estimates the amount of new business in the region attributable to the increased competitive position of the industries within the region.

The estimated annual economic impact from an improved competitive position for the Appalachian Region is listed in **Exhibit 5-2**. The exhibit suggests that the improved competitive position has led to significant economic impacts in the past, and is likely to lead to significant impacts in the future. The table lists the annual dollar economic impact for three different years (1975, 1995, and 2015) and the net total jobs and resident population for the specific year. While **Exhibit 5-2** displays the growth of economic development resulting from an improved competitive position for selected years, **Exhibit 5-3** displays the growth over time.

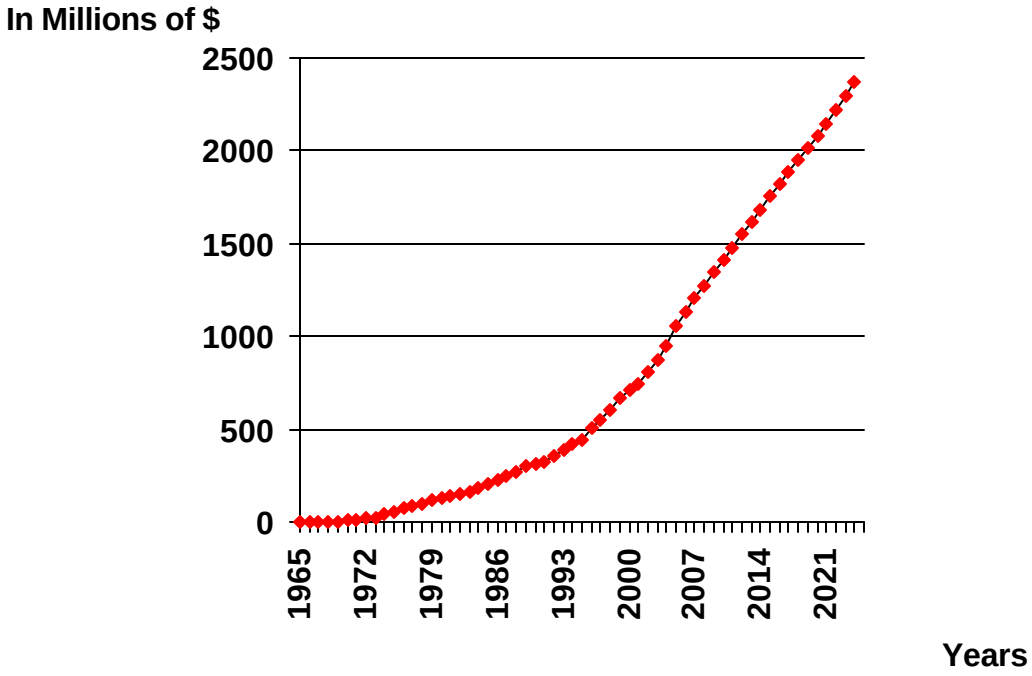
Exhibit 5-2
COMPETITIVE ADVANTAGE ECONOMIC IMPACT
(All dollar values expressed in 1995 dollars, not discounted)

Year	Employment	Population	Wages	Value Added
1975	1,790	2,317	$15,560,000	$54,840,000
1995	12,200	22,750	$324,800,000	$444,830,000
2015	35,800	73,900	$1,001,050,000	$1,752,250,000

While the economic impact of the improved competitive position is rather modest in the initial years, about 1,800 new permanent jobs and valued added of nearly $55 million in 1975, the

economic impact grows substantially over time. In 1995, the improved competitive position of the twelve corridors is estimated to have created over 12,000 new permanent jobs and over $444 million of value added. By year 2015, these values are expected to grow to over 35,000 new jobs with a value added of $1.75 billion by the Year 2015. On average, this would mean that each improved corridor would create about 3,000 permanent jobs by year 2015.

Exhibit 5-3
ECONOMIC IMPACT FROM COMPETITIVE ADVANTAGE
(In Terms of Value Added)
1995 $



This substantial economic impact growth is largely due to the increased volume of traffic over time. In the initial years, only a few of the corridors had been developed and therefore the travel time and VOC savings for the initial years was rather modest. As more and more corridors are developed, the travel time savings and VOC savings grow and, as a result, the economic impact grows.

The sheer magnitude of the competitive position economic impact that these roads are having currently, and are likely to have in the future, highlights the importance of good transportation network for the businesses in a region. This is especially true for a region like Appalachia, which has historically lagged the rest of the U.S in economic growth.

Roadside Services Impact

The second economic development impact component is the economic impact attributable to Roadside Services. Roadside Services comprise those firms which sell goods and services that cater to the traffic along a highway. As described in Chapter 3, these roadside services include gasoline stations, hotels/motels, restaurants, gift shops, and other businesses that are typically located near the highways. As traffic volumes increase, so do the number of roadside service establishments. The economic impact estimates from the increased number of establishments are based on estimates of dollars spent on roadside services per vehicle mile of travel (VMT). The increase in roadside service expenditures is entered into REMI model, which traces the respending of the expenditures through the regional economy and forecasts the future repercussions of such expenditures.

Exhibit 5-4 lists the annual roadside expenditure economic development impacts for the twelve corridors combined. The wages and value added numbers are annual impacts in the stated years; the employment and population numbers represent the net change that exists, by year. Like the competitive advantage impacts, the economic impact created from roadside expenditures is relatively small in the initial years, but the impact grows as the traffic volumes increase and as the number of ADHS segments that are open to traffic increases.

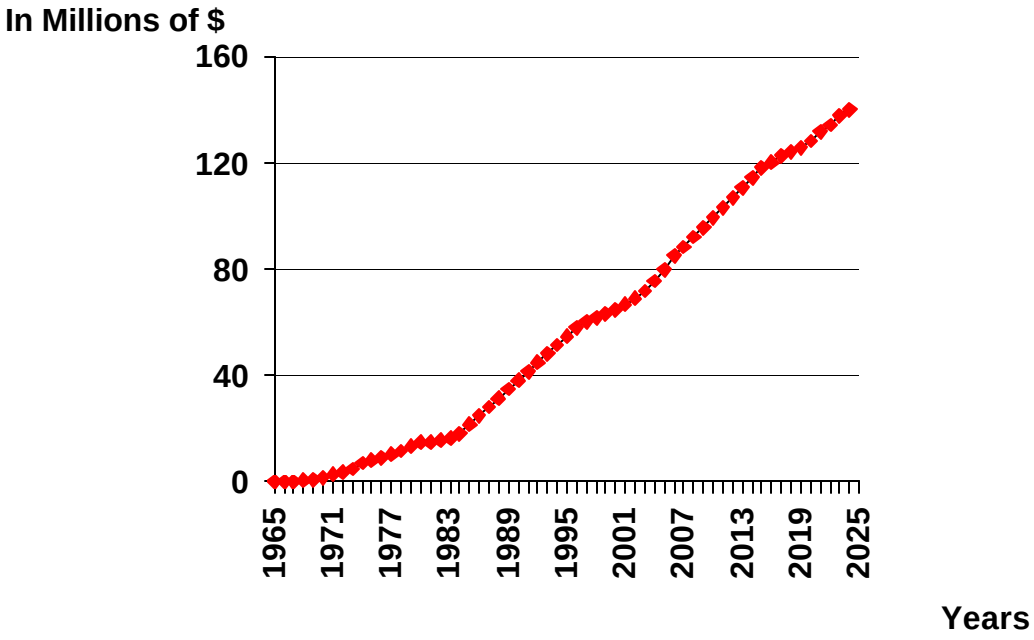
Exhibit 5-4
ROADSIDE EXPENDITURE ECONOMIC IMPACT
(All dollar values expressed in 1995 dollars, not discounted)

Year	Employment	Population	Wages	Value Added
1975 [(a)]	320	270	$2,970,000	$8,190,000
1995	1,390	1,980	$33,220,000	$54,870,000
2015	2,960	4,790	$81,500,000	$118,410,000

(a) In the early years (1975) the ADHS effect is greater on employment than on population. The reason is higher labor force participation rates due to the ADHS, and the ability to commute further distances to work.

This growth is also shown in **Exhibit 5-5**. By the Year 2015, the impact is quite substantial as nearly 3,000 permanent jobs are created with a value added to the Appalachian Region of over $118 million. To give some perspective, this translates into an additional 250 permanent jobs (on average) per corridor by the year 2015.

Exhibit 5-5
ECONOMIC IMPACT FROM ROADSIDE SERVICES
(In Terms of Value Added)
1995 $



Tourism Impact

The ADHS corridors also have the opportunity to influence tourism, to the advantage of the Appalachian Region. Tourists spent considerable sums while traveling, and if additional tourists find their way to Appalachia due to the ADHS, that is good for the economy. A number of the study corridors serve tourist facilities and locations and, as access is improved due to the ADHS, tourists are influenced. The economic impacts believed attributable to these tourism effects are estimated in the study.

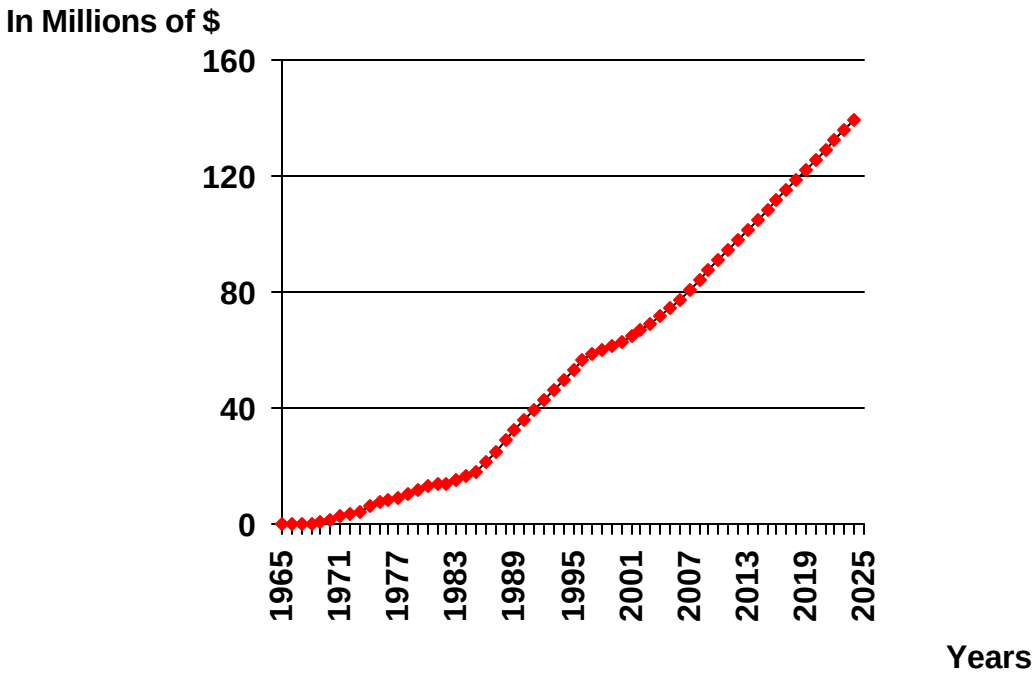
A typical family vacationing in the area spends substantially more money than a person who is just passing through the area. These visitors create economic activity through money they spend shopping, staying at hotels, eating at restaurants, and visiting amusement and recreation centers. A vacationing family could inject hundreds of dollars per day into the local economy and create a substantial economic impact through the multiplier effect of these dollars. This multiplier effect is estimated by REMI for the Appalachian Region.

Exhibit 5-6 lists this estimated impact for the three example years. Similar to the economic impact from improved competitive position and increased expenditures in roadside services, the economic impact that results from tourism is rather modest in the initial years (only 320 new jobs and a value added of $7.35 million created by 1975), but this impact grows substantially over time (almost 2,900 new jobs and a value added of over $100 million by the Year 2015) and its growth is shown in **Exhibit 5-7**. The impact per corridor is slightly less than economic impact from the expenditures of the roadside services as nearly 250 permanent jobs will be created on average per corridor.

Exhibit 5-6
ECONOMIC IMPACT FROM TOURISM
(All dollar values expressed in 1995 dollars, not discounted)

Year	Employment	Population	Wages	Value Added
1975	320	280	$2,430,000	$7,350,000
1995	1,290	1,930	$33,440,000	$52,850,000
2015	2,920	4,880	$75,250,000	$108,110,000

Exhibit 5-7
ECONOMIC IMPACT FROM TOURISM
(In terms of Value Added)
$1995



Construction Economic Impact

The fact that federal dollars are imported into the Region to build the ADHS is of economic value to the Region. The economic impact value of these expenditures to the Region is calculated by the REMI model. The construction cost of designing and building the highways is treated as a positive economic shock to the economy in the REMI model. The model determines the amount of materials, labor, etc., that can be supplied locally and then estimates the total economic development impacts to the region created by highway construction. This impact includes money that is respent through a multiplier effect in the area. While this is a tremendous impact for any one region of the country, it is viewed as a zero net gain to the nation as a whole. The funding for the construction project may result in economic gain for the Appalachian Region can be viewed as a lost opportunity of economic development for another region of the country that did not get a project funded; therefore, from the national perspective there is a zero net gain.

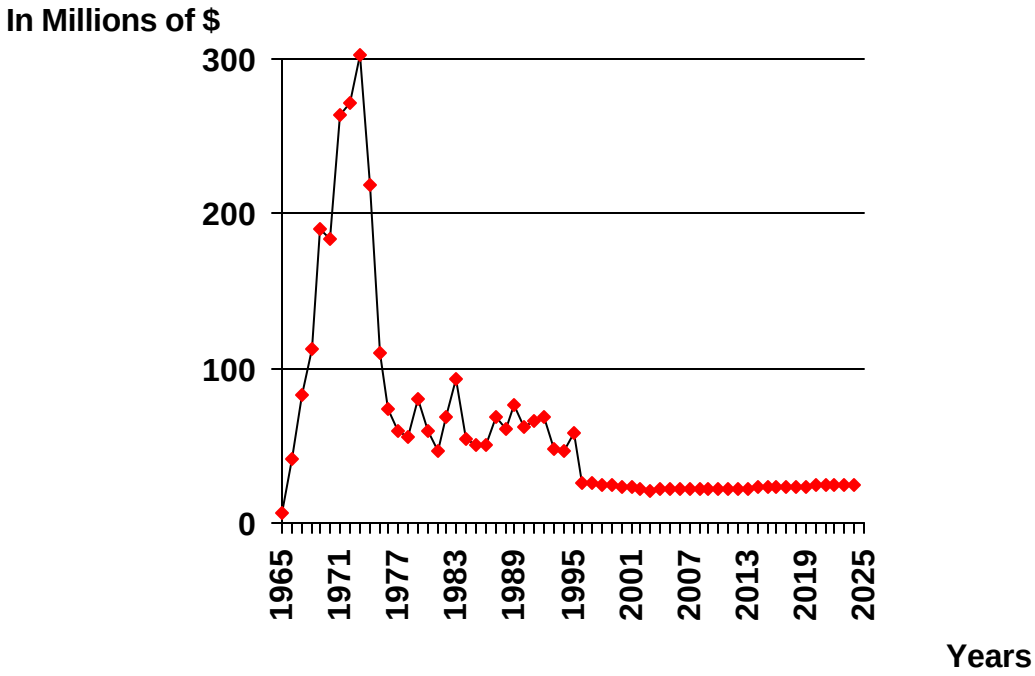
Over $4.6 billion (current dollars) has been spent in the Appalachian Region on the construction of the improved corridors of the ADHS. **Exhibit 5-8** displays the estimated economic impact directly due to the act of making these construction expenditures. Most of the expenditures occurred in the years between 1965-1995 with only maintenance expenditure occurring after Year 1995. In 1975, it is estimated that the money spent on building the ADHS accounted for 3,600 new full time equivalent jobs and a value added impact of over $109 million. This translates into 300 new permanent jobs, on average, per corridor. By 2015, only lingering effects from the initial construction expenditures coupled with the effects from the maintenance expenditure is occurring. It is projected that the capital projects will account for 500 new permanent jobs with a value added of nearly $23 million by year 2015.

Exhibit 5-8
ECONOMIC IMPACT FROM CONSTRUCTION
(All dollar values expressed in 1995 dollars, not discounted)

Year	Employment	Population	Wages	Value Added
1975	3,680	11,820	$47,110,000	$109,900,000
1995	1,390	3,760	$34,620,000	$58,200,000
2015	509	910	$19,960,000	$22,990,000

Exhibit 5-9 presents these impacts over time. The key point is that the construction impacts are large during the construction period, and small after the money is spent and the highway is open. After the year 1995, there is no construction on these completed highway sections and the impact that then occurs is due to the increased highway maintenance expenditures.

Exhibit 5-9
ECONOMIC IMPACT FROM CONSTRUCTION EXPENDITURES
(In Terms of Value Added)
1995$



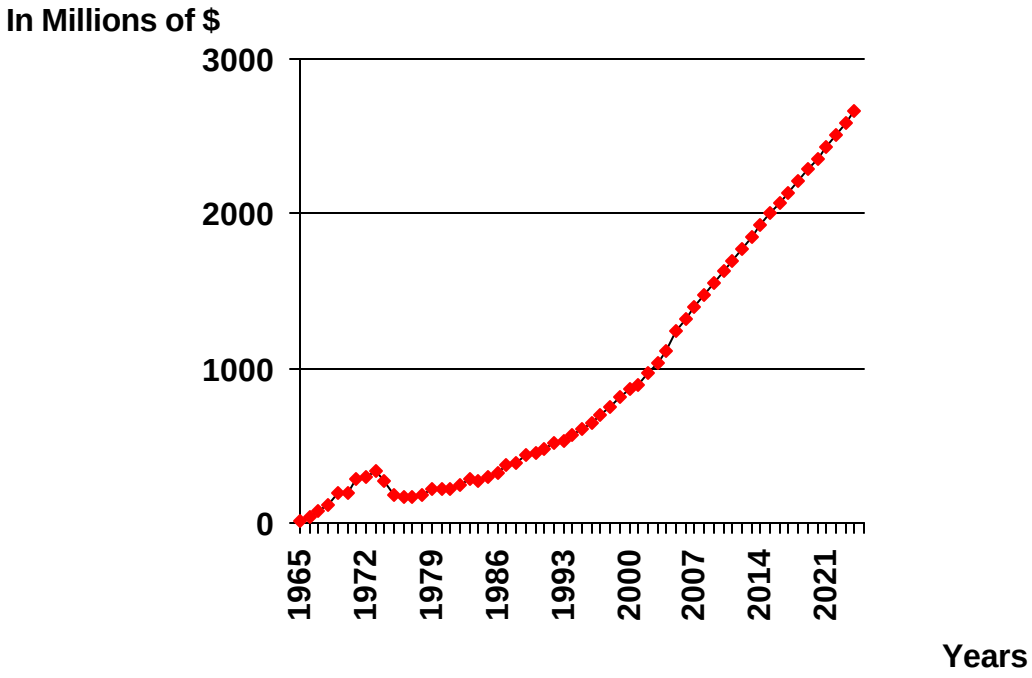
Economic Development Impact Summary

A summary of the total estimated economic impact on the Appalachian Region from the improved corridors is displayed in **Exhibit 5-10**. This is a summary of the economic impacts from the competitive advantage, roadside services, tourism, and the construction expenditure. In examining the table, it is evident that twelve improved corridors have had, and will continue to have, a significant positive impact for the Region. The impact these corridors is having on the economy has grown over time and is projected to create over 42,000 new jobs and over $2 billion of value added impact by the year 2015. Examining the average impact per corridor indicates that over 3,500 permanent jobs are estimated to be created per corridor by the year 2015.

Exhibit 5-10
TOTAL ECONOMIC IMPACT
(All dollar values expressed in 1995 dollars, not discounted)

Year	Employment	Population	Wages	Value Added
1975	6,100	14,700	$68,070,000	$180,280,000
1995	16,260	30,420	$426,080,000	$610,750,000
2015	42,190	84,480	$1,177,770,000	$2,001,760,000

Exhibit 5-11
TOTAL ECONOMIC IMPACT
(In Terms of Value Added)
1995 $



Impacts by Industry Type

A wide variety of firms and economic sectors have benefited from the ADHS. These include firms and industries that use the highways, as well as firms and industries that supply goods and services to those who build the highways, and use the highways.

Exhibit 5-12 lists ten economic sectors, and indicates the estimated number of jobs within each sector that is attributable to the ADHS.

Exhibit 5-12
EMPLOYMENT IMPACTS BY ECONOMIC SECTOR
Three Example Years

	1975		1995		2015	
Economic Sector	**Employ**	**Percent**	**Employ**	**Percent**	**Employ**	**Percent**
Manufacturing	195	3.20%	1,003	6.13%	3,348	7.94%
Mining	34	0.56%	68	0.42%	201	0.48%
Construction	3,059	50.24%	1,010	6.17%	2,479	5.88%
Trans and Pub Utilities	120	1.97%	380	2.32%	1,174	2.78%
Finance and Insurance	112	1.84%	550	3.36%	1,548	3.67%
Retail Trade	899	14.76%	4,378	26.75%	12,078	28.63%
Wholesale Trade	89	1.46%	338	2.07%	1,091	2.59%
Services	835	13.71%	6,339	38.73%	14,832	35.16%
Agr/Forestry/Fish Srv	23	0.38%	371	2.27%	656	1.56%
Government	723	11.87%	1,931	11.80%	4,778	11.33%
TOTAL	6,089		16,368		42,185	

These statistics indicate that the construction industries are the first to benefit but then, later when the highways are open to traffic, the services and retail trade sectors benefit the most. These statistics also suggest that all of the economic sectors are estimated to benefit from the ADHS.

Economic Development Conclusions

Clearly the 12 completed ADHS highway corridors have had a significant positive impact on the people of the Appalachian Region. For example:

- By the year 2015 it is estimated that 42,000 jobs will exist in the Region that, without the ADHS, would not have existed in the Region.

- The net increase in annual value added will be over $2 million by 2015. The total present value of the life cycle net increase in value added is $3.2 billion excluding construction impacts ($4.6 billion including construction impacts).

- The total life cycle economic impact of the 12 ADHS corridors, including the value added plus the portion of the travel efficiency benefits then can properly be added, is $5.5 billion in discounted 1995 price levels.

ECONOMIC DEVELOPMENT IMPACT/COST RESULTS

In Chapter 4 an economic benefit/cost comparison was developed, and the benefit/cost result was a 1.18, indicating that the ADHS significantly contributed to the economic efficiency of the Appalachian Region. Chapter 5 indicates that the ADHS does more than merely increase efficiency; it also creates economic development opportunities for the Appalachian Region (jobs, wages, value added).

To gauge the magnitude of this economic development relative to the costs incurred, an "Impact/Cost Ratio" is also developed. This ratio divides the total life cycle value added impact accruing to the Appalachian Region by the total life cycle costs incurred by the ADHS program (the state and federal dollars).

Impact/Cost Results

The results of this economic development/cost calculation are presented on **Exhibit 5-13**. The impacts used in this calculation include those due to:

- Competitive position
- Roadside expenditures
- Tourism
- Accident savings
- Other efficiencies

Excluded are the impacts attributable to the actual expenditure of federal funds in the Region.

Exhibit 5-13
ECONOMIC IMPACT/COST RESULTS

	Net Present Value ($000)	Internal Rate of Return	Benefit/Cost Ratio
Economic Development Results [(a)]	$1,344,376	8.2%	1.32

(a) These impacts exclude the impacts directly attributable to the expenditure of the federal funds to build the ADHS.

According to **Exhibit 5-13**:

- The economic values accruing to the Appalachian Region are greater than the federal costs of creating those Regional impacts.
- For each $1.00 invested, $1.32 is generated in economic impact value.
- The Appalachian Region is better off by $1.3 billion more than the cost of building the ADHS.
- With a positive Net Present Value, an Internal Rate of Return of 8.29%, and a Benefit/Cost Ratio of 1.32, the 12 ADHS corridors evaluated in this study are found to have had a positive impact on the Region, and a positive impact that exceeds the costs of the ADHS.

According to these statistics, the completed portions of the Appalachian Development Highway System have clearly had a very significant economic development impact on the Appalachian Region. The ADHS highways have caused places in the Region to be more accessible, and have created significant perceived efficiencies. These in turn have made the Region to be a better place to live, work, and invest, which in turn have created economic opportunity. The results are:

1. **Enhanced Economic Growth** – job opportunities, resident population, increased wages, and increased economic prediction (value added).

2. **Economically Viable Highway Investments** – the economic development impact values exceed the costs, implying feasible projects.

Costs in the Impact/Cost Calculation

The costs of the twelve corridors included in the impact/cost calculation include the cost of purchasing the right-of-way, designing, constructing, and maintaining the facility. **Exhibit 5-14** shows the construction and maintenance costs of the twelve corridors combined over the study period. The construction costs include the cost of designing the roads, constructing the major structures, relocating utilities, purchasing the right-of-way, and the constructing of the actual road.

As shown in the exhibit, highway construction costs end in the Year 1995, with only maintenance expenditures remaining for the rest of the study period. The largest outlay of construction expenditures occurs in 1973 when over $850 million (in 1995 dollars) was spent on the various corridors. Over time, the expenditures gradually decreased until 1995 when $34 million was spent. From 1996 to the end of the study period, it is estimated that the net increase in highway maintenance costs will be about $30 million per year, or $2.5 million per corridor per year.

Impacts in the Impact/Cost Calculation

The impacts from the improved corridors may be realized in a number of ways, including improved traffic safety, decreases in fuel and other vehicle operation costs, increased tourism, attraction of new industry, and an increase in roadside businesses. These impacts not only accrue to individuals who use the roads, but can be passed on to others in the Appalachian Region through lower prices for consumers, higher wages for workers, and increased profits for businesses.

Exhibit 5-14
ADHS COSTS BY YEAR IN IMPACT/COST CALCULATION
(Thousands of 1995 $, Not Discounted)

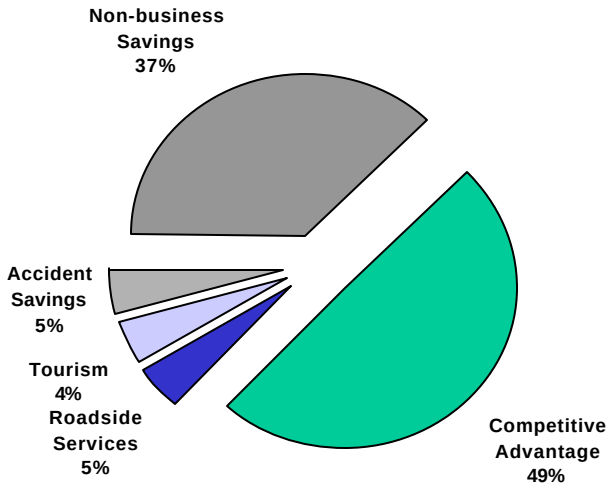
Year	Construction Costs	Maintenance Costs	Total Costs	Year	Construction Costs	Maintenance Costs	Total Costs
1965	19,909.17	0.00	19,909.17	1996	0	29,840.35	29,840.35
1966	117,537.62	0.00	117,537.62	1997	0	30,010.16	30,010.16
1967	235,723.29	-29.90	235,693.39	1998	0	30,135.53	30,135.53
1968	335,328.64	-245.98	335,082.67	1999	0	30,135.53	30,135.53
1969	539,689.93	146.43	539,836.36	2000	0	30,135.53	30,135.53
1970	551,169.13	568.53	551,737.65	2001	0	30,135.53	30,135.53
1971	775,138.19	2,021.84	777,160.03	2002	0	30,135.53	30,135.53
1972	775,403.32	3,266.79	778,670.10	2003	0	30,135.53	30,135.53
1973	848,293.45	4,742.13	853,035.58	2004	0	30,135.53	30,135.53
1974	658,781.88	6,862.97	665,644.85	2005	0	30,135.53	30,135.53
1975	392,227.75	8,595.57	400,823.32	2006	0	30,135.53	30,135.53
1976	288,077.65	10,938.39	299,016.03	2007	0	30,135.53	30,135.53
1977	239,776.97	13,071.29	252,848.26	2008	0	30,135.53	30,135.53
1978	198,702.43	14,239.57	212,942.00	2009	0	30,135.53	30,135.53
1979	232,395.91	16,047.11	248,443.02	2010	0	30,135.53	30,135.53
1980	180,917.07	17,483.04	198,400.11	2011	0	30,135.53	30,135.53
1981	137,288.78	19,099.60	156,388.38	2012	0	30,135.53	30,135.53
1982	174,858.95	20,526.69	195,385.64	2013	0	30,135.53	30,135.53
1983	217,589.03	21,412.51	239,001.54	2014	0	30,135.53	30,135.53
1984	111,262.23	22,442.54	133,704.77	2015	0	30,135.53	30,135.53
1985	87,355.88	23,330.84	110,686.72	2016	0	30,135.53	30,135.53
1986	77,072.95	24,166.09	101,239.04	2017	0	30,135.53	30,135.53
1987	99,511.97	24,866.60	124,378.56	2018	0	30,135.53	30,135.53
1988	74,047.16	25,162.71	99,209.87	2019	0	30,135.53	30,135.53
1989	94,384.55	25,560.73	119,945.28	2020	0	30,135.53	30,135.53
1990	65,354.81	25,893.20	91,248.01	2021	0	30,135.53	30,135.53
1991	65,859.41	26,324.39	92,183.81	2022	0	30,135.53	30,135.53
1992	61,637.56	27,294.46	88,932.02	2023	0	30,135.53	30,135.53
1993	19,278.90	28,119.92	47,398.82	2024	0	30,135.53	30,135.53
1994	9,813.27	28,840.12	38,653.39	2025	-1,317,796.54	0.00	-1,317,796.54
1995	4,888.89	29,655.08	34,543.97				
			Discounted Present Value		**3,978,268.05**	**160,530.34**	**4,138,798.39**

Note: This exhibit presents statistics that are not discounted. In the economic analysis, the construction costs are later discounted at 7 percent per year and summed. The total present values are shown on the bottom of each column of the exhibit.

Therefore, the impacts include not only the economic development impacts, but also the direct benefits of an improved travel efficiency on the corridors. The direct travel efficiency benefits include the non-business travel efficiencies of travel time savings and vehicle operating savings along with the savings from a reduced number of accidents. The total impacts of the twelve corridors experience steady growth over the study period and reach $1 billion by year 1997. By the end of the study period (2025), the value of the annual impacts is estimated to total almost $4 billion.

The total discounted impact types are shown in **Exhibit 5-15**. In the exhibit, the improved competitive advantage of businesses creates over 49 percent of the total impact derived. Non-Business Benefits in the form of travel time and vehicle operating cost savings represents the next largest impact.[1] The remaining impacts (Roadside Services, Tourism Impacts, and Accident Savings) each represent 4 to 5 percent of the total benefits.

Exhibit 5-15
BREAKDOWN OF TOTAL DISCOUNTED IMPACTS BY TYPE (a)
(1965-2025)



(a) This exhibit summarizes the total impacts, of all types, used in the impact/cost calculations.

In Exhibit 5-16, these impacts and benefits are shown per year. In the exhibit, columns **B**, **C**, and **D** are the economic development impacts (the value added impacts) of competitive advantage, roadside services, and tourism per year. Columns **E** and **F** are the travel efficiency impacts of Non-business savings (auto travel time and VOC savings) and Accident Savings. Column **G** represents the sum of the total economic development impacts and the relevant portion of the travel efficiency benefits.

[1] The reason the Non-Business Benefits represent such a large percentage of the total benefits is that over 85 percent of all traffic is non-business related. This large portion of the traffic creates substantial benefits.

Exhibit 5-16
TOTAL IMPACTS IN IMPACT/COST CALCULATION
(All Values in thousands of 1995 $)

A	B	C	D	E	F	G
Year	Competitive Advantage	Roadside/ Impact	Tourism Impact	Accidents Benefit	N-bus auto Savings	Total Benefit
1965	0	0	0	0	0	0
1966	0	0	0	0	0	0
1967	100	50	50	-271	333	262
1968	2,180	610	220	1,017	6,711	10,738
1969	3,430	860	790	831	9,163	15,073
1970	5,740	1,640	1,480	1,560	13,945	24,365
1971	11,690	2,800	2,550	2,516	26,542	46,098
1972	17,160	3,650	3,300	4,946	34,128	63,184
1973	24,480	4,860	4,380	7,108	43,049	83,876
1974	40,240	7,070	6,370	9,804	66,247	129,730
1975	54,840	8,190	7,350	10,853	79,583	160,815
1976	71,090	9,130	8,200	14,028	94,306	196,754
1977	83,790	10,340	9,290	14,465	101,801	219,686
1978	99,300	11,540	10,390	17,624	115,616	254,470
1979	115,240	13,290	11,950	20,535	131,315	292,330
1980	126,110	14,790	13,290	23,089	143,743	321,022
1981	139,690	14,970	13,460	24,227	153,247	345,594
1982	145,870	15,650	14,100	25,885	161,691	363,196
1983	162,670	16,450	14,850	27,966	179,343	401,279
1984	188,360	18,220	16,420	28,010	194,936	445,946
1985	205,320	21,550	18,240	29,497	205,377	479,985
1986	225,780	24,880	21,710	32,753	220,265	525,388
1987	246,790	28,210	25,170	36,722	234,058	570,950
1988	271,250	31,550	28,630	37,256	248,557	617,243
1989	297,690	34,880	32,090	38,020	259,360	662,039
1990	316,480	38,210	35,550	38,414	270,901	699,555
1991	327,180	41,540	39,010	39,078	280,331	727,139
1992	359,160	44,880	42,470	40,564	299,309	786,383
1993	385,610	48,210	45,930	41,479	309,629	830,858
1994	417,980	51,540	49,390	43,070	326,188	888,168
1995	444,830	54,870	52,850	47,449	343,459	943,458
1996	502,790	58,200	56,310	48,579	371,421	1,037,300
1997	549,740	60,270	58,380	49,709	399,384	1,117,483
1998	605,810	61,790	59,860	50,839	427,346	1,205,645
1999	667,590	63,320	61,270	51,969	455,309	1,299,458
2000	713,120	64,910	62,820	53,099	483,271	1,377,221
2001	744,520	66,770	64,550	54,229	511,234	1,441,303
2002	810,210	68,980	66,670	55,359	539,196	1,540,416
2003	873,940	71,890	69,100	56,489	567,159	1,638,578
2004	944,240	75,690	71,790	57,619	595,121	1,744,461
2005	1,059,200	79,900	74,390	58,749	623,084	1,895,323
2006	1,129,920	85,190	77,350	59,879	651,046	2,003,386
2007	1,202,030	88,590	80,560	61,009	679,009	2,111,198
2008	1,272,240	92,140	83,820	62,139	706,972	2,217,311
2009	1,342,310	95,840	87,250	63,269	734,934	2,323,604
2010	1,411,400	99,560	90,740	64,400	762,897	2,428,996
2011	1,480,740	103,290	94,190	65,530	790,859	2,534,609
2012	1,549,810	107,000	97,650	66,660	818,822	2,639,941
2013	1,617,190	110,790	101,080	67,790	846,784	2,743,634
2014	1,686,020	114,600	104,560	68,920	874,747	2,848,846
2015	1,752,250	118,410	108,110	70,050	902,709	2,951,529
2016	1,817,360	110,430	111,620	71,180	930,672	3,041,261
2017	1,885,710	113,930	115,160	72,310	958,634	3,145,744
2018	1,951,270	117,460	118,610	73,440	986,597	3,247,377
2019	2,017,210	121,030	122,070	74,570	1,014,559	3,349,439
2020	2,082,250	124,490	125,520	75,700	1,042,522	3,450,482
2021	2,148,830	127,910	128,960	76,830	1,070,484	3,553,014
2022	2,220,060	131,450	132,370	77,960	1,098,447	3,660,287
2023	2,292,760	134,910	135,730	79,090	1,126,410	3,768,899
2024	2,366,390	138,340	139,140	80,220	1,154,372	3,878,462
2025	0	0	0	0	0	0
Discounted present value	2,699,500	253,070	235,968	247,680	2,175,020	5,483,175

Note: Columns B, C, and D represent the "value added" impacts. Columns E and F are the portion of the efficiencies that are independent of the value added impact. Together they constitute the total ADHS impact.

The Impact/Cost Calculation

In order to place the economic impacts into perspective (relative to the cost outlays which generated the impacts), an impact/cost calculation is made. In this calculation, the net economic impacts accruing to the Appalachian Region are divided by the ADHS costs paid by the Nation.

The complete impact/cost calculation is shown on **Exhibit 5-17**. On this exhibit:

Columns

B, C, D, E, F, G, I are at 1995 price levels, not discounted

K, L are discounted at 7% per year

B, C, D, E, F, G are all economic impacts which can properly be added together

J is the present worth factor at 7% per year

Year 2025 cost is the residual value of the highways in that year

PV at the bottom of each column is the present value sum of each column, discounted at 7% per year

The **Exhibit 5-17** conclusion is that the economic impact/cost comparison indicates that the ADHS positive impact on the Appalachian Region is greater than the total ADHS cost. The key conclusions are:

1. The total economic return on investment is an attractive constant dollar return of 8.29% per year.

2. The Appalachian Region is better off by an estimated $1.3 billion more than the total cost of building and maintaining the ADHS.

3. Each $1.00 invested yields $1.32 in economic development benefit for the Appalachian Region.

4. While the efficiency benefit/cost analysis indicated an economically feasible ADHS (benefit/cost of 1.18), the ADHS from an economic development perspective is even more attractive (impact/cost ratio of 1.32).

Exhibit 5-17
IMPACT-COST ANALYSIS
7 Percent Discount Rate
(All values in 1995 dollars not discounted)

A	B	C	D	E	F	G	I	J	K	L
Year	Competitive Advantage	Roadside/ Impact	Tourism Impact	Accidents Benefit	N-bus auto Savings	Total Benefit	N et Benefit - Costs	Present-Worth Factor	Discounted Costs	Discounted Benefits
1965	0	0	0	0	0	0	-19,909	1.0000	19,909	0
1966	0	0	0	0	0	0	-117,538	0.9346	109,848	0
1967	100	50	50	-271	333	262	-235,432	0.8734	205,864	229
1968	2,180	610	220	1,017	6,711	10,738	-324,344	0.8163	273,527	8,766
1969	3,430	860	790	831	9,163	15,073	-524,763	0.7629	411,839	11,499
1970	5,740	1,640	1,480	1,560	13,945	24,365	-527,372	0.7130	393,381	17,372
1971	11,690	2,800	2,550	2,516	26,542	46,098	-731,062	0.6663	517,855	30,717
1972	17,160	3,650	3,300	4,946	34,128	63,184	-715,486	0.6227	484,917	39,348
1973	24,480	4,860	4,380	7,108	43,049	83,876	-769,159	0.5820	496,474	48,817
1974	40,240	7,070	6,370	9,804	66,247	129,730	-535,915	0.5439	362,067	70,565
1975	54,840	8,190	7,350	10,853	79,583	160,815	-240,008	0.5083	203,758	81,750
1976	71,090	9,130	8,200	14,028	94,306	196,754	-102,262	0.4751	142,060	93,477
1977	83,790	10,340	9,290	14,465	101,801	219,686	-33,162	0.4440	112,268	97,543
1978	99,300	11,540	10,390	17,624	115,616	254,470	41,528	0.4150	88,363	105,596
1979	115,240	13,290	11,950	20,535	131,315	292,330	43,887	0.3878	96,350	113,371
1980	126,110	14,790	13,290	23,089	143,743	321,022	122,622	0.3624	71,909	116,353
1981	139,690	14,970	13,460	24,227	153,247	345,594	189,206	0.3387	52,974	117,065
1982	145,870	15,650	14,100	25,885	161,691	363,196	167,811	0.3166	61,854	114,979
1983	162,670	16,450	14,850	27,966	179,343	401,279	162,278	0.2959	70,712	118,724
1984	188,360	18,220	16,420	28,010	194,936	445,946	312,241	0.2765	36,970	123,308
1985	205,320	21,550	18,240	29,497	205,377	479,985	369,298	0.2584	28,604	124,037
1986	225,780	24,880	21,710	32,753	220,265	525,388	424,149	0.2415	24,451	126,888
1987	246,790	28,210	25,170	36,722	234,058	570,950	446,572	0.2257	28,074	128,871
1988	271,250	31,550	28,630	37,256	248,557	617,243	518,033	0.2109	20,928	130,205
1989	297,690	34,880	32,090	38,020	259,360	662,039	542,094	0.1971	23,647	130,519
1990	316,480	38,210	35,550	38,414	270,901	699,555	608,307	0.1842	16,812	128,892
1991	327,180	41,540	39,010	39,078	280,331	727,139	634,955	0.1722	15,874	125,210
1992	359,160	44,880	42,470	40,564	299,309	786,383	697,451	0.1609	14,312	126,553
1993	385,610	48,210	45,930	41,479	309,629	830,858	783,459	0.1504	7,129	124,963
1994	417,980	51,540	49,390	43,070	326,188	888,168	849,514	0.1406	5,433	124,843
1995	444,830	54,870	52,850	47,449	343,459	943,458	908,914	0.1314	4,538	123,939
1996	502,790	58,200	56,310	48,579	371,421	1,037,300	1,007,460	0.1228	3,664	127,352
1997	549,740	60,270	58,380	49,709	399,384	1,117,483	1,087,473	0.1147	3,443	128,221
1998	605,810	61,790	59,860	50,839	427,346	1,205,645	1,175,510	0.1072	3,232	129,287
1999	667,590	63,320	61,270	51,969	455,309	1,299,458	1,269,322	0.1002	3,020	130,231
2000	713,120	64,910	62,820	53,099	483,271	1,377,221	1,347,085	0.0937	2,823	128,995
2001	744,520	66,770	64,550	54,229	511,234	1,441,303	1,411,168	0.0875	2,638	126,165
2002	810,210	68,980	66,670	55,359	539,196	1,540,416	1,510,280	0.0818	2,465	126,020
2003	873,940	71,890	69,100	56,489	567,159	1,638,578	1,608,443	0.0765	2,304	125,281
2004	944,240	75,690	71,790	57,619	595,121	1,744,461	1,714,325	0.0715	2,153	124,650
2005	1,059,200	79,900	74,390	58,749	623,084	1,895,323	1,865,188	0.0668	2,012	126,570
2006	1,129,920	85,190	77,350	59,879	651,046	2,003,386	1,973,250	0.0624	1,881	125,034
2007	1,202,030	88,590	80,560	61,009	679,009	2,111,198	2,081,063	0.0583	1,758	123,143
2008	1,272,240	92,140	83,820	62,139	706,972	2,217,311	2,187,175	0.0545	1,643	120,872
2009	1,342,310	95,840	87,250	63,269	734,934	2,323,604	2,293,468	0.0509	1,535	118,379
2010	1,411,400	99,560	90,740	64,400	762,897	2,428,996	2,398,861	0.0476	1,435	115,653
2011	1,480,740	103,290	94,190	65,530	790,859	2,534,609	2,504,473	0.0445	1,341	112,787
2012	1,549,810	107,000	97,650	66,660	818,822	2,639,941	2,609,806	0.0416	1,253	109,788
2013	1,617,190	110,790	101,080	67,790	846,784	2,743,634	2,713,498	0.0389	1,171	106,636
2014	1,686,020	114,600	104,560	68,920	874,747	2,848,846	2,818,711	0.0363	1,095	103,482
2015	1,752,250	118,410	108,110	70,050	902,709	2,951,529	2,921,393	0.0339	1,023	100,198
2016	1,817,360	110,430	111,620	71,180	930,672	3,041,261	3,011,126	0.0317	956	96,490
2017	1,885,710	113,930	115,160	72,310	958,634	3,145,744	3,115,609	0.0297	894	93,275
2018	1,951,270	117,460	118,610	73,440	986,597	3,247,377	3,217,241	0.0277	835	89,990
2019	2,017,210	121,030	122,070	74,570	1,014,559	3,349,439	3,319,304	0.0259	780	86,746
2020	2,082,250	124,490	125,520	75,700	1,042,522	3,450,482	3,420,346	0.0242	729	83,516
2021	2,148,830	127,910	128,960	76,830	1,070,484	3,553,014	3,522,879	0.0226	682	80,372
2022	2,220,060	131,450	132,370	77,960	1,098,447	3,660,287	3,630,151	0.0211	637	77,382
2023	2,292,760	134,910	135,730	79,090	1,126,410	3,768,899	3,738,764	0.0198	595	74,466
2024	2,366,390	138,340	139,140	80,220	1,154,372	3,878,462	3,848,326	0.0185	556	71,617
2025	0	0	0	0	0	0	1,317,797	0.0173	-22,742	0
Discounted Present Value	2,699,500	253,070	235,968	247,680	2,175,020	5,483,175	1,344,376		4,138,798	5,483,175
	7.00%	IRR =	8.29%							
	1.32	NPV =	1,344,376.32							

Sensitivity Tests

The economic development impacts and impact/cost results, while valid, are nevertheless sensitive to certain key assumptions and other uncertainties. To depict this, three sensitivity tests were conducted. The first added the construction impacts to the economic development impacts. The second used a constant dollar discount rate of 4%, and the third used a discount rate of 10%.

The results of the sensitivity tests are shown on **Exhibit 5-18**. As shown, only at the unrealistically high discount rate of 10% does the ADHS become infeasible.

Exhibit 5-18
ECONOMIC DEVELOPMENT IMPACT/COST SENSITIVITY RESULTS

	Net Present Value ($000)	Internal Rate of Return	Benefit/Cost Ratio
Feasibility Test [a]	$1,344,376	8.29%	1.32
Including Construction [b]	$2,801,961	10.55%	1.68
Excluding Construction, 4% [c]	$9,971,179	8.29%	2.84
Excluding Construction, 10% [d]	($897,072)	8.29%	.72

(a) The basic test of highway feasibility, suggesting that the ADHS has a legitimate economic rationale.
(b) A sensitivity test wherein the impacts of spending the federal funds in the Region are included as economic impacts. ADHS economic feasibility is enhanced when the construction expenditures are included.
(c) A sensitivity test using a 4% discount rate. ADHS economic feasibility is enhanced.
(d) A sensitivity test using a 10% discount rate. ADHS feasibility is questioned -- but 10% is an unrealistically high constant dollar (excluding inflation) discount rate.

ECONOMIC DEVELOPMENT CONCLUSIONS

From the beginning, the ARC has strived to generate and support economic development in the Appalachian Region. An important method has been the investment in new and improved highways. ARC's investments have created economic activity in the form of jobs, increased income, increased wages, increased production, and an overall improvement in living standard. Both the Impact/Cost and the Benefit/Cost analyses have shown that this investment has resulted in a feasibility ratio of greater than 1.0. This means that the people, businesses, and communities of the Appalachian Region have gained considerably from the highway investments. The results of the analysis provide strong support for the past investment in ADHS highways.

Chapter 6
ADHS COMPLETED SECTIONS ECONOMIC EVALUATION CONCLUSIONS

This study examined the completed portions of the Appalachian Development Highway System and sought to determine the economic benefits and economic impacts estimated for the completed portions of the ADHS. The study then compared those economic benefits and impacts with the tax dollars used to build and maintain the highways, in an attempt to determine what the highway investments have achieved toward net economic development. The study results are summarized in this chapter in four ways:

- Economic Efficiency Benefits;
- Economic Development Impacts;
- Economic Evaluation Results; and
- Study Conclusions.

The study results, from all of these perspectives, indicate that the completed portions of the Appalachian Development Highway System have in fact attained their economic development objectives. As a result of the ADHS, the Appalachian Region has become a better place to live and work, the Region is more efficient, job opportunities have been created and the Region is better able to compete with other regions of the US for economic activity.

ECONOMIC EFFICIENCY BENEFITS

The efficiency benefits calculated in this study are those net user cost savings that FHWA and other highway agencies typically and traditionally calculate when economically evaluating a highway project – travel time savings, vehicle operating cost savings, and accident savings. The total efficiency benefits for three example years for the twelve corridors combined are shown on **Exhibit 6-1**.

Exhibit 6-1
EFFICIENCY GAINS DUE TO ADHS COMPLETED SECTIONS
Appalachian Region
($Thousands)

	Annual Savings		
Savings Type	**1975**	**1995**	**2015**
Time Savings	$207,129	$785,812	$1,943,382
Operating Cost Savings	(10,855)	(11,178)	45,870
Accident Savings	10,853	47,449	70,050
Total Efficiency Gains	$207,127	$822,083	$2,059,302

From a travel perspective, the ADHS corridors clearly make places in the Region more accessible, by dramatically reducing the time it takes to travel from one place to another. The ADHS makes travel in the Appalachian Region safer and more efficient.

But this is only a part of the total ADHS economic value. These efficiencies in turn cause the Appalachian Region to be a better place to work and invest, which creates economic opportunity as discussed below.

ECONOMIC DEVELOPMENT IMPACTS

The study's findings indicate that the completed portions of the ADHS have had a positive effect on the economic well being of the residents and businesses of the Appalachian Region. The ADHS has helped the Region to retain and attract jobs and resident population, and has contributed to the Region's economic health and production (as measured by employment opportunities, resident population, wages and value added).

Job Impacts

The ADHS has provided access to portions of the Region, has helped the Region to be better able to compete economically, and has generally helped to retain some firms, and to attract other firms. All of this has helped to create job opportunities in the Appalachian Region.

Exhibit 6-2 summarizes the net number of jobs in the Appalachian Region estimated to be due to the completed portions of the ADHS. Currently there are an estimated 16,000 jobs in existence in Appalachia due to the twelve completed ADHS corridors and it is forecast that there will be over 42,000 jobs attributable to these same twelve ADHS corridors by the year 2015. As a percentage of total employment in the Appalachian Region, 42,000 jobs is slight; but, in terms of helping the Appalachian Region to retain its residents and offer new opportunities, this is a significant job impact.

Exhibit 6-2
JOBS INCREASE DUE TO ADHS COMPLETED SECTIONS
Appalachian Region

	Jobs in Any Single Year		
Due To	**1975**	**1995**	**2015**
Competitive Advantage	1,790	12,200	35,800
Roadside Expenditures	320	1,390	2,960
Tourism	320	1,290	2,920
ADHS Construction	3,680	1,390	510
Total Jobs	6,100	16,270	42,190

In 1995 only 11 percent of the jobs attributable to the ADHS were due to the act of constructing the highways (the expenditure of the state and federal funds); 89 percent of the jobs were due to the fact that the highways are open and making the Appalachian Region to be more attractive for private investment.

Population Impacts

The twelve ADHS corridors are also expected to help the Region to retain and/or attract population. This is principally because of the job opportunities attributable to the ADHS. The total population increase (retained or attracted) estimated to be due to the twelve ADHS corridors is shown on **Exhibit 6-3**.

Exhibit 6-3
POPULATION INCREASE DUE TO ADHS COMPLETED SECTIONS
Appalachian Region

Due To	Population in Any Single Year 1975	1995	2015
Competitive Advantage	2,320	22,750	73,900
Roadside Expenditures	270	1,980	4,790
Tourism	280	1,930	4,880
ADHS Construction	11,820	3,760	910
Total Population	14,690	30,420	84,480

The vast majority of this population is due to the estimated Competitive Advantage caused by the ADHS. In effect, the study suggests that the ADHS helps the Appalachian Region to better compete, and this helps to retain and attract both job opportunities and resident population.

Wages Impacts

Because jobs will be retained or attracted that otherwise would be lost to the Appalachian Region, wages are paid that would also be otherwise lost. These are summarized on **Exhibit 6-4.** These total over $400 million in 1995, and are estimated at over $1.1 billion by the year 2015. This implies that the ADHS has been successful in attracting jobs.

Exhibit 6-4
WAGES INCREASE DUE TO ADHS COMPLETED SECTIONS
Appalachian Region
($Thousands)

Due To	Annual Wages 1975	1995	2015
Competitive Advantage	$15,560	$324,800	$1,001,050
Roadside Expenditures	2,970	33,220	81,500
Tourism	2,430	33,440	75,250
ADHS Construction	47,110	34,620	19,960
Total Population	$68,070	$426,080	$1,177,760

Value Added Impacts

One way of summarizing the total net economic impact of the twelve corridors in the Appalachian Region is to present the impacts in "value added" terms. Value Added is intended to represent the total net inflow of impacts into the Appalachian Region. It includes the effect of the wage increases, a major portion of the productivity and efficiency gains, and other forms of quantifiable economic benefit and impact. In the calculation of value added impacts, care was taken to avoid the double counting of impacts.

The total value added impacts, by year, are shown on **Exhibit 6-5**. These are estimated at $1.0 billion in 1995, and over $2.9 billion annually by the year 2015. These values are much of the impacts used in the impact/cost calculations.

Because the construction impacts are early in the process, and because their value tapers off once the construction is complete, the construction impacts of **Exhibit 6-5** occur early. Then, following that, the impacts attributable to highway use occur and increase over time.

Exhibit 6-5
VALUE ADDED DUE TO ADHS COMPLETED SECTIONS
Appalachian Region
($Thousands)

	Annual Value Added		
Due To	**1975**	**1995**	**2015**
Competitive Position	$54,840	$444,830	$1,752,250
Roadside Expenditures	8,190	54,870	118,410
Tourism	7,350	52,850	108,110
Other Efficiencies	90,436	390,908	972,759
ADHS Construction	109,900	58,200	22,990
Total Value Added	$270,715	$1,001,658	$2,974,519

Total Impacts and Benefits

Exhibit 6-6 summarizes the total 1965-2025 costs, benefits and impacts, all discounted at 7 percent per year. These are the net total present values that represent the life cycle analysis. As shown, the efficiency benefits exceed the costs (benefit/cost of 1.18), and the economic development impacts also exceed the costs, even when the Construction Impacts are excluded.

Exhibit 6-6
TOTAL DISCOUNTED COSTS, BENEFITS, AND IMPACTS
Completed Segments of ADHS
1965-2025

TOTAL COSTS	
Capital Costs	$3,978,268,000
Maintenance Costs	160,530,000
Total Costs	$4,138,798,000
TOTAL EFFICIENCY BENEFITS	
Time Savings	$4,678,898,000
Vehicle Operating Costs	(32,037,000)
Accident Savings	247,680,000
Total Benefits	$4,894,541,000
TOTAL DEVELOPMENT IMPACTS	
Competitive Advantage	$2,699,500,000
Roadside Impact	253,070,000
Tourism Impact	235,968,000
Other Efficiencies [(a)]	2,422,700,000
Construction Impact [(b)]	1,457,585,000
Total Impacts	$6,940,760,000

(a) Accident savings and non-business other efficiencies not included in the competitive advantage, roadside, and tourism impacts.

(b) Economic value of the federal funds, in terms of hiring road construction workers, etc. Should not be used as benefit when trying to justify the federal expenditure.

ECONOMIC EVALUATION RESULTS

The completed segments of twelve ADHS corridors were evaluated from three different perspectives, with the results summarized on **Exhibit 6-7**.

Exhibit 6-7
ECONOMIC EVALUATION RESULTS
Twelve Completed ADHS Corridors

Perspective	Net Present Value	Internal Rate of Return	Benefit or Impact/Cost Ratio
Economic Efficiency	$+755,743,000	7.87%	1.18
Regional Economic Development	$+1,344,376,000	8.29	1.32
Economic Development Incl. Construction	$+2,801,961,000	10.55	1.68

Evaluation Rules: The Appalachian Development Highway System is economically justified (has an economic rationale) if:

- The Net Present Value is positive (+).
- The Internal Rate of Return is 7.0% or greater.
- The Benefit/Cost Ratio is 1.0 or greater.

NOTE: Economic Efficiency, Regional Economic Development, and Economic Development Including Construction should never be added together. To do so would be to double count.

SOURCE: Wilbur Smith Associates

Economic Efficiency Results

From a travel efficiency perspective (excluding economic development impacts), the ADHS corridors completed to date are estimated to have a legitimate economic rationale. The present value of the economic efficiency gains exceeds the ADHS costs by $755 million, with a constant dollar 7.9% return on investment.

Given that efficiency gains of this type exclude transfer payments and double counting, it is concluded that the ADHS completed segments make sense economically from the national perspective. The gains in efficiency and productivity exceed the costs incurred, returning $1.18 for every $1.00 expended.

Regional Economic Development Results

The Appalachian Regional Commission was established to aid the economic and social well being of the Appalachian Region. Therefore, the extent to which the ADHS has been found to assist the Region with its economic development goals is a very relevant issue for the Appalachian Regional Commission.

For purposes of the economic impact/cost expenditure calculation, the impacts due to the direct expenditure of federal funds are excluded (so as to not attempt to use the expenditure of the funds as a reason to spend the federal funds).

The result, as shown on **Exhibit 6-7** for Net Present Value, is a very attractive $1.34 billion. This means that the residents of the Appalachian Region benefited from the ADHS by $1.34 billion more than the ARC administered federal expenditure of funds to build the ADHS. The ADHS appears to have been a good use of federal investment dollars.

The economic rate of return of 8.29% (in constant dollars) and a discounted impact/cost ratio of 1.32 reinforce the Net Present Value findings. According to this study's calculations, the economic development impacts of the completed portions of the ADHS exceed the cost budget for the ADHS. The ADHS seems to be achieving its economic development goals.

Economic Development Results, Including Construction Impacts

The above conclusions might be viewed as conservative, in that they do not include the impacts that occur in the Region when federal funds are spent in the Region. When the effects of this federal funding are included, the results become even more favorable to the ADHS. When these construction impacts are included, the NPV is a positive $2.8 billion, the IRR is 10.55%, and the Benefit/Cost is 1.68. All of these are very attractive and are indicative of a prudent investment. Clearly the federal expenditures on the ADHS have had positive benefits and impacts on the Appalachian Region.

STUDY CONCLUSIONS

This study examined the twelve ADHS corridors that are complete or nearly complete. It examined the corridors from the economic efficiency perspective and from the Appalachian Region's economic development perspective. The study's key issues were identified in Chapter 1. What follows are the answers to these issues based on the results of this study.

Question #1: To what extent, and in way ways, does the ADHS make the Appalachian Region more efficient?

Conclusion: By supplementing the individual state highway investments, the ADHS provides highways that might not have otherwise been built within the Region. These ADHS highways created benefits in the form of travel efficiencies valued at $4.89 billion (1965-2025). Improved road conditions and access have resulted in greater efficiency. The efficiencies are quantified as accident savings and travel efficiency savings. By making the Region to be more efficient and accessible, economic opportunity has expanded.

Question #2: Has the ADHS directly or indirectly caused job opportunities retention and attraction in the Appalachian Region? How many job opportunities are believed attributable to the completed portions of the ADHS?

Conclusion: The study's calculations find that by 1995 there was a net increase of approximately 16,000 jobs that would not have existed without the completed portions of the ADHS; it is estimated that these twelve corridors will have yielded a net of 42,000 Appalachian jobs by the year 2015. These jobs are estimated to have occurred because the ADHS made the Region more accessible and more efficient as a place to invest, live, and work. The ADHS has played a role in retaining and attracting jobs to the Appalachian Region.

Question #3: Has the ADHS led to increased production in the Region? How much?

Conclusion: According to this study's estimates, the net increase in value added was $1 billion in 1995, and will increase to $2.9 billion by the year 2015. The total present value of this increased production is $6.9 billion (1965-2025). Clearly the ADHS has been successful in increasing the Region's production, which of course results in increased job opportunities and increased wages.

Question #4: Federal funds have been used to build the ADHS. Has the desired economic development occurred? Is the magnitude of that development sufficient to indicate that the ADHS is a good, prudent investment?

Conclusion: The use of federal funds to build these ADHS highways has clearly yielded economic progress for the Appalachian Region. In comparing the net value added increases with the amount of funds used to build and maintain the highways, an impact/cost ratio of 1.32 is determined. This is indicative of a good, prudent investment.

Question #5: What is the economic rate of return on the federal investment? Is it sufficient to indicate that this was a good use of tax payer funds?

Conclusion: The economic rate of return on the federal investment from an efficiency perspective is 7.87 percent and from the Region's economic development perspective is 8.29 percent per year (in constant dollars; if inflation were included, the rate of return is higher). This is a solid return on the investment. Over the life cycle of the ADHS, for each $1 invested, the return is $1.18 in efficiency, and a total of $1.32 in total economic impact ($1.68 when the

construction expenditure impacts are included). These are indicative of a good use of tax payer funds.

Question #6: How do the various ADHS completed corridors compare, one with the others? Do they all appear to have been sound investments?

Conclusion: All of the twelve completed ADHS corridors produce efficiency benefits, from a per corridor low of $59 million (Corridor A/A1) to a high of $1.2 billion (Corridor B). The individual corridor efficiency returns on investment range from 5.44 percent per year (Corridor E) to 10.06 percent (Corridor T). In other words, they all yield a rate of return of a reasonable size. The rate of return for all twelve corridors from the travel efficiency perspective is a very respectable 7.87 percent per year. While some corridors are better than others, they all appear to have been reasonable investments.

Question #7: To what extent have the ADHS corridors benefited the highway users? The non-users? Do people have to use the ADHS corridors in order to benefit from them?

Conclusion: The most direct beneficiary is the highway user. The users have benefited because the highways dramatically increased travel speeds, reduced accidents, and made Appalachian Region places more accessible. By making the Region more accessible, non-users of the highways were positively impacted—due to job creation, better jobs (wages), and other opportunities. Therefore, the ADHS highways appear to have benefited the people of Appalachia, even those who do not use the specific highways.

Question #8: Have the completed ADHS corridors helped the Appalachian Region to compete on a more equal basis with other regions of the US for economic development?

Conclusion: The largest single impact attributable to the ADHS is the fact that the completed ADHS highways have helped the Appalachian Region to be better able to compete for economic opportunity. This competitiveness is valued at $2.7 billion (1965-2025). Clearly, the ADHS has helped the Region to make progress, even though the system is not yet complete.

The Appalachian Development Highway System, as originally conceived by the U.S. Congress, was intended to help the economy of the Appalachian Region. This study examined the ADHS, to determine whether the completed portions of the ADHS have attained their objective.

The ADHS cannot take credit for all growth, or even a majority of the growth, in Appalachia's last thirty-two years. But it can take credit for enough growth (42,000 jobs, 84,000 people, $2.9 billion wages, $6.9 billion value added) to show that the ADHS has been a good investment in Appalachia's, and America's, future.

APPENDIX

This Appendix contains detailed information which supports and explains the results contained in the study's report chapters. The three appendices are as follows:

Appendix A: Revised Economic Model **–** In order to apply the 1995 REMI economic model to both the past (1965-1994) and the future (1996-2025), certain modifications and analyses were necessary. Appendix A describes those economic model changes and analyses.

Appendix B: Efficiency Benefit/Cost Calculations **–** A life cycle 1965-2025 analysis period was used to calculate each corridor's benefit/cost ratio. Appendix B presents each corridor's costs and benefits, by year, over the life cycle period.

Appendix C: Economic Development Impacts by Year **–** In this study the economic development impacts are estimated for all 12 study corridors in total, by impact cause. Appendix C depicts those development impacts, by year, over the life cycle analysis period.

APPENDIX A
REVISED ECONOMIC MODEL

To measure the economic impact of the ADHS, a regional economic model specific to the Appalachian Region was needed. After deliberation, it was agreed that the most appropriate available model was the Regional Economic Models, Inc. (REMI) model, which is a private sector model that was configured for the defined Appalachian Region impact area.

Need to Reconfigure REMI Model

The REMI model has been widely used in many highway corridor feasibility and impact studies throughout the US, and it was used in three of the five "Best Practices" studies referred to by FHWA. However, each of those studies used the "existing REMI model," e.g., 1995 version, which replicates today's economy, and then forecast what might happen to that economy "if a new highway were to be built."

In the ADHS study, however, much of the highways have already been built (between 1965 and 1995). Therefore, the REMI model needed to not only forecast the future (1995-2025) but also to look back in time (1965-1995). To accomplish this, certain changes were needed.

Traditional Use of REMI Model for Highway Improvements

In general, the REMI model is designed to forecast impacts of future investments and is not designed to evaluate economic impacts from the past. As a result, adjustments to the REMI model were considered, which would estimate the economic impacts in the past instead of the future.

To better understand what adjustments to the REMI model are required for this study, it is useful first to describe the usual means in which REMI is used. The REMI model is a structural economic model which examines an economy from a perspective of cause and effect. Within the REMI model, a relationship between endogenous variables (variables that are determined within the model) and exogenous variables (variables determined outside the model) is established. These relationships between these variables are based upon historical relationships and are represented by parameters. Using historical and estimated values for the exogenous variables, REMI is able to develop a base line forecast for the future. To examine the impact an exogenous change can have in the model, changes in policy variables are made. These changes interact with the endogenous variables within the model and develop an economic forecast for the future. The difference between this forecast and the base line forecast is the economic impact that a change in a policy variable can have on a regional economy. Traditionally, a road improvement will affect the level of expenditures in construction, roadside services, as well as tourism; it will also affect the cost of doing business for major industries within a region. By changing the level of expenditures and cost savings for these different industries, an economic forecast can be obtained. However, this study also needed to be able to examine past changes to the economy. An adjustment to the REMI model was therefore requisite.

Revision of the REMI Model

The application of the REMI model to past ADHS improvements required a non-traditional application of the REMI model. A number of adjustments were examined to the REMI model in order to gain estimates for historical economic impact from a road improvement. First, the model could not be *developed* to represent a past non-build environment. Rather, the model had to be *manipulated* to approximate the past. Second, the study time period covers 60 years, while the REMI model can only estimate/forecast impacts for a period of 41 years. Therefore, two separate model runs were required, one for years 1-31 (1965-1995), the other for years 31-60 (1996-2024). In addition, a third run was necessary that overlapped the two previous sets of runs in order to merge the data. This third run contained the data from 1986 through 2025. REMI staff were very helpful in helping to understand how to manipulate the REMI model to generate a non-build base case scenario.

Revising the REMI model relied heavily upon the baseline or control forecast REMI model to make economic impact estimates for the historical years. Both the future and historical estimates of impacts were based upon the baseline control model. While deriving the economic impacts for the future years (1996-2024)[1] is straight forward, deriving the economic impacts for the historical years (1965-1995) is not. To derive the economic impacts for the future years (1996-2024), the economic values for increased travel time savings or increased expenditures can be put into the REMI model using standard procedures in the normal way without any alteration to the inputs or the outputs for REMI. However, in order to gain the economic impact for historical years (1965-1995), alterations must occur in either the REMI inputs or outputs.

In order to pursue a method in which the output of the REMI model was altered, the historical levels of output (employment and value added) had to be established for the years 1965-1995. In doing so, the level of output can be altered by a weighted factor. The baseline control forecast of the REMI model, which predicts future economic impacts (1996-2025), can be used to gain an estimate for the economic impact for road improvement made in the past if the output is weighted by the historical levels (1965-1995). An example may be helpful in creating a clearer explanation.

In order to test this methodology, data were utilized from one of the corridors (Corridor B). The initial construction of corridor B began in the mid 1960's and was first open for traffic in 1968, with other sections opening later. With the improved road, an overall gain in travel efficiency was realized for both automobiles and trucks. By improving the travel efficiency along the corridor, the industries within the region experienced a reduction in the cost of doing business. The travel efficiency gains result in cost savings for the industries within the region and the level of impact for the Appalachian Region can be estimated through the REMI model. However, REMI has a maximum period of analysis of 40 years and this corridor has a time frame of 56 (1968-2024) years. Therefore, it was necessary to put the inputs into REMI into two sets. The first set of inputs was for the historical years 1968 through 1995. The second set of inputs consisted of the future years 1996 through 2024. The second set of inputs could be run through REMI in a straight forward fashion. The value of time saved was put into the model as real dollar values for the years 1996 through 2024 and these values are displayed in **Exhibit A2** in Columns **B**

[1] 1996 through 2024 are defined as the future year forecast period because these are the years that REMI can make economic forecasts.

through **E**. The resulting output in terms of employment and value added is displayed in Columns **F** and **G**.

Exhibit A-1 is explained as follows, for the Corridor B example:

- Time Savings and Vehicle Operating Cost (VOC) Savings are both expressed in dollars per year, are calculated outside of the REMI model, and are input into the REMI model. The values are separately calculated for cars and trucks.

- REMI Output comprises some of the data that is produced by the REMI model, with employment (jobs) and Value Added (dollars) shown.

All columns show that both the efficiency gains (time and VOC) and economic development gains (employment and value added) are expected to increase over time.

While deriving results for the second set (1996-2024) of inputs was straight forward, the derivation of results for the first set (1968-1995) of inputs proved to be more difficult. The first set (1968-1995) of cost savings inputs for the competitive advantage impact was placed into the base REMI model as inputs for the years 1998 through 2025. The output for employment and value added (GRP) is displayed in Column **B** and **C** in **Exhibit A-2**. The values of output for these years will be inflated because the analysis used a REMI model that projects economic impacts for the future (1996-2025) while using historical inputs. In the course of the last three decades, a number of economic and demographic changes have occurred. Therefore, these numbers must be deflated to be more representative of the unbuilt case for the years 1968 through 1995. In order to approximate the inflated level of the numbers, a proxy for deflating the values was created and based on the 1968-1995 value added (GRP) and employment levels divided by the 1998-2025 value added (GRP) and employment levels.[2]

For instance, in the impact counties of the Appalachian Region, the employment level in 1968 was 2,347,526 while the 1998 Regional employment level was 3,717,766. To derive the 1998 deflation factor for employment, the 1968 level (2,328,422) is divided by the 1998 level (3,739,573) to gain a factor of .6314. To derive the 1999 deflation factor for employment, the level of employment for 1969 is divided by the employment level of 1999. A similar procedure is employed to derive employment deflation factors for the years 2000 through 2025 and the deflation factor is displayed in Column **D**. For the value added (GRP) output, a deflation factor is based upon the value added for the historical years (1968-1995) divided by the level of value added (GRP) for future years (1998-2025) and is shown in Column **E**. The employment deflation factor (Column **D**) and value added (GRP) deflation factor (Column **E**) are then multiplied by the output for each of the years to adjust the output (Columns **B** and **C**) to the historical years 1966-1995. The new deflated values for employment and value added (GRP) are shown in bold in Columns **F** and **G**.

[2] In the actual use of REMI for the project, all economic indicators were deflated to historical levels.

Exhibit A-1
Example Inputs and Outputs – Corridor B

	Time Savings		VOC Savings		REMI Output	
Year	Car millions	Truck millions	Car millions	Truck millions	Employment	Value Added millions
Column A	Column B	Column C	Column D	Column E	Column F	Column G
1996	$13.95	$19.12	-$0.77	$4.16	604	$26.51
1997	14.40	19.84	-0.78	4.27	782	35.93
1998	14.86	20.56	-0.79	4.37	928	43.99
1999	15.31	21.28	-0.80	4.48	1,047	50.82
2000	15.76	22.00	-0.81	4.58	1,145	56.81
2001	16.22	22.72	-0.82	4.69	1,229	62.17
2002	16.67	23.44	-0.83	4.79	1,304	67.18
2003	17.12	24.16	-0.84	4.90	1,369	71.64
2004	17.58	24.88	-0.85	5.00	1,429	75.92
2005	18.03	25.60	-0.86	5.11	1,484	79.88
2006	18.48	26.32	-0.87	5.21	1,531	83.70
2007	18.94	27.03	-0.88	5.32	1,575	87.59
2008	19.39	27.75	-0.89	5.43	1,616	91.22
2009	19.84	28.47	-0.90	5.53	1,656	94.86
2010	20.30	29.19	-0.91	5.64	1,693	98.29
2011	20.75	29.91	-0.92	5.74	1,728	101.68
2012	21.20	30.63	-0.93	5.85	1,761	105.05
2013	21.66	31.35	-0.94	5.95	1,792	108.31
2014	22.11	32.07	-0.95	6.06	1,846	112.96
2015	22.56	32.79	-0.96	6.16	1,840	113.99
2016	23.02	33.51	-0.96	6.27	1,869	107.67
2017	23.47	34.23	-0.97	6.37	1,898	110.80
2018	23.92	34.94	-0.98	6.48	1,923	113.65
2019	24.38	35.66	-0.99	6.59	1,949	116.62
2020	24.83	36.38	-1.00	6.69	1,971	119.40
2021	25.28	37.10	-1.01	6.80	1,994	122.28
2022	25.74	37.82	-1.02	6.90	2,017	125.30
2023	26.19	38.54	-1.03	7.01	2,043	128.43
2024	26.64	39.26	-1.04	7.11	2,069	131.52

Exhibit A-2

Procedure for Deflation

Column A	Column B	Column C	Column D	Column E	Column F	Column G
Years	REMI Predicted Employment	REMI Predicted Value Added in millions	Employment Deflation Factor	Valued Added Deflation Factor	Deflated Employment Level	Deflated Value Added Level in millions
1966	0	0	0.623	0.449	**0**	**0**
1967	0	0	0.632	0.455	**0**	**0**
1968	4	0.209	0.631	0.453	**3**	**0.095**
1969	7	0.301	0.633	0.453	**4**	**0.137**
1970	24	1.182	0.633	0.453	**15**	**0.536**
1971	33	1.588	0.634	0.452	**21**	**0.718**
1972	66	3.257	0.64	0.466	**42**	**1.518**
1973	95	4.811	0.658	0.485	**62**	**2.333**
1974	156	7.976	0.686	0.51	**107**	**4.068**
1975	199	10.387	0.698	0.495	**139**	**5.142**
1976	229	12.184	0.69	0.49	**158**	**5.97**
1977	256	14.05	0.712	0.508	**182**	**7.137**
1978	282	15.708	0.733	0.518	**207**	**8.137**
1979	306	17.458	0.758	0.534	**232**	**9.323**
1980	353	20.287	0.772	0.537	**273**	**10.894**
1981	390	22.744	0.769	0.519	**300**	**11.804**
1982	438	25.967	0.767	0.521	**336**	**13.529**
1983	477	28.726	0.755	0.502	**360**	**14.421**
1984	511	31.346	0.753	0.51	**385**	**15.987**
1985	543	33.815	0.785	0.541	**426**	**18.294**
1986	574	36.285	0.805	0.554	**462**	**20.102**
1987	602	38.707	0.823	0.57	**496**	**22.063**
1988	630	40.979	0.848	0.584	**534**	**23.932**
1989	658	43.356	0.874	0.604	**575**	**26.187**
1990	682	45.605	0.901	0.626	**614**	**28.549**
1991	708	47.993	0.923	0.632	**653**	**30.332**
1992	746	51.053	0.928	0.625	**692**	**31.908**
1993	775	53.754	0.946	0.645	**734**	**34.672**
1994	803	56.432	0.97	0.66	**779**	**37.245**
1995	830	59.029	0.99	0.676	**822**	**39.904**

Columns B and C is the output based upon 1996-2025 REMI model using 1966-1995 travel efficiency numbers.

Columns D and E are the deflation factors for employment and value added. These deflation factors are estimated by taking the base years (1966-1995) levels divided by the future years (1996-2025) levels.

Columns F and G are deflated values for the REMI output that represents the economic development impact based upon the 1966-1995 travel efficiency values. The revised values are derived by multiplying Column B and Column C by Columns D and E, respectively.

At this point, a value of output for the years 1998 through 2024 had been calculated. However, upon examination of the output, it was apparent that initial years of the second set of REMI output does not have the accumulated effect of previous economic development. Therefore, this accumulated effect had to be accounted for and estimated.

To merge results of the output, the data set from 1986 -2025 was compiled as a data set that was placed in as a set of inputs into the REMI model for the years 1996-2035. The reason that 1986 was the initial year to this data set was to allow 10 years of accumulation before the 1996 numbers. So the input for 2006 in REMI was actually 1996 and the output for 2006 reflected the output for 1996. Therefore, the output for 2006 through 2010 represented the results for 1996 through 2000 and was used to merge the two sets of output together. Once again, the output values had to be deflated to represent the economic conditions of 1986 through 2025. The results for these years are shown in bold in **Exhibit A-3.**

The above modifications were employed to enable REMI to be used in the study. It required that the historical output from REMI be discounted to historical levels for the time frame of the analysis. The resulting methodology was applied, and the results are summarized in Chapters 5 and 6.

Exhibit A-3
EXAMPLE RESULTS FROM REMI TESTING
THESE MODIFICATION PROCEDURES

Year	Employment	Value Added in millions
1980	273	10.894
1981	300	11.804
1982	336	13.529
1983	360	14.421
1984	385	15.987
1985	426	18.294
1986	462	20.102
1987	496	22.063
1988	534	23.932
1989	575	26.187
1990	614	28.549
1991	653	30.332

1992	692	31.908
1993	734	34.672
1994	779	37.245
1995	822	39.904
1996	**893**	**44.181**
1997	**975**	**47.096**
1998	**1059**	**50.636**
1999	**1092**	**54.462**
2000	**1145**	**62.171**
2001	1229	67.179
2002	1304	71.642
2003	1369	75.919
2004	1429	79.884
2005	1484	83.698
2006	1531	87.593
2007	1575	91.221
2008	1616	94.861
2009	1656	98.293
2010	1693	101.678
2011	1728	105.051
2012	1761	108.309
2013	1792	112.957
2014	1846	113.989
2015	1840	107.671
2016	1869	110.801
2017	1898	113.653
2018	1923	116.621
2019	1949	119.403
2020	1971	122.278

APPENDIX B
EFFICIENCY BENEFIT/COST CALCULATIONS

The results of the travel efficiency benefit and benefit/cost calculations are presented in Chapter 4. In support of those findings, Appendix B presents the actual benefit/cost calculations for each individual corridor on Exhibits B-1 through B-11. Exhibit B-12 then presents the benefit/cost calculations for all twelve corridors combined.

On these exhibits all monetary values are at constant 1995 price levels, not discounted (only the "Discounted Total" on the bottom of each column is discounted). The columns on these exhibits are interpreted as follows:

Construction Costs – The estimated actual expenditures, by year of authorization at 1995 price levels. For example, in 1965 the ARC spent much less than $608,000 on Corridor A/A1; the $608,000 represents the cost in 1995 prices. No costs are shown after 1995 because 1995 is the last year for which "completed" ADHS segments are included in the study.

Maintenance Costs – Annual net increase in costs to each state DOT to administer and maintain the additional lane miles. Annual increases prior to 1995 reflect phasing in of the ADHS highway segments.

Time Savings – The constant dollar values of time times the hours saved due to the ADHS. The numbers increase due to increased traffic levels through the years. Time savings are the dominant form of efficiency savings attributable to the ADHS.

VOC Savings – Annual savings (or losses) in vehicle operating costs (fuel costs, car maintenance costs, etc.). This value is negative (a disbenefit) when the ADHS causes travel to be slightly more expensive (it generally costs more, in vehicle operating cost, to travel at 65 mph than at 50 mph).

Accidents Savings – Annual monetary cost savings due to accident reduction can be a negative value when the trip distance is lengthened due to the ADHS (more vehicle miles of travel), or when induced traffic occurs, and when the change in highway functional classification is slight.

Net Benefits – The non-discounted benefits less the costs, by year. The only number in this column that really matters is the "Discounted Total" at the bottom of the column.

At the bottom right of each exhibit are the three indicators of economic feasibility. A "feasible" highway is one which has a positive Net Present Value (NPV), an Internal Rate of Return of 7.0% or greater, and a discounted Benefit/Cost Ratio of 1.0 or greater. These indicators of feasibility are defined as follows:

- **Net Present Value** – All costs and benefits in future years are discounted back to the base year using a seven percent real (constant dollar) discount rate. The future stream of discounted costs is subtracted from the future stream of discounted benefits. When the sum of the discounted benefits is greater than the sum of the discounted costs, the "net present value" is positive and the highway is deemed to be "economically feasible." The net present value is the best indicator of whether or not a corridor is economically feasible.

- **Discounted Benefit/Cost Ratio** – After the future streams of costs and benefits are discounted, the sum of the discounted benefits is divided by the sum of the discounted costs. When the result is 1.0 or greater, the corridor is considered to be "economically feasible."

- **Internal Rate of Return** – This calculation determines that discount rate at which the net present value difference between costs and benefits is zero. If the rate of return, expressed as a percentage, is equal to or greater than seven percent, then the corridor is deemed to be "economically feasible."

On all of these Exhibit B tables, the calculations are based on the Office of Management and Budget discount rate of 7.0% (constant price level discount rate).

Exhibit B-1
TRAVEL EFFICIENCIES BENEFIT COST ANALYSIS
Georgia - corridor A
Undiscounted 1995 $1,000

Year	Construction Costs	Maintenance Costs	**TOTAL COSTS**	Time Savings	VOC Savings	Accidents Savings	**TOTAL SAVINCS**	NET BENEFITS
1965	608	0	**608**	0	0	0	**0**	(608)
1966	2,088	0	**2,088**	0	0	0	**0**	(2,088)
1967	611	0	**611**	0	0	0	**0**	(611)
1968	294	0	**294**	0	0	0	**0**	(294)
1969	279	0	**279**	0	0	0	**0**	(279)
1970	1,482	0	**1,482**	0	0	0	**0**	(1,482)
1971	12,883	0	**12,883**	0	0	0	**0**	(12,883)
1972	28,141	0	**28,141**	0	0	0	**0**	(28,141)
1973	9,694	0	**9,694**	0	0	0	**0**	(9,694)
1974	9,803	0	**9,803**	0	0	0	**0**	(9,803)
1975	11,677	0	**11,677**	0	0	0	**0**	(11,677)
1976	3,192	0	**3,192**	0	0	0	**0**	(3,192)
1977	2,288	0	**2,288**	0	0	0	**0**	(2,288)
1978	4,279	0	**4,279**	0	0	0	**0**	(4,279)
1979	8,437	0	**8,437**	0	0	0	**0**	(8,437)
1980	2,298	0	**2,298**	0	0	0	**0**	(2,298)
1981	1,186	0	**1,186**	0	0	0	**0**	(1,186)
1982	1,212	0	**1,212**	0	0	0	**0**	(1,212)
1983	3	0	**3**	0	0	0	**0**	(3)
1984	0	309	**309**	8,493	(3,074)	(2,509)	**2,910**	2,601
1985	0	618	**618**	10,488	(3,482)	(2,830)	**4,176**	3,558
1986	0	927	**927**	12,483	(3,890)	(3,150)	**5,442**	4,515
1987	2,138	1,236	**3,374**	14,477	(4,299)	(3,470)	**6,709**	3,334
1988	7,088	1,236	**8,324**	16,472	(4,707)	(3,790)	**7,975**	(349)
1989	2,118	1,236	**3,354**	18,467	(5,115)	(4,111)	**9,241**	5,888
1990	1,051	1,236	**2,287**	20,462	(5,523)	(4,431)	**10,508**	8,221
1991	1,061	1,236	**2,297**	22,457	(5,931)	(4,751)	**11,774**	9,477
1992	0	1,236	**1,236**	24,451	(6,339)	(5,072)	**13,041**	11,805
1993	0	1,236	**1,236**	26,446	(6,747)	(5,392)	**14,307**	13,071
1994	0	1,236	**1,236**	28,441	(7,156)	(5,712)	**15,573**	14,337
1995	0	1,236	**1,236**	30,436	(7,564)	(6,032)	**16,840**	15,604
1996	0	1,236	**1,236**	31,690	(7,698)	(6,242)	**17,751**	16,515
1997	0	1,236	**1,236**	32,945	(7,832)	(6,452)	**18,661**	17,425
1998	0	1,236	**1,236**	34,199	(7,966)	(6,661)	**19,572**	18,336
1999	0	1,236	**1,236**	35,454	(8,100)	(6,871)	**20,483**	19,247
2000	0	1,236	**1,236**	36,708	(8,234)	(7,081)	**21,394**	20,158
2001	0	1,236	**1,236**	37,963	(8,368)	(7,291)	**22,305**	21,069
2002	0	1,236	**1,236**	39,218	(8,502)	(7,500)	**23,216**	21,980
2003	0	1,236	**1,236**	40,472	(8,636)	(7,710)	**24,127**	22,891
2004	0	1,236	**1,236**	41,727	(8,770)	(7,920)	**25,037**	23,801
2005	0	1,236	**1,236**	42,981	(8,904)	(8,129)	**25,948**	24,712
2006	0	1,236	**1,236**	44,236	(9,038)	(8,339)	**26,859**	25,623
2007	0	1,236	**1,236**	45,490	(9,171)	(8,549)	**27,770**	26,534
2008	0	1,236	**1,236**	46,745	(9,305)	(8,758)	**28,681**	27,445
2009	0	1,236	**1,236**	47,999	(9,439)	(8,968)	**29,592**	28,356
2010	0	1,236	**1,236**	49,254	(9,573)	(9,178)	**30,503**	29,267
2011	0	1,236	**1,236**	50,508	(9,707)	(9,388)	**31,413**	30,177
2012	0	1,236	**1,236**	51,763	(9,841)	(9,597)	**32,324**	31,088
2013	0	1,236	**1,236**	53,018	(9,975)	(9,807)	**33,235**	31,999
2014	0	1,236	**1,236**	54,272	(10,109)	(10,017)	**34,146**	32,910
2015	0	1,236	**1,236**	55,527	(10,243)	(10,226)	**35,057**	33,821

2016	0	1,236	**1,236**	56,781	(10,377)	(10,436)	**35,968**	34,732
2017	0	1,236	**1,236**	58,036	(10,511)	(10,646)	**36,879**	35,643
2018	0	1,236	**1,236**	59,290	(10,645)	(10,855)	**37,790**	36,553
2019	0	1,236	**1,236**	60,545	(10,779)	(11,065)	**38,700**	37,464
2020	0	1,236	**1,236**	61,799	(10,913)	(11,275)	**39,611**	38,375
2021	0	1,236	**1,236**	63,054	(11,047)	(11,485)	**40,522**	39,286
2022	0	1,236	**1,236**	64,308	(11,181)	(11,694)	**41,433**	40,197
2023	0	1,236	**1,236**	65,563	(11,315)	(11,904)	**42,344**	41,108
2024	0	1,236	**1,236**	66,817	(11,449)	(12,114)	**43,255**	42,019
2025	(23,330)	0	**(23,330)**	0	0	0	**0**	23,330
Total	90,581	48,824	**139,405**	1,661,936	(341,456)	(317,408)	**1,003,072**	863,668
Discounted Total	55,318	4,119	**59,437**	105,069	(24,497)	(21,244)	**59,328**	(109)
					Net Present value ($ 1,000):			**(109)**
					IRR(%):			**7.0**
					Benefits/Costs Ratio:			**1.00**

Note: Discount rate is 7%.

Exhibit B-2
TRAVEL EFFICIENCIES BENEFIT COST ANALYSIS
Corridor B - KY, NC, TN, VA
Undiscounted 1995 $1,000

Year	Construction Costs	Maintenance Costs	**TOTAL COSTS**	Time Savings	VOC Savings	Accidents Savings	**TOTAL SAVINGS**	NET BENEFITS
1965	5,984	0	**5,984**	0	0	0	**0**	(5,984)
1966	33,033	0	**33,033**	0	0	0	**0**	(33,033)
1967	63,167	0	**63,167**	0	0	0	**0**	(63,167)
1968	93,052	(110)	**92,942**	4,043	686	370	**5,099**	(87,844)
1969	125,380	(6)	**125,373**	4,416	693	412	**5,521**	(119,852)
1970	86,661	47	**86,705**	10,919	(484)	1,098	**11,533**	(75,175)
1971	133,986	450	**134,436**	17,563	605	488	**18,656**	(115,780)
1972	139,398	771	**140,169**	22,928	.736	2,020	**25,685**	(114,484)
1973	141,786	1,212	**142,998**	26,351	864	2,862	**30,078**	(112,9201
1974	94,710	1,410	**96,120**	35,379	1.767	3,384	**40,530**	(55,590)
1975	75,728	1,591	**77,319**	42,094	2,005	3,410	**47,509**	(29,810)
1976	64,509	1,825	**66,333**	44,991	2,047	3,576	**50,614**	(15,719)
1977	64,854	2,021	**66,874**	49,149	1,343	3.712	**54,203**	(12,671)
1978	68,621	2,187	**70,808**	52,100	1,354	3,876	**57,329**	(13,479)
1979	63,946	2,267	**66,214**	56,664	1,783	4,770	**63,216**	(2,998)
1980	75,310	2,258	**77,569**	64,120	826	5.752	**70,698**	(6,871)
1981	45,543	2,396	**47,939**	68,334	1,153	6,546	**76,032**	28,093
1982	70,822	2,561	**73,383**	75,170	1,041	7.718	**83,929**	10,546
1983	149,357	2,858	**152,215**	92,826	5,645	8,320	**106,791**	(45,425)
1984	59,264	3,130	**62,394**	103,499	7,086	9,454	**120,039**	57,645
1985	26,260	3,422	**29,681**	111.711	7,271	10,702	**129,684**	100,002
1986	33,775	3,686	**37,461**	117,178	7,571	11,162	**135,912**	98,451
1987	34,177	3,831	**38,005**	129,782	10,855	14,931	**155,568**	117,560
1988	13,964	3,917	**17,881**	136,034	11,427	15.714	**163,175**	145,294
1989	20,890	3,956	**24,846**	142,286	11,999	16,498	**170,783**	145,937
1990	10,166	3,995	**14,161**	148,539	12,571	17,281	**178,391**	164,230
1991	9,803	3,995	**13,798**	154,791	13,143	18,064	**185,998**	172,200
1992	14,077	4,013	**18,090**	163,052	14,215	19,911	**197,178**	179,088
1993	3,677	4,031	**7,705**	169,375	14,793	20.715	**204,882**	197,174
1994	2,000	4,049	**6,049**	175,698	15,371	21,518	**212,587**	206,538
1995	1,351	4,126	**5,477**	184,198	15,633	22,564	**222,394**	216,918
1996	0	4,184	**4,184**	197,036	17,326	23,270	**237,632**	233,448
1997	0	4,242	**4,242**	209,874	19,020	23,976	**252,869**	248,627
1998	0	4,300	**4,300**	222,712	20,714	24,682	**268,107**	263,807
1999	0	4,300	**4,300**	235,550	22,407	25,388	**283,344**	279,044
2000	0	4,300	**4,300**	248,387	24,101	26,093	**298,582**	294,282
2001	0	4,300	**4,300**	261,225	25,795	26,799	**313,820**	309,519
2002	0	4,300	**4,300**	274,063	27,488	27,505	**329,057**	324.757
2003	0	4,300	**4,300**	286,901	29,182	28,211	**344,295**	339,995
2004	0	4,300	**4,300**	299,739	30,876	28,917	**359,532**	355,232
2005	0	4,300	**4,300**	312,577	32,570	29,623	**374,770**	370,470
2006	0	4,300	**4,300**	325,415	34,263	30,329	**390,007**	385,707
2007	0	4,300	**4,300**	338,253	35,957	31,035	**405,245**	400,945
2008	0	4,300	**4,300**	351,091	37,651	31.741	**420,482**	416,182
2009	0	4,300	**4,300**	363,929	39,344	32,447	**435,720**	431,420
2010	0	4,300	**4,300**	376.767	41,038	33,152	**450,957**	446,657
2011	0	4,300	**4,300**	389,605	42,732	33,858	**466,195**	461,895
2012	0	4,300	**4,300**	402,443	44,426	34,564	**481,433**	477,132
2013	0	4,300	**4,300**	415,281	46,119	35,270	**496,670**	492,370
2014	0	4,300	**4,300**	428,119	47,813	35,976	**511,908**	507,608
2015	0	4,300	**4,300**	440,957	49,507	36,682	**527,145**	522,845

2016	0	4,300	**4,300**	453.795	51,200	37,388	**542,383**	538,083
2017	0	4,300	**4,300**	466,633	52,894	38,094	**557,620**	553,320
2018	0	4,300	**4,300**	479,470	54,588	38,800	**572,858**	568,558
2019	0	4,300	**4,300**	492,309	56,281	39,505	**588,095**	583,795
2020	0	4,300	**4,300**	505,146	57,975	40,211	**603,333**	599,033
2021	0	4,300	**4,300**	517,984	59,669	40,917	**618,570**	614,270
2022	0	4,300	**4,300**	530,822	61,363	41,623	**633,805**	629,508
2023	0	4,300	**4,300**	543,660	63,056	42,329	**649,046**	644.746
2024	0	4,300	**4,300**	556,498	64,750	43,035	**664,283**	659,983
2025	(456,568)	0	**(456,568)**	0	0	0	**0**	456,568
Total	1,368,683	194,415	**1,563,098**	13,329,428	1,354,104	1,218,247	**15,901,780**	14,338,682
Discounted								
Total	879,597	23,972	**903,569**	1,049,252	83,937	102,100	**1,235,290**	331,721
					Net Present value ($1000):			**331,721**
					IRR (%):			**8.66**
					Benefits/Costs Ratio:			**1.37**

Note: Discount rate is 7%.

Exhibit B-3
TRAVEL EFFICIENCIES BENEFIT COST ANALYSIS
Corridor D - OH, WV
Undiscounted 1995 $1,000

Year	Construction Costs	Maintenance Costs	**TOTAL COSTS**	Time Savings	VOC Savings	Accidents Savings	**TOTAL SAVINGS**	**NET BENEFITS**
1965	2,125	0	**2,125**	0	0	0	0	(2,125)
1966	17,770	0	**17,770**	0	0	0	0	(17,770)
1967	44,271	0	**44,271**	0	0	0	0	(44,271)
1968	74,265	0	**74,265**	0	0	0	0	(74,265)
1969	165,915	57	**165,972**	449	(443)	64	**69**	(165,902)
1970	110,497	204	**110,701**	2,559	(795)	503	**2,268**	(108,434)
1971	93,179	565	**93,743**	10,159	(2,491)	1,478	**9,146**	(84,598)
1972	77,941	954	**78,895**	11,704	(2,700)	1,820	**10,823**	(68,072)
1973	62,094	1,367	**63,461**	14,323	(2,955)	2,496	**13,864**	(49,597)
1974	63,199	1,735	**64,933**	18,277	(3,662)	3,069	**17,684**	(47,249)
1975	21,072	1,888	**22,960**	19,714	(3,872)	3,224	**19,066**	(3,894)
1976	10,335	2,013	**12,348**	21,151	(4,082)	3,380	**20,448**	8,100
1977	7,414	2,058	**9,472**	22,587	(4,292)	3,535	**21,830**	12,359
1978	10,446	2,083	**12,529**	27,518	(4,141)	4,036	**27,413**	14,884
1979	31,484	2,107	**33,591**	29,598	(4,303)	4,227	**29,522**	(4,068)
1980	11,553	2,171	**13,725**	34,034	(5,606)	4,668	**33,096**	19,371
1981	6,039	2,235	**8,274**	36,686	(5,868)	4,883	**35,701**	27,427
1982	6,664	2,275	**8,939**	39,337	(6,131)	5,098	**38,305**	29,367
1983	5,276	2,394	**7,670**	43,964	(7,188)	5,699	**42,475**	34,805
1984	3,111	2,573	**5,684**	49,163	(7,537)	6,646	**48,271**	42,587
1985	5,945	2,751	**8,696**	52,236	(7,879)	6,928	**51,285**	42,589
1986	2,221	2,930	**5,150**	55,310	(8,221)	7,211	**54,300**	49,149
1987	821	3,028	**3,849**	58,384	(8,563)	7,493	**57,314**	53,464
1988	771	3,028	**3,799**	61,457	(8,905)	7,776	**60,328**	56,530
1989	1,395	3,028	**4,423**	64,531	(9,247)	8,058	**63,342**	58,919
1990	4,894	3,028	**7,922**	67,605	(9,589)	8,341	**66,357**	58,435
1991	1,491	3,028	**4,519**	70,678	(9,931)	8,623	**69,371**	64,852
1992	763	3,028	**3,791**	73,752	(10,272)	8,906	**72,385**	68,595
1993	740	3,028	**3,768**	76,826	(10,614)	9,188	**75,400**	71,632
1994	0	3,028	**3,028**	79,899	(10,956)	9,471	**78,414**	75,386
1995	0	3,028	**3,028**	82,973	(11,298)	9,753	**81,428**	78,400
1996	0	3,028	**3,028**	85,318	(11,484)	9,945	**83,779**	80,751
1997	0	3,028	**3,028**	87,663	(11,6701	10,136	**86,129**	83,101
1998	0	3,028	**3,028**	90,008	(11,856)	10,327	**88,480**	85,452
1999	0	3,028	**3,028**	92,354	(12,042)	10,518	**90,830**	87,802
2000	0	3,028	**3,028**	94,699	(12,228)	10,710	**93,181**	90,153
2001	0	3,028	**3,028**	97,044	(12,414)	10,901	**95,531**	92,503 '
2002	0	3,028	**3,028**	99,389	(12,600)	11,092	**97,882**	94,854
2003	0	3,028	**3,028**	101,734	(12,785)	11,283	**100,232**	97,204
2004	0	3,028	**3,028**	104,079	(12,971)	11,475	**102,583**	99,555
2005	0	3,028	**3,028**	106,425	(13,157)	11,666	**104,933**	101,905
2006	0	3,028	**3,028**	108,770	(13,343)	11,857	**107,284**	104,256
2007	0	3,028	**3,028**	111,115	(13,529)	12,048	**109,634**	106,606
2008	0	3,028	**3,028**	113,460	(13,715)	12,240	**111,985**	108,957
2009	0	3,028	**3,028**	115,805	(13,901)	12,431	**114,335**	111,307
2010	0	3,028	**3,028**	118,151	(14,087)	12,622	**116,686**	113,658
2011	0	3,028	**3,028**	120,496	(14,273)	12,813	**119,036**	116,008
2012	0	3,028	**3,028**	122,841	(14,459)	13,005	**121,387**	118,359
2013	0	3,028	**3,028**	125,186	(14,645)	13,196	**123,737**	120,709
2014	0	3,028	**3,028**	127,531	(14,831)	13,387	**126,088**	123,060
2015	0	3,028	**3,028**	129,876	(15,017)	13,578	**128,438**	125,410

2016	0	3,028	**3,028**	132,222	(15,203)	13,770	**130,789**	127,761
2017	0	3,028	**3,028**	134,567	(15,389)	13,961	**133,139**	130,111
2018	0	3,028	**3,028**	136,912	(15,575)	14,152	**135,490**	132,462
2019	0	3,028	**3,028**	139,257	(15,761)	14,343	**137,840**	134,812
2020	0	3,028	**3,028**	141,602	(15,946)	14,535	**140,191**	137,163
2021	0	3,028	**3,028**	143,948	(16,132)	14,726	**142,541**	139,513
2022	0	3,028	**3,028**	146,293	(16,318)	14,917	**144,892**	141,864
2023	0	3,028	**3,028**	148,638	(16,504)	15,108	**147,242**	144,214
2024	0	3,028	**3,028**	150,983	(16,690)	15,300	**149,593**	146,565
2025	(93,112)	0	**(93,112)**	0	0	0	0	93,112
Total	750,578	147,424	**898,002**	4,551,239	(580,066)	512,618	**4,483,791**	3,585,789
Discounted Total	517,035	20,711	**537,746**	430,767	(63,663)	54,341	**421,445**	(116,301)
					Net Present Value ($1000):			**(116,301)**
					IRR (%):			**5.8**
					Benefits/Costs Ratio:			**0.78**

Note: Discount rate is 7%.

Exhibit B-4
TRAVEL EFFICIENCIES BENEFIT COST ANALYSIS
Corridor E. MD, WV
Undiscounted 1995 $1,000

Year	Costs	Construction Maintenance Costs	**TOTAL COSTS**	Time Savings	VOC Savings	Accidents Savings	**TOTAL SAVINGS**	NET BENEFITS
1965	71	0	**71**	0	0	0	**0**	(71)
1966	4,365	0	**4,365**	0	0	0	**0**	(4,365)
1967	22,420	0	**22,420**	0	0	0	**0**	(22,420)
1968	32,284	28	**32,312**	2,229	420	38	**2,687**	(29,625)
1969	17,262	56	**17,318**	2,329	434	39	**2,802**	(14,516)
1970	44,629	83	**44,712**	2,429	447	40	**2,917**	(41,796)
1971	101,950	324	**102,275**	8,279	(339)	(169)	**7,771**	(94,504)
1972	159,661	538	**160,199**	8,492	(343)	(171)	**7,978**	(152,221)
1973	129,292	751	**130,043**	8,705	(346)	(174)	**8,185**	(121,857)
1974	94,863	1,247	**96,110**	12,934	(19)	(200)	**12,715**	(83,395)
1975	40,287	1,617	**41,904**	13,279	(1,252)	(1,030)	**10,997**	(30,908)
1976	17,707	2,115	**19,823**	18,543	(993)	(1,003)	**16,547**	(3,276)
1977	10,737	2,613	**13,350**	19,720	(1,122)	(1,088)	**17,511**	4,161
1978	2,676	2,829	**5,504**	20,898	(1,251)	(1,172)	**18,474**	12,970
1979	1,978	3,613	**5,591**	27,853	(554)	(1,515)	**25,784**	20,193
1980	2,352	4,270	**6,622**	29,536	(681)	(1,613)	**27,242**	20,620
1981	9,973	4,927	**14,900**	31,219	(809)	(1,711)	**28,700**	13,800
1982	35,068	5,583	**40,652**	32,902	(936)	(1,809)	**30,158**	(10,494)
1983	13,979	5,583	**19,563**	34,586	(1,063)	(1,907)	**31,616**	12,053
1984	11,261	5,583	**16,844**	36,269	(1,191)	(2,004)	**33,074**	16,229
1985	14,436	5,583	**20,020**	37,952	(1,318)	(2,102)	**34,531**	14,512
1986	8,026	5,583	**13,610**	39,635	(1,446)	(2,200)	**35,989**	22,380
1987	13,189	5,583	**18,773**	41,318	(1,573)	(2,298)	**37,447**	18,675
1988	18,527	5,583	**24,110**	43,002	(1,701)	(2,396)	**38,905**	14,795
1989	44,893	5,583	**50,476**	44,685	(1,828)	(2,494)	**40,363**	(10,113)
1990	17,989	5,583	**23,573**	46,368	(1,955)	(2,592)	**41,821**	18,249
1991	19,212	5,583	**24,795**	48,051	(2,083)	(2,689)	**43,279**	18,484
1992	10,442	6,195	**16,637**	69,866	(379)	(3,312)	**66,175**	49,539
1993	1,869	6,812	**8,681**	73,092	(668)	(3,462)	**68,962**	60,281
1994	1,714	7,439	**9,153**	75,662	(824)	(3,579)	**71,259**	62,106
1995	0	8,065	**8,065**	78,232	(979)	(3,697)	**73,556**	65,490
1996	0	8,081	**8,081**	81,647	(1,307)	(3,854)	**76,485**	68,404
1997	0	8,081	**8,081**	85,061	(1,636)	(4,011)	**79,415**	71,334
1998	0	8,081	**8,081**	88,476	(1,964)	(4,168)	**82,344**	74,263
1999	0	8,081	**8,081**	91,890	(2,292)	(4,325)	**85,273**	77,193
2000	0	8,081	**8,081**	95,305	(2,620)	(4,482)	**88,203**	80,122
2001	0	8,081	**8,081**	98,719	(2,948)	(4,639)	**91,132**	83,051
2002	0	8,081	**8,081**	102,134	(3,276)	(4,796)	**94,062**	85,981
2003	0	8,081	**8,081**	105,548	(3,604)	(4,953)	**96,991**	88,910
2004	0	8,081	**8,081**	108,963	(3,932)	(5,110)	**99,921**	91,840
2005	0	8,081	**8,081**	112,377	(4,260)	(5,267)	**102,850**	94,769
2006	0	8,081	**8,081**	115,792	(4,588)	(5,424)	**105,780**	97,699
2007	0	8,081	**8,081**	119,207	(4,916)	(5,581)	**108,709**	100,628
2008	0	8,081	**8,081**	122,621	(5,244)	(5,738)	**111,639**	103,558
2009	0	8,081	**8,081**	126,036	(5,572)	(5,895)	**114,568**	106,487
2010	0	8,081	**8,081**	129,450	(5,900)	(6,052)	**117,498**	109,417
2011	0	8,081	**8,081**	132,865	(6,228)	(6,209)	**120,427**	112,346
2012	0	8,081	**8,081**	136,279	(6,556)	(6,366)	**123,357**	115,276
2013	0	8,081	**8,081**	139,694	(6,884)	(6,524)	**126,286**	118,205
2014	0	8,081	**8,081**	143,108	(7,212)	(6,681)	**129,216**	121,135
2015	0	8,081	**8,081**	146,523	(7,540)	(6,838)	**132,145**	124,064

2016	0	8,081	**8,081**	149,937	(7,868)	(6,995)	**135,075**	126,994
2017	0	8,081	**8,081**	153,352	(8,196)	(7,152)	**138,004**	129,923
2018	0	8,081	**8,081**	156,766	(8,524)	(7,309)	**140,934**	132,853
2019	0	8,081	**8,081**	160,181	(8,852)	(7,466)	**143,863**	135,782
2020	0	8,081	**8,081**	163,596	(9,180)	(7,623)	**146,793**	138,712
2021	0	8,081	**8,081**	167,010	(9,508)	(7,780)	**149,722**	141,641
2022	0	8,081	**8,081**	170,425	(9,836)	(7,937)	**152,652**	144,571
2023	0	8,081	**8,081**	173,839	(10,164)	(8,094)	**155,581**	147,500
2024	0	8,081	**8,081**	177,254	(10,492)	(8,251)	**158,511**	150,430
2025	(136,080)	0	**(136,080)**	0	0	0	**0**	136,080
Total	767,034	343,704	**1,110,737**	4,662,121	(195,450)	(221,790)	**4,244,881**	3.134,144
Discounted Total	444,194	38,331	**482,524**	387,641	(12,623)	(18,653)	**356,366**	(126,158)
					Net Present value ($1000):			**(126,158)**
					IRR (%):			**5.4**
					Benefits/Costs Ratio:			**0.74**

Note: Discount rate is 7%.

Exhibit B-5
TRAVEL EFFICIENCIES BENEFIT COST ANALYSIS
Corridor F - KY, TN
(1995 $1,000)

Year	Costs	Construction Maintenance Costs	**TOTAL COSTS**	Time Savings	VOC Savings	Accidents Savings	**TOTAL SAVINGS**	NET BENEFITS
1965	3,087	0	**3,087**	0	0	0	**0**	(3,087)
1966	12,664	0	**12,664**	0	0	0	**0**	(12,664)
1967	12,424	0	**12,424**	0	0	0	**0**	(12,424)
1968	15,041	(6)	**15,035**	263	(36)	57	**284**	(14,750)
1969	18,117	1	**18,118**	306	(41)	62	**327**	(17,790)
1970	16,002	8	**16,010**	349	(45)	67	**370**	(15,640)
1971	32,921	1	**32,922**	497	(102)	120	**515**	(32,407)
1972	26,678	15	**26,693**	585	(114)	129	**600**	(26,092)
1973	31,875	(154)	**31,721**	4,283	234	1,003	**5,520**	(26,200)
1974	36,388	(35)	**36,354**	4,647	223	1,048	**5,919**	(30,435)
1975	35,769	70	**35,840**	5,012	212	1,093	**6,317**	(29,523)
1976	36,148	203	**36,351**	6,805	5	1,300	**8,110**	(28,241)
1977	34,465	344	**34,809**	9,926	(246)	1,643	**11,323**	(23,486)
1978	16,384	503	**16,887**	10,848	(451)	1,756	**12,153**	(4,734)
1979	5,562	688	**6,249**	11,539	(493)	1,824	**12,870**	6,621
1980	2,624	821	**3,446**	12,231	(535)	1,893	**13,588**	10,143
1981	717	834	**1,551**	12,922	(578)	1,962	**14,306**	12,755
1982	644	834	**1,478**	13,613	(620)	2,030	**15,024**	13,546
1983	2,299	834	**3,134**	14,305	(662)	2,099	**15,742**	12,608
1984	657	834	**1,491**	14,996	(704)	2,168	**16,460**	14,969
1985	298	834	**1,132**	15,688	(747)	2,236	**17,177**	16,045
1986	301	834	**1,135**	16,379	(789)	2,305	**17,895**	16,760
1987	0	834	**834**	17,070	(831)	2,374	**18,613**	17,779
1988	0	834	**834**	17,762	(873)	2,443	**19,331**	18,497
1989	0	834	**834**	18,453	(916)	2,511	**20,049**	19,214
1990	0	834	**834**	19,144	(958)	2,580	**20,767**	19,932
1991	1,431	834	**2,265**	19,836	(1,000)	2,649	**21,484**	19,219
1992	5,171	834	**6,006**	20,527	(1,042)	2,717	**22,202**	16,196
1993	1,515	834	**2,349**	21,218	(1,084)	2,786	**22,920**	20,571
1994	695	834	**1,529**	21,910	(1,127)	2,855	**23,638**	22,109
1995	684	834	**1,519**	22,601	(1,169)	2,923	**24,356**	22,837
1996	0	834	**834**	23,656	(1,201)	3,007	**25,462**	24,628
1997	0	834	**834**	24,712	(1,234)	3,090	**26,568**	25,734
1998	0	834	**834**	25,767	(1,266)	3,173	**27,674**	26,840
1999	0	834	**834**	26,822	(1,298)	3,256	**28,780**	27,946
2000	0	834	**834**	27,877	(1,330)	3,340	**29,886**	29,052
2001	0	834	**834**	28,933	(1,363)	3,423	**30,993**	30,158
2002	0	834	**834**	29,988	(1,395)	3,506	**32,099**	31,264
2003	0	834	**834**	31,043	(1,427)	3,589	**33,205**	32,371
2004	0	834	**834**	32,098	(1,460)	3,673	**34,311**	33,477
2005	0	834	**834**	33,153	(1,492)	3,756	**35,417**	34,583
2006	0	834	**834**	34,209	(1,524)	3,839	**36,523**	35,689
2007	0	834	**834**	35,264	(1,556)	3,922	**37,630**	36,795
2008	0	834	**834**	36,319	(1,589)	4,005	**38,736**	37,901
2009	0	834	**834**	37,374	(1,621)	4,089	**39,842**	39,007
2010	0	834	**834**	38,429	(1,653)	4,172	**40,948**	40,114
2011	0	834	**834**	39,485	(1,686)	4,255	**42,054**	41,220
2012	0	834	**834**	40,540	(1,718)	4,338	**43,160**	42,326
2013	0	834	**834**	41,595	(1,750)	4,422	**44,266**	43,432
2014	0	834	**834**	42,650	(1,783)	4,505	**45,373**	44,538
2015	0	834	**834**	43,706	(1,815)	4,588	**46,479**	45,644

2016	0	834	**834**	44,761	(1,847)	4,671	**47,585**	46,751
2017	0	834	**834**	45,816	(1,879)	4,754	**48,691**	47,857
2018	0	834	**834**	46,871	(1,912)	4,838	**49,797**	48,963
2019	0	834	**834**	47,926	(1,944)	4,921	**50,903**	50,069
2020	0	834	**834**	48,982	(1,976)	5,004	**52,009**	51,175
2021	0	834	**834**	50,037	(2,009)	5,087	**53,116**	52,281
2022	0	834	**834**	51,092	(2,041)	5,171	**54,222**	53,387
2023	0	834	**834**	52,147	(2,073)	5,254	**55,328**	54,494
2024	0	834	**834**	53,203	(2,105)	5,337	**56,434**	55,600
2025	(67,918)	0	**(67,918)**	0	0	0	**0**	67,918
Total	282,642	39,169	**321,811**	1,448,171	(62,437)	169,619	**1,555,353**	1,233,542
Discounted								
Total	189,274	4,729	**194,003**	131,034	(5,318)	18,125	**143,841**	(50,162)
					Net Present Value ($1000):			**(50,162)**
					IRR (%):			**5.5**
					Benefits/Costs Ratio:			**0.74**

Note: Discount rate is 7%.

Exhibit B-6
TRAVEL EFFICIENCIES BENEFIT COST ANALYSIS
Kentucky. Corridor I
Undiscounted 1995 $1,000

Year	Costs	Construction Maintenance Costs	**TOTAL COSTS**	Time Savings	VOC Savings	Accidents Savings	**TOTAL SAVINGS**	NET BENEFITS
1965	2,139	0	**2,139**	0	0	0	**0**	(2,139)
1966	18,009	0	**18,009**	0	0	0	**0**	(18,009)
1967	40,224	0	**40,224**	0	0	0	**0**	(40,224)
1968	27,683	(117)	**27,565**	3,424	187	245	**3,857**	(23,709)
1969	45,824	(19)	**45,804**	3,804	205	271	**4,280**	(41,524)
1970	24,213	32	**24,244**	5,423	263	465	**6,152**	(18,092)
1971	12,928	181	**13,109**	5,921	284	504	**6,709**	(6,399)
1972	8,380	183	**8,563**	6,869	234	455	**7,558**	(1,006)
1973	3,156	262	**3,418**	7,393	251	488	**8,132**	4,714
1974	3,939	289	**4,228**	7,917	268	521	**8,706**	4,478
1975	1,350	316	**1,666**	8,441	285	554	**9,280**	7,614
1976	1,302	316	**1,618**	8,965	302	587	**9,854**	8,236
1977	709	316	**1,025**	9,489	319	620	**10,428**	9,403
1978	11,766	316	**12,083**	10,013	336	654	**11,002**	(1,080)
1979	34,180	316	**34,496**	10,537	353	687	**11,577**	(22,920)
1980	9,056	316	**9,372**	11,061	370	720	**12,151**	2,779
1981	4,937	316	**5,253**	11,585	387	753	**12,725**	7,472
1982	5,969	316	**6,285**	12,109	404	786	**13,299**	7,013
1983	304	316	**620**	12,633	421	819	**13,873**	13,253
1984	144	316	**460**	13,157	438	853	**14,447**	13,987
1985	130	316	**447**	13,681	455	886	**15,021**	14,575
1986	0	316	**316**	14,205	472	919	**15,596**	15,279
1987	0	316	**316**	14,729	489	952	**16,170**	15,853
1988	0	316	**316**	15,253	506	985	**16,744**	16,428
1989	0	316	**316**	15,777	523	1,018	**17,318**	17,002
1990	0	316	**316**	16,301	540	1,052	**17,892**	17,576
1991	0	316	**316**	16,825	557	1,085	**18,466**	18,150
1992	0	316	**316**	17,349	574	1,118	**19,040**	18,724
1993	0	316	**316**	17,873	591	1,151	**19,614**	19,298
1994	0	316	**316**	18,397	608	1,184	**20,189**	19,872
1995	0	316	**316**	18,921	625	1,217	**20,763**	20,447
1996	0	316	**316**	19,454	635	1,235	**21,325**	21,008
1997	0	316	**316**	19,988	646	1,253	**21,886**	21,570
1998	0	316	**316**	20,522	656	1,270	**22,448**	22,132
1999	0	316	**316**	21,056	667	1,288	**23,010**	22,694
2000	0	316	**316**	21,589	677	1,305	**23,572**	23,255
2001	0	316	**316**	22,123	687	1,323	**24,133**	23,817
2002	0	316	**316**	22,657	698	1,340	**24,695**	24,379
2003	0	316	**316**	23,190	708	1,358	**25,257**	24,941
2004	0	316	**316**	23,724	719	1,376	**25,819**	25,502
2005	0	316	**316**	24,258	729	1,393	**26,380**	26,064
2006	0	316	**316**	24,792	740	1,411	**26,942**	26,626
2007	0	316	**316**	25,325	750	1,428	**27,504**	27,188
2008	0	316	**316**	25,859	761	1,446	**28,066**	27,749
2009	0	316	**316**	26,393	771	1,463	**28,627**	28,311
2010	0	316	**316**	26,927	782	1,481	**29,189**	28,873
2011	0	316	**316**	27,460	792	1,499	**29,751**	29,435
2012	0	316	**316**	27,994	803	1,516	**30,313**	29,996
2013	0	316	**316**	28,528	813	1,534	**30,874**	30,558
2014	0	316	**316**	29,061	824	1,551	**31,436**	31,120

2015	0	316	**316**	29,595	834	1,569	**31,998**	31,682
2016	0	316	**316**	30,129	844	1,586	**32,560**	32,243
2017	0	316	**316**	30,663	855	1,604	**33,121**	32,805
2018	0	316	**316**	31,196	865	1,622	**33,683**	33,367
2019	0	316	**316**	31,730	876	1,639	**34,245**	33,929
2020	0	316	**316**	32,264	886	1,657	**34,807**	34,491
2021	0	316	**316**	32,797	897	1,674	**35,369**	35,052
2022	0	316	**316**	33,331	907	1,692	**35,930**	35,614
2023	0	316	**316**	33,865	918	1,709	**36,492**	36,176
2024	0	316	**316**	34,399	928	1,727	**37,054**	36,738
2025	(37,409)	0	**(37,409)**	0	0	0	**0**	37,409
Total	218,932	16,621	**235,553**	1,108,913	33,916	64,498	**1,207,327**	971,773
Discounted Total	161,546	2,645	**164,191**	130,097	4.440	8,353	**142,891**	(21,300)
					Net Present Value ($1000):			**132,292**
					IRR (%):			**8.8**
					Benefits/Costs Ratio:			**1.50**

Note: Discount rate is 7%.

Exhibit B-7
TRAVEL EFFICIENCIES BENEFIT COST ANALYSIS
Corridor J - KY, TN
(1995 $1,000)

Year	Construction Costs	Maintenance Costs	**TOTAL COSTS**	Time Savings	VOC Savings	Accidents Savings	**TOTAL SAVINGS**	NET BENEFITS
1965	758	0	**758**	0	0	0	**0**	(758)
1966	4,673	0	**4,673**	0	0	0	**0**	(4,673)
1967	8,478	0	**8,478**	0	0	0	**0**	(8,478)
1968	7,114	0	**7,114**	0	0	0	**0**	(7,114)
1969	11,419	0	**11,419**	0	0	0	**0**	(11,419)
1970	16,599	(30)	**16,569**	174	(14)	(46)	**114**	(16,456)
1971	37,119	(20)	**37,100**	182	(15)	(48)	**119**	(36,981)
1972	24,212	(10)	**24,202**	190	(16)	(50)	**124**	(24,078)
1973	46,960	21	**46,981**	74	(219)	(168)	**(314)**	(47,295)
1974	57,803	5	**57,808**	2,424	(376)	141	**2,189**	(55,619)
1975	31,028	1	**31,029**	4,366	(415)	143	**4,095**	(26,934)
1976	30,929	208	**31,137**	6,215	(429)	239	**6,025**	(25,112)
1977	29,762	438	**30,200**	8,270	27	229	**8,526**	(21,674)
1978	35,152	601	**35,753**	8,802	58	235	**9,094**	(26,658)
1979	36,853	789	**37,642**	16,157	945	51	**17,153**	(20,488)
1980	25,775	968	**26,743**	17,500	669	124	**18,293**	(8,450)
1981	27,519	1,265	**28,784**	20,652	929	(6)	**21,576**	(1,208)
1982	19,086	1,562	**20,647**	21,856	981	(9)	**22,828**	2,181
1983	14,353	1,760	**16,113**	23,060	1,032	(12)	**24,080**	7,966
1984	10,847	1,857	**12,704**	25,608	1,175	189	**26,971**	14,267
1985	12,771	1,886	**14,657**	26,883	1,230	195	**28,308**	13,650
1986	12,749	1,916	**14,665**	28,158	1,286	201	**29,645**	14,980
1987	19,405	1,945	**21,350**	29,433	1,342	207	**30,982**	9,632
1988	12,611	2,036	**14,647**	39,881	2,709	(237)	**42,353**	27,706
1989	13,793	2,127	**15,920**	41,362	2,792	(238)	**43,915**	27,995
1990	11,904	2,271	**14,175**	48,829	1,482	(821)	**49,490**	35,315
1991	26,254	2,552	**28,806**	50,798	911	(1,134)	**50,574**	21,768
1992	27,668	2,743	**30,410**	52,678	914	(1,165)	**52,428**	22,017
1993	8,887	2,933	**11,821**	54,558	918	(1,195)	**54,282**	42,461
1994	5,241	2,964	**8,205**	56,439	922	(1,226)	**56,135**	47,931
1995	2,693	2,964	**5,657**	58,319	926	(1,256)	**57,989**	52,332
1996	0	2,964	**2,964**	68,803	1,697	(1,649)	**68,851**	65,887
1997	0	2,964	**2,964**	79,287	2,468	(2,042)	**79,713**	76,749
1998	0	2,964	**2,964**	89,770	3,239	(2,435)	**90,574**	87,611
1999	0	2,964	**2,964**	100,254	4,010	(2,828)	**101,436**	98,472
2000	0	2,964	**2,964**	110,738	4,780	(3,220)	**112,298**	109,334
2001	0	2,964	**2,964**	121,222	5,551	(3,613)	**123,160**	120,196
2002	0	2,964	**2,964**	131,705	6,322	(4,006)	**134,021**	131,058
2003	0	2,964	**2,964**	142,189	7,093	(4,399)	**144,883**	141,919
2004	0	2,964	**2,964**	152,673	7,864	(4,792)	**155,745**	152,781
2005	0	2,964	**2,964**	163,156	8,635	(5,184)	**166,607**	163,643
2006	0	2,964	**2,964**	173,640	9,405	(5,577)	**177,468**	174,504
2007	0	2,964	**2,964**	184,124	10,176	(5,970)	**188,330**	185,366
2008	0	2,964	**2,964**	194,608	10,947	(6,363)	**199,192**	196,228
2009	0	2,964	**2,964**	205,091	11,718	(6,756)	**210,054**	207,090
2010	0	2,964	**2,964**	215,575	12,489	(7,148)	**220,915**	217,951
2011	0	2,964	**2,964**	226,059	13,260	(7,541)	**231,777**	228,813
2012	0	2,964	**2,964**	236,542	14,030	11,934)	**242,639**	239,675
2013	0	2,964	**2,964**	247,026	14,801	(8,327)	**253,501**	250,537
2014	0	2,964	**2,964**	257,510	15,572	(8,720)	**264,362**	261,398
2015	0	2,964	**2,964**	267,994	16,343	(9,112)	**275,224**	272,260

2016	0	2,964	**2,964**	278,477	17,114	(9,505)	**286,086**	283,122
2017	0	2,964	**2,964**	288,961	17,885	(9,898)	**296,948**	293,984
2018	0	2,964	**2,964**	299,445	18,655	(10,291)	**307,809**	304,845
2019	0	2,964	**2,964**	309,928	19,426	(10,684)	**318,671**	315,707
2020	0	2,964	**2,964**	320,412	20,197	(11,077)	**329,533**	326,569
2021	0	2,964	**2,964**	330,896	20,968	(11,469)	**340,395**	337,431
2022	0	2,964	**2,964**	341,380	21,739	(11,862)	**351,256**	348,292
2023	0	2,964	**2,964**	351,863	22,510	(12,255)	**362,118**	359,154
2024	0	2,964	**2,964**	362,347	23,281	(12,648)	**372,980**	370,016
2025	(150,216)	0	**(150,216)**	0	0	0	**0**	150,216
Total	480,198	121,704	**601,902**	6,894,540	381,940	(212,964)	**7,063,517**	6,461,615
Discounted Total	251,514	11,865	**263,380**	386,875	17,518	(8,721)	**395,672**	132,292
					Net Present Value ($1000):			**132,292**
					IRR (%):			**8.8**
					Benefits/Costs Ratio:			**1.50**

Note: Discount rate is 7%.

Exhibit B-8
TRAVEL EFFICIENCIES BENEFIT COST ANALYSIS
West Virginia – Corridor L
Undiscounted 1995 $1,000

Year	Construction Costs	Maintenance Costs	**TOTAL COSTS**	Time Savings	VOC Savings	Accidents Savings	**TOTAL SAVINGS**	NET BENEFITS
1965	0	0	**0**	0	0	0	**0**	0
1966	726	0	**726**	0	0	0	**0**	(726)
1967	3,240	0	**3,240**	0	0	0	**0**	(3,240)
1968	7,776	0	**7,776**	0	0	0	**0**	(7,776)
1969	27,285	0	**27,285**	0	0	0	**0**	(27,285)
1970	63,388	0	**63,388**	0	0	0	**0**	(63,388)
1971	94,615	24	**94,639**	2,224	(121)	567	**2,669**	(91,970)
1972	69,595	76	**69,672**	4,444	266	1,248	**5,958**	(63,713)
1973	63,422	129	**63,550**	4,993	287	1,356	**6,636**	(56,914)
1974	66,779	269	**67,047**	6,625	(487)	1,289	**7,426**	(59,621)
1975	21,448	384	**21,833**	7,402	(561)	1,381	**8,222**	(13,610)
1976	11,115	472	**11,588**	8,179	(635)	1,474	**9,018**	(2,569)
1977	13,225	579	**13,804**	9,169	(1,603)	1,080	**8,646**	(5,157)
1978	10,158	614	**10,772**	10,960	(1,798)	1,372	**10,535**	(238)
1979	2,708	649	**3,357**	12,013	(1,955)	1,458	**11,516**	8,159
1980	1,318	698	**2,017**	13,658	(2,113)	1,652	**13,197**	11,180
1981	1,106	729	**1,834**	14,746	(2,266)	1,745	**14,226**	12,391
1982	26	743	**769**	15,834	(2,418)	1,839	**15,254**	14,486
1983	9	756	**766**	16,922	(2,571)	1,932	**16,283**	15,517
1984	3	756	**759**	18,010	(2,724)	2,025	**17,312**	16,553
1985	1	756	**758**	19,098	(2,876)	2,119	**18,341**	17,583
1986	0	756	**756**	20,186	(3,029)	2,212	**19,370**	18,613
1987	0	756	**756**	21,275	(3,182)	2,305	**20,398**	19,642
1988	0	756	**756**	22,363	(3,334)	2,399	**21,427**	20,671
1989	0	756	**756**	23,451	(3,487)	2,492	**22,456**	21,699
1990	0	756	**756**	24,539	(3,640)	2,585	**23,485**	22,728
1991	0	756	**756**	25,627	(3,792)	2,679	**24,513**	23,757
1992	0	756	**756**	26,715	(3,945)	2,772	**25,542**	24,786
1993	0	756	**756**	27,803	(4,097)	2,865	**26,571**	25,815
1994	0	756	**756**	28,891	(4,250)	2,959	**27,600**	26,843
1995	0	824	**824**	41,980	(4,270)	6,235	**43,946**	43,122
1996	0	891	**891**	45,696	(4,364)	6,599	**47,931**	47,040
1997	0	958	**958**	49,412	(4,458)	6,962	**51,916**	50,958
1998	0	1,025	**1,025**	53,128	(4,552)	7,326	**55,901**	54,876
1999	0	1,025	**1,025**	56,843	(4,646)	7,689	**59,887**	58,861
2000	0	1,025	**1,025**	60,559	(4,740)	8,052	**63,872**	62,847
2001	0	1,025	**1,025**	64,275	(4,834)	8,416	**67,857**	66,832
2002	0	1,025	**1,025**	67,991	(4,928)	8,779	**71,842**	70,817
2003	0	1,025	**1,025**	71,707	(5,022)	9,143	**75,828**	74,802
2004	0	1,025	**1,025**	75,423	(5,116)	9,506	**79,813**	78,788
2005	0	1,025	**1,025**	79,139	(5,210)	9,869	**83,798**	82,773
2006	0	1,025	**1,025**	82,854	(5,304)	10,233	**87,784**	86,758
2007	0	1,025	**1,025**	86,570	(5,398)	10,596	**91,769**	90,743
2008	0	1,025	**1,025**	90,286	(5,492)	10,960	**95,754**	94,729
2009	0	1,025	**1,025**	94,002	(5,586)	11,323	**99,739**	98,714
2010	0	1,025	**1,025**	97,718	(5,680)	11,686	**103,725**	102,699
2011	0	1,025	**1,025**	101,434	(5,774)	12,050	**107,710**	106,684
2012	0	1,025	**1,025**	105,150	(5,868)	12,413	**111,695**	110,670

2013	0	1,025	**1,025**	108,865	(5,962)	12,777	**115,680**	114,655
2014	0	1,025	**1,025**	112,581	(6,056)	13,140	**119,666**	118,640
2015	0	1,025	**1,025**	116,297	(6,150)	13,503	**123,651**	122,626
2016	0	1,025	**1,025**	120,013	(6,244)	13,867	**127,636**	126,611
2017	0	1,025	**1,025**	123,729	(6,337)	14,230	**131,621**	130,596
2018	0	1,025	**1,025**	127,445	(6,431)	14,594	**135,607**	134,581
2019	0	1,025	**1,025**	131,161	(6,525)	14,957	**139,592**	138,567
2020	0	1,025	**1,025**	134,876	(6,619)	15,320	**143,577**	142,552
2021	0	1,025	**1,025**	138,592	(6,713)	15,684	**147,562**	146,537
2022	0	1,025	**1,025**	142,308	(6,807)	16,047	**151,548**	150,522
2023	0	1,025	**1,025**	146,024	(6,901)	16,411	**155,533**	154,508
2024	0	1,025	**1,025**	149,740	(6,995)	16,774	**159,518**	158,493
2025	(32,105)	0	**(32,105)**	0	0	0	**0**	32,105
Total	425,841	44,799	**470,640**	3,260,925	(223,309)	390,945	**3,428,561**	2,957,921
Discounted Total	264,599	5,460	**270,059**	222,867	(20,963)	28,459	**230,363**	(39,696)

Net Present Value ($1000):	(39,696)
IRR (%):	6.3
Benefits/Costs Ratio:	0.85

Note: Discount rate is 7%.

Exhibit B-9
TRAVEL EFFICIENCIES BENEFIT COST ANALYSIS
Pennsylvania - Corridor P
Undiscounted 1995 $1,000

Year	Costs	Construction Maintenance Costs	**TOTAL COSTS**	Time Savings	VEC Savings	Accidents Savings	**TOTAL SAVINGS**	NET BENEFITS
1965	0	0	**0**	0	0	0	**0**	0
1966	2,632	0	**2,632**	0	0	0	**0**	(2,632)
1967	9,616	0	**9,616**	0	0	0	**0**	(9,616)
1968	7,640	0	**7,640**	0	0	0	**0**	(7,640)
1969	19,592	33	**19,625**	13	(1,247)	(663)	**(1,898)**	(21,523)
1970	33,780	66	**33,847**	(5)	(1,268)	(680)	**(1,953)**	(35,800)
1971	25,699	233	**25,932**	4,839	(239)	(553)	**4,048**	(21,885)
1972	39,707	471	**40,178**	8,887	(459)	(1,122)	**7,306**	(32,872)
1973	77,208	794	**78,002**	13,578	(1,191)	(1,841)	**10,547**	(67,456)
1974	69,977	1,117	**71,094**	14,292	(1,166)	(1,864)	**11,262**	(59,832)
1975	72,899	1,295	**74,194**	15,005	(1,142)	(1,886)	**11,977**	(62,217)
1976	33,022	1,429	**34,451**	16,950	(1,223)	(1,563)	**14,164**	(20,287)
1977	24,388	1,444	**25,832**	17,669	(1,199)	(1,584)	**14,886**	(10,945)
1978	9,694	1,459	**11,153**	18,389	(1,175)	(1,605)	**15,609**	4,455
1979	7,082	1,516	**8,598**	23,138	(1,137)	(405)	**21,596**	12,998
1980	19,017	1,558	**20,575**	23,857	(1,113)	(427)	**22,318**	1,743
1981	5,723	1,600	**7,323**	24,577	(1,089)	(448)	**23,040**	15,717
1982	3,238	1,642	**4,880**	25,296	(1,065)	(469)	**23,762**	18,882
1983	3,095	1,642	**4,737**	26,016	(1,041)	(4901	**24,485**	19,747
1984	36	1,642	**1,678**	26,735	(1,017)	(511)	**25,207**	23,529
1985	33	1,642	**1,675**	27,454	(993)	(532)	**25,929**	24,254
1986	1,210	1,642	**2,853**	28,174	(969)	(553)	**26,651**	23,799
1987	4,324	1,642	**5,966**	28,893	(945)	(574)	**27,374**	21,408
1988	1,224	1,642	**2,867**	29,613	(921)	(595)	**28,096**	25,229
1989	606	1,642	**2,248**	30,332	(897)	(616)	**28,818**	26,570
1990	602	1,642	**2,244**	31,051	(873)	(637)	**29,541**	27,297
1991	0	1,642	**1,642**	31,771	(849)	(658)	**30,263**	28,621
1992	0	1,642	**1,642**	32,490	(826)	(680)	**30,985**	29,343
1993	0	1,642	**1,642**	33,210	(802)	(701)	**31,707**	30,065
1994	0	1,642	**1,642**	33,929	(778)	(722)	**32,430**	30,788
1995	0	1,642	**1,642**	34,648	(754)	(743)	**33,152**	31,510
1996	0	1,642	**1,642**	37,931	(761)	(771)	**36,398**	34,756
1997	0	1,642	**1,642**	41,213	(769)	(799)	**39,645**	38,003
1998	0	1,642	**1,642**	44,495	(777)	(827)	**42,891**	41,249
1999	0	1,642	**1,642**	47,778	(784)	(855)	**46,138**	44,496
2000	0	1,642	**1,642**	51,060	(792)	(883)	**49,384**	47,742
2001	0	1,642	**1,642**	54,342	(800)	(911)	**52,631**	50,989
2002	0	1,642	**1,642**	57,624	(808)	(940)	**55,877**	54,235
2003	0	1,642	**1,642**	60,907	(815)	(968)	**59,124**	57,482
2004	0	1,642	**1,642**	64,189	(823)	(996)	**62,370**	60,728
2005	0	1,642	**1,642**	67,471	(831)	(1,024)	**65,617**	63,975
2006	0	1,642	**1,642**	70,754	(838)	(1,052)	**68,863**	67,221
2007	0	1,642	**1,642**	74,036	(846)	(1,080)	**72,110**	70,468
2008	0	1,642	**1,642**	77,318	(854)	(1,108)	**75,356**	73,714
2009	0	1,642	**1,642**	80,601	(861)	(1,136)	**78,603**	76,961
2010	0	1,642	**1,642**	83,883	(869)	(1,165)	**81,849**	80,207
2011	0	1,642	**1,642**	87,165	(877)	(1,193)	**85,096**	83,454
2012	0	1,642	**1,642**	90,447	(885)	(1,221)	**88,342**	86,700
2013	0	1,642	**1,642**	93,730	(892)	(1,249)	**91,589**	89,947
2014	0	1,642	**1,642**	97,012	(900)	(1,277)	**94,835**	93,193

2015	0	1,642	**1,642**	100,294	(908)	(1,305)	**98,082**	96,440
2016	0	1,642	**1,642**	103,577	(915)	(1,333)	**101,328**	99,686
2017	0	1,642	**1,642**	106,859	(923)	(1,361)	**104,575**	102,932
2018	0	1,642	**1,642**	110,141	(931)	(1,389)	**107,821**	106,179
2019	0	1,642	**1,642**	113,424	(938)	(1,418)	**111,068**	109,425
2020	0	1,642	**1,642**	116,706	(946)	(1,446)	**114,314**	112,672
2021	0	1,642	**1,642**	119,988	(954)	(1,474)	**117,560**	115,918
2022	0	1,642	**1,642**	123,271	(962)	(1,502)	**120,807**	119,165
2023	0	1,642	**1,642**	126,553	(969)	(1,530)	**124,053**	122,411
2024	0	1,642	**1,642**	129,835	(977)	(1,558)	**127,300**	125,658
2025	(73,473)	0	**(73,473)**	0		0	**0**	73,473
Total	398,573	83,626	**482,199**	3,033,405	(51,586)	(56,891)	**2,924,929**	2,442,730
Discounted								
Total	245,423	12,507	**257,930**	261,422	(10,412)	(10,354)	**240,656**	(17,274)
					Net present Value ($1000):			**(17,274)**
					IRR (%):			**6.6**
					Benefits/costs Ratio:			**0.93**

Note: Discount rate is 7%.

Exhibit 8-10
TRAVEL EFFICIENCIES BENEFIT COST ANALYSIS
Corridor Q - VA, WV
Undiscounted 1995 $1,000

Year	Construction Costs	Maintenance Costs	**TOTAL COSTS**	Time Savings	VOC Savings	Accidents Savings	**TOTAL SAVINGS**	NET BENEFITS
1965	5,138	0	**5,138**	0	0	0	**0**	(5,138)
1966	21,578	0	**21,578**	0	0	0	**0**	(21,578)
1967	23,586	(30)	**23,557**	1,029	(434)	(271)	**324**	(23,232)
1968	25,223	(40)	**25,182**	2,405	(411)	306	**2,300**	(22,882)
1969	20,106	26	**20,132**	7,099	(31)	646	**7,715**	(12,418)
1970	33,820	129	**33,949**	7,474	(46)	663	**8,091**	(25,858)
1971	63,749	205	**63,954**	7,850	(61)	679	**8,468**	(55,487)
1972	80,618	183	**80,801**	9,259	(250)	1,169	**10,178**	(70,623)
1973	87,915	246	**88,161**	14,839	(599)	1,636	**15,876**	(72,285)
1974	39,982	342	**40,324**	15,925	(636)	1,696	**16,984**	(23,340)
1975	30,090	364	**30,454**	20,091	(1,323)	2,436	**21,204**	(9,250)
1976	44,213	490	**44,703**	21,327	(1,3891	2,528	**22,465**	(22,238)
1977	36,077	593	**36,670**	24,989	(1,773)	2,788	**26,003**	(10,666)
1978	14,021	554	**14,575**	40,445	(2,826)	4,924	**42,543**	27,968
1979	11,188	755	**11,943**	42,522	(2,956)	5,098	**44,664**	32,721
1980	10,645	956	**11,601**	44,599	(3,087)	5,273	**46,785**	35,184
1981	3,067	1,118	**4,185**	46,676	(3,218)	5,447	**48,906**	44,721
1982	1,671	1,118	**2,789**	48,753	(3,349)	5,622	**51,027**	48,237
1983	1,857	1,118	**2,975**	50,831	(3,480)	5,796	**53,147**	50,172
1984	3,173	1,118	**4,291**	52,908	(3,610)	5,971	**55,268**	50,977
1985	3,929	1,118	**5,048**	54,985	(3,741)	6,145	**57,389**	52,341
1986	1,410	1,039	**2,450**	65,154	(4,252)	8,005	**68,907**	66,457
1987	1,418	1,105	**2,523**	67,231	(4,383)	8,179	**71,028**	68,505
1988	2,410	1,171	**3,580**	69,308	(4,513)	8,354	**73,149**	69,569
1989	2,333	1,236	**3,569**	71,386	(4,644)	8,528	**75,269**	71,701
1990	6,406	1,236	**7,642**	73,463	(4,775)	8,703	**77,390**	69,749
1991	2,152	1,236	**3,388**	75,540	(4,906)	8,877	**79,511**	76,123
1992	954	1,236	**2,190**	77,617	(5,036)	9,052	**81,632**	79,442
1993	926	1,236	**2,162**	79,694	(5,167)	9,226	**83,753**	81,591
1994	0	1,236	**1,236**	81,771	(5,298)	9,401	**85,873**	84,637
1995	0	1,236	**1,236**	83,848	(5,429)	9,575	**87,994**	86,758
1996	0	1,236	**1,236**	87,972	(5,676)	9,903	**92,198**	90,962
1997	0	1,236	**1,236**	92,096	(5,923)	10,230	**96,403**	95,167
1998	0	1,236	**1,236**	96,220	(6,171)	10,558	**100,607**	99,371
1999	0	1,236	**1,236**	100,344	(6,418)	10,886	**104,812**	103,576
2000	0	1,236	**1,236**	104,468	(6,665)	11,213	**109,016**	107,780
2001	0	1,236	**1,236**	108,592	(6,912)	11,541	**113,220**	111,984
2002	0	1,236	**1,236**	112,716	(7,160)	11,869	**117,425**	116,189
2003	0	1,236	**1,236**	116,840	(7,407)	12,196	**121,629**	120,393
2004	0	1,236	**1,236**	120,964	(7,654)	12,524	**125,834**	124,598
2005	0	1,236	**1,236**	125,088	(7,902)	12,852	**130,038**	128,802
2006	0	1,236	**1,236**	129,212	(8,149)	13,179	**134,243**	133,006
2007	0	1,236	**1,236**	133,336	(8,396)	13,507	**138,447**	137,211
2008	0	1,236	**1,236**	137,460	(8,643)	13,835	**142,651**	141,415
2009	0	1,236	**1,236**	141,584	(8,891)	14,162	**146,856**	145,620
2010	0	1,236	**1,236**	145,708	(9,138)	14,490	**151,060**	149,824
2011	0	1,236	**1,236**	149,832	(9,385)	14,818	**155,265**	154,028
2012	0	1,236	**1,236**	153,956	(9,632)	15,145	**159,469**	158,233
2013	0	1,236	**1,236**	158,080	(9,880)	15,473	**163,673**	162,437
2014	0	1,236	**1,236**	162,204	(10,127)	15,801	**167,878**	166,642
2015	0	1,236	**1,236**	166,328	(10,374)	16,128	**172,082**	170,846

2016	0	1,236	**1,236**	170,452	(10,622)	16,456	**176,287**	175,051
2017	0	1,236	**1,236**	174,576	(10,869)	16,784	**180,491**	179,255
2018	0	1,236	**1,236**	178,700	(11,116)	17,111	**184,695**	183,459
2019	0	1,236	**1,236**	182,824	(11,363)	17,439	**188,900**	187,664
2020	0	1,236	**1,236**	186,948	(11,611)	17,767	**193,104**	191,868
2021	0	1,236	**1,236**	191,072	(11,858)	18,094	**197,309**	196,073
2022	0	1,236	**1,236**	195,196	(12,105)	18,422	**201,513**	200,277
2023	0	1,236	**1,236**	199,320	(12,353)	18,750	**205,718**	204,481
2024	0	1,236	**1,236**	203,444	(12,600)	19,077	**209,922**	208,686
2025	(128,686)	0	**(128,686)**	0	0	0	**0**	128,686
Total	450,970	58,179	**509,149**	5,484,552	(346,622)	566,660	**5,704,590**	5,195,441
Discounted Total	320,695	7,468	**328,163**	501,308	(31,755)	55,153	**524,706**	196,543
					Net Present Value ($1000):			**196,543**
					IRR (%):			**9.8**
					Benefits/Costs Ratio:			**1.60**

Note: Discount rate is 7%.

Exhibit 8-11
TRAVEL EFFICIENCIES BENEFIT COST ANALYSIS
Corridor T - NY, PA
Undiscounted 1995 $1,000

Year	Construction Costs	Maintenance Costs	**TOTAL COSTS**	Time Savings	VOC Savings	Accidents Savings	**TOTAL SAVINGS**	NET BENEFITS
1965	0	0	**0**	0	0	0	**0**	0
1966	0	0	**0**	0	0	0	**0**	0
1967	7,685	0	**7,685**	0	0	0	**0**	(7,685)
1968	44,957	0	**44,957**	0	0	0	**0**	(44,957)
1969	88,510	0	**88,510**	0	0	0	**0**	(88,510)
1970	120,097	29	**120,126**	754	90	(551)	**294**	(119,832)
1971	166,109	58	**166,167**	754	90	(551)	**294**	(165,873)
1972	121,071	86	**121,157**	755	90	(551)	**294**	(120,863)
1973	194,892	115	**195,007**	755	90	(551)	**294**	(194,713)
1974	121,338	485	**121,823**	43,113	(2,562)	719	**41,270**	(80,553)
1975	50,879	1,068	**51,947**	71,727	(4,794)	1,526	**68,459**	16,512
1976	35,605	1,867	**37,471**	84,886	(71)	3,510	**88,325**	50,854
1977	15,859	2,665	**18,525**	85,671	(129)	3,530	**89,072**	70,547
1978	15,505	3,094	**18,600**	86,456	(188)	3,550	**89,818**	71,218
1979	28,979	3,346	**32,326**	91,018	807	4,341	**96,166**	63,841
1980	20,967	3,466	**24,434**	104,179	1,445	5,047	**110,671**	86,237
1981	31,479	3,679	**35,159**	109,039	2,711	5,055	**116,805**	81,646
1982	30,458	3,892	**34,351**	109,893	2,661	5,077	**117,632**	83,281
1983	27,055	4,149	**31,205**	116,094	1,376	5,709	**123,179**	91,975
1984	22,769	4,323	**27,091**	116,913	1,331	5,729	**123,974**	96,882
1985	23,552	4,403	**27,955**	117,732	1,286	5,750	**124,768**	96,813
1986	17,381	4,536	**21,917**	122,530	1,993	6,642	**131,165**	109,248
1987	24,039	4,589	**28,629**	123,134	1,918	6,623	**131,675**	103,047
1988	17,453	4,643	**22,096**	123,739	1,843	6,604	**132,186**	110,090
1989	8,356	4,845	**13,202**	128,439	3,006	6,372	**137,818**	124,616
1990	12,343	4,995	**17,338**	129,044	2,931	6,354	**138,328**	120,990
1991	4,456	5,145	**9,601**	129,648	2,856	6,335	**138,839**	129,238
1992	2,563	5,295	**7,858**	130,253	2,781	6,316	**139,349**	131,491
1993	1,664	5,295	**6,959**	130,857	2,706	6,297	**139,860**	132,901
1994	163	5,339	**5,502**	148,459	3,153	6,922	**158,534**	153,031
1995	161	5,384	**5,544**	149,656	3,101	6,909	**159,666**	154,121
1996	0	5,428	**5,428**	164,487	4,507	7,138	**176,132**	170,704
1997	0	5,472	**5,472**	179,319	5,914	7,366	**192,599**	187,127
1998	0	5,472	**5,472**	194,150	7,321	7,595	**209,066**	203,594
1999	0	5,472	**5,472**	208,982	8,727	7,824	**225,533**	220,060
2000	0	5,472	**5,472**	223,813	10,134	8,052	**242,000**	236,527
2001	0	5,472	**5,472**	238,645	11,540	8,281	**258,466**	252,994
2002	0	5,472	**5,472**	253,476	12,947	8,510	**274,933**	269,460
2003	0	5,472	**5,472**	268,308	14,353	8,738	**291,400**	285,927
2004	0	5,472	**5,472**	283,139	15,760	8,967	**307,866**	302,394
2005	0	5,472	**5,472**	297,971	17,167	9,196	**324,333**	318,861
2006	0	5,472	**5,472**	312,802	18,573	9,424	**340,800**	335,327
2007	0	5,472	**5,472**	327,634	19,980	9,653	**357,267**	351,794
2008	0	5,472	**5,472**	342,465	21,386	9,882	**373,733**	368,261
2009	0	5,472	**5,472**	357,297	22,793	10,110	**390,200**	384,728
2010	0	5,472	**5,472**	372,128	24,199	10,339	**406,667**	401,194
2011	0	5,472	**5,472**	386,960	25,606	10,568	**423,134**	417,661
2012	0	5,472	**5,472**	401,791	27,013	10,796	**439,600**	434,128
2013	0	5,472	**5,472**	416,623	28,419	11,025	**456,067**	450,595
2014	0	5,472	**5,472**	431,454	29,826	11,254	**472,534**	467,061
2015	0	5,472	**5,472**	446,286	31,232	11,482	**489,001**	483,528

2016	0	5,472	**5,472**	461,117	32,639	11,711	**505,467**	499,995
2017	0	5,472	**5,472**	475,949	34,046	11,940	**521,934**	516,462
2018	0	5,472	**5,472**	490,780	35,452	12,168	**538,401**	532,928
2019	0	5,472	**5,472**	505,612	36,859	12,397	**554,868**	549,395
2020	0	5,472	**5,472**	520,443	38,265	12,626	**571,334**	565,862
2021	' 0	5,472	**5,472**	535,275	39,672	12,854	**587,801**	582,329
2022	0	5,472	**5,472**	550,106	41,078	13,083	**604,268**	598,795
2023	0	5,472	**5,472**	564,938	42,485	13,312	**620,734**	615,262
2024	0	5,472	**5,472**	579,769	43,892	13,540	**637,201**	631,729
2025	(118,900)	0	**(118,900)**	0	0	0	**0**	118,900
Total	1,137,449	245,448	**1,382,898**	13,247,222	732,306	**412,545**	**14,392,073**	13,009,176
Discounted Total	649,074	28,723	**677,797**	1,072,564	31,299	40,120	**1,143,984**	466,187
					Net Present Value ($1000):			**466,187**
					IRR (%):			**10.1**
					Benefits/Costs Ratio:			**1.69**

Note: Discount rate is 7%.

Exhibit 8-12
TRAVEL EFFICIENCIES BENEFIT COST ANALYSIS
All Corridors
Undiscounted 1995 $1,000

Year	Costs	Construction Maintenance Costs	**TOTAL COSTS**	Time Savings	VOC Savings	Accidents Savings	**TOTAL SAVINCS**	NET BENEFITS
1965	19,909	0	**19,909**	0	0	0	**0**	(19,909)
1966	117,538	0	**117,538**	0	0	0	**0**	(117,538)
1967	235,723	(30)	**235,693**	1,029	(434)	(271)	**324**	(235,369)
1968	335,329	(246)	**335,083**	12,364	845	1,017	**14,227**	(320,856)
1969	539,690	146	**539,836**	18,415	(4301	831	**18,817**	(521,020)
1970	551,169	569	**551,738**	30,077	(1,851)	1,560	**29,786**	(521,952)
1971	775,138	2,022	**777,160**	58,268	(2,389)	2,516	**58,395**	(718,765)
1972	775,403	3,267	**778,670**	74,114	(2,555)	4,946	**76,505**	(702,165)
1973	848,293	4,742	**853,036**	95,295	(3,585)	7,108	**98,818**	(754,218)
1974	658,782	6,863	**665,645**	161,532	(6,650)	9,804	**164,686**	(500,959)
1975	392,228	8,596	**400,823**	207,129	(10,855)	10,853	**207,127**	(193,696)
1976	288,078	10,938	**299,016**	238,010	(6,467)	14,028	**245,572**	(53,445)
1977	239,777	13,071	**252,848**	256,640	(8,676)	14,465	**262,429**	9,581
1978	198,702	14,240	**212,942**	286,429	(10,083)	17,624	**293,970**	81,028
1979	232,396	16,047	**248,443**	321,040	(7,511)	20,535	**334,064**	85,621
1980	180,917	17,483	**198,400**	354,774	(9,826)	23,089	**368,037**	169,637
1981	137,289	19,100	**156,388**	376,435	(8,647)	24,227	**392,015**	235,627
1982	174,859	20,527	**195,386**	394,764	(9,432)	25,885	**411,217**	215,831
1983	217,589	21,413	**239,002**	431,235	(7,531)	27,966	**451,670**	212,668
1984	111,262	22,443	**133,705**	465,750	(9,828)	28,010	**483,932**	350,227
1985	87,356	23,331	**110,687**	487,907	(10,795)	29,497	**506,609**	395,923
1986	77,073	24,166	**101,239**	519,392	(11,274)	32,753	**540,871**	439,632
1987	99,512	24,867	**124,379**	545,727	(9,172)	36,722	**573,278**	448,899
1988	74,047	25,163	**99,210**	574,883	(8,4701	37,256	**603,669**	504,460
1989	94,385	25,561	**119,945**	599,168	(7,814)	38,020	**629,373**	509,428
1990	65,355	25,893	**91,248**	625,344	(9,789)	38,414	**653,969**	562,721
1991	65,859	26,324	**92,184**	646,020	(11,025)	39,078	**674,073**	581,889
1992	61,638	27,294	**88,932**	688,749	(9,356)	40,564	**719,958**	631,026
1993	19,279	28,120	**47,399**	710,951	(10,172)	41,479	**742,258**	694,859
1994	9,813	28,840	**38,653**	749,495	(10,334)	43,070	**782,231**	743,578
1995	4,889	29,655	**34,544**	785,812	(11,178)	47,449	**822,083**	787,539
1996	0	29,840	**29,840**	843,690	(8,325)	48,579	**883,944**	854,103
1997	0	30,010	**30,010**	901,569	(5,473)	49,709	**945,805**	915,795
1998	0	30,136	**30,136**	959,447	(2,621)	50,839	**1,007,666**	977,530
1999	0	30,136	**30,136**	1,017,326	232	51,969	**1,069,527**	1,039,391
2000	0	30,136	**30,136**	1,075,204	3,084	53,099	**1,131,388**	1,101,252
2001	0	30,136	**30,136**	1,133,083	5,936	54,229	**1,193,248**	1,163,113
2002	0	30,136	**30,136**	1,190,961	8,789	55,359	**1,255,109**	1,224,974
2003	0	30,136	**30,136**	1,248,840	11,641	56,489	**1,316,970**	1,286,835
2004	0	30,136	**30,136**	1,306,719	14,493	57,619	**1,378,831**	1,348,696
2005	0	30,136	**30,136**	1,364,597	17,346	58,749	**1,440,692**	1,410,557
2006	0	30,136	**30,136**	1,422,475	20,198	59,879	**1,502,553**	1,472,418
2007	0	30,136	**30,136**	1,480,354	23,051	61,009	**1,564,414**	1,534,279
2008	0	30,136	**30,136**	1,538,233	25,903	62,139	**1,626,275**	1,596,140
2009	0	30,136	**30,136**	1,596,111	28,755	63,269	**1,688,136**	1,658,001
2010	0	30,136	**30,136**	1,653,990	31,608	64,400	**1,749,997**	1,719,861
2011	0	30,136	**30,136**	1,711,868	34,460	65,530	**1,811,858**	1,781,722
2012	0	30,136	**30,136**	1,769,747	37,312	66,660	**1,873,719**	1,843,583
2013	0	30,136	**30,136**	1,827,625	40,165	67,790	**1,935,580**	1,905,444
2014	0	30,136	**30,136**	1,885,504	43,017	68,920	**1,997,441**	1,967,305

2015	0	30,136	**30,136**	1,943,382	45,869	70,050	**2,059,302**	2,029,166
2016	0	30,136	**30,136**	2,001,261	48,722	71,180	**2,121,163**	2,091,027
2017	0	30,136	**30,136**	2,059,140	51,574	72,310	**2,183,024**	2,152,888
2018	0	30,136	**30,136**	2,117,018	54,427	73,440	**2,244,884**	2,214,749
2019	0	30,136	**30,136**	2,174,897	57,279	74,570	**2,306,745**	2,276,610
2020	0	30,136	**30,136**	2,232,775	60,131	75,700	**2,368,606**	2,338,471
2021	0	30,136	**30,136**	2,290,654	62,984	76,830	**2,430,467**	2,400,332
2022	0	30,136	**30,136**	2,348,532	65,836	77,960	**2,492,328**	2,462,193
2023	0	30,136	**30,136**	2,406,411	68,688	79,090	**2,554,189**	2,524,054
2024	0	30,136	**30,136**	2,464,289	71,541	80,220	**2,616,050**	2,585,914
2025	(1,317,797)	0	**(1,317,797)**	0	0	0	**0**	1,317,797
Total	6,371,480	1,343,913	**7,715,393**	58,682,453	701,340	**2,526,080**	**61,909,873**	54,194,480
Discounted								
Total	3,978,268	160,530	**4,138,798**	4,678,898	(32,037)	247,680	**4,894,541**	755,743
					Net Present value ($1000):			**755,743**
					IRR (%):			**7.9**
					Benefits/Costs Ratio:			**1.18**

Note: Discount rate is 7%.

APPENDIX C
ECONOMIC DEVELOPMENT IMPACTS BY YEAR

One of the advantages afforded by the REMI model is its ability to track economic development impacts over time in a dynamic way. Reasons why the impacts increase over time are because traffic increases, and because population increases, and because the number of ADHS completed highway sections continue to increase; another important reason is that the impacts tend to build on themselves. For example, the study shows that the Appalachian Region number of people and employees increased in part due to the ADHS.

Contained in Appendix C are tables which show how the various economic development impacts are estimated to change over time. As shown, all impact types (employment, population, wages and value added) increase through the entire 1965-2024 analysis period. This is because of the dynamic nature of the economic development process, and because of the dynamic nature of the REMI model.

Exhibits C-1 through C-4 show the impacts by cause (competitive advantage, roadside services, tourism, and construction), and **Exhibit C-5** presents the total economic development impacts for all eleven studied ADHS corridors.

Each exhibit follows a consistent format in which the first column (Column **A**) is the year, second column (Column **B**) displays the number of new permanent jobs created, the third column (Column **C**) is the additional population created, the fourth column (Column **D**) is the total increase in wages, and the fifth and final column (Column **E**) is the valued added created.

For each of the economic indicators and for each year, the additional jobs, the additional population, the increase in wages, and the increase in value added is determined by the difference between the values of the economic indicators for the control forecast and the values for the economic indicators for the new forecast. The control forecast represents the economic values if none of the ADHS highways were ever built. The values for any year, e.g., 2015, represent the additional jobs, the increase in population, the increase in the value of wages paid out, and the additional value added relative to the control forecast. The values displayed for wages and value added are in millions of dollars.

Exhibit C-1
Competitive Advantage Impacts

A year	B employment	C population	D wages	E value added
			millions	
1966	0	0	0.00	0.00
1967	3	2	0.02	0.10
1968	75	43	0.38	2.18
1969	119	110	0.59	3.43
1970	198	202	1.09	5.74
1971	392	399	2.42	11.69
1972	556	660	3.63	17.16
1973	776	977	5.51	24.48

1974	1330	1534	10.34	40.24
1975	1792	2317	15.56	54.84
1976	2269	3202	21.42	71.09
1977	2655	4102	27.61	83.79
1978	3111	5012	35.53	99.30
1979	3618	6026	44.30	115.24
1980	4029	7087	54.03	126.11
1981	4380	8134	61.21	139.69
1982	4615	9134	67.17	145.87
1983	5008	10175	81.92	162.67
1984	5628	11224	95.14	188.36
1985	6087	12238	106.49	205.32
1986	6586	13229	121.75	225.78
1987	7162	14245	139.80	246.79
1988	7780	15240	157.62	271.25
1989	8401	16239	177.46	297.69
1990	8970	17250	193.79	316.48
1991	9334	18302	217.89	327.18
1992	10046	19434	245.01	359.16
1993	10692	20578	271.55	385.61
1994	11438	21710	307.28	417.98
1995	12195	22747	324.80	444.83
1996	14755	24833	341.60	502.79
1997	15835	26995	360.12	549.74
1998	16870	29111	380.33	605.81
1999	17931	31346	402.12	667.59
2000	18957	33795	425.53	713.12
2001	19989	36330	450.48	744.52
2002	21006	38906	477.03	810.21
2003	21958	41486	505.21	873.94
2004	22882	44100	534.99	944.24
2005	24067	46140	544.13	1059.20
2006	25319	47839	582.35	1129.92
2007	26625	49423	622.86	1202.03
2008	27874	52887	663.64	1272.24
2009	29096	56234	706.38	1342.31
2010	30274	59464	749.96	1411.40
2011	31441	62577	795.63	1480.74
2012	32579	65571	843.28	1549.81
2013	33674	68448	892.44	1617.19
2014	34769	71222	946.67	1686.02
2015	35796	73904	1001.05	1752.25
2016	36780	76487	1056.68	1817.36
2017	37800	78999	1117.34	1885.71

2018	38753	81428	1178.38	1951.27
2019	39693	83795	1242.82	2017.21
2020	40597	86099	1309.07	2082.25
2021	41517	88363	1379.52	2148.83
2022	42496	90636	1455.99	2220.06
2023	43483	92906	1537.63	2292.76
2024	44475	95169	1625.14	2366.39

Exhibit C-2
Roadside Services Impact

A	B	C	D	E
year	**employment**	**population**	**wages**	**value added**
				millions
1966	0	0	0	0
1967	2	1	0.01	0.05
1968	24	5	0.12	0.61
1969	34	14	0.17	0.86
1970	65	30	0.36	1.64
1971	113	59	0.68	2.80
1972	145	96	0.99	3.65
1973	191	142	1.45	4.86
1974	269	201	2.26	7.07
1975	316	274	2.97	8.19
1976	364	354	3.90	9.13
1977	405	440	4.65	10.34
1978	457	524	5.55	11.54
1979	514	613	6.84	13.29
1980	562	707	8.29	14.79
1981	584	799	9.18	14.97
1982	594	883	10.09	15.65
1983	639	968	11.12	16.45
1984	719	1058	12.17	18.22
1985	765	1144	13.83	21.55
1986	823	1228	15.32	24.88
1987	875	1310	16.46	28.21
1988	938	1388	18.24	31.55
1989	1000	1467	20.19	34.88
1990	1067	1545	22.14	38.21
1991	1103	1623	24.00	41.54
1992	1183	1712	26.09	44.88
1993	1242	1801	28.36	48.21
1994	1311	1892	30.63	51.54
1995	1390	1980	33.22	54.87

1996	1485	2079	34.62	58.20
1997	1578	2189	38.60	60.27
1998	1668	2298	40.86	61.79
1999	1757	2403	42.29	63.32
2000	1843	2516	43.36	64.91
2001	1928	2644	44.42	66.77
2002	2011	2776	45.61	68.98
2003	2093	2908	46.99	71.89
2004	2174	3037	48.71	75.69
2005	2253	3170	50.64	79.90
2006	2346	3351	52.65	85.19
2007	2412	3548	54.92	88.59
2008	2480	3729	57.39	92.14
2009	2552	3903	60.24	95.84
2010	2622	4070	63.24	99.56
2011	2693	4229	66.49	103.29
2012	2761	4381	69.82	107.00
2013	2831	4525	73.50	110.79
2014	2898	4662	77.38	114.60
2015	2964	4794	81.50	118.41
2016	3031	1352	78.90	110.43
2017	3096	1447	83.08	113.93
2018	3161	1535	87.56	117.46
2019	3224	1624	92.19	121.03
2020	3286	1712	97.03	124.49
2021	3348	1795	102.08	127.91
2022	3407	1880	107.45	131.45
2023	3465	1962	112.92	134.91
2024	3523	2046	118.58	138.34

Exhibit C-3
Tourism Impact

A year	B employment	C population	D wages	E value added
				millions
1966	0	0	0	0
1967	3	1	0.01	0.05
1968	13	3	0.06	0.22
1969	34	11	0.16	0.79
1970	66	29	0.34	1.48
1971	115	59	0.63	2.55
1972	147	97	0.88	3.3
1973	191	145	1.24	4.38
1974	267	205	1.91	6.37

1975	312	281	2.43	7.35
1976	359	363	3.07	8.2
1977	399	451	3.7	9.29
1978	447	535	4.54	10.39
1979	502	627	5.63	11.95
1980	547	720	6.66	13.29
1981	567	812	7.53	13.46
1982	574	896	8.02	14.1
1983	616	982	8.86	14.85
1984	691	1070	10.65	16.42
1985	733	1154	11.81	18.24
1986	786	1232	13.15	21.71
1987	832	1313	14.65	25.17
1988	890	1386	16.56	28.63
1989	945	1460	18.27	32.09
1990	1005	1533	20.42	35.55
1991	1035	1608	21.88	39.01
1992	1106	1689	24.97	42.47
1993	1157	1773	27.07	45.93
1994	1218	1854	30	49.39
1995	1287	1933	33.44	52.85
1996	1386	2069	36.67	56.31
1997	1480	2204	38.61	58.38
1998	1571	2340	40.76	59.86
1999	1659	2475	42.05	61.27
2000	1745	2611	42.83	62.82
2001	1828	2747	43.62	64.55
2002	1909	2882	44.48	66.67
2003	1988	3018	45.57	69.1
2004	2064	3107	46.93	71.79
2005	2330	3289	48.48	74.39
2006	2388	3495	50.13	77.35
2007	2451	3690	52.03	80.56
2008	2514	3870	54.21	83.82
2009	2576	4040	56.67	87.25
2010	2638	4200	59.34	90.74
2011	2697	4352	62.16	94.19
2012	2756	4493	65.07	97.65
2013	2813	4628	68.3	101.08
2014	2869	4756	71.63	104.56
2015	2924	4876	75.25	108.11
2016	2977	1357	79.01	111.62
2017	3030	1450	82.97	115.16
2018	3081	1533	87.11	118.61

2019	3129	1617	91.45	122.07
2020	3177	1698	95.93	125.52
2021	3222	1778	100.69	128.96
2022	3265	1854	105.61	132.37
2023	3309	1931	110.59	135.73
2024	3334	2005	115.85	139.14

Exhibit C-4
Construction Impacts

A	B	C	D	E
year	employment	population	wages	value added
			millions	
1965	200	49	1.19	6.69
1966	1266	371	7.79	41.52
1967	2532	1065	16.42	82.20
1968	3473	2007	21.75	112.43
1969	6046	3492	41.17	189.97
1970	5856	5025	44.55	183.56
1971	8217	6947	67.94	263.63
1972	8358	8899	76.84	271.04
1973	9249	10675	92.60	302.38
1974	7093	11802	76.84	219.06
1975	3679	11819	47.11	109.90
1976	2549	11329	34.02	73.92
1977	2141	10736	27.94	59.89
1978	2016	10107	25.08	55.96
1979	2774	9707	37.01	80.38
1980	2157	9242	28.82	59.50
1981	1728	8619	21.07	47.15
1982	2412	8176	35.78	68.72
1983	3105	8000	57.43	93.32
1984	1860	7552	30.19	54.44
1985	1724	6950	27.09	50.43
1986	1708	6402	27.92	50.95
1987	2219	5996	44.45	68.55
1988	1972	5604	39.77	60.94
1989	2400	5287	56.08	76.61
1990	1973	4967	45.21	61.58
1991	2108	4693	55.23	65.83
1992	2139	4492	60.76	68.24
1993	1524	4207	41.24	47.40
1994	1462	3909	41.86	46.01
1995	1392	3760	34.62	58.20
1996	602	3490	14.27	26.18

1997	600	3221	15.70	25.96
1998	578	2951	16.10	25.18
1999	557	2682	16.06	24.25
2000	538	2413	15.93	23.38
2001	524	2143	15.78	22.71
2002	513	1874	15.65	22.26
2003	477	1604	12.91	20.06
2004	510	1335	15.70	22.17
2005	504	1065	16.07	21.89
2006	501	796	16.24	21.80
2007	498	823	16.40	21.77
2008	497	840	16.62	21.77
2009	497	859	16.93	21.80
2010	498	872	17.30	22.01
2011	501	885	17.74	22.14
2012	501	894	18.19	22.27
2013	505	902	18.76	22.54
2014	506	904	19.28	22.71
2015	509	909	19.96	22.99
2016	512	911	20.66	23.21
2017	514	918	21.37	23.46
2018	515	917	22.11	23.57
2019	518	920	22.89	23.81
2020	519	919	23.72	24.01
2021	521	923	24.58	24.20
2022	522	925	25.49	24.38
2023	522	928	26.44	24.55
2024	523	930	25.15	24.02

Exhibit C-5

Total Economic Development Impacts

A year	B employment	C population	D wages	E value added
			millions	
1965	200	49	1.19	6.69
1966	1266	371	7.79	41.52
1967	2540	1068	16.46	82.4
1968	3584	2058	22.31	115.44
1969	6233	3626	42.09	195.06
1970	6184	5286	46.33	192.43
1971	8837	7464	71.69	280.66
1972	9205	9751	82.35	295.15
1973	10409	11939	100.8	336.1

1974	8959	13741	91.35	272.75
1975	6099	14691	68.07	180.28
1976	5541	15248	62.41	162.35
1977	5600	15728	63.9	163.31
1978	6031	16178	70.71	177.2
1979	7408	16972	93.78	220.87
1980	7295	17757	97.8	213.69
1981	7259	18364	98.99	215.28
1982	8194	19090	121.06	244.34
1983	9368	20125	159.34	287.29
1984	8897	20904	148.15	277.44
1985	9309	21486	159.21	295.54
1986	9903	22092	178.14	323.31
1987	11088	22864	215.36	368.72
1988	11580	23618	232.19	392.36
1989	12747	24453	272	441.27
1990	13015	25295	281.56	451.82
1991	13580	26226	319	473.55
1992	14475	27327	356.84	514.74
1993	14614	28359	368.22	527.15
1994	15428	29366	409.77	564.92
1995	16264	30419	426.08	610.75
1996	18229	32471	427.16	643.49
1997	19494	34609	453.03	694.35
1998	20687	36700	478.05	752.63
1999	21904	38907	502.52	816.44
2000	23083	41335	527.64	864.24
2001	24269	43864	554.31	898.55
2002	25439	46437	582.78	968.12
2003	26516	49016	610.68	1034.99
2004	27631	51579	646.33	1113.89
2005	29154	53664	659.32	1235.38
2006	30554	55481	701.37	1314.27
2007	31986	57484	746.21	1392.95
2008	33365	61326	791.86	1469.97
2009	34721	65036	840.22	1547.2
2010	36032	68606	889.83	1623.71
2011	37332	72043	942.02	1700.36
2012	38597	75339	996.36	1776.73
2013	39823	78503	1052.99	1851.61
2014	41042	81544	1114.96	1927.89
2015	42193	84483	1177.77	2001.76
2016	43300	80107	1235.24	2062.62
2017	44440	82814	1304.76	2138.26

2018	45510	85413	1375.15	2210.9
2019	46564	87956	1449.35	2284.11
2020	47579	90428	1525.75	2356.28
2021	48608	92859	1606.87	2429.9
2022	49690	95295	1694.54	2508.26
2023	50779	97727	1787.58	2587.95
2024	51855	100150	1884.72	2667.89