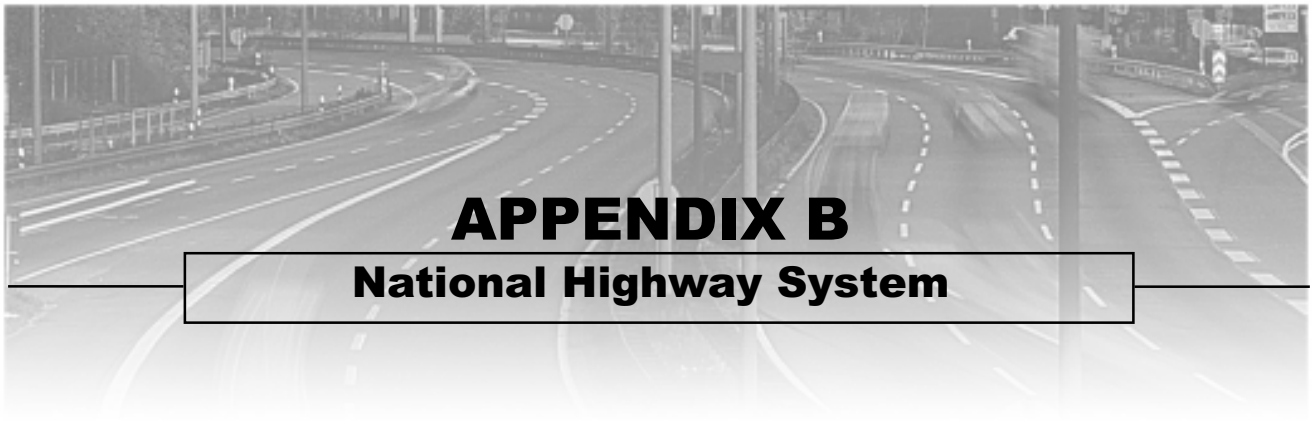


APPENDIX B
National Highway System

Introduction

The National Highway System (NHS) was established by the National Highway System Designation Act of 1995. This system consists of the highways of greatest National interest, including all of the Interstate highways, a large portion of other principal arterial highways, and a small portion of mileage on the other functional systems.

This appendix presents NHS characteristics, conditions, operational performance, finance, and future investment requirement information in a similar format as used to present information on all roads in Chapters 2, 3, 4, 6, 7, 8 and 9. See these chapters for additional background material on the statistics presented in this chapter.

Personal mobility and safety information comparable to that included in Chapters 1 and 5 is not available for the NHS specifically. The type of sensitivity analysis described in Chapter 10 was not performed on the NHS investment requirements separately.

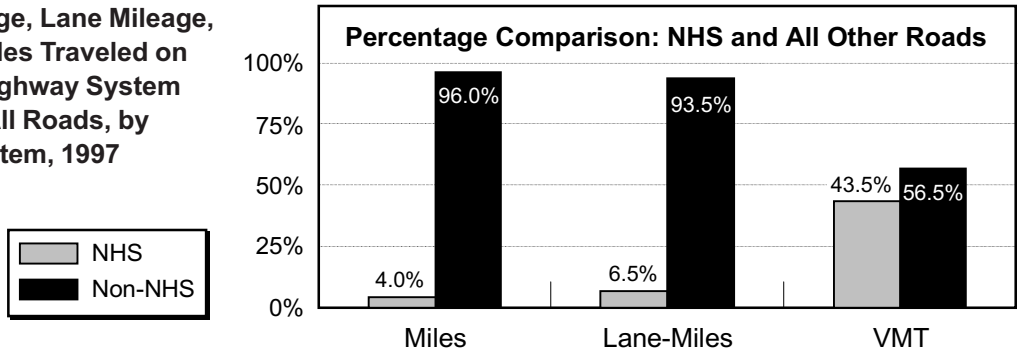
The Federal Highway Administration is currently working on a separate study of the conditions and investment requirements of NHS Freight Connectors. Some preliminary information on the conditions of these vital links is included in Appendix C.

System and Use Characteristics

While only 4.0 percent of total road mileage is on the NHS, these roads carry 43.5 percent of total vehicle miles traveled (VMT). Exhibit B-1 summarizes NHS route miles, lanes miles, and VMT by functional class.

Exhibit B-1

Highway Mileage, Lane Mileage, and Vehicle-Miles Traveled on the National Highway System Compared to All Roads, by Functional System, 1997



	Miles		Lane-Miles		Vehicle-Miles Traveled	
	Total on NHS	Percent of Functional Class	Total on NHS	Percent of Functional Class	Total on NHS (millions)	Percent of Functional Class
Rural NHS						
Interstate	32,919	100.0%	133,573	100.0%	241,451	100.0%
Other Principal Arterial	82,699	84.1%	213,854	85.9%	200,630	87.6%
Minor Arterial	1,703	1.2%	4,084	1.4%	3,494	2.1%
Major Collector	508	0.1%	1,148	0.1%	831	0.4%
Minor Collector	25	0.0%	59	0.0%	26	0.0%
Local	49	0.0%	102	0.0%	46	0.0%
Subtotal Rural NHS	117,903	3.8%	352,820	5.5%	446,478	44.4%
Urban NHS						
Interstate	13,395	100.0%	72,967	100.0%	364,769	100.0%
Other Freeway & Expressway	7,858	86.2%	36,339	87.8%	146,783	91.5%
Other Principal Arterial	18,801	35.2%	68,584	37.2%	152,747	39.4%
Minor Arterial	1,022	1.1%	3,146	1.4%	5,023	1.7%
Collector	243	0.3%	624	0.3%	733	0.6%
Local	119	0.0%	279	0.0%	159	0.1%
Subtotal Urban NHS	41,438	4.9%	181,939	9.6%	670,214	42.9%
Total NHS	159,341	4.0%	534,759	6.5%	1,116,692	43.5%

Source: June 1999 HPMS.

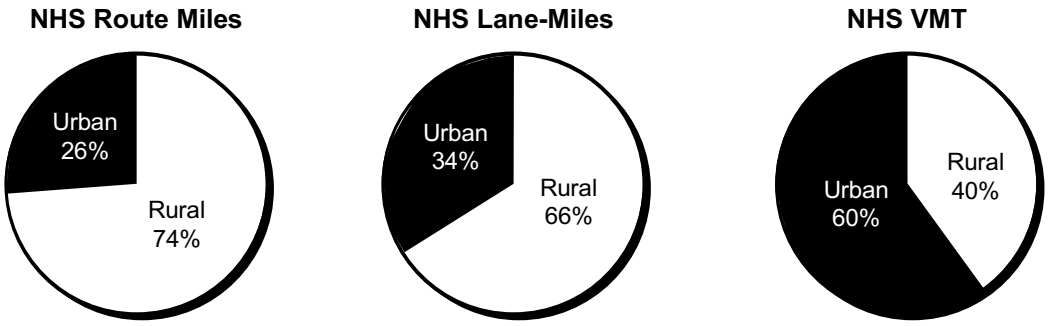
Exhibit B-2 shows how NHS mileage, lane miles, and VMT are split between rural and urban areas. While 74.0 percent of NHS mileage is in rural areas, and 66.0 percent of NHS lane mileage is in rural areas, only 40.0 percent of NHS VMT is in rural areas. Note that all areas over 5,000 in population are considered urban.

System Conditions

The *Federal Highway Administration 1998 National Strategic Plan* introduced a new descriptive term for pavement condition, "acceptable ride quality." The Strategic Plan stated that by 2008, 93 percent of the NHS mileage should meet pavement standards for "acceptable ride quality." In order

Exhibit B-2

Rural and Urban NHS Mileage, Lane Miles, and VMT, 1997



to be rated "acceptable" pavement must have an International Roughness Index (IRI) value less than or equal to 170 inches per mile. As shown in Exhibit B-3, the percentage of NHS miles with acceptable ride quality has increased each year from 1993 to 1995, improving from 88.7 percent to 91.7 percent.

Exhibit B-3

Percentage of NHS Miles with Acceptable Ride Quality, 1993-1997

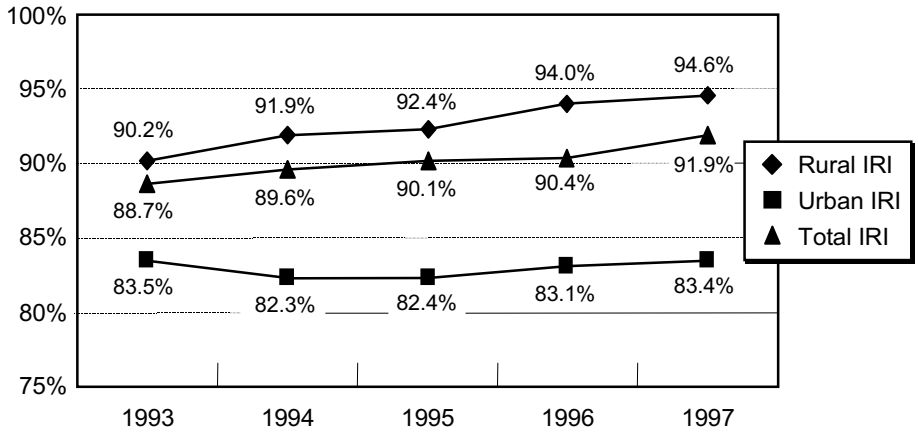


Exhibit B-4 presents information on NHS pavement condition, using the five categories (poor, mediocre, fair, good, very good) discussed in Chapter 3. In that chapter, different standards were applied to Interstate and non-Interstate highways for categorizing pavement, as described in Exhibit 3-3. In Exhibit B-4, the Interstate standards were applied to all NHS sections, regardless of functional class, so that all sections that did not meet the Strategic Plan standard for acceptable ride quality would be classified as "poor." Therefore, some non-Interstate NHS sections that were classified as "fair" in Chapter 3 would be classified as "mediocre" in this Appendix. Also, all non-Interstate NHS sections classified as "mediocre" in Chapter 3 are identified as "poor" in this Appendix.

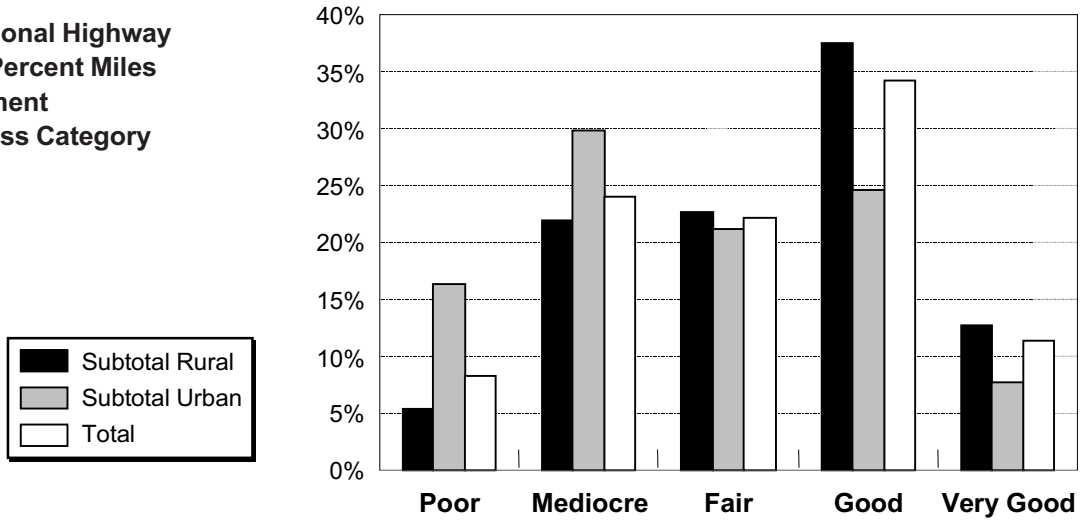
Rural NHS routes tend to have better pavement conditions than urban NHS routes, which is consistent with the results reported for all roads in Chapter 3. The percent of poor pavement for rural NHS routes is 5.3 percent, compared to 16.4 percent in NHS routes in urban areas. The Interstate component of the NHS tends to have better ride quality than the non-Interstate component. Pavement condition on the NHS improved between 1995 and 1997, as described in Exhibit B-5. The percent of pavement in poor, mediocre or fair condition fell from 60.3 percent to 54.4 percent. The percent of pavement in good or very good condition rose from 39.8 percent to 45.7 percent.

Q. How do NHS pavement conditions compare with pavement conditions on other roads?

A. The percent of pavement in "good" or "very good" condition in rural areas on the NHS is 50.1 percent, compared to 43.5 percent for all rural arterials and collectors. The percent of pavement in "good" or "very good" condition in urban areas on the NHS is 32.3 percent, compared to 35.4 percent for all urban arterials and collectors. Since the Interstate standards for categorizing pavement were applied to all NHS sections in this appendix, the percentages for "fair," "mediocre" and "poor" pavement aren't directly comparable to those reported in Chapter 3 for all roads.

Exhibit B-4

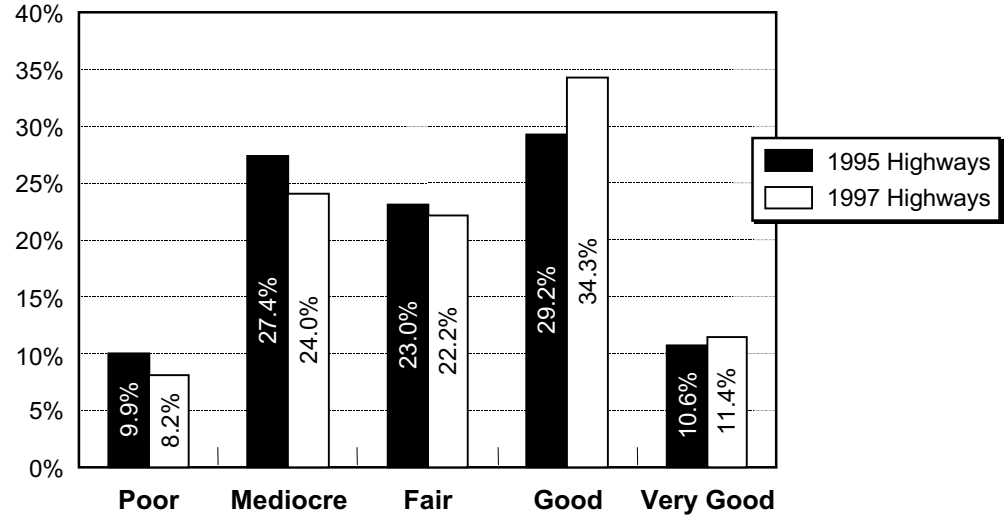
1997 National Highway System Percent Miles by Pavement Roughness Category



	Poor	Mediocre	Fair	Good	Very Good
Rural					
Interstate	3.7%	19.0%	20.2%	40.0%	17.0%
Other Principal Arterials	5.9%	23.0%	23.6%	36.8%	10.7%
Minor Arterials	11.7%	24.7%	15.7%	25.0%	23.0%
Major Collectors	13.2%	23.6%	23.3%	37.9%	2.1%
Minor Collectors	8.3%	50.0%	16.7%	33.3%	0.0%
Local	26.2%	26.2%	19.0%	14.3%	14.3%
Subtotal Rural	**5.3%**	**21.9%**	**22.6%**	**37.5%**	**12.6%**
Urban					
Interstate	9.2%	26.7%	23.6%	31.3%	9.2%
Other Freeways and Expressways	11.3%	34.0%	24.7%	25.6%	4.4%
Other Principal Arterials	23.6%	30.8%	18.1%	19.8%	7.6%
Minor Arterials	22.0%	25.6%	21.5%	18.4%	12.4%
Collectors	29.2%	29.2%	15.5%	14.9%	11.2%
Local	38.7%	14.7%	12.0%	17.3%	0.0%
Subtotal Urban	**16.4%**	**29.9%**	**21.2%**	**24.7%**	**7.6%**
Total	**8.2%**	**24.0%**	**22.2%**	**34.3%**	**11.4%**

Exhibit B-5

Comparison of 1995 and 1997 Pavement Condition on the NHS



Bridge Conditions

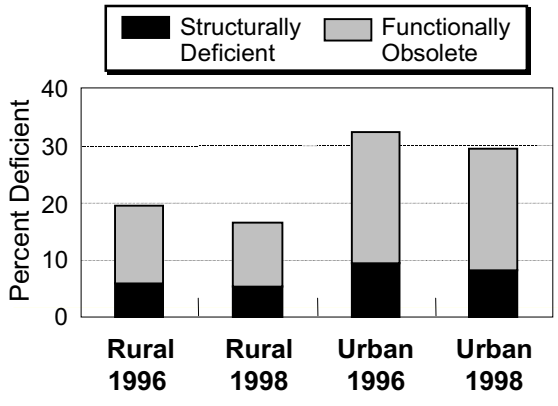
Bridge deficiency data are not yet available for the designated NHS. Exhibit B-6 contains information on bridge deficiencies for the interim NHS (including all Interstate and Other Principal Arterials). From 1996 to 1998 the share of total bridges that were deficient fell from 25.8 percent to 23.1 percent. Structural deficiencies fell from 7.6 percent to 6.9 percent, while functional deficiencies declined from 18.2 percent to 16.2 percent. Deficiencies in both rural and urban areas declined.

Q. **How do bridge conditions on the interim NHS compare with bridge conditions on other roads?**

A. Overall, the percent of deficient bridges is lower on the interim NHS (23.1 percent) than on all bridges in the Nation (29.6 percent). However, the percent of functional deficiencies is higher on the interim NHS (16.2 percent) than on all bridges (13.6 percent). Note that the interim NHS includes all Interstate and Other Principal Arterials.

Exhibit B-6

Interim NHS Bridge Deficiencies



	1996		1998	
	Number	Percent	Number	Percent
Rural Bridges	63,083		62,832	
Deficient Bridges	12,183	19.3%	10,521	16.7%
Structural	3,682	5.8%	3,387	5.4%
Functional	8,501	13.5%	7,134	11.4%
Urban Bridges	64,653		66,164	
Deficient Bridges	20,737	32.1%	19,325	29.2%
Structural	6,008	9.3%	5,509	8.3%
Functional	14,729	22.8%	13,816	20.9%
Total Bridges	127,736		128,996	
Deficient Bridges	32,920	25.8%	29,846	23.1%
Structural	9,690	7.6%	8,896	6.9%
Functional	23,230	18.2%	20,950	16.2%

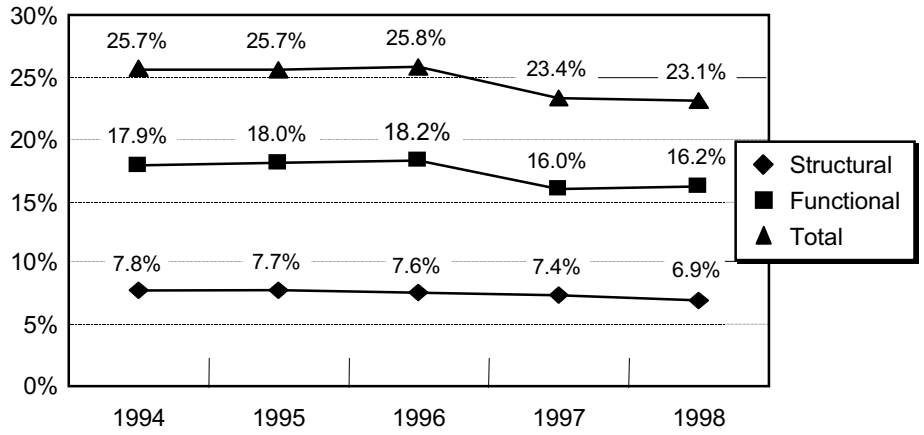
Source: National Bridge Inventory.

The *Federal Highway Administration 1998 National Strategic Plan* established a target to reduce the percentage of NHS bridges that are classified as deficient to 20 percent by 2008. As shown in Exhibit B-7, the percentage of bridge deficiencies on the NHS has declined from 1994 to 1998 from 25.8 percent to 23.1 percent.

Most of the reduction in the percent of bridge deficiencies occurred between 1996 and 1998. While structural deficiencies declined each year from 1994 to 1998, the percent of functionally obsolete bridges rose from 1994 to 1996, before declining in 1997.

Exhibit B-7

NHS Bridges: Percent Deficient, 1994-1998



Operational Performance

Chapter 4 introduced "delay" as a measure of highway operational performance. Delay is a modeled measure calculated as the difference between estimated average travel speed and free flow travel speed. In this report, delay is expressed in terms of vehicle-hours of delay per thousand VMT. Overall delay on the NHS declined from 4.397 to 4.368 hours per thousand VMT between 1995 and 1997.

Q. **How does delay on the NHS compare with delay on all arterials and collectors?**

A. Delay per thousand VMT is lower on the NHS (4.368 hours) than on all arterials and collectors (8.973). Delay is generally lower on the higher-ordered functional systems that make up the bulk on NHS mileage.

Volume/service flow (V/SF) is a measure of the severity of congestion. The V/SF is the ratio between the volume of traffic actually using a highway during the peak hour, and the theoretical capacity of the highway to accommodate traffic. This report has traditionally used a threshold value of 0.80 to describe the onset of congestion. Between 1995 and 1997, the percent of urban peak hour travel on the NHS that occurs in congested conditions rose from 44.9 percent to 45.2 percent.

Q. **How does the percentage of urban peak-hour congestion on the NHS compare to peak-hour congestion on all urban principal arterials?**

A. The percent of peak-hour urban traffic that operates at a V/SF greater than or equal to 0.80 is higher on the NHS (45.2 percent) than on all urban principal arterials combined (40.2 percent). The NHS includes the entire Interstate system, and V/SF ratios on urban Interstates tend to be higher than on other urban principal arterials.

Q. How do the conditions and performance of NHS routes with heavy truck traffic compare to those with fewer trucks?

A. Approximately 20 percent of NHS mileage has truck traffic that exceeds 25 percent of total traffic on these routes. Exhibit B-8 compares the percent of pavement with acceptable ride quality and the percent of congested travel for NHS routes with 25 percent or more trucks with those with lighter truck traffic. As indicated earlier, to meet the FHWA Strategic Plan standard for acceptable ride quality, pavement must have an IRI value of 170 or less. In this exhibit, congested travel includes sections with a V/SF ratio of 0.80 or higher.

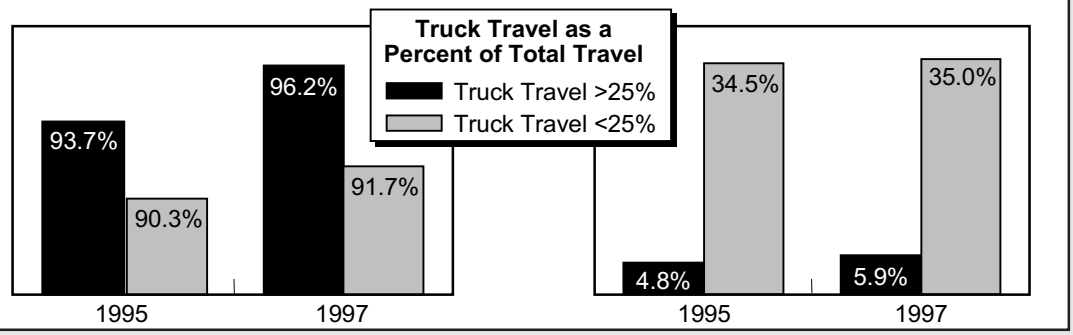
This exhibit shows that on the NHS pavement is in better condition on routes with high truck travel than on those with fewer trucks, and the portion of miles with smooth pavement increased from 1995 to 1997. While heavier vehicles cause more damage to pavement than lighter vehicles, routes most used by trucks are typically those with pavement with a higher strength than average, and that receive more than average attention from the appropriate jurisdictions for rehabilitation and maintenance.

The exhibit also shows that there is less congestion on routes with a high percentage of truck travel, but that the congestion on those routes is increasing. Truck drivers chose routes with less congestion when feasible.

Exhibit B-8

Conditions and Performance of NHS Routes With Heavy Truck Traffic

National Highway System



Finance

In 1997, all levels of government spent $22.5 billion for capital outlay on the NHS. This represents 46.2 percent of the total capital outlay on all roads. An estimated $9.1 billion of Federal grants to States and local governments was used for capital outlay on the NHS in 1997. This is the equivalent of 40.5 percent of the total capital outlay for the NHS.

Q. How reliable is this NHS finance data?

A. The overall NHS expenditure data are derived from annual expenditure reports provided by the States to FHWA. The reported NHS capital outlay figures were reduced for some States because they appeared to be reporting expenditures on the Interim NHS, rather than the smaller officially designated NHS. The $22.5 billion in this report appears consistent with the $20.3 billion shown in the 1997 C&P report.

The 40.5 percent Federal share of NHS funding was derived from an analysis of a new report of Federal obligations on the NHS developed from FHWA's Fiscal Management Information System (FMIS). This value is well below the 61.7 percent Federal share reported in the 1997 C&P report, which was estimated based on functional class data.

The newly developed data suggests that the Federal government is funding a smaller percentage of total capital expenditures on the NHS (40.5 percent) than of capital expenditures off the NHS (41.6 percent). This may be accurate, or there might be problems in the data that are making the Federal share of NHS capital expenditures appear smaller than it really is. If States have been over-reporting total NHS expenditures or if Federal obligations for some projects on the NHS have been coded in FMIS as if they weren't on the NHS, then the Federal share on the NHS identified in this report would be understated.

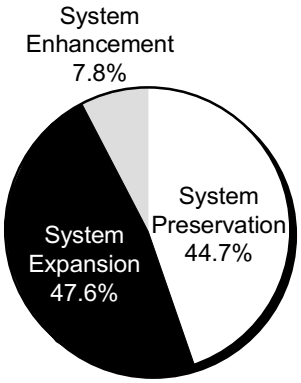
Investment Requirements

Of the $94.0 billion average annual Cost to Improve Highways and Bridges introduced in Chapter 7, $40.9 billion or 43.5 percent is for the NHS. At this level of investment, all cost-beneficial highway improvements would be made, and the backlog of deficient bridges would be eliminated. Exhibit B-9 breaks down these totals into its separate system preservation, system expansion, and system enhancement components for rural and urban NHS routes.

Exhibit B-9

NHS Component of Cost to Improve Highways and Bridges (Billions of 1997 Dollars)

	System Preservation			System Expansion	System Enhance-ments	Total
	Highway	Bridge	Total			
Rural	$5.4	$1.5	$6.8	$6.2	$0.9	$13.9
Urban	$6.4	$5.0	$11.4	$13.3	$2.3	$27.0
Total	**$11.8**	**$6.5**	**$18.2**	**$19.5**	**$3.2**	**$40.9**



Distribution by Improvement Type

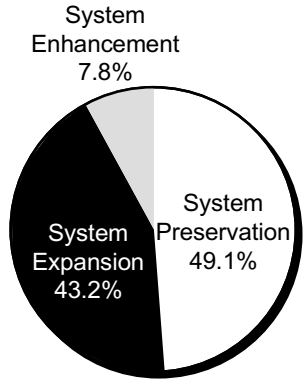
Of the $56.6 billion average annual Cost to Maintain Highways and Bridges discussed in Chapter 7, $26.8 billion or 47.3 percent is for the NHS. At this level of investment, average pavement conditions for highways overall would be maintained at current levels, and the current backlog of deficient bridges would be maintained. The highway and bridge investment scenarios attempt to maintain the overall system rather than individual functional class or the NHS. At the level of investment specified, average IRI on the NHS would improve by 9.8 percent, and average IRI on non-NHS sections would get worse.

Exhibit B-10 breaks down the NHS component of the Cost to Maintain Highways and Bridges into separate system preservation, system expansion, and system enhancement components.

Exhibit B-10

NHS Component of Cost to Maintain Highways and Bridges (Billions of 1997 Dollars)

	System Preservation			System Expansion	System Enhance-ments	Total
	Highway	Bridge	Total			
Rural	$4.2	$0.7	$4.9	$4.1	$0.6	$9.6
Urban	$5.0	$3.3	$8.3	$7.4	$1.5	$17.2
Total	**$9.2**	**$4.0**	**$13.1**	**$11.6**	**$2.1**	**$26.8**



Distribution by Improvement Type

Q. **Is the NHS component of the Cost to Maintain Highways and Bridges different than the results that would be obtained if only NHS sections were analyzed?**

A. Yes. As indicated earlier, investing at the level of the Cost to Maintain Highways and Bridges would maintain IRI for highways overall, but average IRI on the NHS would improve, and average IRI off the NHS would get worse. Using the same analytical approach but considering only NHS sections, the Cost to Maintain NHS Highways and Bridges would be $23.2 billion. This level of investment would be adequate to maintain average IRI on the NHS at current levels, as well as make equally cost-beneficial investments in system expansion and system enhancement.

The NHS component of the Cost to Improve Highways and Bridges would be identical to the results that would be obtained by analyzing NHS sections alone.

Comparison of Spending and Investment Requirements

Investment by all levels of government on the NHS would need to increase approximately $4.3 billion (19.1 percent) above the 1997 level of $22.5 billion to reach the level of NHS component of the Cost to Maintain Highways and Bridges. NHS investment would need to increase approximately 81.8 percent to reach the Cost to Improve Highways and Bridges. As shown in Exhibit B-11, while the relative increase in spending required to close the "gap" between current spending and the Cost to Improve is smaller for the NHS than for other roads, the relative increase in spending required to close the "gap" between spending and the Cost to Maintain is larger for the NHS than for other roads. This difference is somewhat deceptive, because as indicated earlier, the recommended investment pattern for the Cost to Maintain would actually improve IRI on the NHS. Average annual investment on the NHS would only need to increase by 3.1 percent to $23.2 billion in order to maintain average IRI on the NHS at current levels.

Exhibit B-11

Average Annual Investment Required to Maintain and Improve Highways and Bridges Versus 1997 Capital Outlay on and off the NHS

	Cost to Maintain Highways and Bridges			Cost to Improve Highways and Bridges		
	On NHS	Off NHS	Total	On NHS	Off NHS	Total
Average Annual Investment Requirements (Billions of $1997)	$26.8	$29.8	$56.6	$40.9	$53.1	$94.0
1997 Capital Outlay	$22.5	$26.2	$48.7	$22.5	$26.2	$48.7
Percent Difference	19.1%	13.7%	16.2%	81.8%	102.7%	93.0%