

Major Corridor Investment-Benefit Analysis System

Abstract

This paper discusses the Major Corridor Investment-Benefit Analysis System, which recently was developed for the Indiana Department of Transportation. The purpose of the system is to provide an analytical tool for use by INDOT in evaluating and comparing the impacts of major corridor highway investments in the state. The system combines a statewide travel demand model, a user benefit/cost analysis model, and a regional econometric model. The paper describes the conceptual approach behind the model. It also presents the results from an application of the model to analyze the transportation and economic impacts of the upgrade of U.S. 31 between Indianapolis and South Bend to Interstate level of service. Issues addressed by the model include the impact of travel time savings and other user benefits on business users of the highway; and the potential for the study corridor to attract new businesses or tourists as a result of improved access to markets.

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Major Corridor Investment-Benefit Analysis System

This paper describes the Indiana Department of Transportation's Major Corridor Investment-Benefit Analysis System. It illustrates the use of the system to estimate the transportation and economic impacts of proposed major corridor improvements to U.S. 31 between Indianapolis and South Bend, Indiana.

The study estimates the transportation and economic impacts of major improvements to the entire 122-mile corridor between I-465 in Indianapolis and the U.S. 20 bypass in South Bend. The study area is defined as Hamilton, Tipton, Howard, Miami, Cass, Fulton, Marshall, St. Joseph, and Elkhart counties. The objectives of the study are to: evaluate the regional economic impacts of transportation improvements to the U.S. 31 corridor; ensure cost-effective public sector investment by comparing economic benefits to implementation costs; and enhance previous and ongoing U.S. 31 studies with information on a broader range of potential impacts.

Conceptual Approach

The traditional approach to highway benefit/cost analysis focuses on the benefits of the highway to its users, in terms of changes in travel time, safety, or operating costs. These changes can be quantified in monetary terms, and compared to the project's implementation costs to evaluate the cost-effectiveness of the project as a public sector investment. A broader approach, enabled by recent advances in economic forecasting and modeling techniques, considers not only the direct benefits of the highway on its users, but also the broader impacts on the regional economy. Economic benefits are defined as benefit to the economy such as the generation of additional jobs, business sales, or disposable income. The most common measure of economic benefit is change in disposable income, which reflects the change in wage income earned in the region. These benefits can be compared to economic costs, which represent the outflow of disposable income.

INDOT's Major Corridor Investment-Benefit Analysis System conducts such an economic impact analysis in five steps:

1. **Conduct transportation network analysis.** The Indiana Statewide Travel Model is used to generate projections of traffic volumes and travel times on the highway network in the corridor, as well as in the state as whole. Two forecasts are developed and compared – one assuming the improvements are implemented, and one assuming they do not occur.
2. **Estimate user benefits.** NET_BC, a user benefit-cost analysis model developed by Bernardin, Lochmueller & Associates, Inc., is applied to these estimates of traffic volumes and travel times to calculate the costs associated with travel time, safety, and vehicle operation in the corridor. The “no build” and “build” costs are compared to estimate the user benefits associated with the improvement.
3. **Calculate direct economic benefits.** A system of linked economic models is applied to calculate the money value of direct economic benefits for businesses. The portion of user benefits that accrue to businesses is estimated in terms of its impact on business costs and productivity. The changes in customer and labor market size are estimated based on the

travel time changes, and applied in a business location model to identify the types of industries that may be attracted to the study area as a result of the highway improvements, and a projected number of additional jobs in each industry. Finally, direct tourist impacts are estimated based on changes in travel time from major tourist origin markets.

4. **Project secondary economic benefits.** A regional economic simulation model developed by Regional Economic Models, Inc. is applied to forecast the indirect and induced impacts of the direct economic benefits. This model generates estimates of changes in regional employment, income, and output.
5. **Conduct benefit/cost analysis.** These direct, indirect, and induced impacts are aggregated, discounted over time, and compared to the stream of capital and operating costs to determine an overall project benefit/cost ratio.

Study Area Economy and Transportation System

The study corridor runs from the northern suburbs of Indianapolis to the South Bend and Elkhart metropolitan areas on the Michigan border. Total population of the corridor was 791,000 in 1994. The corridor's population increased 1.4 percent annually between 1990 and 1995, and is projected to grow 0.9 percent annually between 1995 and 2020. Employment has been growing faster than population, with an annual increase of 2.4 percent between 1990 and 1995 and a projected annual increase of 1.5 percent through the year 2020. Forecast employment growth rates are about 50 percent higher than for the state of Indiana and for the United States.

U.S. 31 is the primary north/south route through north central Indiana. It is currently a four-lane divided highway, with varying levels of access control. In Hamilton County, access is primarily but not exclusively limited to the 12 signalized intersections along the highway. Howard County has 15 stoplights and numerous curb cuts and is fronted by significant amounts of retail and service development. Tipton, Miami, Fulton, and Marshall Counties are primarily rural and contain a total of only two stoplights. As U.S. 31 approaches U.S. 20 near South Bend, it is fronted by significant commercial activity and contains two stoplights, numerous curb cuts, and a center turn lane in some places. After intersecting U.S. 20, it becomes limited access and bypasses the city.

For the corridor as a whole, vehicle-miles of travel (VMT) are projected to increase by 59 percent and vehicle-hours of travel by 75 percent by the year 2020 (Table 1). Average travel speed is expected to drop somewhat from 39.7 to 36.1 miles per hour, under the baseline scenario in which U.S. 31 is not upgraded.

Table 1. Current and Forecast U.S. 31 Corridor Population, Employment, and Traffic

	1995	2020	Percent Change
Population (thousands)	802	997	24
Employment (thousands)	498	645	30
Vehicle-miles of travel (thousands)	13,622	21,718	59
Vehicle-hours of travel (thousands)	343	601	75
Average speed (miles per hour)	39.7	36.1	-9

Source: Woods and Poole Economics, Inc.; Cambridge Systematics, Inc., Indiana Statewide Travel model.

The largest increase in traffic is projected to occur in high-growth Hamilton County, where traffic will nearly double between I-465 and SR 431 (Table 2). Due to increased traffic volumes, total travel time between I-465 and SR 26 in Kokomo is expected to increase by roughly five minutes by the year 2020. Traffic volumes are also projected to increase in the northern part of the corridor, although travel times from Kokomo to South Bend will not be significantly affected.

Table 2. Current and Forecast U.S. 31 Travel Times and Traffic Volumes

Highway Segment	Free-Flow Travel Time (min.) ¹		Average Daily Traffic	
	1995	2020 (No-Build)	1995	2020 (No-Build)
I-465 to SR 431	6.7	8.2	39,200	78,800
SR 431 to SR 26	32.9	35.3	24,200	39,800
SR 26 to U.S. 35 (N)	12.1	12.5	28,200	36,400
U.S. 35 (N) to U.S. 24	14.3	14.4	18,400	23,800
U.S. 24 to U.S. 30	46.7	46.6	12,600	18,500
U.S. 30 to U.S. 20	22.7	22.8	20,300	35,200
Corridor Total	138.5	143.2	22,000	36,100

(1) Travel times assume free-flow speeds. Actual travel times in the no-build scenario are higher due to signalization.

Source: Cambridge Systematics, Inc., Indiana Statewide Travel Model.

Route Improvement Concept

The proposed major corridor improvement concept for U.S. 31 is for an upgrade of the corridor to Interstate design standards. The Interstate design standard is characterized by total access control; two (or more) travel lanes in each direction; and posted speeds of 55 miles per hour in urban areas and 65 miles per hour in rural areas. The proposed highway improvement includes construction of a new east-side bypass of Kokomo and a new freeway-to-freeway interchange with I-465 (Figure 1).

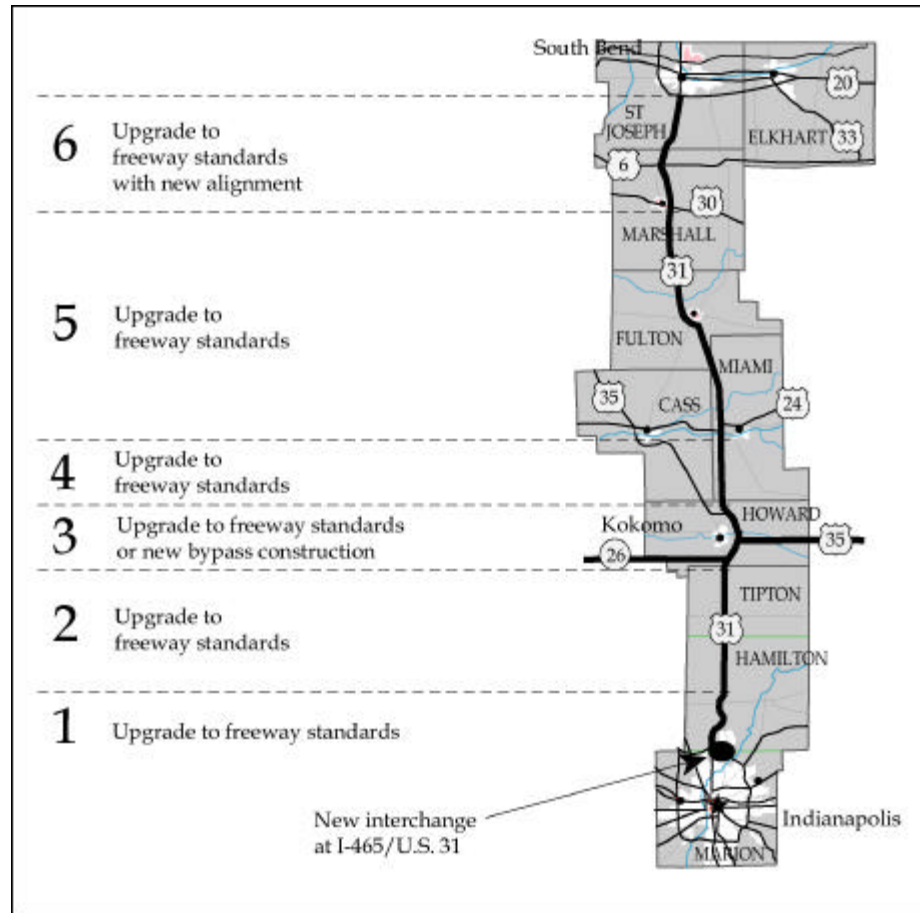
Transportation Impacts

The proposed improvement is projected to lead a seven percent increase in VMT throughout the study area, compared to the “no build” forecast that assumes no changes to existing U.S. 31.¹ The average free-flow speed along U.S. 31 from I-465 to the U.S. 20 bypass would increase to 60.3 miles per hour, compared with 50.3 miles per hour in the no-build forecast.² For all segments of the statewide highway network in the study area, average free-flow speed would

¹This forecast excludes potential diversion of trips among origin/destination pairs, so that total VMT statewide does not change significantly.

²Actual speeds in the no-build forecast are lower than 50.3 miles per hour due to signalization.

Figure 1. U.S. 31 Route Improvement Concept



increase from 36.0 to 40.1 miles per hour. With this improvement in average speeds, vehicle-hours of traffic (VHT) would decrease despite the increase in overall VMT. VHT is projected to decrease 4.3 percent in the study area and 1.3 percent for the state as a whole.

Average daily traffic (ADT) would be expected to increase significantly along most segments of U.S. 31, with an average increase of approximately 45 percent for the corridor as a whole (Table 3). In absolute numbers of trips, the increase would be largest at the southern end of the corridor. Average daily trips would decrease on many of the parallel north-south routes, which would be characterized by slower speeds and longer driving times than U.S. 31.

Due to the increase in average free-flow speeds along U.S. 31, the total travel time along the corridor between I-465 and the U.S. 20 bypass would decrease more than 21 minutes. Adjusting for the elimination of signalization, the total decrease in travel time would be closer to 35 minutes along the entire corridor.

User Benefits

The user benefits attributable to the U.S. 31 corridor improvement fall into three categories:

Table 3. Projected Changes in Average Daily Traffic from U.S. 31 Corridor Improvements, 2020

U.S. 31 Link	Number of Trips			Travel Time (minutes) ⁽¹⁾		
	No-Build	Build	Difference	No-Build	Build	Difference
I-465 to SR 431	78,800	122,200	43,400	8.22	6.06	-2.16
SR 431 to SR 26	39,800	61,400	21,600	35.30	28.61	-6.69
SR 26 to U.S. 35 (north leg) ⁽²⁾	36,400	41,900	5,500	12.53	14.09	1.56
U.S. 35 (north leg) to U.S. 24	23,800	37,000	13,200	14.43	12.03	-2.40
U.S. 24 to U.S. 30	18,500	30,700	12,200	46.64	39.43	-7.21
U.S. 30 to U.S. 20 bypass	35,200	42,900	7,700	22.79	18.97	-3.82
I-465 to U.S. 20 bypass	36,100	52,600	16,500	143.17	121.91	-21.26

⁽¹⁾ Travel times assume free-flow speeds. Actual travel times in the no-build scenario are higher due to signalization.

⁽²⁾ Data shown are for the existing U.S. 31 alignment, which will continue to represent the shortest path through the metropolitan area. The projected number of average daily trips on the eastside bypass is 9,900.

Source: Cambridge Systematics, Inc., Indiana Statewide Travel Model.

1. **Travel time savings** reflect the dollar value of the reduction in VHT that is associated with the project. Over the 30-year analysis period, the cumulative value of these travel time savings for trips originating in Indiana is \$5.3 billion in 1997 dollars.
2. **Safety cost savings** reflect the projected reduction in the number of accidents that would occur as a result of the improvement in the functional class of the facility, as seen in the reduction in congestion and the level of entering and exiting traffic. By the year 2020 the annual number of accidents in the state is expected to decrease by approximately 2,600, or about two percent. Using standard dollar values for accident costs by type, the cumulative savings over the 30-year analysis period for trips originating in Indiana is \$2.6 billion in 1997 dollars.
3. **Vehicle operating cost changes** reflect changes in average operating speed. With the decrease in congestion and signalization associated with the highway improvement, autos and trucks will be operating at speeds higher than their optimal speed for maximizing efficiency and fuel economy. Consequently, cumulative operating costs for the period 2005 to 2034 are expected to increase \$537 million for automobiles and \$34 million for trucks, measured in 1997 dollars.

The cumulative total of all user benefits for trips originating in Indiana over the 30-year analysis period is \$7.3 billion in 1997 dollars (Table 4). The majority (72 percent) of these benefits are the result of the travel time savings.

Personal auto trips account for 66 percent of the user benefits, or \$4.8 billion in 1997 dollars over the 30-year period. The portion of auto user benefits associated with commuting to and from work does not affect business costs, except for those cases where it affects employee work hours (applicable to relatively few jobs) or prevailing wage rates (applicable mostly in competitive urban labor markets). The portion of auto user benefits associated with recreational and social trips is a quality of life benefit, but does not affect regional income flows. Because these benefits have no multiplier effects, they are not considered further in the economic analysis.

Table 4. Summary of User Benefits from U.S. 31 Corridor Improvements
Millions of \$1997, Cumulative 30-Year Change, Trips Originating in Indiana Only

	Non-work Auto	Work Auto	Truck	Total	Percent
Travel Time Savings	\$3,451	\$1,389	\$430	\$5,270	72
Safety Cost Savings	1,785	667	153	2,604	36
Vehicle Operating Cost Changes	(408)	(129)	(34)	(571)	-8
Total	\$4,827	\$1,926	\$549	\$7,303	
Percent	66	26	8		

Source: Bernardin, Lochmueller, and Associates, Inc.

Economic Impacts

The highway improvement project would produce three types of direct economic impacts:

1. Expansion of existing businesses associated with the direct business cost impact of the user benefits. These impacts are measured in terms of changes in cost and productivity measures for specific industries.
2. Attraction of new businesses to the study area associated with the market access effects of the highway improvement. These impacts are measured in terms of direct new jobs by industry.
3. Changes in tourist activity in the corridor associated with the market access effects of the highway improvement. These impacts are measured in terms of changes in visitor-days by type of visitor.

These direct economic impacts produce secondary impacts in the form of increased sales for businesses producing intermediate products and services (indirect impacts), and increased sales for businesses benefiting from consumer spending from workers in the direct and indirect jobs (induced impacts). The indirect and induced impacts are measured in terms of changes in regional employment, output, or income.

Business Cost Savings

Travel time savings and safety cost savings for trucks represent a real reduction in business operating costs, which are only partially offset by increased vehicle operating costs. These benefits accrue to the for-hire trucking industry, as well as to industries that own and operate private fleets. Although concentrated in the study area, these benefits also would be experienced by trucking companies and other businesses based elsewhere in Indiana who ship to the study area. The cumulative value of these benefits statewide is \$549 million in 1997 dollars.

The portion of auto travel time savings and safety cost savings that is associated with “on-the-clock” work trips represents a change in the productivity of labor (for workers’ time) and

capital (for business-owned automobiles). These are partially offset by the increase in business auto operating costs. The cumulative value of the direct business auto user benefits over the 30-year analysis period is \$0.9 billion statewide in 1997 dollars. Industries with significant amounts of business auto travel primarily include: transportation service industries, such as taxi and limousine services; businesses that deliver products, such as certain types of restaurants and retail businesses; and businesses with professional or sales staff who travel for client meetings, including real estate, finance, business service, home health care, and other personal service industries.

Business Attraction Impacts

The highway project would enhance the attractiveness of business locations in the study area in several ways:

- **Connections to outside areas.** The highway project would improve connections from points throughout the study area to Indianapolis and the rest of central and southern Indiana, as well as further south to Kentucky and Tennessee. It also would improve connections from the entire study area to western Michigan, where urban areas such as Grand Rapids, Benton Harbor, and Muskegon support a large number of businesses producing motor vehicle parts, appliances, office furniture, and other durable goods. In addition, the central and southern portions of the corridor would improve connections with important origin and destination markets in Detroit and northern Ohio, as well as Chicago and Milwaukee.
- **Extension of labor market and shopping areas.** The reduction in travel times expected as a result of the U.S. 31 improvement would extend the labor market (defined as 30 minutes travel time) of most cities located along the corridor more than 10 percent. The increase would be most significant for the smaller cities in the central portion of the corridor such as Peru, Rochester, and Plymouth, where labor markets would increase more than 20 percent. The expanded labor market would help attract labor-intensive businesses to these locations, overcoming some of the concerns about the tight labor market that many economic development agencies in the corridor see as a constraint on future growth.
- **Extension of delivery service areas.** The highway project would extend the one-day delivery service area for truck trips (generally defined as six hours or approximately 250 miles) moving into or out of the study area. The expected 35 minute reduction in travel times along the corridor would enable businesses to more effectively serve customers in states such as Kentucky, Tennessee, or Michigan. With the travel time improvements, a one-day truck trip from Kokomo would be able to serve markets including Chicago, Milwaukee, St. Louis, Detroit, Cleveland, Columbus, Cincinnati, and Louisville.

The analysis identified industries that are dependent on highway access, and have the potential for attraction to the study area based on the highway benefits. In general, these businesses depend on high volumes of truck shipments and timely delivery of supplies. Approximately 200 direct new jobs are expected to be attracted in these industries as a result of the highway project. These direct jobs would be concentrated in five industries: 1) motor vehicles and parts; 2) fabricated metal products; 3) rubber and plastics; 4) electrical equipment; and 5) retail trade. The actual business attraction will depend on the extent to which the state and the region market the highway improvement and implement complementary economic development incentives.

Tourism Impacts

The U.S. 31 improvement would enhance the region's tourist activity in several ways:

- **Improved access to the South Bend area from central and southern Indiana.** The highway project would enhance connections and reduce travel time between the large base of tourism activity in South Bend and Elkhart and origin markets to the south. It also would enhance the competitiveness of these markets for conventions and business meetings.
- **Improved access to Indianapolis from western Michigan and the South Bend area.** Access to Indianapolis from the western Michigan market would improve due to the reduction in travel times along U.S. 31. In addition, Indianapolis could become more attractive as a day trip or weekend trip from the South Bend area, in part attracting side trips from visitors whose primary destination is South Bend.
- **Increase in the frequency and size of motor coach tours.** While most tourists are from within the state, a number of coach tours from the Midwest region and Kentucky currently visit the U.S. 31 corridor. Interstate access is important to motorcoach tours and improvement of U.S. 31 would help attract coach tours to the central corridor area where there is currently no Interstate access.

The total number of annual visitor-days to the study area is projected to increase by 90,000, approximately a two percent increase in the number of annual visitor-days in the region. This increase will be partially offset by a decrease in tourist activity in the rest of the state, as some trips shift from Indianapolis and other markets to South Bend and other parts of the corridor. Additional visitors will contribute to the regional economy by spending money in various sectors. The direct spending impact of the additional visitor-days in the study area is estimated at \$8 million per year. The industries that will benefit from the direct spending include hotels and lodging (\$3 million), restaurants (\$2.4 million), personal services, and retail trade.

Cumulative Economic Impacts

The cumulative effect of these changes would be to create an additional 5,010 jobs by the year 2034, the end of the forecast period (Table 5). These would include 1,880 jobs in the study area and 3,130 jobs in the rest of the state. Although the rest of the state is projected to lose some jobs and tourist activity to the study area, it will experience an overall employment gain as a result of two factors: direct business cost savings experienced by manufacturers, distributors, and motor carriers based elsewhere in the state who ship goods to the study area; and increased demand for business and financial services, which are concentrated in Indianapolis, from industries in the study area.

These jobs would be distributed among several industries, concentrating in services and trade. The employment would be phased in over two decades. Business sales are projected to increase a cumulative total of \$3.9 billion over the 30-year analysis period in the study area, with a \$4.8 billion increase in the rest of the state. Real disposable income is projected to increase \$1.8 billion in the study area and \$3.0 billion in the rest of the state.

Table 5. Projected Long-Term Economic Impact of U.S. 31 Corridor Improvements
Difference from Control Forecast

	2010	2015	2020	2025	2030
Study Area					
Total Employment (Thousands)	0.61	1.03	1.36	1.66	1.87
Population (Thousands)	0.19	1.24	2.09	2.80	3.31
Business Sales (Millions of \$1997)	\$ 40	\$ 86	\$136	\$191	\$232
Disposable Income (Millions of \$1997)	\$ 29	\$ 47	\$ 64	\$ 81	\$ 95
Total State					
Total Employment (Thousands)	1.35	2.48	3.30	4.04	4.66
Population (Thousands)	0.52	3.31	5.56	7.43	8.84
Business Sales (Millions of \$1997)	\$100	\$208	\$305	\$410	\$503
Disposable Income (Millions of \$1997)	\$ 80	\$130	\$173	\$216	\$255

Source: Cambridge Systematics, Inc., Major Corridor Investment-Benefit Analysis System.

Benefit/Cost Analysis

A benefit/cost assessment of a proposed highway investment involves comparing the entire stream of benefits resulting from the construction of a project over a specific period of years with the entire stream of costs over the same period. For the U.S. 31 analysis, both the benefit and cost estimates are presented in 1997 dollars, and are discounted at a rate of seven percent per year to compute their present value. Discounting compensates for differences in the timing of benefits and costs over the analysis period. The analysis period is from 2005, the year construction begins, until 2034.

The benefit/cost framework requires analysis of the following costs (Table 6):

- **Capital costs.** The capital cost for the U.S. 31 improvement concept is \$1.1 billion, including \$798 million in construction costs and \$288 million in right-of-way costs. The construction cost total includes roadway, bridge, interchange, grade separation, and traffic maintenance costs; a 20 percent contingency is excluded from these calculations. The right-of-way costs include land acquisition, land improvement, and relocation.
- **Operations and maintenance costs.** The annual operations and maintenance costs for the U.S. 31 improvement is assumed to be \$370,000 per year, beginning in the year 2010.

The total present value of these costs is \$894 million in 1997 dollars.

Table 6. Economic Benefit/Cost Analysis of U.S. 31 Corridor Improvements
Millions of \$1997, Net Present Value, Seven Percent Discount Rate, Cumulative Change, 2005-2034

Benefits	
Personal Auto User Benefits	\$1,468
Economic Benefits	1,326
Residual Value	75
Total Benefits	\$2,869
Costs	
Construction	\$ 891
Operations and Maintenance	3
Total Costs	\$ 894
Net Benefit	\$1,974
Benefit/Cost Ratio	3.2

Source: Cambridge Systematics, Inc., Major Corridor Investment-Benefit Analysis System.

The benefit/cost framework requires analysis of the following benefits:

- **User benefits for personal auto use.** The travel time, safety, and operating cost benefits that accrue to personal auto travelers (e.g., for commuting, social, and recreational trips) can be valued in monetary terms. However, these are separated from the user benefits for business auto and truck use, which generate economic impacts because they create additional income.
- **Direct, indirect, and induced economic impacts.** Economic impacts are associated with the expansion of existing businesses, the attraction of new businesses, and changes in tourist activity. These impacts are reported together to eliminate possible double-counting. They are measured in terms of changes in real disposable income.
- **Residual value.** The residual value represents the estimated value of the highway structure and pavement at the completion of the 30-year analysis period, given standard assumptions about depreciation rates. It is estimated at \$610 million in 1997 dollars.

The total present value of all benefits is \$2.9 billion in 1997 dollars. The present value of the economic benefits is \$1.3 billion, or slightly less than half of this total. The net benefit is nearly \$2.0 billion, which indicates that the project would create a net benefit for the regional economy. The benefit/cost ratio is 3.2 to 1.

The following types of benefits and costs are not included in the benefit/cost analysis: 1) disbenefits associated with the disruption and detouring of traffic during the construction period; 2) disbenefits associated with the project financing, such as the cost of debt servicing; 3) benefits of partial operation of the upgraded facility during the construction period; 4) benefits resulting from the expenditures for construction of the proposed project, which are temporary in nature; and 5) shifts in business sales associated with localized changes in pass-by traffic and access to businesses abutting U.S. 31.