Highlights

In order to correctly interpret the analyses presented in this report, it is important to understand the framework in which they were developed and to recognize their limitations. As stated in the "Introduction," this document is intended to provide Congress with an objective appraisal of the physical conditions, operational performance, and financing mechanisms of highways, bridges, and transit systems based both on the current state of these systems and on the projected future state of these systems under a set of alternative future investment scenarios. The trends identified in this report reflect more recent data than the last edition, as well as enhancements to the analyses based on ongoing work by the Federal Highway Administration (FHWA) and the Federal Transit Administration (FTA). These enhancements improve the estimation of the conditions and performance of highways, bridges, and transit and better forecast the impact that future investment may be expected to have on maintaining and improving this transportation infrastructure.

Since this edition of the C&P report is based primarily on data through the year 2006, it does not yet fully reflect the effects of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU), which authorized Federal highway and transit funding for Federal fiscal years 2005 through 2009. This "Highlights" section generally compares 2006 statistics with those for 1997, the last year preceding the enactment of the Transportation Equity Act for the 21st Century (TEA-21). As discussed in the "Introduction," other sections within this report assess recent trends over different time periods.

Cautionary Note on Using This Report

It is important to note that this document is not a statement of Administration policy and that the future investment scenarios presented in this report are intended to be illustrative only. **The report does not endorse any particular level of future highway, bridge, or transit investment**; it does not address questions as to what future Federal surface transportation programs should look like, or what level of future surface transportation funding can or should be provided by the Federal government, State governments, local governments, the private sector, or system users. Making recommendations on policy issues such as these would go beyond the legislative mandate for the report and would violate its objectivity. Outside analysts can and do make use of the statistics presented in the C&P report to draw their own conclusions, but any analysis attempting to use the information presented in this report to determine a target Federal program size would require a whole series of additional policy and technical assumptions that go well beyond what is reflected in the report itself.

What is a "Need"?

The current legislative requirement for an "Infrastructure Investment Needs Report" in 23 USC 502(h), and the comparable legislative requirements for this type of report in the past (dating back to 1968 on the highway side and 1984 on the transit side), do not define exactly what a "need" is; economists largely reject a concept of a "need" that is divorced from demand and price considerations. The report series began as a combined "wish list" of State highway needs. Over time, national engineering standards were defined and utilized to develop a set of "needs" on a uniform national basis. As the report series evolved further, economic considerations were brought into the analysis, looking at the impact of system conditions and performance on highway and transit users as well as on highway agencies and transit operators. The current generation of analytical tools attempt to combine engineering and economic procedures, determining deficiencies based on engineering standards while applying benefit-cost analysis procedures to identify potential capital improvements to address those deficiencies that may have positive net benefits.

The investment scenario estimates presented in this report represent an estimate of what level of performance **could** be achieved with a given level of funding, not what **would** be achieved with it. While the models assume that projects are prioritized based on their benefit-cost ratios, that assumption is not consistent with actual patterns of project selection and funding distribution that occur in the real world. Consequently, the level of investment identified as the amount required to maintain a certain performance level should be viewed as the minimum amount that would be required if all other modeling assumptions prove to be accurate.

It is important to note that the benefit-cost analysis procedures currently employed are not equally robust among all of the different types of infrastructure investments covered in this report. Further, this approach does not subject potential capital improvements to the type of rate of return analysis that would typically be employed in the private sector. The United States Department of Transportation (DOT) continues to look for ways to address the limitations of the existing analytical procedures.

Uncertainty in Transportation Investment/Performance Modeling

As in any modeling process, simplifying assumptions have been made to make analysis practical and to meet the limitations of available data. Since the ultimate decisions concerning highways, bridges, and transit systems are primarily made by their owners at the State and local level, they have a much stronger business case for collecting and retaining detailed data on individual system components. The Federal government collects selected data from States and transit operators to support this report, as well as a number of other Federal activities, but these data are not sufficiently robust to make definitive recommendations concerning specific transportation investments in specific locations. While potential improvements are evaluated based on benefit-cost analysis, not all external costs (such as noise pollution) or external benefits (such as the impact of transportation investments on productivity) are fully considered. Across a broad program of investment projects, such external effects may cancel each other; but, to the extent that they do not, the true "needs" may be either higher or lower than would be predicted by the models. This topic is discussed in the Introduction to Part II.

A State or local government performing an investment analysis for a real-world project would presumably have better information concerning the capital costs associated with the project, as well as localized information that would influence the evaluation of the project's potential benefits and external societal costs. To the extent that State and local governments include other factors beyond economic considerations in their investment decision-making process, benefit-cost ratios will not be maximized. In fact, there is mounting evidence that the benefit-cost ratios of highway and public transportation investments have declined significantly in recent years. Moreover, current processes and approaches do little to ensure that investment resources are appropriately targeted.

Impact of Financing Structures on Transportation Investment/ Performance Analysis

This report has traditionally identified the amount of additional spending above current levels that would be required to achieve certain performance benchmarks, without incorporating the impact of the types of revenues that would support this additional spending. This approach was in keeping with the general philosophy referenced earlier that the assignment of responsibility for the costs associated with a given scenario to any particular level of government or funding source falls beyond the legislative mandate for this report. However, the implicit assumption built into this approach has been that the financing mechanisms would not have any impact on investment scenarios themselves. In reality, however, increasing funding from general revenue sources (such as property taxes, sales taxes, income taxes, etc.) would have different implications than increased funding from user charges (such as fuel taxes, tolls, and fares).

For this report, a series of parallel highway investment/performance analyses have been developed to compare the implications of funding potential increases in capital spending through non-user based financing mechanisms, fixed rate user financing mechanisms, or variable rate user financing mechanisms. The analyses assuming fixed rate or variable rate user financing presume that any funding to support increases in highway and bridge investment above 2006 levels would be financed by highway users on a per-VMT basis. A feedback loop has been added to the modeling process to account for the impact that this change in the "price" of travel experienced by individual system users would have on projected future travel volumes and overall system performance. The methodology used for these analyses is presented in greater detail in Appendix A.

When highway users make decisions about whether, when, and where to travel, they consider both implicit costs (such as travel time and safety risk) and explicit, out-of-pocket costs (such as fuel costs and tolls). Under uncongested conditions, their use of the road will not have an appreciable effect on the costs faced by other users. As traffic volumes begin to approach the carrying capacity of the road, however, traffic congestion and delays begin to set in and travel times for all users begin to rise, with each additional vehicle making the situation progressively worse. However, individual travelers do not take into account the delays and additional costs that their use of the facility imposes on other travelers, focusing instead only on the costs that they bear themselves. To maximize net social benefits, users of congested facilities would be levied charges precisely corresponding to the economic cost of the delay they impose on one another, thereby more efficiently spreading traffic volumes and allowing the diverse preferences of users to be expressed. In the absence of efficient pricing, options for reducing congestion externalities and increasing societal benefits are limited. In addition, the efficient level of investment in highway capacity is larger under the current system of highway user charges (primarily fuel and other indirect taxes) than would be the case with full-cost pricing of highway use.

The variable rate user financing analyses presented in this report assume the immediate widespread adoption of congestion pricing on all Federal-aid Highways, with peak period charges set independently for individual congested highway sections based on the estimated cost of the negative impact that each driver has on all other users of that section. The projected revenue that would be generated from such congestion charges was then applied to cover the difference between the investment level being studied and the current 2006 level of combined public and private highway capital investment. If the revenue from these variable rate charges would not be sufficient for this purpose, the analyses assumed the imposition of an additional fixed rate charge. In cases where projected congestion pricing revenue exceeded the level needed to support the level of investment being studied, a negative fixed rate charge was applied, simulating the effects of lowering existing fuel taxes, fixed rate tolls, or other fees imposed on highway users.

While the above discussion focuses on highway pricing, the same considerations may apply to transit investments. Anecdotal evidence suggests that transit routes in major metropolitan areas are approaching their passenger-carrying capacities during peak travel hours, with a commensurate deterioration in the quality of service. Some of this crowding could be reduced by increasing fares during peak hours. Certain considerations, however, may limit the ability of transportation authorities to price transit services more efficiently, such as the ability of the fare system to handle peak pricing, and the desire to provide transit as a low-cost service to transit-dependent riders. Additionally, the fact that overcrowded transit lines are often in corridors with heavily congested highways makes a joint solution to the pricing problems on both highways and transit more complicated to analyze, devise, and implement. Measuring the actual crowding on transit systems during peak periods, and the development of a more sophisticated crowding metric than the one currently used by FTA, are areas for further research.

Impact of New Technologies

The highway investment analysis procedures used to develop the investment scenarios for this report have been modified to reflect the impact that certain types of operational strategies and intelligent transportation systems (ITS) deployments may have on system performance in the future, based on current deployment trends. However, any more aggressive and effective deployment of ITS and other technologies beyond that modeled in this analysis is expected to further reduce the level of future capacity investment required to achieve any specific level of performance. The sensitivity analysis in Chapter 10 explores the potential impacts of more rapid deployment of existing technologies.

New technology holds promise in other areas as well. Improved pavement and bridge technologies have the potential to reduce future system rehabilitation costs, while improved highway and transit vehicle technologies could interact with ITS deployments to enhance operating efficiency. The baseline analyses presented in this report do not attempt to assume the future impacts of these types of technological improvements, but it is important to recognize their potential when considering the findings of this report. The sensitivity analysis in Chapter 10 explores the potential impacts of a significant extension of pavement life. Further discussion of new technologies is included in Part IV.

What Does it Mean to “Maintain?”

There are many different ways to measure well how various components of the transportation system are operating; no single performance metric captures all aspects of system conditions and performance. The “Maintain” scenarios presented in this report each point to a level of capital investment that could keep the conditions and performance of the overall system 20 years from now in roughly the same shape that it is in today. The “Maintain” scenarios are defined differently in this report for different system components. This is because of the different characteristics of the highway, bridge, and transit systems; the capability of the different analytical tools to analyze highway, bridge, and transit investment for this report; and the limitations of the underlying data.

The highway investment/performance analyses presented in this report identify the potential impacts of a range of alternative investment levels on varying indicators of system conditions and performance. The primary “Maintain” scenarios for highways focus on maintaining adjusted highway user costs, reflecting the impact that the physical conditions and operational performance of the highway system has on highway users. An alternative “Maintain” scenario for highways identifies levels of investment in pavement improvements that could be adequate to sustain average pavement conditions for various subsets of the highway system at base year levels, and the level of system expansion investment that could be adequate to keep average traveler delay from rising. The “Maintain” scenarios for bridges reflect estimated levels of investment that could be sufficient to keep the backlog of economically justifiable bridge improvements in 20 years at the same size as it is today. The “Maintain” scenarios for transit reflect the estimated level of investment that would be sufficient to accelerate the rehabilitation and replacement of transit assets to achieve the following objectives: (1) to keep the average transit asset condition in 20 years equal to the average transit asset condition in the base year, and (2) to have the average occupancy rate for each mode, as measured by passenger miles per peak vehicle, remain the same in 20 years as in the base year.

In each case, the investment scenarios outlined in this report represent an estimate of what level of performance **could** be achieved with a given level of funding, not what **would** be achieved with it. While the models assume that projects are prioritized based on their benefit-cost ratios, that assumption is not consistent with actual patterns of project selection and funding distribution that occur in the real world. Consequently, the level of investment identified as the amount sufficient to maintain a certain performance level should be viewed as the minimum amount that would be sufficient if all other modeling assumptions prove to be accurate.

While the investment scenarios presented in this report focus on sustaining conditions at base-year levels, the base year is different for each edition of the report; i.e., the prevailing conditions and performance in the 2006 base year analyzed in this report differ from those for the 2004 base year presented in the 2006 edition of the report. Hence, as the level of current system conditions and performance varies over time, the investment scenarios that are based on maintaining the status quo are effectively targeting something different each time. It is important to recognize this when comparing the results of different reports in the series.

It should be noted that some of the investment scenarios in this report have been renamed using the term "sustain" rather than "maintain." This change was made to reduce confusion as all of the scenarios pertain to capital improvements only, and none includes the costs associated with routine maintenance.

What Does it Mean to "Improve?"

In theory, if the estimated investment level associated with a "Maintain" scenario is accurate, and the "correct" projects are chosen, then spending $1 more than that level would result in an improved system. In practice, the "Improve" scenarios in this report have been more aggressive, picking some higher target level of future conditions and performance. Three alternative "Improve" scenarios for highways are presented, which focus on identifying levels of investment at which all potential projects with benefit-cost ratios of 1.5, 1.2, and 1.0, respectively, could be implemented. The scenarios reflecting a minimum benefit-cost ratio of 1.0 can be viewed as an "investment ceiling" above which it would not be cost beneficial to invest, even if unlimited funding were available. The scenarios reflecting higher minimum benefit-cost ratios are included in recognition that available funding is not unlimited, and many decisions on highway funding levels must be weighed against potential cost beneficial investments in other government programs and across various industries within the private sector that would produce more benefits to society.

Due to limitations in data availability and current analytical modeling capabilities, the "Improve" scenarios for bridges and transit are defined differently from those for highways. The "Improve" scenarios for bridges reflect the estimated level of investment that would be sufficient to eliminate the backlog of economically justifiable bridge improvements by the end of 20 years. The "Improve" scenarios for transit reflect the estimated level of investment that would be sufficient to accelerate the rehabilitation and replacement of transit assets to achieve the following objectives: (1) to reach an average condition of "good" for transit assets at the end of the 20-year period, (2) to reduce vehicle occupancy levels in agency-modes with occupancy levels one deviation above the national average to that level, and (3) to increase speeds in urbanized areas with average speeds one deviation below the national average to that level by investing in new rail or bus rapid transit service. Two sets of "Improve" transit scenarios are presented which reflect costs associated with those agency-modes passing an initial benefit-cost ratio screen of 1.0 or 1.2, respectively. [Note the term agency-mode refers to each mode (e.g. passenger rail, motor bus, etc.) within each transit agency.]

It is important to recognize several key limitations of the "Improve" scenarios presented in this report. First, while the models assume that projects are prioritized based on their benefit-cost ratios, that assumption is not consistent with actual patterns of project selection and funding distribution that occur in actual practice. Consequently, if investment rose to the levels identified in the "Improve" scenarios, there are few mechanisms to ensure that these funds would be invested in projects that would be cost beneficial. As a result, the impacts on actual conditions and performance may be far less significant than what is projected for these scenarios. Second, simple benefit-cost analysis is not a commonly utilized capital investment model in the private sector. Instead, firms utilize a rate of return approach focusing on cash revenues and costs and compare various investment options and their corresponding risk. In other words, a project that is barely cost beneficial would almost certainly not be undertaken when compared to an array of investment options that potentially produce higher returns at equivalent or lower risk. Third, these scenarios do not address practical considerations concerning whether the highway and transit construction industries would be capable of absorbing such a large increase in funding within the 20-year analysis period. Such an expansion of infrastructure investment could significantly increase the rate of inflation within these industry sectors, a factor that is not considered in the constant dollar investment analyses presented in this report. Fourth, the legal and political complexities frequently associated with major highway capacity projects might preclude certain improvements from being made, even if they could be justified on benefit-cost criteria. In particular, the time required to move an urban capacity expansion project from "first thought" to actual completion may well exceed the 20-year analysis period.

Highlights: Highways and Bridges

In nominal dollar terms, combined investment by all levels of government in highway and bridge infrastructure has increased sharply since TEA-21 was enacted. Total highway expenditures by Federal, State, and local governments increased by 58.0 percent between 1997 and 2006, to $161.1 billion. Highway capital spending alone rose from $48.4 billion in 1997 to $78.7 billion in 2006, a 62.7 percent increase. However, recent sharp increases in highway construction costs have eroded the purchasing power of this investment; in constant dollar terms, capital spending fell by 4.4 percent over this period. The FHWA Composite Bid Price Index increased by 43.3 percent between 2004 and 2006 due to sharp increases in the prices of materials such as steel, asphalt, and cement.

Because the Federal-aid Highway program is a multiple-year reimbursable program, the impact of increases in obligation levels phases in gradually over a number of years. The portion of total highway capital spending funded by the Federal government rose from 41.6 percent to 44.0 percent between 1997 and 2006. This share dipped below 40 percent in 1998 for the first time since 1959; TEA-21's passage relatively late in fiscal year 1998 reduced its impact on cash expenditures during that initial year, but subsequently this share rebounded up to 46 percent in 2002 before tailing back off more recently to the 44 percent to 45 percent range.

The TEA-21 era and the early portion of the SAFETEA-LU era have also coincided with a shift in the types of capital improvements being made by State and local governments. The portion of capital investment going for "system rehabilitation" (the resurfacing, rehabilitation, or reconstruction of existing highway lanes and bridges) increased from 47.6 percent in 1997 to 51.3 percent in 2006. The percentage of capital spending directed towards "system expansion" (the construction of new highways and bridges and lane additions to existing highways) decreased from 44.4 percent to 38.2 percent over this period, while the portion used for "system enhancement" (including safety enhancements, traffic control facilities, and environmental enhancements) increased from 8.0 percent to 10.5 percent.

Investment in system rehabilitation rose by 0.4 percent in constant dollar terms between 1997 and 2006, despite the overall decline of 4.4 percent for all capital spending over this period noted above. Funding for system enhancement rose by 22.7 percent in constant dollar terms over this period, while investment in system expansion decreased by 14.2 percent in constant dollar terms.

Physical Conditions Have Improved in Some Areas

The increase in system rehabilitation investment since 1997 has had a positive effect on the physical condition of key subsets of the Nation's highway and bridge infrastructure. The National Highway System (NHS) includes those roads that are most important to interstate travel, economic expansion, and national defense. While the NHS makes up only 4.0 percent of total mileage, it carries 44.6 percent of total travel in the United States. The percentage of NHS VMT on pavements with "good" ride quality rose from 39 percent in 1997 to 57 percent in 2006. The share of NHS VMT on roads with "acceptable" ride quality (a lower standard that includes roads classified as "good") has also increased over this period, from 89 percent to 93 percent. The percentage of deck area on NHS bridges classified as deficient declined from 33.0 percent in 1997 to 29.2 percent in 2006. About three-quarters of deficiencies on NHS bridges relate to functional obsolescence rather than to structural issues; some NHS bridges are narrower than current design standards would call for given the traffic volumes they currently carry.

Looking beyond the NHS to all arterials and collectors for which pavement condition data are collected reveals less favorable trends. While the percentage of all VMT on pavements with "good" ride quality rose from 39.4 percent in 1997 to 47.0 percent in 2006, the share of VMT on roads with "acceptable" ride quality fell from 86.4 percent to 86.0 percent. While the percentage of pavements with acceptable ride quality has been growing in rural and small urban areas, urbanized areas have experienced declines.

The raw share (not weighted by deck area) of all bridges classified as deficient dropped from 32.7 percent in 1997 to 27.6 percent in 2006. Most of this decline was the due to reductions in the percent of structurally deficient bridges. Bridge conditions tend to vary by functional system; for example, the percentage of Interstate bridges classified as structurally deficient or functionally obsolete is lower than the comparable percentages for bridges on collectors or local roads.

Operational Performance Has Declined, But Shows Signs of Stabilizing

Despite improving conditions on many roads and bridges, operational performance—the quality of use of that infrastructure—has deteriorated since 1997. This is reflected in measures of congestion in all urbanized areas developed for FHWA by the Texas Transportation Institute (TTI). From 1997 to 2005, the estimated percentage of travel occurring under congested conditions rose from 24.9 percent to 28.7 percent; however, this statistic increased by only 0.1 percentage point between 2004 and 2005. The average length of congested conditions increased from 5.9 hours per day in 1997 to 6.4 hours per day, but has remained constant at that level since 2002. TTI estimates that drivers experienced over 4.2 billion hours of delay and wasted approximately 2.9 billion gallons of fuel in 2005.

Highway Safety Has Improved

Considerable progress has been made in reducing fatality rates and injury rates over time, including the period from 1997 through 2006. The fatality rate per 100 million VMT has declined from 1.64 to 1.41 over that period. The actual number of highway fatalities has remained relatively constant over this period, remaining in a range from 41,500 to 43,500 per year. The injury rate per 100 million VMT declined from 131 in 1997 to 85 in 2006. Preliminary data for 2007 show a decline in both fatalities and injuries.

Highway safety remains a top priority within the DOT, and the improvement of the Nation's roadway infrastructure is an important component of the effort to reduce highway fatalities and injuries.

Future Capital Investment Scenarios

This report includes a series of highway and bridge investment/performance analyses examining 24 alternative levels of future combined public and private capital spending for the period from 2007 through 2026, each of which assumes a uniform annual rate of increase or decrease relative to the $78.7 billion of combined highway capital spending in 2006. These alternatives covered a wide range of possible future spending, extending from a level consistent with a decrease in capital spending in constant dollar terms of 7.64 percent per year (equating to an average annual investment level of $37.9 billion over 20 years) up to a level consistent with an annual constant dollar increase in capital spending of 7.76 percent per year (equating to an average annual investment level of $188.9 billion for the period from 2007 through 2026).

Drawing upon these investment/performance analyses, a series of illustrative scenarios were selected for further exploration and presentation in more detail. For each type of scenario, two versions were developed assuming any increases in investment would be supported by either a fixed rate user financing mechanism (such as tolls, VMT charges, or fuel taxes) or a variable rate user financing mechanism (such as congestion pricing). The scenario criteria were applied separately to the Interstate System, the NHS, and the highway system overall.

The **Sustain Current Spending scenarios** assume that capital spending is maintained in constant dollar terms at base year 2006 levels between 2007 and 2026. The **Sustain Conditions and Performance scenarios** assume that capital investment gradually changes in constant dollar terms over 20 years to the point at which future conditions and performance would be maintained at a level sufficient to keep adjusted average user costs and the economic backlog of potential bridge investments from rising above their 2006 levels, based on projections of future highway use.

Three scenarios are presented that would each improve overall system conditions and performance. The **MinBCR=1.5 scenario** assumes that investment gradually increases in constant dollar terms over 20 years up to the point at which all potential capital improvements with a benefit-cost ratio of 1.5 or higher are funded by 2026, and the economic backlog of potential bridges investment is reduced to zero. The **MinBCR=1.2 scenario** makes the same assumptions, but at a benefit-cost ratio of 1.2 or higher. The **MinBCR=1.0 scenario**, meanwhile, assumes that investment gradually increases over 20 years up to the point at which all potentially cost beneficial investments are funded by 2026; the version of this scenario assuming variable rate user financing (i.e., congestion pricing) is also described as the **Maximum Economic Investment scenario**.

Interstate System Scenarios

All levels of government spent a combined $16.5 billion in 2006 on capital improvements to the Interstate Highway System. Assuming fixed rate user financing, system conditions and performance are projected to decline below base-year levels at this level of investment. Achieving the **Sustain Conditions and Performance scenario** objectives would require an annual spending increase of 3.71 percent in constant dollar terms, translating into an average annual investment level of $25.8 billion over the period from 2007 through 2026, stated in constant 2006 dollars. The average annual investment levels for this period associated with the **MinBCR=1.5**, **MinBCR=1.2**, and **MinBCR=1.0 scenarios** are $39.0 billion, $43.5 billion, and $47.0 billion, respectively, translating into annual constant dollar spending growth rates

Derivation of the Highway Capital Investment Scenarios

The highway capital investment scenarios presented in this report are derived from separate analyses developed using the Highway Economic Requirements System (HERS), the National Bridge Investment Analysis System (NBIAS), combined with estimates for types of highway capital investments that are not presently modeled. Separate versions of each scenario are presented based on alternative assumptions about future financing mechanisms (as the manner in which future investment is financed would have an impact on future VMT), and the scenario criteria are applied separately to the Interstate Highway System, the National Highway System, and all roads combined.

1) The first step in developing the highway capital investment scenarios is determining the portion of current highway capital spending that is equivalent to the investment types that are modeled in HERS, modeled in NBIAS, or not currently modeled. [*See Exhibit 7-1.*]
2) The second step is to specify a series of alternative spending levels for HERS or NBIAS to analyze.
   a) Each alternative is determined by applying a uniform annual rate of growth (or decline) in constant dollar terms relative to actual expenditures in 2006 for the system component being analyzed. [*See Exhibit 7-2.*]
   b) For example, highway capital spending totaled approximately $78.7 billion in 2006. If spending were to grow by 1 percent per year in constant dollar terms, this would translate into annual levels (all stated in constant 2006 dollars) of $79.5 billion in 2007, $80.3 billion in 2008, $81.1billion in 2009, etc., reaching $96.0 billion in 2026, producing a 20-year total of $1.75 trillion, which would translate into an average annual investment level of $87.5 billion in constant 2006 dollars.
   c) Each individual HERS model run tied to a specified alternative spending level produces a series of outputs, including projections of future measures of system conditions and performance such as average pavement condition, average delay, adjusted average user costs, and the economic backlog of bridge investments; HERS also identifies the benefit-cost ratio of the last project implemented (as the model assumes available funding will be directed to projects with the highest values first). NBIAS produces output on the economic bridge investment backlog, representing bridge investments that would be cost-beneficial.
3) The third step is to identify the individual HERS and NBIAS runs that would meet the criteria defined for a specific scenario. This step must be repeated for each financing mechanism (fixed rate user financing or variable rate user financing) and system subset (Interstate, NHS, or all roads) being analyzed.
   a) By definition, the **Sustain Current Spending scenario** assumes no growth in constant dollar spending (i.e., that spending will keep pace with future inflation), and that future investments in the types of improvements modeled in HERS and NBIAS would remain unchanged for the system subset being analyzed.
   b) The HERS component of the **Sustain Conditions and Performance scenario** is defined as the level of investment that results in adjusted average user costs in 2026 matching those in 2006. [*See Exhibits 7-5, 7-15, and 7-18 for information on all roads, the NHS, and the Interstate System, respectively.*] The NBIAS component is defined as the level of investment at which the economic bridge investment backlog in 2026 would match that in 2006. [*See Exhibits 7-21, 7-12, and 7-23.*]
   c) The HERS component of the **MinBCR=1.5 scenario** is defined as the level of investment for which the lowest benefit-cost ratio for any project implemented would be exactly 1.5. The HERS component of the **MinBCR=1.2** and **MinBCR=1.0 scenarios** are defined in the same manner, except that their benefit-cost ratio cutoffs are 1.2 and 1.0, respectively. [*See Exhibit 7-14.*] The NBIAS component of all three of these scenarios is defined as the level of investment that would eliminate the economic bridge investment backlog by 2026. [*See Exhibits 7-21, 7-12, and 7-23.*]
4) The final step is to combine the investment levels identified for the separate HERS and NBIAS analyses meeting the criteria for the scenario; the combined results are then adjusted upwards to account for types of capital investments that are not captured in either model. [*See Exhibits 8-1, 8-6, and 8-11.*]

of 7.61 percent, 8.52 percent, and 9.15 percent. Each of these higher investment levels would achieve progressively larger improvements to Interstate System conditions and performance, but would be subject to diminishing returns, because each would incorporate a progressively larger share of projects with relatively smaller net benefits.

Assuming variable rate user financing, with congestion charges imposed immediately on a widespread basis and with rates set at a level consistent with the cost each driver imposes on other drivers on a congested facility, system conditions and performance would be projected to improve if spending were sustained at $16.5 billion per year in constant dollar terms. The objectives of the **Sustain Conditions and Performance scenario** could be achieved even if annual spending were to decrease by 3.49 percent in constant dollar terms, translating into an average annual investment level of $11.6 billion over the period from 2007 through 2026. The average annual investment levels for this period associated with the **MinBCR=1.5**, **MinBCR=1.2**, and **MinBCR=1.0 scenarios** are $24.0 billion, 27.5 billion, and $30.4 billion, respectively, translating into annual constant dollar spending growth rates of 3.43 percent, 4.64 percent, and 5.49 percent. Each of these investment levels is stated in constant 2006 dollars.

The estimated annual revenue that would be generated by the congestion charges on the Interstate System range from $20.1 billion for the **MinBCR=1.0 scenario** up to $29.9 billion for the **Sustain Conditions and Performance scenario**, stated in constant 2006 dollars. The scenarios with higher overall spending levels would generate less revenue, because the additional capacity expansion investments included in these scenarios would cause the overall level of congestion to be lower, so that drivers have smaller negative impact on each other. For all of these scenarios, the amount of congestion pricing revenue generated would be more than sufficient to cover the additional spending associated with that scenario. While these analyses assumed that such surplus revenues would be rebated to highway users in the form of reductions to existing fixed rate user charges (such as fixed rate tolls or fuel taxes), they could also be used to support increased investment in transit, or for other purposes.

NHS Scenarios

All levels of government spent a combined $37.1 billion in 2006 on capital improvements to the NHS. Assuming fixed rate user financing, system conditions and performance are projected to decline below base-year levels at this level of investment for the period through 2026. Achieving the **Sustain Conditions and Performance scenario** objectives would require an annual spending increase of 0.41 percent in constant dollar terms, translating into an average annual investment level of $38.7 billion over the period from 2007 through 2026, stated in constant 2006 dollars. The average annual investment levels for this period associated with the **MinBCR=1.5**, **MinBCR=1.2**, and **MinBCR=1.0 scenarios** are $60.7 billion, $69.2 billion, and $76.1 billion, respectively, translating into annual constant dollar spending growth rates of 4.49 percent, 5.62 percent, and 6.43 percent. As these growth rates are smaller than those identified for the comparable Interstate scenarios above, this suggests that current spending on the non-Interstate portions of the NHS is addressing a greater share of capital investment needs than is current spending on the Interstate System.

Assuming variable rate user financing (i.e., widespread congestion pricing), system conditions and performance would be projected to improve if spending were sustained at $37.1 billion per year in constant dollar terms. The objectives of the **Sustain Conditions and Performance scenario** could be achieved even if annual spending were to decrease by 6.54 percent in constant dollar terms, translating into an average annual investment level of $19.6 billion over the period from 2007 through 2026. The average annual investment levels for this period associated with the **MinBCR=1.5**, **MinBCR=1.2**, and **MinBCR=1.0 scenarios** are $38.9 billion, $44.9 billion, and $50.1 billion, respectively, translating into annual constant dollar spending growth rates of 0.46 percent, 1.80 percent, and 2.79 percent. Each of these investment levels is stated in constant 2006 dollars.

The estimated annual revenue that would be generated by the congestion tolls on the NHS system range from $30.0 billion for the **MinBCR=1.0 scenario** up to $42.9 billion for the **Sustain Conditions and Performance scenario**, stated in constant 2006 dollars. For all of these scenarios, the amount of congestion pricing revenue generated would be more than sufficient to cover the additional spending associated with that scenario.

Systemwide Scenarios

All levels of government spent a combined $78.7 billion in 2006 on capital improvements to roads and bridges. Assuming fixed rate user financing, system conditions and performance are projected to decline below base year levels at this level of investment for the period through 2026. Achieving the **Sustain Conditions and Performance scenario** objectives would require an annual spending increase of 2.72 percent in constant dollar terms, translating into an average annual investment level of $105.6 billion over the period from 2007 through 2026, stated in constant 2006 dollars. The average annual investment levels for this period associated with the **MinBCR=1.5**, **MinBCR=1.2**, and **MinBCR=1.0 scenarios** are $137.4 billion, $157.1 billion, and $174.6 billion, respectively, translating into annual constant dollar spending growth rates of 5.05 percent, 6.21 percent, and 7.10 percent. As these growth rates are higher than those identified for the comparable NHS scenarios above, this suggests that current spending on the NHS is addressing a greater share of capital investment needs than is current spending off of the NHS.

Assuming variable rate user financing, system conditions and performance would be projected to improve if spending were sustained at $78.7 billion per year in constant dollar terms. The objectives of the **Sustain Conditions and Performance scenario** could be achieved even if spending were to decrease by 0.94 percent per year in constant dollar terms, translating into an average annual investment level of $71.3 billion over the period from 2007 through 2026. The average annual investment levels for this period associated with the **MinBCR=1.5**, **MinBCR=1.2**, and **MinBCR=1.0 scenarios** are $101.8 billion, $117.2 billion, and $131.3 billion, respectively, translating into annual constant dollar spending growth rates of 2.40 percent, 3.65 percent, and 4.66 percent. Each of these investment levels is stated in constant 2006 dollars.

The estimated annual revenue that would be generated by the congestion tolls on the system as a whole range from $38.1 billion for the **MinBCR=1.0 scenario** up to $47.0 billion for the **Sustain Conditions and Performance scenario**, stated in constant 2006 dollars. In this case, the level of revenue generated under the **MinBCR=1.0 scenario** was insufficient to cover the full cost of the scenario, so the analysis assumed an additional fixed rate user charge would be applied to cover the difference.

While the **Sustain Current Spending scenario** and the **Sustain Conditions and Performance scenario** are not defined in terms of specific minimum benefit-cost ratio thresholds, the underlying analyses used to develop these scenarios do indicate the benefit-cost ratio of the last project selected. The fixed rate user financing and variable rate user financing versions of the **Sustain Current Spending scenario** for all roads are associated with benefit-cost ratio cutoffs of 2.89 and 1.90, respectively. The comparable values for the fixed rate user financing and variable rate user financing versions of the **Sustain Conditions and Performance scenario** for all roads are 1.98 and 2.25, respectively.

Supplemental Systemwide Scenarios

Two supplemental scenarios were developed at the systemwide level only. The **Sustain Conditions and Performance of System Components scenario** represents a more aggressive "Maintain" scenario than the **Sustain Conditions and Performance scenario** discussed above. Rather than targeting average conditions and performance on a systemwide basis, the **Sustain Conditions and Performance of System Components scenario** would sustain average pavement condition and traveler delay on each individual highway functional system at 2006 levels where it is cost beneficial to do so.

The **Sustain Conditions and Improve Performance scenario** represents a hybrid between a "Maintain" and an "Improve" scenario, combining system rehabilitation investments from the **Sustain Conditions and Performance of System Components scenario** with system expansion investments from the **MinBCR=1.0 scenario**.

Assuming fixed rate user financing, achieving the goals of the **Sustain Conditions and Performance of System Components scenario** would require an annual spending increase of 3.83 percent in constant dollar terms, translating into an average annual investment level of $119.5 billion over the period from 2007 through 2026. The average annual investment level for this period associated with the **Sustain Conditions and Improve Performance scenario** is $145.3 billion stated in constant 2006 dollars, translating into an annual constant dollar spending growth rate of 5.54 percent.

Assuming variable rate user financing, the objectives of the **Sustain Conditions and Performance of System Components scenario** could be achieved if spending were to increase by 0.55 percent per year in constant dollar terms, translating into an average annual investment level of $83.4 billion over the period from 2007 through 2026. The average annual investment level for this period associated with the **Sustain Conditions and Improve Performance scenario** is $104.9 billion stated in constant 2006 dollars, translating into an annual constant dollar spending growth rate of 2.67 percent.

Highlights: Transit

Record levels of Federal investment in transit under TEA-21 were not only matched, but exceeded by the combined investments of State and local governments from 1997 through 2006. Total funding by Federal, State, and local governments reached its highest level of $30.9 billion in 2006, a 76.9 percent increase in current dollars from $17.5 billion in 1997, equal to a 40.9 percent increase in constant dollar terms (the gross domestic product deflator was used to develop constant dollar estimates). Federal funding in current dollars increased by 70.3 percent, from $4.7 billion in 1997 to $8.1 billion in 2006, equal to a 35.6 percent increase in constant dollar terms. State and local funding in current dollars increased by 79.4 percent, from $12.7 billion in 1997 to $22.8 billion in 2006, equal to a 42.8 percent increase in constant dollar terms Total funding for transit, including system-generated revenues, increased by 66.8 percent, from $26.0 billion in 1997 to $43.4 billion in 2006, an increase of 32.8 percent in constant dollars.

In 2006, total transit agency expenditures for capital investment were $12.8 billion in current dollars, accounting for 29.3 percent of total transit spending. Federal funds provided $5.6 billion of total transit agency capital investments, State funds provided $1.7 billion, and local funds provided $5.5 billion. Capital investment funding for transit from the Federal government increased by 34.2 percent from 1997 to 2006, and capital investment funding for transit from State and local sources increased by 105.7 percent from 1997 to 2006. Between 2004 and 2006, State and local funding for transit capital expenditures declined by 6.5 percent. Federal funding for transit capital investment was $4.1 billion in 1997 and $5.6 billion in 2006.

Transit Infrastructure Has Expanded

The significant growth in total capital investment under TEA-21 is reflected in an expansion of the Nation's transit infrastructure. Between 1997 and 2006, the number of active urban transit vehicles as reported to the National Transit Database increased by 25.3 percent, from 102,258 to 128,132. Track mileage grew by 18.9 percent, from 9,922 miles in 1997 to 11,796 miles in 2006. The number of stations increased by 13.9 percent, from 2,681 in 1997 to 3,053 in 2006; and the number of urban maintenance facilities increased by 11.5 percent, from 729 in 1997 to 813 in 2006.

Transit Use Has Increased

With new and modernized transit vehicles and facilities, passenger use has also increased, particularly transit rail use. Passenger miles traveled (PMT) on transit increased by 23.1 percent, from 40.2 billion in 1997 to 49.5 billion in 2006. PMT on nonrail transit (primarily buses) increased by 18.4 percent, from 19.0 billion in 1997 to 22.5 billion in 2006. PMT on rail increased by 28.0 percent, from 21.1 billion in 1997 to 27.0 billion in 2006. The distance traveled by all transit vehicles in revenue service, adjusted for differences in carrying capacities, increased by 31.8 percent, from 3.5 billion full-capacity bus miles in 1997 to 4.6 billion equivalent miles in 2006.

Physical Conditions for Most Assets Have Improved

The FTA uses a numerical scale ranging from 1 to 5 to describe the condition of transit assets. A rating of 5, or "excellent," indicates that the asset is in nearly new condition or lacks visible defects. At the other end of the scale, a rating of 1 indicates that the asset needs immediate repair and may have one or more seriously damaged components. In between, 2 indicates "poor," a condition rating of 3 indicates "adequate" condition, and a condition rating of 4 indicates the asset is in "good" condition. It is important to note that the numerical scale used by FTA is continuous, meaning that condition ratings may take on any value within the 1 to 5 interval. For the purposes of this report, state of good repair was defined using TERM's numerically based system for evaluating transit asset conditions. Specifically, this report considers an asset to be in a state of good repair when the physical condition of that asset is at or above a specific condition rating value of 2.5 (the mid-point between adequate and marginal). Similarly, an entire transit system would be in a state of good repair if all of its assets have an estimated condition value of 2.5 or higher. The level of investment required to attain and maintain a state of good repair is therefore that amount required to rehabilitate and replace all assets with estimated condition ratings that are less than this minimum condition value.

Bus and rail vehicle conditions have improved since 1997. Bus vehicle condition ratings increased from 2.94 in 1997 to 3.01 in 2006. However, it should be noted that average bus vehicle conditions have declined since 2004, with an average estimated condition of 3.08. Rail vehicle condition ratings increased from 3.42 in 1997 to 3.51 in 2006, representing the highest condition rating over that time period.

Urban bus maintenance facility condition ratings improved slightly from 3.23 in 2000 to 3.26 in 2006. Average condition is not available for 1997. Sixty-four percent of all urban bus maintenance facilities were in adequate (3) or better condition in 2006, compared with 67 percent in 2000 and 77 percent in 1997. Rail facility condition ratings improved from 3.18 in 2000 to 3.68 in 2006. As with buses, average condition is not available for 1997. Approximately 74 percent of rail facilities were estimated to be in adequate or better condition in 2006, compared with 80 percent in 2002 and 77 percent in 1997. (Note that the deterioration schedules used to estimate 1997 facility conditions were revised and that 1997 conditions are not directly comparable to those for 2002 and 2004.)

Between 2004 and 2006, the conditions of track and structures declined, with vehicle storage yards improving slightly. The average condition rating estimates for systems, including traction power, communications, and revenue collection, declined from 2004 to 2006. However, one component of systems, train control, improved slightly during this time period from 3.39 to 3.50. The condition ratings of rail stations increased from 3.37 in 2004 to 3.53 in 2006. The changes in the conditions of nonvehicle assets reflect both actual changes and changes based on new information. The nonvehicle transit asset data used by FTA to estimate conditions are updated for selected operators with each report cycle. Most of this information is not reported to the NTD and must be collected directly from transit agencies.

Comparison: Rail Modernization and the Conditions and Performance Report

In February of 2009, FTA released a Report to Congress on Rail Modernization. The objective of that study was to assess what steps would be needed to overcome capital investment backlogs at the nation's seven largest transit rail operators. Data from those operators that were used for that study are consistent with data used for this report. However, the C&P report also includes data representing the rest of the Nation's transit systems. The two reports vary in terms of scope, scenarios, key assumptions, and types of analyses.

The key distinguishing factor between the reports is the selection of scenarios. For the Rail Modernization analysis, the focus centered upon determining the level of investment required to bring all assets to a **State of Good Repair,** which for the purposes of the report was defined as:

- **State of Good Repair:** A state of good repair was defined using TERM's numerically based condition rating scale of 1 to 5 (poor to excellent) for evaluating transit asset conditions. An asset or a transit system is considered be in a state of good repair if the asset or system has an estimated condition value of 2.5 or higher (the mid-point between adequate (3) and marginal (2)). The level of investment required to attain and maintain a state of good repair is therefore that amount required to rehabilitate and replace all assets with estimated condition ratings that are less than this minimum condition value. The backlog to achieve a state of good repair includes the cost of postponed rehabilitations.

The C&P report traditionally focuses upon four primary investment scenarios, including:

- **Maintain Conditions:** Transit assets are replaced and rehabilitated over the 20-year period such that the average condition of the assets existing at the beginning of the period remains the same at the end of the period.
- **Maintain Performance**: New transit vehicles and infrastructure investments are undertaken to accommodate increases in transit ridership so that the vehicle utilization rate existing at the beginning of the period remains the same at the end of the period.
- **Improve Conditions:** Transit asset rehabilitation and replacement is accelerated to improve the average condition of all transit assets to a "good" level (4) at the end of the 20-year period (2026). However, if an average condition of good can be reached only by replacing assets that are still in operationally acceptable condition, then the "Improve Conditions" scenario instead targets a slightly lower condition level.
- **Improve Performance:** The performance of the Nation's transit system is improved as additional investments in bus rapid transit, light rail, or heavy rail are undertaken in urbanized areas with the most crowded vehicles and the systems with the slowest speeds to reduce vehicle utilization rates (and crowding) and increase average transit operating speeds.

Further, the C&P report scenarios have differing maintain and improve condition rating standards by asset category (guideway, facilities, systems, stations, and vehicles). One limitation of these scenarios is that the concept of backlog is not well defined, and the estimates do not include postponed rehabs.

In addition to the differences in the scenarios, the two studies vary in the base year dollars employed (2008 vs. 2006) and the application of benefit-cost tests. TERM's benefit-cost test was not used for the Rail Modernization study; thus, the cost effectiveness of the investments required to attain a state of good repair was not considered. The Rail Modernization study can be described as an "engineering approach" while the C&P report takes more of an "economic approach." They are equally valid, within the limits of their assumptions. Future C&P reports will include a version of the **State of Good Repair** scenario.

Operational Performance

FTA analyzes speed and vehicle utilization on the basis of the direction of their change only, as the optimal levels are unknown. While transit speed and utilization are frequently inversely related, this relationship may not always hold; it appears to hold most consistently for major rail modes. Vehicle speed on nonrail modes may be affected by road congestion, and capacity utilization may be affected by changes in agency-reported vehicle passenger-carrying capacities.

Vehicle speed is calculated by dividing vehicle revenue miles by vehicle revenue hours and, therefore, takes into account the effects of the number of stops, vehicle dwell times, road congestion, and operational deficiencies on average vehicle speed. In 2006, average vehicle speed was 20.0 miles per hour compared with 20.1 in 2004 and 19.6 miles per hour in 2002. Average nonrail vehicle speed was 14.4 miles per hour in 2006 compared with 14.0 miles per hour in 2004. Average rail vehicle speed in 2006 was 24.8 miles per hour, which was lower than the 25.0 miles per hour observed in 2004.

Vehicle utilization is measured by the ratio of passenger miles traveled to vehicles operated in maximum service, adjusted to take into account differences in vehicle capacity. The utilization of heavy rail, commuter rail, and light rail overall increased from 1997 to 2000 and declined from 2001 to 2003, moving inversely with rail speeds. For 2006, utilization for heavy rail and commuter rail declined while utilization for light rail increased in comparison to 2004 levels.

Vehicle utilization of motor bus was higher in 2006 than in 1997. For all other nonrail modes, including demand response, ferryboat, trolleybus, and vanpool, vehicle utilization has declined since that time.

Potential Transit Capital Investment Impacts

Select Capital Investment Scenarios

The average annual **Maintain Conditions and Performance scenario** for transit asset conditions and operating performance is estimated to be $15.1 billion, compared with the $12.8 billion in actual 2006 capital spending. Asset expansion accounts for 28 percent of these projected funding requirements.

This estimated $15.1 billion investment to maintain transit conditions and performance is based on maintaining transit asset conditions and on expanding service to meet an increase in ridership consistent with metropolitan planning organization (MPO) estimates of 1.5 percent per year.

Urban areas with populations of more than 1 million make up 88.6 percent of transit investment estimates, reflecting the fact that, in 2006, 92 percent of the Nation's passenger miles were in those areas. Under the **Maintain Conditions and Performance scenario**, 68.2 percent of total transit investment in large urban areas, or $8.8 billion annually, is for rail infrastructure.

Fifty-nine percent of the total amount estimated by the **Maintain Conditions and Performance scenario** ($8.9 billion dollars annually) and 60.2 percent of the total amount estimated by the **Improve Conditions and Performance scenario** ($12.7 billion annually) are for rail infrastructure. Under the **Maintain Conditions and Performance scenario,** vehicles account for the highest proportion, approximately 36.3 percent, of projected capital outlays for both rail and nonrail modes. Guideways account for 19.0 percent of rail and nonrail investments. Changes in investment needs by asset type have not changed materially from those reported in the 2006 C&P Report.

The average annual cost to **Improve Conditions and Performance** for both the physical condition of transit assets and transit operational performance to targeted levels by 2026 is estimated to be $21.1 billion in constant 2006 dollars, 64.8 percent higher than transit capital spending of $12.8 billion in 2006. The **Improve Conditions and Performance scenario** is an upper limit of the economically justifiable level of transit investments. The **Improve Conditions and Performance scenario** assumes that all assets are close to good condition (4) by the end of the investment period. Of this $21.1 billion total, $5.9 billion is estimated as a measure to increase passenger speeds and reduce crowding in systems not operating at a condition of good performance threshold levels. Similarly to the **Maintain Conditions and Performance scenario,** vehicles make up the highest proportion of investments, at 35.5 percent across rail and nonrail asset types.

The variable rate user financing scenarios examined in the highway analysis assume a reduction in peak period VMT, a portion of which could be diverted to transit. Continuing with the pricing scenarios presented in the highway sections of this report, as VMT are diverted from highways to transit, expansion investment is required to support the increase in transit ridership while maintaining current performance at today's levels. The analysis assumes that between 25 percent and 50 percent of diverted auto users shift to transit as their preferred modal choice, based on the projected VMT for the highway **Sustain Current Spending** and **Maximum Economic Investment scenarios.** In summary, at a benefit-ratio of greater than or equal to 1.0 in the **Improve Conditions and Performance scenario**, this range increases to $24.6 billion to $28.8 billion per year. In addition to impacting the investment requirements for transit expansion needs, the diversion of highway VMT to transit would reduce the resultant emissions from automobiles for the diverted travelers by nearly 50 percent across all scenarios evaluated.

The projected investment scenarios are sensitive to forecasts of PMT. The investment scenario estimates presented in this report are based on an average annual increase in ridership of 1.5 percent, an average of transit travel forecasts from 92 MPOs. At this level, the annual cost to **Maintain Conditions and Performance** is projected at $15.1 billion, with the projected annual cost to **Improve Conditions and Performance** is $21.1 billion. As the PMT growth rate increases by 50 percent to 2.25 percent, an additional 11.0 percent is required in the **Maintain Conditions and Performance scenario,** with an additional 10.2 percent required for improvement. Similarly, if the PMT growth rate is reduced by 50 percent (to 0.75 percent), the impact is a reduction of 14.6 percent to **Maintain** and 8.0 percent to **Improve Conditions and Performance.**