Chapter 9

Impacts of Investment

Summary

This chapter, which was first introduced in the 1999 Report, serves two major purposes. The first is to discuss the impacts of historic investment, relating the condition and performance trends reported in Chapters 3 and 4 with the financial trends reported in Chapter 6. The second is to discuss the impacts of future investment, exploring the impacts of investing at different levels of funding, building on the analysis in Chapters 7 and 8.

The highway portion of this chapter begins by examining the impacts that recent and historical funding patterns have had on highway conditions and performance. The section then discusses the impacts that different levels of future investment would be expected to have in five areas: pavement condition; operational performance; different types of highway user costs; future highway travel growth; and the bridge preservation backlog. The impacts on condition and performance in particular have been designed to project future values of some of the measures presented in Chapters 3 and 4.

The transit portion points out that transit investment requirements are driven by projected transit demand, but do not, at this time, take into account any additional demand that may be generated by this transit capital investment. The transit section also examines historical trends in condition and performance measures, and the differences between recent transit capital funding levels and estimated rehabilitation and replacement needs.

Impacts of Highway and Bridge Investment

The first part of this section compares recent trends in highway and bridge investments with the changes in conditions and operational performance described in Chapters 3 and 4. This includes an analysis of whether the gap identified in Chapter 8 between current funding and the Cost to Maintain Highways and Bridges is consistent with recent condition and operational performance trends.

The subsequent parts explore some of the impacts that future levels of investment would be expected to have on highway conditions and performance, highway user costs, and future travel growth (derived solely from the Highway Economic Requirements System [HERS]), and the bridge preservation backlog (derived from the National Bridge Investment Analysis System [NBIAS]). Impacts are presented for a variety of future investment levels, including the two key investment scenarios in Chapters 7 and 8 and other levels corresponding to certain condition and performance benchmarks. Total investment at the different levels was derived using the external adjustment procedures described in Chapter 7 for non-modeled capital expenditures. Bridge preservation investments from NBIAS were interpolated from the two NBIAS investment scenarios and current bridge preservation spending levels.

Linkage Between Recent Condition and Performance Trends and Recent Spending Trends

As discussed in Chapter 6, capital spending by all levels of government has increased from 1997 to 2000 by 33.7 percent, from $48.4 billion to $64.6 billion. This equates to a 19.9 percent increase in constant dollar terms, as spending grew much faster than the rate of inflation. Over the same period, the percentage of total capital outlay used for system preservation rose from 47.6 percent in 1997 to 52.0 percent in 2000. The combined result of this increase in total capital investment and the shift in the types of investments being made was a 45.7 percent increase in spending on system preservation, from $23.0 billion to $33.6 billion. As indicated in Chapter 6, the term system preservation is used in this report to describe capital improvement on existing roads and bridges intended to preserve the existing pavement and bridge infrastructure.

The percentage of capital outlay used for system expansion fell from 44.4 percent in 1997 to 40.2 percent in 2000. Spending for system expansion grew more slowly than that for system preservation over this period, rising 20.8 percent from $21.5 billion dollars in 1997 to $25.9 billion in 2000.

Physical Conditions

The improved highway and bridge conditions reported in Chapter 3 reflect the effects of the increased investment in system preservation noted above. The share of miles on the National Highway System with “acceptable” ride quality increased from 89.5 percent to 93.5 percent from 1997 to 2000. Acceptable miles on Interstate highways in urbanized areas rose from 90.0 percent to 93.0 percent, over this period. The percent of urbanized Interstates meeting the stricter criteria for “good” ride quality increased from 39.3 percent to 48.2 percent over this same period. While pavement conditions declined on some of the lower ordered functional systems, the percentage of road miles with good ride quality rose from 43.2 percent to 43.5 percent between 1997 and 2000. The percent of deficient bridges decreased from 1998 to 2000, falling from 29.6 percent to 28.6 percent.

Operational Performance

While investment in system expansion has increased since 1997, it has declined as a share of total capital spending, as noted above. Based on the new performance measures adopted by the Federal Highway Administration (FHWA) and described in Chapter 4, congestion has continued to increase between 1997 and 2000. The Percent of Travel Under Congested Conditions increased from 31.7 percent to 33.1 percent from 1997 to 2000, while the Percent Additional Travel Time increased from 45.0 percent to 51.0 percent. The annual change in Percent Additional Travel Time has remained constant since 1997, increasing at approximately two percentage points per year. The yearly increase for Percent of Travel Under Congested Conditions has remained fairly constant at one-half percentage point per year.

> **Q. Are the recent trends in condition and performance consistent with the gap identified in Chapter 8 between current funding and the Cost to Maintain Highways and Bridges?**
>
> **A.** Yes. The new operational performance measures described in this report show that congestion is getting worse in the Nation's urban areas. Increased investment would be required to maintain the overall conditions and performance of the highway system to a level at which user costs would stop rising in constant dollar terms.
>
> While there has been an increase in the number of miles of acceptable pavement on the National Highway System and the Interstate System, the positive impacts on highway users of improved ride quality on these systems are outweighed by the negative impacts on drivers of increasing congestion.
>
> As indicated in Chapter 8, spending on bridge preservation has exceeded the investment requirements for the bridge component of the Cost to Maintain scenario in recent years. This is consistent with the ongoing reduction in the percentage of deficient bridges.

The Average Annual Hours of Traveler Delay in urbanized areas increased from 28.1 hours to 31.2 hours between 1997 and 2000. However, the rate of change for Annual Hours of Traveler Delay has decreased. Prior to 1997, the increase in the Average Annual Hours of Traveler Delay was over 1 hour per year. This has reduced to a rate of approximately 0.6 hours per year between 1997 and 2000. This decline may be the result of increased investment in system expansion and traffic operational improvements, over this period. However, this level of investment has not stopped the overall growth in congestion.

Impact of Future Investment on Highway Conditions and Performance

The HERS model has recently been modified to provide output measures that are consistent with the condition and performance measures discussed in Chapters 3 and 4. As a result, the model can now forecast future values of these metrics under different funding scenarios.

Impact on Physical Conditions

Exhibit 9-1 shows how future measures of pavement conditions would vary at different investment levels. The second column shows the portion of the total investment at each level that is derived directly from HERS. The third column, Average IRI, is a measure of average pavement conditions (the International Roughness Index [IRI] is discussed in Chapter 3). The other two measures show the percentage of vehicle miles on pavement having an IRI value below 95 and an IRI value below 170. These two IRI values were defined in Chapter 3 as the thresholds for rating pavement ride quality as good and acceptable, respectively.

Exhibit 9-1

Projected Changes in Highway Physical Conditions Compared to 2000 Levels for Different Possible Funding Levels

AVERAGE ANNUAL INVESTMENT (BILLIONS OF 2000 DOLLARS) Total	HERS Derived	PERCENT CHANGE IN AVERAGE IRI	PERCENT OF VMT ON ROADS WITH IRI<95	IRI<170	FUNDING LEVEL DESCRIPTION: Investment Required to...
			43.9%	85.1%	2000 Values
$106.9	$69.1	-13.9%	59.2%	94.0%	Improve Highways and Bridges
$90.5	$58.2	-6.1%	51.6%	89.8%	
$82.6	$52.9	**0.0%**	44.7%	86.5%	**Maintain Average IRI**
$77.1	$49.2	6.1%	39.4%	83.2%	
$75.9	$48.4	7.8%	38.2%	82.6%	Maintain Highways and Bridges
$73.8	$46.8	10.4%	35.9%	80.9%	
$70.6	$44.3	16.5%	31.6%	78.2%	
$68.0	$42.4	20.9%	28.6%	75.9%	
$64.6	$39.8	26.1%	25.6%	73.4%	Maintain Current Spending

Source: Highway Economic Requirements System.

At the funding level estimated in Chapter 7 as the Cost to Improve Highways and Bridges ($106.9 billion annually), the average pavement quality would improve by 14 percent, while the percentage of miles traveled on pavement rated as adequate or better would rise from 85 percent to 94 percent. At the Cost to Maintain level, average IRI would increase by 7.8 percent, and the travel percentage on good pavement would decrease from 44 percent to 38 percent.

Exhibit 9-1 also shows projections of pavement quality at other funding levels, of which two deserve special attention. The HERS model predicts that an average annual overall funding level of $82.6 billion (which includes $52.9 billion in directly modeled expenditures) would be necessary to maintain average IRI. This was the indicator used to define the **Maintain Physical Conditions** benchmark in the 1999 C&P, which in turn was used to define the Cost to Maintain Highways and Bridges in that report. It shows the level of investment such that the average pavement condition at the end of the 20-year analysis period would match that observed in 2000. Under this investment strategy, existing and accruing system deficiencies would be selectively corrected; some highway sections would improve, some would deteriorate. Note that this scenario assumes that investment in system enhancements will continue to occur and that system expansion will continue where economically justified, so it does not represent the absolute minimum amount required to preserve the existing system. At this level of investment, the percentages of travel on good and/or adequate roads would increase slightly.

The **Maintain Current Spending** benchmark noted in Exhibit 9-1 relates directly to highway funding levels, rather than to measures of conditions and performance. At this point, highway spending would be held at 2000 funding levels (in constant dollars), increasing only with inflation. At this level of funding, average IRI would increase by 26 percent, while the percentage of travel on roads with good and adequate pavement would fall to 26 percent and 73 percent, respectively. Note, however, that these values from HERS assume the shift from preservation improvement spending toward capacity improvements that was discussed in Chapter 8.

Q. Would it be necessary to invest the full amount identified in Exhibit 9-1 as the Cost to Maintain Average IRI, in order to maintain average pavement condition?

A. No. The $82.6 billion average annual amount specified includes a mix of improvements designed to attain the highest possible level of benefits, including some improvements that do not address the physical conditions of highways and bridges. If all investment requirements for system expansion and system enhancements were ignored, an average annual investment of $39.7 billion in system preservation would be sufficient to maintain physical conditions. However, if total highway and bridge capital investment were limited to $39.7 billion annually, the analytical procedures used in this report suggest that it would be more cost-beneficial to split this amount among system preservation, system expansion, and system enhancements, rather than use it all for system preservation.

It should also be noted that the level of investment identified by HERS as necessary to maintain IRI is higher than the level needed to maintain user costs (per the HERS scenario used for the Cost to Maintain Highways and Bridges elsewhere in this report). This is the reverse of what was presented in the 1999 C&P. The reason is that, in this case, HERS is identifying more cost-beneficial capacity improvements relative to pavement improvements than previously, resulting in a lower minimum benefit-cost ratio (and thus higher investment total) being necessary to maintain IRI at its current level. This is due both to the recent trends toward improved pavement quality and worsening congestion on highways, and to the addition of other types of delay (most notably incident delay) to the HERS analysis of highway user costs.

Impact on Performance

Exhibit 9-2 shows how several indicators of highway operational performance would be affected at various levels of spending. The first of these is average speed of highway vehicles, a simple measure of average traffic flow, which also corresponds to one of the two transit performance measures used in TERM (See Chapter 7). The table indicates that an average annual investment of $73.8 billion would be sufficient to maintain average highway speeds at their 2000 level of 42.3 miles per hour. This dollar amount is slightly lower than

Exhibit 9-2

Projected Changes in Highway Performance Compared to 2000 Levels for Different Possible Funding Levels

AVERAGE ANNUAL INVESTMENT (BILLIONS OF 2000 DOLLARS) Total	HERS Derived	AVERAGE SPEED (MPH)	PERCENT OF VMT ON ROADS WITH V/SF>.80	V/SF>.95	FUNDING LEVEL DESCRIPTION: Investment Required to...
		42.3	22.2%	12.3%	2000 Values
$106.9	$69.1	44.8	15.4%	6.2%	Improve Highways and Bridges
$90.5	$58.2	44.1	21.2%	10.0%	
$82.6	$52.9	43.4	24.1%	11.7%	
$77.1	$49.2	42.8	25.9%	12.8%	
$75.9	$48.4	42.7	26.2%	13.0%	Maintain Highways and Bridges
$73.8	$46.8	**42.3**	26.7%	13.4%	**Maintain Average Speed**
$70.6	$44.3	41.7	27.2%	14.1%	
$68.0	$42.4	41.1	27.5%	14.4%	
$64.6	$39.8	40.3	27.7%	14.8%	Maintain Current Spending

Source: Highway Economic Requirements System.

the amount identified as the Cost to Maintain Highways and Bridges. At the Cost to Improve level of spending, average speeds would increase to 44.8 miles per hour, whereas they would drop by 2.0 miles per hour if highway expenditures were maintained at their 2000 levels.

The next two indicators show the estimated percentage of vehicle miles traveled (VMT) occurring on roads with peak volume-to-service flow (capacity) ratios above 0.80 and above 0.95. As indicated in Chapter 4, these levels are generally used to describe congested and severely congested operating conditions on highways, respectively. If 2000 highway funding levels were maintained through 2020, the percentage of VMT on congested and severely congested roads to 15.4 percent and 6.2 percent, respectively.

Q. What are the projected values for the new FHWA performance measures in 2020 at different levels of investment?

A. Chapter 4 discussed three new highway performance measures (and their historic and 2000 values) that have been adopted by the FHWA for its strategic and performance planning process. The three measures (defined in Chapter 4) are Percent Additional Travel Time, Annual Delay per Capita, and Percent Congested Travel. The HERS model has recently been modified to calculate current and projected values of congestion measures similar to these. Some preliminary results from this output are shown in Exhibit 9-3.

Exhibit 9-3

Projected Changes in Highway Performance Compared to 2000 Levels for Different Possible Funding Levels

AVERAGE ANNUAL INVESTMENT (BILLIONS OF 2000 DOLLARS) Total	HERS Derived	PERCENT ADDITIONAL TRAVEL TIME	ANNUAL DELAY PER CAPITA	PERCENT CONGESTED TRAVEL	FUNDING LEVEL DESCRIPTION: Investment Required to...
		51	31.2	33.1	2000 Values
$106.9	$69.1	33	26.1	34.3	Improve Highways and Bridges
$90.5	$58.2	37	29.8	35.7	
$82.6	$52.9	40	31.9	36.0	
$77.1	$49.2	42	33.8	36.2	
$75.9	$48.4	42	34.2	36.3	Maintain Highways and Bridges
$73.8	$46.8	43	34.7	36.3	
$70.6	$44.3	45	35.7	36.4	
$68.0	$42.4	44	35.5	36.4	
$64.6	$39.8	45	35.9	36.4	Maintain Current Spending

Source: Highway Economic Requirements System.

Exhibit 9-3 indicates that greater levels of highway capital expenditures will generally result in improvements in the values of the three FHWA performance measures. The projected 2020 value for Annual Delay per Capita is 26.1 hours at the Cost to Improve level and 35.9 hours at the current funding level, compared with a 2000 value of 31.2 hours. However, projections for the Percent Additional Travel Time measure indicate substantial improvements at all levels of investment, whereas the Percent Congested Travel would increase at all levels of investment. Further calibration of the HERS model will be necessary to ensure that the calculation of these measures is consistent with those done for the FHWA performance plan.

At the Cost to Maintain level of investment, the percentage of VMT on congested roads would also increase, to 26.2 percent. In order for capacity improvements to be "implemented" by HERS, the improvement must meet the minimum BCR test. As a result, there may be some road segments in a given time period that meet or exceed the threshold for being considered congested, but which do not merit capacity expansion in HERS.

Impact of Investment on Different Types of Highway User Costs

The HERS model defines benefits as reductions in highway user costs, agency costs, and societal costs. Highway user costs are composed of travel time costs, vehicle operating costs, and crash costs. The HERS-derived portion of the Cost to Maintain Highways and Bridges scenario in Chapter 7 was based on a Maintain User Costs benchmark. The analysis presented there estimates that an average annual investment of $75.9 billion would be required to maintain highway user costs at their baseline 2000 levels.

Exhibit 9-4 describes how travel time costs, vehicle operating costs, and total user costs are influenced by the total amount invested in highways. The overall average crash costs calculated by HERS do not vary significantly at different investment levels.

While an average annual highway investment of $75.9 billion would maintain overall user costs, the effect on individual user cost components would vary. Travel time costs would fall by 1.0 percent, whereas average vehicle operating costs would rise by 1.8 percent. A slightly lower investment of between $70.6 and $73.8 billion would be sufficient to maintain travel time costs. Vehicle operating costs would be maintained or decreased only if average annual investment exceeded $90.6 billion for highways and bridges.

Exhibit 9-4

Projected Changes in Highway User Costs Compared to 2000 Levels for Different Possible Funding Levels

AVERAGE ANNUAL INVESTMENT (BILLIONS OF 2000 DOLLARS)		PERCENT CHANGE IN			
Total	HERS Derived	TOTAL USER COSTS	TRAVEL TIME COSTS	VEHICLE OPERATING COSTS	FUNDING LEVEL DESCRIPTION: Investment Required to...
$106.9	$69.1	-3.6%	-6.3%	-0.7%	Improve Highways and Bridges
$90.5	$57.6	-2.4%	-4.4%	0.4%	
$82.6	$52.2	-1.3%	-2.8%	0.7%	
$77.1	$48.6	-0.3%	-1.4%	1.4%	
$75.9	$48.0	**0.0%**	-1.0%	1.8%	**Maintain User Cost**
$73.8	$46.7	0.5%	-0.2%	2.2%	
$70.6	$44.0	1.6%	1.4%	2.9%	
$68.0	$42.2	2.6%	2.8%	3.2%	
$64.6	$40.6	3.9%	5.0%	3.9%	Maintain Current Spending

Source: Highway Economic Requirements System.

Estimates of total user costs vary at different levels of future investment, rising 3.9 percent at the current spending level and falling 3.6 percent at the maximum economic level of investment. Travel time costs show slightly greater variation, ranging from a 5.0 percent increase at current funding levels to a 6.3 percent decrease at the Cost to Improve level.

The percent change in user costs shown in Exhibit 9-4 is tempered by the operation of the elasticity features in HERS. The model assumes that if user costs are reduced on a section, additional travel will shift to that section. This additional traffic volume tends to offset some of the initial reduction in user costs. Conversely, if user costs increase on a highway segment, drivers will be diverted away to other routes, other modes, or will eliminate some trips entirely. When some vehicles abandon a given highway segment, the remaining drivers benefit in terms of reduced congestion delay, which offsets part of the initial increase in user costs. The impact of different investment levels on highway travel is discussed in the next section.

Q. Do the travel demand elasticity features in HERS differentiate between the components of user costs based on how accurately highway users perceive them?

A. No. The model assumes that comparable reductions or increases in travel time costs, vehicle operating costs, or crash costs would have the same effect on future VMT. The elasticity values in HERS were developed from studies relating actual costs to observed behavior; these studies did not explicitly consider perceived cost.

Highway users can directly observe some types of user costs such as travel time and fuel costs. Other types of user costs, such as crash costs, can only be measured indirectly. In the short run, directly observed costs may have a greater effect on travel choice than costs that are harder to perceive. However, while highway users may not be able to accurately assess the crash risk for a given facility, they can incorporate their general perceptions of the relative safety of a facility into their decision-making process. The model assumes that the highway users perceptions of costs are accurate, in the absence of strong empirical evidence that they are biased.

Impact of Investment Levels on Future Travel Growth

As discussed in Chapter 7, HERS predicts that the level of investment in highways will affect future VMT growth. The travel demand elasticity features in HERS assume that highway users will respond to increases in the cost of traveling a highway facility by shifting to other routes, switching to other modes of transportation, or forgoing some trips entirely. The model also assumes that reducing user costs (see above) on a facility will induce additional traffic on that route that would not otherwise have occurred. Future pavement and widening improvements would tend to reduce highway user costs, and induce additional travel. If a highway section is not improved, highway user costs on that section would tend to rise over time due to pavement deterioration and/or increased congestion, thereby suppressing some travel.

One implication of travel demand elasticity is that each different scenario and benchmark developed using HERS results in a different projection of future VMT. The higher the overall investment level, the higher the projected travel will be. Another implication is that any external projection of future VMT growth will only be valid for a single level of investment in HERS. Thus, the State-supplied 20-year growth forecasts in HPMS would only be valid under a specific set of conditions. HERS assumes the HPMS forecasts represent the level of travel that would occur if a constant level of service were maintained. As indicated in Chapter 7, this implies that travel will occur at this level only if pavement and capacity improvements made on the segment during the next 20 years are sufficient to maintain highway user costs at current levels.

The assumption that the HPMS travel forecasts implicitly represent a constant price is supported by recent research done on behalf of the FHWA, which created a year-by-year forecast for future VMT at the national level based on forecasts of demographic and economic variables. The forecasts made by this model, which does not incorporate any information on future levels of service, imply an average annual VMT growth rate which is very similar to the baseline growth rate implicit in the HPMS data.

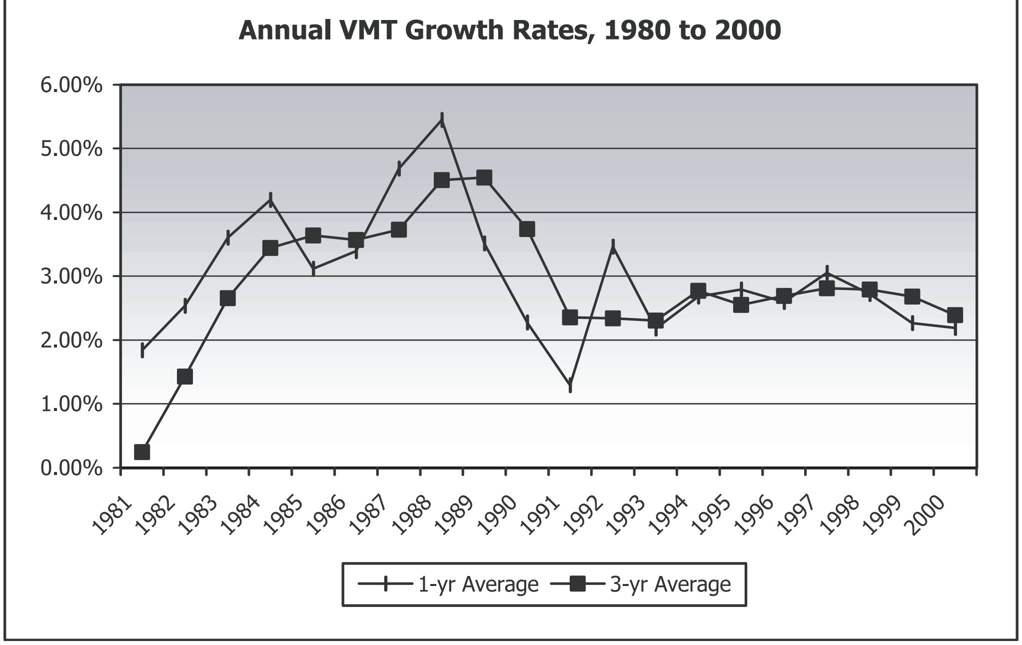
Historic Travel Growth

Exhibit 9-5 shows annual VMT growth rates for the 20-year period from 1980 to 2000. The average annual VMT growth rate over this period was 2.99 percent. Travel growth has varied somewhat in individual years, ranging from 1.29 percent in 1991 to an increase of 5.45 percent in 1988. Highway travel growth is typically lower during periods of slow economic growth and/or higher fuel prices, and higher during periods of economic expansion. VMT growth was below average during the 1981-1982 and 1990-1991 recessions, while annual VMT growth was higher than 3 percent every year from 1983 through 1989. Exhibit 9-2 shows that travel grew more slowly during the economic expansion of the 1990s than in the 1980s, reflecting a long term trend toward lower VMT growth rates.

Q. Does annual highway VMT ever decrease from one year to the next?

A. Yes. In three different years during the energy crises of the 1970's (1974, 1978, and 1979), annual VMT in the U.S. declined by 2.5, 1.0, and 0.1 percent, respectively.

Exhibit 9-5



Projected Average Annual Travel Growth

Exhibit 9-6 shows how the effective VMT growth rates in HERS are influenced by the total amount invested in highways, and the location of highway improvements in urban and rural areas.

Based on the baseline future travel forecasts in HPMS, the weighted average annual growth rate for all sample sections is 2.08 percent. Projected growth in rural areas (2.26 percent average annual) is somewhat larger than in urban areas (1.96 percent).

If average annual highway and bridge capital outlay rose to $75.9 billion in constant 2000 dollars, HERS predicts that overall highway user costs would remain at 2000 levels. The Maintain User Costs scenario derived from HERS attempts to maintain the average user costs for the entire highway system, but user costs can vary on individual functional classes and on individual highway sections. In this particular analysis, however, the resulting average annual VMT growth rates in urban areas and in the Nation as a whole at this level of investment match those derived from the baseline HPMS data. Rural VMT growth rates would be just slightly higher than the baseline.

Implementing all of the cost-beneficial highway investments in the $106.9 billion Cost to Improve scenario would reduce user costs, resulting in higher travel growth rates than currently projected in HPMS, due to the travel demand elasticity features in HERS. Total VMT would grow at an average annual rate of 2.26 percent, while rural and urban VMT would grow at 2.37 and 2.19 percent, respectively. Note, however, that these elevated levels are well below the average annual growth rates experienced over the last 20 years.

In 2000, all levels of government spent $64.6 billion for highway capital outlay, corresponding to the Maintain Current Spending row in Exhibit 9-6. If average annual investment remains at this level in constant dollar terms over the next 20 years, HERS projects that the increase in user costs would limit average annual urban VMT growth to 1.72 percent and average annual rural VMT growth to 2.21 percent, both of which are below the baseline forecasts in HPMS.

As indicated in Chapter 8, average annual capital investment on highways and bridges by all levels of government from 2000-2003 is expected to grow to $67.9 billion in constant 2000 dollars. This amount is approximately equal to the $68.0 billion shown in the next-to-last row in Exhibit 9-6. The table indicates that

Q. What about VMT growth in large urbanized areas?

A. The weighted average annual growth rate for all HPMS sample sections in urbanized areas with population over 1 million is 1.82 percent, which is lower than the rate for urban areas generally. The average annual VMT growth rates forecast by metropolitan planning organizations (MPOs) in large urbanized areas surveyed by the Federal Transit Administration (FTA) imply an average annual growth rate of 1.74 percent, indicating that the MPO forecasts may continue to imply slightly rising highway user costs in those areas.

Exhibit 9-6

Projected Average Annual VMT Growth Rates 2001-2020 for Different Possible Funding Levels

AVERAGE ANNUAL INVESTMENT (BILLIONS OF 2000 DOLLARS)		AVERAGE ANNUAL VMT GROWTH			
Total	HERS Derived	Total	Rural	Urban	FUNDING LEVEL DESCRIPTION: Investment Required to...
		2.08%	2.26%	1.96%	HPMS Baseline
$106.9	$69.1	2.26%	2.37%	2.19%	Improve Highways and Bridges
$90.5	$58.2	2.20%	2.34%	2.10%	
$82.6	$52.9	2.14%	2.31%	2.04%	
$77.1	$49.2	2.10%	2.28%	1.98%	
$75.9	$48.4	2.08%	2.28%	1.96%	Maintain User Cost
$73.8	$46.8	2.06%	2.27%	1.92%	
$70.6	$44.3	2.01%	2.24%	1.85%	
$68.0	$42.4	1.96%	2.23%	1.79%	
$64.6	$39.8	1.91%	2.21%	1.72%	Maintain Current Spending

Source: Highway Economic Requirements System.

if this level of investment were sustained for 20 years, and used in the manner recommended by HERS, the model projects that urban VMT growth would rise at an average annual rate of approximately 1.79 percent, and overall VMT would grow at an average of 1.96 percent.

Overall Projected Travel, Year by Year

The future travel growth projections in HPMS indicate future levels of VMT, but don't provide any information as to how travel will grow year by year within the 20-year forecast period. The 2.08 percent overall average annual projected travel growth derived from HPMS is below the 2000 growth rate of 2.19 percent and well below the 2.99 percent average annual VMT growth rate from 1980 to 2000. Rather than assuming that VMT growth will suddenly drop to 2.08 percent in 1998 and remain constant for the next 20 years, the HERS model assumes that VMT growth rates will gradually decline over the 2000 to 2020 period. As discussed in Chapter 7, the model accomplishes this by assuming that VMT growth will be linear, growing by a constant amount annually rather than at a constant rate. For example, if travel grows at an average annual rate of 2.08 percent, this would result in an increase in travel between 2000 and 2020 of 1.41 trillion vehicle miles. The baseline forecasts used in the HERS model would assume that VMT will increase by 1/20 of this amount, 70.3 billion vehicle miles, during each of the 20 years. As VMT grows each year, the fixed annual increase will represent a smaller percentage of the existing VMT base. This assumption is also consistent with the FHWA's year-by-year national VMT forecasts referred to above.

Exhibit 9-7 shows projected year-by-year VMT derived from HERS for three different funding levels. If average annual investment were to reach the Cost to Improve Highways and Bridges level, VMT would be expected to grow to 4.32 trillion in 2020. If average annual investment remains at 2000 levels in constant dollar terms, VMT would grow to only 4.04 trillion, while VMT growth at the Cost to Maintain level of investment would reach 4.18 trillion. Note that projected travel growth for each of these funding levels is well below the historic growth rate over the last 20 years.

Impact of Investment on the Bridge Preservation Backlog

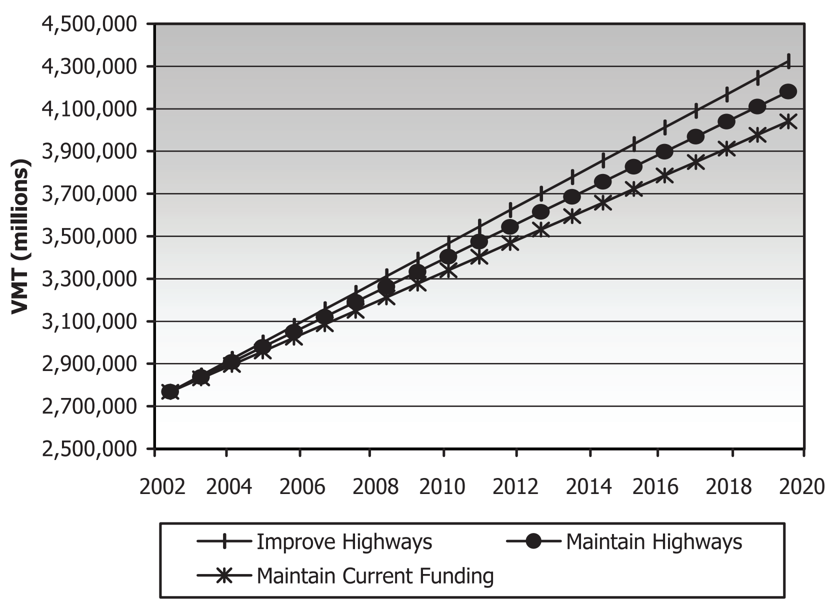
Chapter 7 notes that funding bridge investments at $9.4 billion annually over a 20-year period would eliminate the existing backlog and correct other deficiencies by 2020. This is the Eliminate Deficiencies Scenario. Chapter 7 notes that funding bridge investments at $7.3 billion annually would ensure that the existing bridge investment backlog does not increase above its current level. This is the Maintain Backlog scenario.

Exhibit 9-8 describes projected changes in the bridge backlog for different funding levels. The existing backlog is estimated at $54.7 billion. If investment over the 20-year period were limited to $4.0 billion per year, the backlog would rise to $130.2 billion. If bridge investment were maintained at the 2000 funding level in constant dollars ($7.6 billion), the bridge backlog would be projected to decrease by 13.7 percent, to $47.2 billion.

Exhibit 9-7

Annual Projected Highway VMT at Different Funding Levels (VMT in Millions; Funding in Billions of 2000 Dollars)

FUNDING LEVEL DESCRIPTION	COST TO IMPROVE HIGHWAYS AND BRIDGES	COST TO MAINTAIN HIGHWAYS AND BRIDGES	ACTUAL 2000 CAPITAL OUTLAY
Funding Level ($ Billions)	**$106.9**	**$75.9**	**$64.6**
2000	**2,767,367**	**2,767,367**	**2,767,367**
2001	2,845,161	2,838,006	2,831,033
2002	2,922,956	2,908,646	2,894,700
2003	3,000,750	2,979,285	2,958,366
2004	3,078,544	3,049,925	3,022,033
2005	3,156,338	3,120,564	3,085,699
2006	3,234,133	3,191,203	3,149,365
2007	3,311,927	3,261,843	3,213,032
2008	3,389,721	3,332,482	3,276,698
2009	3,467,516	3,403,122	3,340,365
2010	3,545,310	3,473,761	3,404,031
2011	3,623,104	3,544,400	3,467,698
2012	3,700,899	3,615,040	3,531,364
2013	3,778,693	3,685,679	3,595,030
2014	3,856,487	3,756,319	3,658,697
2015	3,934,281	3,826,958	3,722,363
2016	4,012,076	3,897,597	3,786,030
2017	4,089,870	3,968,237	3,849,696
2018	4,167,664	4,038,876	3,913,362
2019	4,245,459	4,109,516	3,977,029
2020	**4,323,253**	**4,180,155**	**4,040,695**



Source: Highway Economic Requirements System.

Exhibit 9-8

Projected Changes in Bridge Preservation Backlog Compared to 2000 Levels for Different Possible Funding Levels

AVERAGE ANNUAL INVESTMENT (BILLIONS OF 2000 DOLLARS)	BACKLOG	PERCENT CHANGE FROM 2000	FUNDING LEVEL DESCRIPTION: Investment Required to…
$9.4	$0.0	-100.0%	Eliminate Deficiencies
$9.0	$19.5	-64.4%	
$8.0	$41.9	-23.4%	
$7.6	$47.2	**-13.7%**	Maintain Current Spending
$7.3	$54.7	**0.0%**	Maintain Backlog
$7.0	$65.6	20.5%	
$6.0	$80.9	47.9%	
$5.0	$96.5	76.4%	
$4.0	$130.2	138.1%	

Source: National Bridge Investment Analysis System.

Transit Investment Impacts

Transit investment leads to improved transit access, an increase in transit ridership, a reduction in the number of cars on the road, improved air quality, and improved accessibility to jobs and other local resources. For example, transit investment of $10.5 billion in 21 New Starts projects as authorized by TEA-21 for Full Funding Grant Agreements are expected to:

- Add over 550,000 average weekday boardings and carry an additional 162 million riders, of which about 75.5 million would have formerly driven to work.
- Remove 62.5 million cars from the road annually.
- Improve air quality by reducing 60 billion tons of carbon dioxide emissions annually.
- Remove 62,500 million cars from the road and save over 76 million hours of travel-time annually.
- Provide transit access to an additional 920 thousand households, of which 87 thousand are low income.

Transit Investment, Historical Conditions, and Performance Trends

Historically and since 1993 (as shown in Chapter 8, Exhibit 8-12), actual investment in transit capital infrastructure has fallen below estimated investment requirements to Maintain Conditions and Performance and to Improve Conditions and Performance. As a result, asset conditions over the last years have not changed significantly while capacity has increased below the rate of increase in ridership.

Historical Condition Trends

FTA has historical information on average vehicle age, number of overage vehicles and average vehicle condition back to 1987. Historical trends, therefore, are analyzed over this period. As indicated in Chapter 3, Exhibit 3-38, the average condition of bus vehicles has been relatively constant over the last 13 years, with a very slight improvement since 1993, in spite of the spending and requirements gap. The average condition of rail vehicles, on the other hand, appears to be very gradually declining—from 3.91 in 1987 to 3.55 in 2000. [See Chapter 3, Exhibit 3-4]. While the average age of bus vehicles (including vans) has remained relatively constant, the average age of the rail fleet has increased from 15.6 years in 1987 to 20.4 years in 1997 and 21.8 years in 2000. The absolute number of overage vehicles, both bus and rail, has also increased. In 2000, there were about 16,000 overage buses—44 percent more than in 1987—and 6,770 overage rail vehicles—138 percent more than in 1987. Although the condition of the non-vehicle infrastructure appears to be similar to the condition in 1997, as discussed in Chapters 3 and 7, a significant percentage of this infrastructure is in less-than-adequate condition.

Historical Performance Trends

Historical performance trends between 1987 and 2000 are provided in Chapter 4, Exhibits 4-17 and 4-20. The performance of non-rail modes has been relatively constant. The average speed of non-rail vehicles in 2000 was the same as the 14-year average for the years between 1987 and 2000. The bus vehicle utilization rate was relatively low in 2000, compared to the rates that existed over this 14-year period, and in particular when compared with the rates between 1987 and 1991. The utilization rate of demand response vehicles in 2000 was slightly above the 14-year average, but lower than the utilization rates in 1997, 1998 and 1999. There is an indication that the performance of rail transit modes, as evidenced by speed and occupancy rates, may be very slightly declining. In 2000, the average rail speed was 24.9 miles per hour—its lowest rate since 1990 (average rail speeds were slightly lower between 1987 and 1989)—and rail vehicle utilization rates (an indicator of potential crowding) reached new highs in 2000, well above the utilization rates that existed in any of the previous years back to 1987. *[See Chapter 4, Exhibit 4-17 and Exhibit 4-20].*

Historical Transit Investment and Estimated Rehabilitation and Replacement Needs

As discussed in Chapter 8 previous C&P reports have estimated that then-current capital spending levels were well below the amount required to Maintain both Conditions and Performance. *[See Exhibit 8-12].* As shown in Exhibit 9-9, these amounts have been equal to or slightly higher than the pure replacement and rehabilitation levels necessary to Maintain Conditions. Based on theinformation reported to FTA on transit agencies' asset purchases, about half of current capital spending appears to have been allocated to rehabilitation and replacement expenditures. The remainder has gone to asset expansion, also contributing to higher average condition levels through the purchase of new assets.

Maintain Conditions—Past spending levels have resulted in maintained conditions for buses and almost maintained conditions for rail vehicles, even though the absolute number of overage bus and rail vehicles has increased considerably since the late eighties. The investment required to Maintain Conditions will continue to increase in line with increases in the size of the transit infrastructure base.

Maintain Performance—Over the past few years, funding levels have been sufficient to Maintain Performance for bus modes of public transport, but may not have been sufficient for rail modes, as evidenced by a slight decline in the average speed and slight increase in vehicle utilization rates of rail transit services.

Exhibit 9-9

Current Transit Capital Spending Levels vs Rehabilitation and Replacement Needs, 1993-2000

(Billions of Current Dollars)

ANALYSIS YEAR	CURRENT CAPITAL SPENDING	ESTIMATED REPLACEMENT AND REHABILITATION NEEDS
1993	$5.7	$5.1
1995	$7.0	$7.0
1997	$7.6	$7.0
2000	$9.1	$9.2

Sources: National Transit Database and Transit Economic Requirements Model.

Impact of Investment Levels on Future Transit Use (PMT Growth)

Assumed growth in passenger miles traveled (PMT) based on Metropolitan Planning Organization (MPO) forecasts is the primary factor in the estimation of transit investment needs. (See Chapter 10 for an analysis of the effect of variations in PMT growth on transit investment needs.) Estimated capital spending levels are those that would be required to assure that increases in demand, i.e., ridership, are accommodated without degrading overall performance, i.e., service quality. The Transit Economic Requirements Model (TERM) does not yet permit an assessment of how the required investment levels estimated by TERM would affect transit ridership, user costs, and the potential for additional capital investment. The problem is that it is difficult to separate the effect of capital investment from the effect of other variables that impact ridership. This is an area for further FTA research.