Chapter 3

System Conditions

Road Conditions

The condition of roadway pavements can affect the costs associated with both passenger travel and freight transportation. Poor road surfaces cause additional wear and tear on vehicle suspensions, wheels, and tires. When vehicles slow down in heavy traffic for potholes or very rough pavement, this can create significant queuing and subsequent delay. Unexpected changes in surface conditions can also increase the frequency of crashes. Inadequate road surfaces can reduce road friction, which affects the stopping ability and maneuverability of vehicles.

This section examines the physical conditions of the Nation's roadways, addressing both roadway surface conditions and other condition measures. This information is presented for Federal-aid highways only, as pavement data are not collected in the Highway Performance Monitoring System (HPMS) for those roads functionally classified as rural minor collectors, rural local, or urban local. Separate statistics are presented for the National Highway System (NHS).

Subsequent sections within this chapter explore the physical conditions of bridges and transit systems. Operational performance trends are discussed separately in Chapter 4, while Chapter 5 explores various safety performance measures. Other aspects of system performance pertaining to livability and sustainability are discussed in Part III.

Q&A

What are some factors that should be considered in defining a "State of Good Repair" for transportation assets?

There is broad consensus that our Nation's transportation infrastructure falls short of a "State of Good Repair"; there is, however, no nationally accepted definition of exactly how the term should be defined in the context of various types of transportation assets.

The condition of some asset types have traditionally been measured by multiple quantitative indicators, which are often weighted differently in the assessment process of different transportation asset owners. Other kinds of assets have traditionally been measured using a single qualitative rating, but this introduces subjectivity into the assessment process, as different asset owners, or different individual raters, might apply such rating criteria differently. Thus, while a "State of Good Repair" goal is conducive to measurement, identifying investments that provide the greatest utility in meeting this goal would require consideration of a broad range of metrics within the context of sound asset management principles. Investment decisions should take into account the life-cycle costs of potential alternatives, including the capital costs, maintenance costs, and user costs associated with alternative strategies.

In establishing performance targets for individual assets, it is important to consider how different metrics would reasonably be expected to vary over the asset's life cycle in response to an analytically sound pattern of capital and maintenance actions. It is important that target thresholds be set at levels high enough to measure overall progress, but not so high that they might inadvertently produce suboptimal decision making.

Another key consideration in setting performance targets is how particular assets are utilized. The physical condition of a heavily used asset will, by definition, impact more users than that of a lightly used asset. Applying higher performance standards to heavily used assets would help to capture their greater impact on the traveling public. Also, in selecting potential measures to target, it is important to recognize that some aspects of asset condition have more direct impact on system users than others. Ideally, the performance measures selected for a given type of asset would roughly reflect the weighting of agency costs and user costs that would be determined as part of a full life-cycle cost analysis for that type of asset.

Other fundamental questions to be answered are whether a particular asset is still serving the purpose for which it was originally intended, and whether the long-term benefits that it provides exceed the cost of keeping the asset in service. Simply because a previous decision was made to invest in an asset should not automatically mean that the asset should be kept in a "State of Good Repair" in perpetuity, without considering the merits of the alternative possibility of taking the asset out of service.

Pavement Terminology and Measurements

The pavement condition ratings presented in this section are derived from one of two measures: the International Roughness Index (IRI) or the Present Serviceability Rating (PSR). The IRI measures the cumulative deviation from a smooth surface in inches per mile. The PSR is a subjective rating system based on a scale of 0 to 5. The HPMS coding instructions recommend the reporting of IRI data for all facility types, but permit States to instead provide PSR data for roadway sections classified as rural major collectors, urban minor arterials, or urban collectors. The Federal Highway Administration (FHWA) adopted the IRI for the higher functional classifications because it is an objective measurement and is generally accepted worldwide as a pavement roughness measurement. The IRI system results in more consistent data for trend analyses and cross jurisdiction comparisons.

Q&A

What are some measures of pavement condition other than IRI?

Other principal measures of pavement condition or distress such as rutting, cracking, and faulting exist, but are not currently reported in HPMS. However, the HPMS reporting requirements have been modified to collect information on these distresses and other pavement-related data. This additional information should be available in time to be included in the 2012 C&P Report.

In addition to allowing more robust assessments of the current state of the Nation's pavements, these new data will support the use of enhanced pavement deterioration equations in the HERS model, which will provide refined projections of future pavement conditions.

For this report, a conversion table was used to translate PSR values into equivalent IRI values to classify mileage. *Exhibit 3-1* contains a description of qualitative pavement condition terms used in this report and corresponding quantitative PSR and IRI values. The translation between PSR and IRI is not exact; IRI values are based on objective measurements of pavement roughness, while PSR is a subjective evaluation of a broader range of pavement characteristics. The term "good ride quality" applies to pavements with an IRI value of less than 95 inches per mile. The term "acceptable ride quality" applies to pavements with an IRI value of less than or equal to 170 inches per mile, which includes those pavements classified as having good ride quality. It is important to note that the specific IRI values associated with good ride quality and acceptable ride quality were adopted by the FHWA as pavement condition indicators for NHS; while these values are applied to all Federal-aid highways in this report, States and local governments may have different standards of what constitutes "acceptable" pavement conditions, particularly for lower volume roadways that are not part of the NHS.

Exhibit 3-1

Pavement Condition Criteria

	All Functional Classifications	
Ride Quality Terms*	**IRI Rating**	**PSR Rating**
Good	< 95	≥ 3.5
Acceptable	≤ 170	≥ 2.5

** The rating thresholds for "good" and "acceptable" ride quality used in this report were initially determined for use in assessing pavements on the NHS. Some transportation agencies may use less stringent standards for lower functional classification roadways.*

Source: Highway Performance Monitoring System (HPMS).

Implications of Pavement Ride Quality for Highway Users

Among the three major components of highway user costs measured in this report (travel time costs, vehicle operating costs, and crash costs), pavement condition has the most direct impact on vehicle operating costs in the form of increased wear and tear on vehicles and repair costs. Poor pavement can also impact travel time costs to the extent that road conditions force drivers to reduce speed and can have an impact on crash rates. Highway user costs are discussed in more detail in Chapter 7.

Because the terms "good ride quality" and "acceptable ride quality" are defined based on a range of IRI values, the impact that pavements classified in these categories have on highway user costs varies. In general, pavements falling below the acceptable ride quality threshold would tend to have greater impacts on user costs than those classified as having acceptable or good ride quality. However, the relative impacts on user costs of a pavement with an IRI of 169 (acceptable) compared with a pavement with an IRI of 171 (not acceptable) would not be significant. The same would be true for pavements just above or below the good ride quality standard (an IRI of less than or equal to 95).

The impact of pavement ride quality on user costs will tend to be higher on the higher functional classification roadways such as Interstate System highways than on the roadways with lower functional classifications such as connectors. Vehicle speed can significantly influence the impact that poor ride quality has on highway user costs. For example, a vehicle encountering a pothole at 55 miles per hour on an Interstate highway would experience relatively more wear and tear than a vehicle encountering an identical pothole on a collector at 25 miles per hour.

Poor ride quality would also tend to have a greater impact on Interstate highways due to their higher traffic volumes. The Interstate System supports the movement of passenger vehicles and trucks at relatively high speeds across the Nation. Poor ride quality can cause drivers to travel at a lower speed than the facility is otherwise capable of supporting, thereby increasing the time of individual trips and adding to congestion. In the case of freight movement, this reduction in travel speed would add to the cost of the delivery of goods. Conversely, because traffic volumes and average speeds on collectors are lower to begin with, poor ride quality on such facilities would not have as great an impact on vehicle speeds as comparable conditions would on higher functional classification roadways.

Q&A

What goals were established by the Department of Transportation for pavement ride quality?

The Department of Transportation's *FY 2009 Performance and Accountability Report* presented an FY 2009 target of 57 percent for the share of travel on the NHS on pavements with good ride quality.

Pavement Ride Quality on the National Highway System

As shown in *Exhibit 3-2,* the share of VMT on NHS pavements with acceptable ride quality has changed very little from approximately 91 percent in 2000 to approximately 92 percent in 2008. However, the share of VMT on NHS pavements meeting the more rigorous standard of good ride quality has risen sharply over time, from approximately 48 percent in 2000 to approximately 57 percent in 2008. As noted above, the percentage of pavements with good ride quality is a subset of the percentage of pavements with acceptable ride quality.

As shown in *Exhibit 3-3*, rural NHS routes tend to have better pavement conditions than urban NHS routes. The share of rural VMT on NHS pavements providing good ride quality increased from 63.6 percent in 2000 to 74.5 percent in 2008. The share of NHS VMT on pavements with good ride quality in urban areas increased from 37.9 percent in 2000 to 47.9 percent in 2008.

Exhibit 3-2

Percent of NHS VMT on Pavements With Good and Acceptable Ride Quality, 2000–2008

Calendar Year	2000	2002	2004	2006	2008
Fiscal Year *	2001	2003	2005	2007	2009
Good (IRI < 95)	48%	50%	52%	57%	57%
Acceptable (IRI ≤ 170)	91%	91%	91%	93%	92%

**The pavement data in this section reflect conditions as of December 31 of each year, as reported in HPMS. In this report, these values are presented on a calendar year basis, consistent with the annual* Highway Statistics *publication. Some other Departmental documents, such as the* FY 2009 Performance and Accountability Report*, are based on a Federal fiscal year basis; values as of December 31 in one calendar year fall into the next fiscal year. For example, the 57 percent figure identified as "good" for calendar year 2008 in this exhibit, is reported as a fiscal year 2009 value in the* FY 2009 Performance and Accountability Report*.*

Source: Highway Performance Monitoring System as of November 2009.

Exhibit 3-3

Percent of VMT on NHS Pavements With Good and Acceptable Ride Quality in Rural and Urban Areas, 2000–2008

	2000	2002	2004	2006	2008
Rural					
Good (IRI < 95)	63.6%	66.6%	68.0%	73.6%	74.5%
Acceptable (IRI ≤ 170)	96.8%	96.9%	97.0%	97.8%	97.5%
Urban					
Good (IRI < 95)	37.9%	38.6%	42.5%	47.7%	47.9%
Acceptable (IRI ≤ 170)	87.0%	86.1%	86.9%	90.0%	89.0%

Source: Highway Performance Monitoring System as of November 2009.

The portion of VMT on rural pavements meeting the standard of acceptable ride quality increased slightly from 96.8 percent in 2000 to 97.5 percent in 2008. The share of urban NHS VMT on acceptable pavements rose from 87.0 percent in 2000 to 89.0 percent in 2008.

Pavement Ride Quality on Federal-Aid Highways

The HPMS collects ride quality data only for Federal-aid highways, which include all functional classes except for rural minor collectors, rural local, and urban local. As described in Chapter 2, these three functional classifications account for approximately three-fourths of the total mileage on the Nation's system, but carry less than one-sixth of the total daily VMT on the Nation's roadway system. Because the focus of this report is on VMT-based measures of ride quality rather than mileage-based measures, the omission of these functional classes from the statistics in this section is less significant.

As shown in *Exhibit 3-4*, for those functional classes on which data are collected, the VMT on pavements with good ride quality increased from 42.8 percent in 2000 to 46.4 percent in 2008. The VMT on pavements meeting the standard of acceptable (which includes the category of good) remained about the same at 85.5 percent in 2000 and 85.4 percent in 2008.

As noted in Chapter 2, rural areas contain about three-fourths of road miles, but support only about one-third of annual national VMT. Consequently, pavement conditions in urban areas have a greater impact on the VMT-weighted measure shown in *Exhibit 3-4* than do pavement conditions in rural areas. Pavement conditions are generally better in rural areas. For those functional systems for which data are available, the share of rural VMT on pavements with good ride quality rose from 55.2 percent in 2000 to 62.5 percent in 2008, while the portion of urban VMT on pavements with good ride quality increased from 35.0 percent to 38.9 percent in 2008. The share of VMT on pavements with acceptable ride quality rose slightly from 2000 to 2008 in both rural and urban areas.

Pavement Ride Quality by Functional Classification

While the percentage of both rural and urban VMT on pavements with good ride quality rose from 2000 to 2008, this improvement was concentrated among the higher-order functional systems. *Exhibit 3-4* shows that the share of VMT on pavements with good ride quality declined over this period for rural major collectors, urban minor arterials, and urban collectors. The largest decline occurred on urban collectors, as the portion of VMT on pavements with good ride quality dropped from 37.9 percent in 2000 to 31.5 percent in 2008.

The percentage of VMT on pavements with acceptable ride quality fell slightly from 2000 to 2008, driven by reductions in the percentages for the rural portion of the Interstate System, urban minor arterials, and urban collectors. The share of VMT on pavements with acceptable ride quality rose for each of the other functional systems included in *Exhibit 3-4*. The portion of urban collector VMT on pavements with acceptable ride quality dropped from 76.1 percent to 72.0 percent over this 8-year period, the largest decline among any functional system.

Exhibit 3-4

Percent of VMT on Pavements With Good and Acceptable Ride Quality, by Functional System, 2000–2008

	2000	2002	2004	2006	2008
Functional System			**Percent Good**		
Rural Interstate	69.6%	72.2%	73.7%	78.6%	79.0%
Rural Principal Arterial	56.8%	60.2%	61.0%	66.8%	68.4%
Rural Minor Arterial	48.9%	51.0%	51.5%	56.3%	56.2%
Rural Major Collector	39.9%	42.4%	40.3%	39.8%	39.0%
Subtotal Rural	**55.2%**	**58.0%**	**58.3%**	**62.2%**	**62.5%**
Urban Interstate	43.6%	45.0%	49.4%	54.0%	55.7%
Urban Other Freeway & Expressway	32.4%	33.6%	38.8%	45.3%	44.4%
Urban Other Principal Arterial	26.9%	25.7%	26.5%	28.8%	26.9%
Urban Minor Arterial	34.4%	34.1%	32.3%	33.6%	32.5%
Urban Collector	37.9%	35.5%	35.7%	34.1%	31.5%
Subtotal Urban	**35.0%**	**34.9%**	**36.6%**	**39.5%**	**38.9%**
Total Good *	**42.8%**	**43.8%**	**44.2%**	**47.0%**	**46.4%**
Functional System			**Percent Acceptable**		
Rural Interstate	97.4%	97.3%	97.8%	98.2%	97.3%
Rural Principal Arterial	96.0%	96.2%	96.1%	97.0%	97.6%
Rural Minor Arterial	93.1%	93.8%	94.3%	95.1%	94.5%
Rural Major Collector	86.9%	87.6%	88.5%	87.8%	88.3%
Subtotal Rural	**93.8%**	**94.1%**	**94.5%**	**94.9%**	**94.8%**
Urban Interstate	91.2%	89.6%	90.3%	92.7%	91.9%
Urban Other Freeway & Expressway	87.2%	87.8%	87.7%	92.1%	91.4%
Urban Other Principal Arterial	71.0%	71.0%	72.6%	73.8%	72.4%
Urban Minor Arterial	76.5%	76.3%	73.8%	75.6%	75.5%
Urban Collector	76.1%	74.6%	72.6%	72.6%	72.0%
Subtotal Urban	**80.3%**	**79.8%**	**79.7%**	**81.7%**	**85.4%**
Total Acceptable *	**85.5%**	**85.3%**	**84.9%**	**86.0%**	**85.4%**

** Totals shown reflect Federal-aid highways only and exclude roads classified as rural minor collector, rural local, or urban local, for which pavement data are not reported in HPMS.*

Source: Highway Performance Monitoring System as of December 2009.

Interstate Pavement Ride Quality

Among all of the functional systems identified in *Exhibit 3-4*, the rural portion of the Interstate System had the highest percentage of VMT on pavements with good ride quality in 2008, at 79.0 percent. The share of urban Interstate System VMT on pavements with good ride quality from 2000 to 2008 rose from 43.6 percent to 55.7 percent, which represented the largest increase among the functional systems for which data are available.

A total of 97.3 percent of all VMT on the rural portion of the Interstate System occurred on pavements with acceptable ride quality. On the urban portion of the Interstate System, the share of urban Interstate System VMT occurring on pavements with good and acceptable ride quality in 2008 was 55.7 percent and 91.9 percent, respectively.

Pavement Ride Quality by Mileage

Exhibit 3-5 shows the pavement ride quality by functional classification from 2000 to 2008 based on mileage, rather than on VMT. On a mileage basis, the percentage of pavements with both good and acceptable ride quality declined from 2000 to 2008. Consistent with the VMT-weighted figures presented earlier, the share of pavements with good ride quality declined for rural major collectors, urban minor arterials, and urban collectors. However, since these functional systems constitute a greater share of total mileage than total travel, these declines had a relatively larger impact on the totals presented in *Exhibit 3-5* than on those presented in *Exhibit 3-4*.

Exhibit 3-5

Percent of Mileage With Acceptable and Good Ride Quality, by Functional System, 2000–2008

	2000	2002	2004	2006	2008
Functional System			**Percent Good**		
Rural Interstate	68.5%	71.9%	72.9%	77.2%	78.2%
Rural Principal Arterial	57.4%	60.9%	60.1%	65.3%	66.5%
Rural Minor Arterial	47.7%	50.2%	47.6%	53.3%	53.3%
Rural Major Collector	36.2%	43.1%	36.3%	35.1%	34.0%
Subtotal Rural	**46.5%**	**50.9%**	**47.0%**	**45.4%**	**44.9%**
Urban Interstate	50.0%	50.9%	55.0%	59.3%	61.4%
Urban Other Freeway & Expressway	38.7%	40.9%	44.6%	50.2%	50.6%
Urban Other Principal Arterial	26.9%	25.7%	26.2%	29.7%	27.4%
Urban Minor Arterial	37.7%	38.8%	35.7%	33.0%	32.1%
Urban Collector	31.0%	33.4%	31.2%	30.1%	28.3%
Subtotal Urban	**33.6%**	**34.3%**	**33.6%**	**33.3%**	**32.0%**
Total Good *	**43.2%**	**46.6%**	**43.1%**	**41.5%**	**40.7%**
Functional System			**Percent Acceptable**		
Rural Interstate	97.8%	97.8%	98.0%	98.0%	98.0%
Rural Principal Arterial	96.0%	96.6%	95.8%	96.7%	97.1%
Rural Minor Arterial	92.0%	93.8%	93.9%	94.0%	94.1%
Rural Major Collector	82.1%	85.9%	85.8%	84.5%	85.1%
Subtotal Rural	**89.0%**	**91.0%**	**90.9%**	**89.0%**	**89.4%**
Urban Interstate	93.4%	92.2%	92.6%	94.5%	94.4%
Urban Other Freeway & Expressway	89.0%	89.5%	90.2%	93.2%	93.3%
Urban Other Principal Arterial	71.3%	71.1%	72.7%	74.4%	73.1%
Urban Minor Arterial	78.7%	77.3%	76.0%	75.0%	74.7%
Urban Collector	75.3%	75.9%	73.5%	67.9%	68.0%
Subtotal Urban	**77.3%**	**76.9%**	**76.5%**	**74.0%**	**73.6%**
Total Acceptable *	**86.0%**	**87.4%**	**86.6%**	**84.2%**	**84.2%**

** Totals shown reflect Federal-aid highways only and exclude roads classified as rural minor collector, rural local, or urban local, for which pavement data are not reported in HPMS.*

Source: Highway Performance Monitoring System as of December 2009.

Lane Width

Lane width affects capacity and safety; narrow lanes have a lower capacity and can affect the frequency of crashes. As with roadway alignment, lane width is more crucial on those functional classifications with higher travel volumes.

Currently, higher functional systems such as the Interstate System are expected to have 12-foot lanes. Approximately 98.8 percent of all Interstate System highways had lane widths of 12 feet or greater in 2008. As shown in *Exhibit 3-6,* approximately 99.0 percent of rural Interstate System miles and 98.4 percent of urban Interstate System miles have minimum 12-foot lane widths.

Exhibit 3-6

Lane Width by Functional Class, 2008

	≥ 12 foot	11 foot	10 foot	9 foot	< 9 foot
Rural					
Interstate	99.0%	1.0%	0.0%	0.0%	0.0%
Other Principal Arterial	89.9%	8.4%	1.4%	0.2%	0.1%
Minor Arterial	70.9%	18.9%	9.2%	0.8%	0.1%
Major Collector	39.8%	26.7%	25.4%	6.2%	1.8%
Urban					
Interstate	98.4%	1.4%	0.1%	0.1%	0.0%
Other Freeway & Expressway	94.3%	5.1%	0.6%	0.0%	0.0%
Other Principal Arterial	82.0%	12.7%	4.8%	0.3%	0.3%
Minor Arterial	66.5%	18.8%	12.3%	1.7%	0.6%
Collector	52.5%	19.3%	20.4%	5.9%	1.9%

Source: Highway Performance Monitoring System as of December 2009.

A slight majority (52.5 percent) of urban collectors have lane widths of 12 feet or greater, but approximately one-fifth have 11-foot lanes, and about one-fifth have 10-foot lanes. Among rural major collectors, 39.8 percent have lane widths of 12 feet or greater, but approximately one-fourth have 11-foot lanes and one-fourth have 10-foot lanes. Roughly one in every 13 miles on rural major collectors has lane widths of 9 feet or less.

Roadway Alignment

The term "Roadway Alignment" refers to the curvature and grade of a roadway; i.e., the extent to which it swings from side to side, and points up or down. The term "Horizontal Alignment" relates to curvature, while the term "Vertical Alignment" relates to gradient. Alignment adequacy affects the level of service and safety of the highway system. Inadequate alignment may result in speed reductions and impaired sight distance. In particular, trucks are affected by inadequate vertical alignment with regard to speed. Alignment adequacy is evaluated on a scale from Code 1 (best) to Code 4 (worst).

Alignment adequacy is more important on roads with higher travel speeds and/or higher volumes (e.g., the Interstate System). Alignment is generally not a major issue in urban areas; therefore, only rural alignment statistics are presented in this section. The amount of change in roadway alignment over time is gradual and occurs only during major reconstruction of existing roadways. New roadways are constructed to meet current vertical and horizontal alignment criteria and therefore do not generally have alignment problems, except under very extreme conditions.

As shown in *Exhibit 3-7,* approximately 95.6 percent of rural Interstate System miles are classified as Code 1 for horizontal alignment and 92.7 percent as Code 1 for vertical alignment. In contrast, the percentage of rural minor arterial miles classified as Code 1 for horizontal and vertical alignment, respectively, are only 72.8 percent and 55.1 percent.

Exhibit 3-7

Rural Alignment by Functional Class, 2008

	Code 1	Code 2	Code 3	Code 4
Horizontal				
Interstate	95.6%	0.4%	1.2%	2.8%
Other Principal Arterial	77.9%	8.5%	5.0%	8.6%
Minor Arterial	72.8%	6.3%	7.5%	13.5%
Major Collector	88.0%	0.9%	0.9%	10.3%
Vertical				
Interstate	92.7%	6.0%	0.8%	0.5%
Other Principal Arterial	67.4%	21.3%	6.2%	5.1%
Minor Arterial	55.1%	23.6%	13.2%	8.1%
Major Collector	63.6%	21.1%	9.9%	5.4%

Code 1 All curves and grades meet appropriate design standards.

Code 2 Some curves or grades are below design standards for new construction, but curves can be negotiated safely at prevailing speed limits. Truck speed is not substantially affected.

Code 3 Infrequent curves or grades occur that impair sight distance or severely affect truck speeds. May have reduced speed limits.

Code 4 Frequent grades occur that impair sight distance or severely affect truck speeds. Generally, curves are unsafe or uncomfortable at prevailing speed limit, or the speed limit is severely restricted due to the design speed limits of the curves.

Source: Highway Performance Monitoring System as of December 2009.

Bridge System Conditions

The data used to evaluate the condition of the Nation's bridges is drawn from the National Bridge Inventory (NBI) and reflects information gathered by the States during their periodic safety inspection of bridges. Bridge inspectors are trained to inspect bridges based on, as a minimum, the criteria in the National Bridge Inspection Standards (NBIS). Regular inspections are required for all 603,310 bridges with spans of more than 20 feet (6.1 meters) located on public roads.

Some of the statistics presented in this section are based on actual bridge counts, while others are weighted by bridge deck area (taking bridge size into account) or by average daily traffic (ADT). ADT represents the number of vehicles crossing a structure on a typical day, but does not reflect the length of the structure crossed. In contrast, the VMT-weighted figures for pavements presented in the previous section take into account both the number of vehicles and the distance they travel.

Q&A

How often are the bridges inspected?

Most bridges in the NBI are inspected once every 24 months. Structures with advanced deterioration or other conditions warranting close monitoring may be inspected more frequently. Certain types of structures in satisfactory or better condition as well as other factors, including but not limited to structure type and description, structure age, and structure load rating, may receive an exemption from the 24-month inspection cycle. With FHWA approval, these structures may be inspected at intervals that do not exceed 48 months. A discussion of the criteria can be found in Technical Advisory 5140.21, subparagraph 7 of *Varying the Frequency of Routine Inspection* (http://staffnet/pgc/results.cfm?id=2341)

Approximately 83 percent of bridges are inspected once every 24 months, 12 percent are inspected on a 12-month cycle, and 5 percent are inspected on a maximum 48-month cycle.

All data presented in this section are from the NBI database as of October 2009. As noted in Chapter 2, since a majority of bridges are inspected once every 24 months, the "2009" NBI data actually reflect the condition of individual bridges from late 2007 through late 2009, or late 2008 on average.

Bridge Ratings and Classifications

From the information collected through the inspection process, assessments are performed to determine the adequacy of a structure to service the current structural and functional demands; factors considered include load-carrying capacity, deck geometry, clearances, waterway adequacy, and approach roadway alignment. Structural assessments together with ratings of the physical condition of key bridge components determine whether a bridge should be classified as "**structurally deficient.**" Functional adequacy is assessed by comparing the existing geometric configurations and design load carrying capacities to current standards and demands. Disparities between the actual and preferred configurations are used to determine whether a bridge should be classified as "**functionally obsolete.**"

Q&A

What makes a bridge structurally deficient, and are structurally deficient bridges unsafe?

Structurally deficient bridges are **not** inherently unsafe.

Bridges are considered structurally deficient if significant load-carrying elements are found to be in poor or worse condition due to deterioration and/or damage, or the adequacy of the waterway opening provided by the bridge is determined to be extremely insufficient to the point of causing intolerable roadway traffic interruptions.

The classification of a bridge as structurally deficient does not imply that it is likely to collapse or that it is unsafe. By conducting properly scheduled inspections, unsafe conditions may be identified; if the bridge is determined to be unsafe, the structure must be closed. A deficient bridge, when left open to traffic, typically requires significant maintenance and repair to remain in service and eventual rehabilitation or replacement to address deficiencies. To remain in service, structurally deficient bridges often have weight limits that restrict the gross weight of vehicles using the bridges to less than the maximum weight typically allowed by statute.

Condition Ratings

The primary considerations in classifying structural deficiencies are the bridge component condition ratings. The NBI database contains condition ratings on the three primary components of a bridge: the deck, superstructure, and substructure. The bridge deck is the surface on which vehicles travel and is supported by the superstructure. The superstructure transfers the load of the deck and bridge traffic to the substructure, which provides support for the entire bridge.

Condition ratings have been established to measure the state of bridge components over time in a consistent and uniform manner. Bridge inspectors assign condition ratings by evaluating the severity of any deterioration of bridge components relative to their as-built condition, and the extent to which this deterioration affects the performance of the component being rated. These ratings provide an overall characterization of the general condition of the entire component being rated; the condition of specific individual bridge elements may be higher or lower. *Exhibit 3-8* describes the bridge condition ratings in more detail.

Q&A

How does a bridge become functionally obsolete?

Functional obsolescence is a function of the geometrics of the bridge in relation to the geometrics required by current design standards. While structural deficiencies are generally the result of deterioration of the conditions of the bridge components, functional obsolescence generally results from changing traffic demands on the structure. Facilities, including bridges, are designed to conform to the design standards in place at the time they are designed. Over time, improvements are made to the design requirements. As an example, a bridge designed in the 1930s would have shoulder widths in conformance with the design standards of the 1930s, but current design standards are based on different criteria and require wider bridge shoulders to meet current safety standards. The difference between the required, current-day shoulder width and the 1930s' designed shoulder width represents a deficiency. The magnitude of these types of deficiencies determines whether a bridge is classified as functionally obsolete.

Exhibit 3-8

Bridge Condition Rating Categories

Rating	Condition Category	Description*
9	Excellent	
8	Very Good	No problems noted.
7	Good	Some minor problems.
6	Satisfactory	Structural elements show some minor deterioration.
5	Fair	All primary structural elements are sound but may have minor section loss, cracking, spalling, or scour.
4	Poor	Advanced section loss, deterioration, spalling, or scour.
3	Serious	Loss of section, deterioration, spalling, or scour have seriously affected primary structural components. Local failures are possible. Fatigue cracks in steel or shear cracks in concrete may be present.
2	Critical	Advanced deterioration of primary structural elements. Fatigue cracks in steel or shear cracks in concrete may be present or scour may have removed substructure support. Unless closely monitored, it may be necessary to close the bridge until corrective action is taken.
1	Imminent Failure	Major deterioration or section loss present in critical structural components, or obvious loss present in critical structural components, or obvious vertical or horizontal movement affecting structural stability. Bridge is closed to traffic, but corrective action may be sufficient to put the bridge back in light service.
0	Failed	Bridge is out of service and is beyond corrective action.

******The term "section loss" is defined in The Bridge Inspector's Reference Manual (BIRM) Publication No. FHWA NHI 03-001 as the loss of a (bridge) member's cross-sectional area usually by corrosion or decay. A "spall" is a depression in a concrete member resulting from the separation and removal of a volume of the surface concrete. Spalls can be caused by corroding reinforcement, friction from thermal movement, and overstress. The term "scour" refers to the erosion of streambed or bank material around bridge supports due to flowing water.*

Source: Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges, Report No. FHWA-PD-96-001.

The condition ratings for bridges in the Nation are shown in *Exhibit 3-9.* When a primary component of a structure has a rating of 4 or lower, it is considered to be structurally deficient. A structural deficiency does not indicate that a bridge is unsafe but instead indicates the extent to which a bridge has depreciated from its original condition when first built. Once bridge components become structurally deficient, the bridge may experience reduced performance in the form of lane closures or load limits. Bridges with components in such disrepair that there is a safety risk are closed to traffic.

Exhibit 3-9

Bridge Condition Ratings, 2009

Deck Rating Distribution			
Rating *	Bridge Count	Deck Area Weighting	ADT Weighting
9	4.0%	2.9%	2.0%
8	17.4%	15.2%	11.3%
7	37.5%	41.3%	42.2%
6	23.2%	24.9%	26.5%
5	12.4%	10.7%	12.4%
4	4.0%	3.7%	4.1%
3	1.0%	1.0%	1.2%
2	0.3%	0.1%	0.1%
1	0.1%	0.1%	0.1%
0	0.2%	0.1%	0.0%

Superstructure Rating Distribution			
Rating*	Bridge Count	Deck Area Weighting	ADT Weighting
9	4.6%	3.8%	2.7%
8	22.8%	24.8%	22.4%
7	34.0%	36.8%	41.9%
6	21.4%	21.1%	21.9%
5	11.6%	9.8%	8.6%
4	3.9%	2.9%	2.1%
3	1.1%	0.6%	0.4%
2	0.3%	0.2%	0.1%
1	0.1%	0.0%	0.0%
0	0.2%	0.1%	0.0%

Substructure Rating Distribution			
Rating*	Bridge Count	Deck Area Weighting	ADT Weighting
9	4.3%	3.4%	2.2%
8	17.5%	17.0%	12.6%
7	36.0%	44.4%	51.2%
6	22.7%	22.1%	23.2%
5	12.5%	9.6%	8.5%
4	4.9%	2.8%	1.9%
3	1.3%	0.5%	0.2%
2	0.5%	0.1%	0.0%
1	0.1%	0.0%	0.0%
0	0.2%	0.1%	0.0%

** Percentages are based on deck ratings for 468,466 bridges, superstructure ratings for 473,116 bridges, and substructure ratings for 473,305 bridges. These percentages exclude 124,823 culverts (self-contained units located under roadway fill that do not have a deck, superstructure, or substructure), other structures for which these ratings are nonapplicable, and other structures for which no value was coded.*

Source: National Bridge Inventory, October 2009.

Approximately 58.9 percent of the bridges rated had bridge decks in good (7) or better condition. Weighting bridges by deck area changes this value to 59.4 percent, suggesting that larger bridges are in slightly better shape on average; the corresponding value weighted by ADT is 55.6 percent, suggesting that bridge decks on heavily traveled bridges are in slightly worse shape on average. The share of bridge decks rated as poor (4) or worse was 5.5 percent based on raw bridge counts or weighted by ADT; the corresponding figure weighted by deck area was 5.0 percent.

Weighted by deck area, the share of bridge superstructures rated as good (7) or better was

Q&A

What is the condition of the culverts included in the NBI?

There are 129,351 culverts reflected in the NBI. Culverts are self-contained units located under roadway fill, typically constructed of concrete or corrugated steel. Multiple pipes or boxes placed side by side are considered to be a structure and are included in the NBI if they span a total length in excess of 6.1 meters and carry a public roadway. As these structures lack decks, superstructures, and substructures, culverts are rated based on their overall condition as a whole. *Exhibit 3-10* shows the distribution of culvert condition ratings.

Exhibit 3-10

Culvert Condition Ratings, 2009

Rating	Number of Culverts	Percent
9	4,517	3.5%
8	24,674	19.1%
7	55,875	43.2%
6	32,845	25.4%
5	8,771	6.8%
4	2,106	1.6%
3	457	0.4%
2	67	0.1%
1	7	0.0%
0	32	0.0%
Total	**129,351**	**100.0%**

Source: National Bridge Inventory, October 2009.

65.4 percent, while the comparable value for bridge substructures was 64.8 percent. The share of bridge superstructures weighted by deck area rated as poor or worse was 3.8 percent, compared to 3.5 percent for bridge substructures. The percentages shown in *Exhibit 3-9* do not reflect culverts, which do not have a deck, superstructure or substructure, but instead are self contained units typically located under roadway fill.

Appraisal Ratings

Appraisal ratings are based on an evaluation of bridge characteristics relative to the current standards used for highway and bridge design. Such ratings factor into the classification of bridges as structurally deficient or functionally obsolete. *Exhibit 3-11* describes appraisal rating codes in more detail.

Exhibit 3-11

Bridge Appraisal Rating Categories

Rating	Description
N	Not applicable.
9	Superior to present desirable criteria.
8	Equal to present desirable criteria.
7	Better than present minimum criteria.
6	Equal to present minimum criteria.
5	Somewhat better than minimum adequacy to tolerate being left in place as-is.
4	Meets minimum tolerable limits to be left in place as-is.
3	Basically intolerable requiring a high priority of corrective action.
2	Basically intolerable requiring a high priority of replacement.
1	This value of rating code is not used.
0	Bridge closed.

Source: Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges, Report No. FHWA-PD-96-001.

Structural Evaluation and Waterway Adequacy Ratings

Load-carrying capacity does not influence the assignment of the condition ratings referenced above, but it does factor into the structural evaluation appraisal rating. This is calculated according to the capacity ratings for various categories of traffic in terms of ADT. A structural evaluation rating of 3 indicates that the load-carrying capacity does not meet current design standards, but can be mitigated through corrective action; in this case, the bridge is classified as functionally obsolete. A structural evaluation rating of 2 or lower indicates that the load-carrying capacity is too low and the structure should be replaced; in this case, the bridge is classified as structurally deficient. Again, neither rating is indicative of a bridge that is unsafe but rather a measure of the bridge's original design and the extent of the bridge's depreciation relative to current design standards.

The waterway adequacy appraisal rating describes the size of the opening of the structure with respect to the passage of water flow under the bridge. This rating, which considers the potential for a structure to be submerged during a flood event and the potential inconvenience to the traveling public, is based on criteria assigned by functional classification. Bridges with waterway adequacy appraisal ratings of 3 are classified as functionally obsolete, while those with waterway adequacy appraisal ratings of 2 or lower are classified as structurally deficient.

Exhibit 3-12 shows the distribution of structural evaluation and waterway adequacy ratings. Approximately 6.9 percent of bridges received a structural evaluation rating of 3 or less. Weighting bridges by deck area reduces this value to 3.2 percent; the comparable ADT-weighted figure is 1.6 percent. This suggests that larger, more heavily traveled bridges have fewer problems in terms of load-carrying capacity than smaller less-traveled bridges, on average. Only 1.0 percent of structures spanning waterways received a waterway adequacy rating of 3 or less; the comparable figures weighted by deck area and weighted by ADT were both 0.3 percent.

Reporting Deficient Deck Area

The FHWA is exploring alternate methods of reporting total deficient bridge deck area. Under the current method, the total deck area on deficient bridges is divided by the total deck area of all bridges for a particular year. As new bridges are constructed, their area is included in the denominator of this computation; even if the total deck area on deficient bridges remained constant from one year to the next, the increase in the total deck area of all bridges would cause the deck-area weighted percent of deficient bridges to decrease. Concerns have been raised that this method can inadvertently mask relevant changes to the condition of existing bridges.

Exhibit 3-12

Structural Evaluation and Waterway Adequacy Appraisal Ratings, 2009

	Structural Evaluation			Waterway Adequacy		
Rating*	**Structures**	**Weighted by Deck Area**	**Weighted by ADT**	**Structures**	**Weighted by Deck Area**	**Weighted by ADT**
9	1.7%	1.7%	1.1%	11.0%	24.6%	20.1%
8	13.7%	12.9%	10.6%	35.6%	45.0%	43.3%
7	26.4%	34.7%	40.1%	22.6%	12.8%	13.7%
6	25.3%	26.0%	28.2%	20.9%	13.3%	18.5%
5	16.3%	15.3%	14.0%	5.3%	2.8%	2.7%
4	9.6%	6.2%	4.5%	3.6%	1.2%	1.3%
3	2.3%	1.7%	1.0%	0.7%	0.2%	0.2%
2	4.0%	1.3%	0.5%	0.1%	0.0%	0.0%
1	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
0	0.6%	0.2%	0.1%	0.2%	0.1%	0.0%

** Percentages are based on structural evaluation ratings for 597,266 bridges and waterway adequacy ratings for 501,043 bridges. Bridges that are not over a waterway are not rated for waterway adequacy.*

Source: National Bridge Inventory, October 2009

Deck Geometry, Underclearance, and Approach Alignment Ratings

While load-carrying capacity and waterway adequacy can trigger the classification of a bridge as functionally obsolete, the primary considerations in determining functional obsolescence are functional and geometric-based appraisal ratings, including the deck geometry appraisal rating, the underclearance appraisal rating, and the approach roadway alignment appraisal rating.

Deck geometry ratings reflect the width of the bridge, the minimum vertical clearance over the bridge, the ADT, the number of lanes carried by the structure, whether two-way or one-way traffic is serviced, and the functional classification of the structure. As noted above, appraisal ratings are based on an evaluation of bridge characteristics relative to the current standards used for highway and bridge design; thus, the deck geometry rating is based in part on the difference between the actual width of the structure and the current design standard for the width of a structure with the same characteristics as the bridge being rated.

Underclearance appraisals consider both the vertical and horizontal underclearances as measured from the roadway or railway to the nearest bridge component. The functional classification of the underpassing route is considered, along with its Federal-aid designation and defense categorization (i.e., whether the bridge crosses over a Strategic Highway Network STRAHNET route).

Approach alignment ratings differ from the deck geometry and underclearance appraisal ratings in that, rather than comparing approach roadway alignment with current standards, they are determined by comparing the existing approach roadway alignment to the bridge to the general alignment for the section of highway the bridge is on. Deficiencies are identified where the bridge route does not function adequately because of alignment disparities.

Exhibit 3-13 shows the distribution of appraisal ratings for deck geometry, underclearance, and approach alignment. Approximately 8.6 percent of bridges received a deck geometry rating of 2 or lower, indicating problems that generally would not be correctable unless the structure were replaced. The comparable figure weighted by ADT is 10.8 percent because deck geometry adequacy is more of a problem on higher-traveled routes, on average. Approximately 0.3 percent of approach alignments were rated 2 or lower; for those bridges for which underclearance adequacy was evaluated, 3.1 percent were rated 2 or lower.

Exhibit 3-13

Bridge Appraisal Ratings Based on Geometry and Function, 2009

Deck Geometry Rating Distribution			
Rating*	Bridge Count	Deck Area Weighting	ADT Weighting
9	8.9%	21.2%	31.0%
8	2.2%	2.4%	2.0%
7	11.3%	14.4%	12.4%
6	20.7%	16.4%	13.5%
5	22.6%	15.8%	11.7%
4	18.4%	16.5%	14.7%
3	7.2%	4.8%	4.0%
2	8.5%	8.5%	10.8%
1	0.0%	0.0%	0.0%
0	0.1%	0.1%	0.0%

Approach Alignment Rating Distribution			
Rating*	Bridge Count	Deck Area Weighting	ADT Weighting
9	2.7%	3.5%	5.4%
8	62.4%	73.2%	79.2%
7	12.3%	10.0%	7.9%
6	14.4%	8.9%	5.5%
5	3.8%	2.1%	1.1%
4	2.8%	1.5%	0.8%
3	1.4%	0.6%	0.2%
2	0.2%	0.1%	0.0%
1	0.0%	0.0%	0.0%
0	0.1%	0.0%	0.0%

Underclearance Rating Distribution			
Rating*	Bridge Count	Deck Area Weighting	ADT Weighting
9	10.4%	12.3%	9.1%
8	2.0%	2.0%	1.6%
7	9.1%	8.3%	7.8%
6	17.3%	16.7%	17.1%
5	16.2%	14.2%	15.0%
4	20.3%	19.3%	23.5%
3	21.6%	24.2%	23.4%
2	3.0%	2.9%	2.4%
1	0.0%	0.0%	0.0%
0	0.1%	0.1%	0.0%

** Percentages are based on deck geometry ratings for 519,386 structures, approach alignment ratings for 602,100 structures, and underclearance ratings for 101,860 structures. Underclearance adequacy is rated only for those bridges crossing over a highway or railroad.*

Source: National Bridge Inventory, October 2009.

Condition and Appraisal Ratings Relative to Structurally Deficient/ Functionally Obsolete Designations

The discussion of condition and appraisal ratings above identifies some specific trigger values that will result in the designation of a bridge as structurally deficient or functionally obsolete. However, it is important to note that condition and appraisal ratings are not cumulative; for example, a single bridge may have multiple deficiencies that each would warrant a classification of functionally obsolete.

Bridges may have both structural problems that would warrant a classification of structurally deficient and functional issues that would warrant a classification of functionally obsolete. However, when summary NBI bridge condition metrics are presented, bridges are reported as being in one of three mutually exclusive categories—structurally deficient, functionally obsolete, or non-deficient. The standard NBI data reporting convention is that **if a bridge meets the criteria to be classified as both structurally deficient and functionally obsolete, it is identified only as structurally deficient**, because structural deficiencies are considered more critical. Thus, while a significant percentage of bridges classified as structurally deficient will also have functional issues in need of correction, bridges classified as functionally obsolete do not have significant structural deficiencies.

Bridge Conditions on the NHS

Exhibit 3-14 identifies the percent of bridges on the National Highway System (NHS) classified as structurally deficient or functionally obsolete based on the number of bridges, bridges weighted by deck area, and bridges weighted by ADT. The FHWA has adopted deck-area weighting for use in agency performance planning in recognition of the significant logistical and financial challenges that may be involved in addressing deficiencies on larger bridges. The total number of NHS bridges for individual years are identified in Chapter 2.

Approximately 21.9 percent of the 117,510 NHS bridges were classified as deficient in 2009; the comparable values weighted by ADT and deck area were 26.2 percent and 29.2 percent, respectively. This suggests that there is a greater-than-average concentration of deficiencies on heavily traveled and larger bridges, respectively.

The share of NHS bridges weighted by deck area that are classified as structurally deficient decreased from 8.4 percent in 2001 to 8.2 percent in 2009, while the deck-area weighted share classified as functionally obsolete decreased from 22.0 percent to 21.0 percent over the same period. NHS routes tend to carry significantly more traffic than the average road, and functional obsolescence remains a significant challenge on NHS bridges.

Exhibit 3-14

NHS Bridge Deficiences, 2001–2009

Analysis Approach	Percentage of Deficient Bridges by Year				
	2001	**2003**	**2005**	**2007**	**2009**
Weighted By Deck Area					
Structurally Deficient	8.4%	8.8%	8.5%	8.4%	8.2%
Functionally Obsolete	22.0%	20.9%	21.3%	21.3%	21.0%
Total Deficient	**30.4%**	**29.7%**	**29.8%**	**29.7%**	**29.2%**
Weighted By ADT					
Structurally Deficient	7.2%	7.1%	6.6%	6.5%	6.2%
Functionally Obsolete	20.5%	20.0%	20.2%	20.2%	20.0%
Total Deficient	**27.7%**	**27.1%**	**26.8%**	**26.7%**	**26.2%**
By Bridge Count					
Structurally Deficient	6.0%	5.9%	5.7%	5.5%	5.2%
Functionally Obsolete	17.4%	17.0%	16.9%	16.7%	16.6%
Total Deficient	**23.3%**	**22.9%**	**22.6%**	**22.2%**	**21.9%**

Source: National Bridge Inventory, October 2009.

Systemwide Bridge Conditions

Exhibit 3-15 identifies the percentage of all bridges classified as structurally deficient or functionally obsolete based on the number of bridges, bridges weighted by deck area, and bridges weighted by ADT. The total number of bridges has grown over time; totals for individual years are identified in Chapter 2.

Q&A

What goals were established by the Department of Transportation for NHS bridges?

The Department of Transportation's *FY 2009 Performance and Accountability Report* presented a fiscal year (FY) 2009 target of 29.0 percent for the share of deck area on NHS bridges rated as deficient.

Based on raw bridge counts, approximately 12.0 percent of bridges were classified as structurally deficient in 2009, and 14.5 percent were classified as functionally obsolete. Weighted by deck area, the comparable shares were 9.3 percent structurally deficient and 20.2 percent functionally obsolete. The differences are even more pronounced when bridges are weighted by ADT, as this adjustment results in a structural deficient share of 7.0 percent and a functionally obsolete share of 21.7 percent.

Since 2001, the total share of deficient bridges weighted by deck area has decreased from 31.3 percent to 29.4 percent, representing an overall improvement in the condition of the Nation's bridges. Whether considering raw bridge counts, deck-area-weighted values, or ADT-weighted values, more progress was made during this period in reducing the percentage of structurally deficient bridges than in reducing the share of functionally obsolete bridges.

Exhibit 3-15

Systemwide Bridge Deficiencies, 2001–2009

Analysis Approach	Percentage of Deficient Bridges by Year				
	2001	**2003**	**2005**	**2007**	**2009**
Weighted By Deck Area					
Structurally Deficient	10.5%	10.3%	9.8%	9.5%	9.3%
Functionally Obsolete	20.9%	20.4%	20.7%	20.6%	20.2%
Total Deficient	**31.3%**	**30.8%**	**30.5%**	**30.1%**	**29.4%**
Weighted By ADT					
Structurally Deficient	8.1%	7.9%	7.4%	7.3%	7.0%
Functionally Obsolete	22.4%	22.0%	22.0%	22.0%	21.7%
Total Deficient	**30.5%**	**29.9%**	**29.4%**	**29.4%**	**28.7%**
By Bridge Count					
Structurally Deficient	14.6%	13.9%	13.1%	12.3%	12.0%
Functionally Obsolete	15.5%	15.3%	15.1%	14.8%	14.5%
Total Deficient	**30.1%**	**29.1%**	**28.2%**	**27.2%**	**26.5%**

Source: National Bridge Inventory, October 2009.

Rural and Urban Deficient Bridges by Functional Classification

Based on the number of bridges, the total percentage of structurally deficient and functionally obsolete bridges on the Nation's roadways decreased from 30.1 percent in 2001 to 26.5 percent in 2009. The percentage of structurally deficient bridges for most functional classes decreased from 2001 to 2009, with the exception of rural Interstate System bridges. As shown in *Exhibit 3-16*, the share of rural Interstate System bridges classified as structurally deficient increased from 4.1 percent to 4.5 percent over this period. The share of bridges classified as functionally obsolete decreased for most functional classes except for urban collectors, which experienced an increase from 28.1 percent in 2001 to 28.3 percent in 2009.

Exhibit 3-16

Bridge Deficiences by Functional Class, 2001–2009

	Percentage of Structurally Deficient Bridges by Year				
Functional System	**2001**	**2003**	**2005**	**2007**	**2009**
Rural					
Interstate	4.1%	4.4%	4.2%	4.4%	4.5%
Other Principal Arterial	5.6%	5.5%	5.3%	5.0%	4.7%
Minor Arterial	8.7%	8.6%	8.4%	8.2%	7.8%
Major Collector	12.3%	12.1%	11.4%	10.8%	10.5%
Minor Collector	14.6%	14.0%	13.0%	12.5%	12.4%
Local	22.7%	21.4%	19.9%	18.7%	18.3%
Subtotal Rural	**16.0%**	**15.2%**	**14.3%**	**13.5%**	**13.3%**
Urban					
Interstate	6.5%	6.5%	6.2%	6.0%	5.8%
Other Freeway and Expressway	6.5%	6.3%	5.9%	6.0%	5.4%
Other Principal Arterial	10.0%	9.5%	9.1%	8.7%	8.3%
Minor Arterial	11.0%	10.6%	10.3%	10.0%	9.5%
Collector	12.0%	11.4%	11.3%	11.0%	10.3%
Local	12.6%	11.8%	11.6%	10.9%	10.6%
Subtotal Urban	**9.8%**	**9.4%**	**9.1%**	**8.8%**	**8.4%**

	Percentage of Functionally Obsolete Bridges by Year				
Functional System	**2001**	**2003**	**2005**	**2007**	**2009**
Rural					
Interstate	12.8%	12.8%	12.5%	11.7%	11.7%
Other Principal Arterial	10.8%	10.0%	9.6%	9.1%	8.8%
Minor Arterial	12.6%	11.7%	11.3%	10.8%	10.3%
Major Collector	11.3%	11.2%	10.9%	10.3%	9.7%
Minor Collector	12.5%	12.2%	12.0%	11.6%	11.1%
Local	13.7%	13.3%	13.0%	12.5%	12.0%
Subtotal Rural	**12.7%**	**12.3%**	**12.0%**	**11.5%**	**11.0%**
Urban					
Interstate	23.4%	22.9%	23.6%	23.8%	23.2%
Other Freeway and Expressway	24.2%	23.6%	23.3%	22.8%	22.3%
Other Principal Arterial	25.3%	25.5%	24.8%	24.5%	24.1%
Minor Arterial	29.7%	29.4%	29.0%	29.4%	28.9%
Collector	28.1%	28.6%	28.9%	28.5%	28.3%
Local	21.5%	21.9%	22.1%	21.5%	21.1%
Subtotal Urban	**25.1%**	**25.1%**	**25.1%**	**24.9%**	**24.5%**

Source: National Bridge Inventory, October 2009.

Among the individual functional classes, the highest percentage observed in 2009 for structurally deficient bridges was 18.3 percent for rural minor collectors; despite the increase noted above, the rural portion of the Interstate System had the lowest percentage of structurally deficient bridges. Urban minor arterials had the highest share of functionally obsolete bridges, 28.9 percent in 2009, while only 8.8 percent of rural other principal arterials were classified as functionally obsolete.

Deficient Bridges by Owner

Bridge deficiencies by ownership are examined in *Exhibit 3-17*. Each State has the responsibility for inspection of all bridges in that State except for tribally or Federally owned bridges. The agency that owns a bridge is responsible for its maintenance and operation. Interagency agreements may be formed, such as those between State highway agencies and localities. In these cases, a secondary agency (such as the State) performs maintenance and operation work under agreement with the owner. However, such agreements do not transfer ownership and, therefore, do not negate the responsibilities of the bridge owners for maintenance and operation in compliance with Federal and State requirements.

Exhibit 3-17

Bridge Deficiencies by Owner, 2009

	Federal	State	Local	Private/ Other*	Total
Count					
Total Bridges	8,452	290,062	303,014	1,782	603,310
Total Deficient	2,293	71,680	84,766	1,120	159,859
Structurally Deficient	762	23,919	47,161	559	72,401
Functionally Obsolete	1,531	47,761	37,605	561	87,458
Percentages					
Percent of Total Inventory Owned	1.4%	48.1%	50.2%	0.3%	100.0%
Percent Deficient	27.1%	24.7%	28.0%	62.9%	26.5%
Percent Structurally Deficient	9.0%	8.2%	15.6%	31.4%	12.0%
Percent Functionally Obsolete	18.1%	16.5%	12.4%	31.5%	14.5%

** Note that these data only reflect bridges for which inspection reports were submitted to the NBI. An unknown number of privately owned bridges are omitted.*

Source: National Bridge Inventory, October 2009.

While the number of privately owned bridges reported in the NBI is relatively small, at 0.3 percent of the total number of bridges, about 62.9 percent of them were classified as deficient in 2009. State-owned bridges had the lowest share of structurally deficient bridges in 2009, at approximately 8.2 percent. Bridges owned by local governments had the lowest share of functionally obsolete bridges, at only 12.4 percent. These findings are consistent with the types of bridges owned by the different levels of government; local governments tend to own smaller bridges with lower traffic levels than average, for which functional obsolescence is less of an issue.

Historic Bridges on the Nation's Roadways

Of the 603,310 bridges in the National Bridge Inventory, 1,767 (0.29 percent) are registered as historic and an additional 3,846 (0.64 percent) are eligible to be registered. Some historic bridges carry significant traffic volumes; over 17 percent of the bridges on the historic register are on principal arterials.

Bridges do not have to be extremely old to be classified as historic. Approximately 9.5 percent of the registered historic bridges are 50 years in age or less, well within the typical useful lifespan of a bridge; approximately 4.1 percent are 10 years old or less.

Of the registered historic bridges, 33.3 percent of them have current ratings that cause them to be classified as structurally deficient while 40.2 percent are classified as functionally obsolete. At some time, it will be necessary to take mitigation actions on those bridges classified as structurally deficient; however, mitigation actions on the bridges classified as functionally obsolete may not be possible due to the historic classification. These bridges are still open to vehicular traffic even though, in some cases, heavy trucks and similar vehicles may not be allowed to use a particular historic bridge.

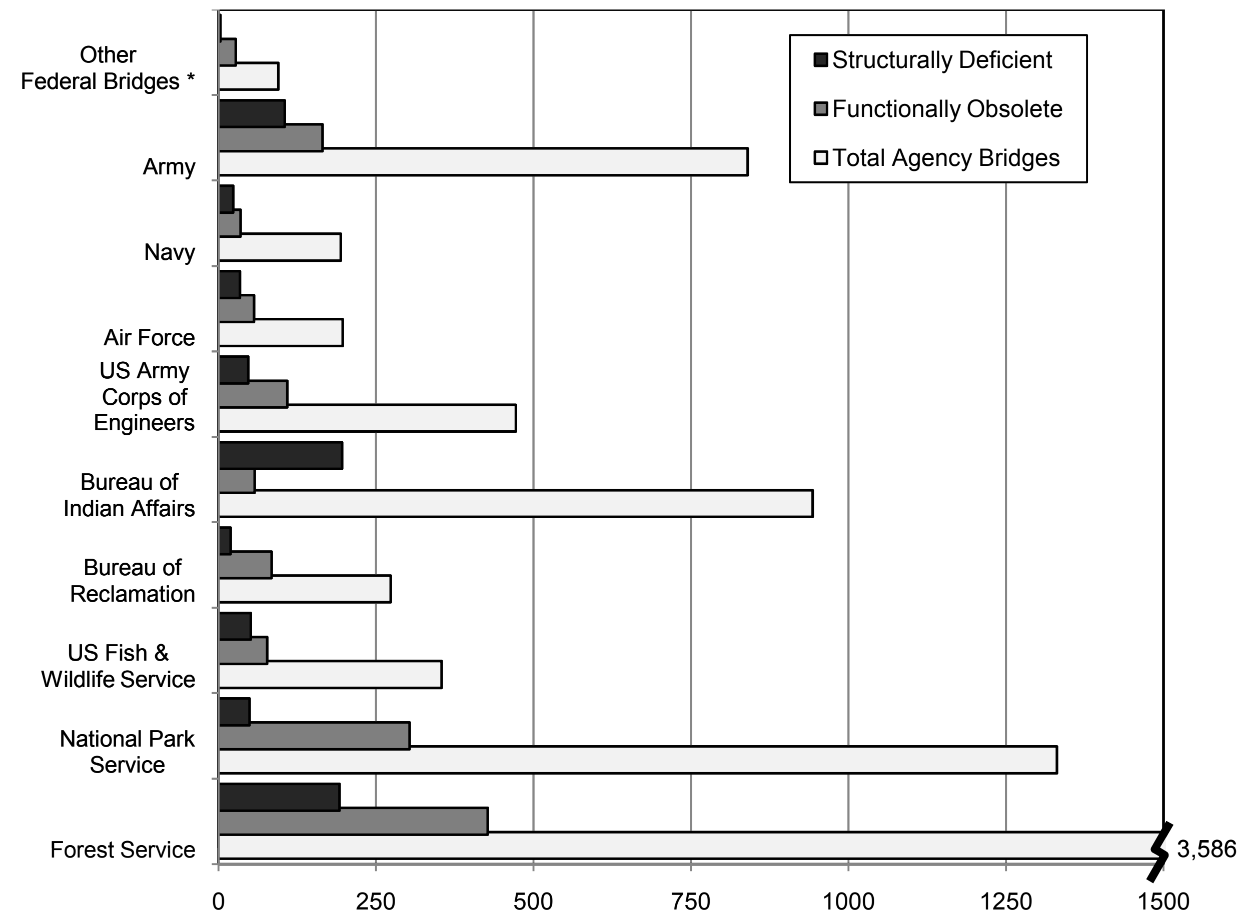
Q&A

How are Federal bridge deficiencies distributed among various Federal agencies?

Exhibit 3-18 illustrates the status of bridges for individual Federal agencies as of 2009. Among these agencies, the Forest Service owns the most bridges (3,586) and has the most functionally obsolete bridges in its inventory (427). The National Park Service also owns a significant number of bridges classified as functionally obsolete (303). The Bureau of Indian Affairs owns the most bridges classified as structurally deficient (196), slightly more than the number owned by the Forest Service (192).

Exhibit 3-18

Status of the Federal Bridge Inventory, 2009



** Includes bridges owned by the General Services Administration, the National Aeronautics and Space Administration, the Department of Energy, the Pentagon Reservation, the Department of Agriculture, the National Security Agency, the National Zoo, Washington Airports, and the Tennessee Valley Authority.*

Source: National Bridge Inventory.

Bridges by Age

Exhibit 3-19 identifies the age composition of Interstate System bridges, NHS bridges, and all bridges combined. As of 2009, approximately 38.1 percent of the Nation's bridges were between 26 and 50 years old; this share is higher for NHS bridges, 54.6 percent, while 71.1 percent of the Interstate bridges fell into this age range. The clustering of bridges in this age range has potential implications in terms of long-term bridge rehabilitation and replacement strategies because the need for such actions may be concentrated within certain time periods rather than being spread out evenly, which might be the case if the original construction of bridges had been spread out more evenly over time. However, a number of other variables such as maintenance practices and environmental conditions also affect when future capital investments might be needed.

Exhibit 3-19

Bridges by Age Range, as of 2009

Age Range	All Bridges Count	All Bridges Percent	NHS Bridges Count	NHS Bridges Percent	Interstate Bridges Count	Interstate Bridges Percent
0–10 Years	68,406	11.3%	12,028	10.2%	3,537	6.4%
11–25 Years	123,860	20.5%	19,026	16.2%	5,878	10.7%
26–50 Years	230,128	38.1%	64,116	54.6%	39,137	71.1%
51–75 Years	121,543	20.1%	17,811	15.2%	6,253	11.4%
76–100 Years	49,122	8.1%	4,284	3.6%	168	0.3%
>100 Years	9,865	1.6%	194	0.2%	9	0.0%
Not reported	386	0.1%	51	0.0%	29	0.1%
Total	**603,310**	**100.0%**	**117,510**	**100.0%**	**55,011**	**100.0%**

Source: National Bridge Inventory, October 2009.

Exhibit 3-20 identifies the distribution of bridge deficiencies within the age ranges presented in *Exhibit 3-19*. The percent of bridges classified as either structurally deficient or functionally obsolete generally tends to rise as bridges age. Among Interstate System bridges, 22.8 percent of the bridges constructed between 26 and 50 years ago were classified as deficient; this share rose to 35.2 percent for Interstate System bridges constructed between 51 and 75 years ago. Note that some existing bridges were absorbed into the Interstate System at the time it was designated; some of these structures remain in service today.

The age of a bridge structure is one indicator of its serviceability. However, a combination of several factors impacts the serviceability of a structure, including the original type of design; the frequency, timeliness, effectiveness, and appropriateness of the maintenance activities implemented over the life of the structure; the loading the structure has been subject to during its life; the climate of the area where the structure is located; and any additional stresses from events such as flooding to which the structure has been subjected.

Q&A

Why are there bridges less than ten years old that are classified as deficient?

Current laws and regulations permit the building of bridges off the Federal-aid system to design standards (width, clearance, etc.) that may be less than the minimum current design standards for bridges on the Federal-aid system. Newly constructed, replaced, or major rehabilitated bridges built to lesser design standards are often classified as functionally obsolete once they are open to traffic.

Also, design exceptions for less than the minimum current standards for bridges on the Federal-aid system are sometimes approved depending on the circumstances. Physical constraints within urban areas can limit the size of a new bridge, thus resulting in a relatively young deficient bridge. Additionally, extreme events such as earthquakes can render a new bridge structurally deficient.

The FHWA established the "10-Year Rule" for determining a bridge's eligibility for Federal funds after new construction, replacement, or major rehabilitation has taken place. Bridges that have been newly constructed, replaced, or had major rehabilitation within the past 10 years are not eligible for Federal funds and are not used to apportion Highway Bridge Program funds.

The 10-Year Rule encourages States to address all the deficiencies of a bridge at one time rather than separately, which results in multiple traffic disruptions and additional costs. The rule also assists in preventing intentional manipulation of the apportionment process of Highway Bridge Program funds. Without it, States could minimize the amount of improvements on deficient bridges to maintain them in a safe condition but still in a deficient classification, so that their deck areas would still contribute to a stable or increased apportionment of Highway Bridge Program funds.

It should be noted that some standard NBI data reports on structurally deficient and functionally obsolete bridges, including those used in the C&P report prior to the 2008 edition, exclude bridges that fall under the 10-Year Rule, which has the effect of reducing the apparent number of deficient bridges.

Exhibit 3-20

Bridge Deficiencies by Period Built, as of 2009

Age Range of All Bridges	Bridge Count	Structurally Deficient		Functionally Obsolete		All Deficient	
		Count	Percent	Count	Percent	Count	Percent
0–10 Years	68,406	552	0.8%	6,507	9.5%	7,059	10.3%
11–25 Years	123,860	3,183	2.6%	11,325	9.1%	14,508	11.7%
26–50 Years	230,128	22,720	9.9%	32,357	14.1%	55,077	23.9%
51–75 Years	121,543	26,244	21.6%	23,836	19.6%	50,080	41.2%
76–100 Years	49,122	15,668	31.9%	10,882	22.2%	26,550	54.0%
>100 Years	9,865	3,993	40.5%	2,455	24.9%	6,448	65.4%
Null	386	41	10.6%	96	24.9%	137	35.5%
Total	**603,310**	**72,401**	**12.0%**	**87,458**	**14.5%**	**159,859**	**26.5%**

Age Range of NHS Bridges	Bridge Count	Structurally Deficient		Functionally Obsolete		All Deficient	
		Count	Percent	Count	Percent	Count	Percent
0–10 Years	12,028	60	0.5%	1,458	12.1%	1,518	12.6%
11–25 Years	19,026	142	0.7%	1,960	10.3%	2,102	11.0%
26–50 Years	64,116	3,609	5.6%	10,829	16.9%	14,438	22.5%
51–75 Years	17,811	1,709	9.6%	4,367	24.5%	6,076	34.1%
76–100 Years	4,284	579	13.5%	865	20.2%	1,444	33.7%
>100 Years	194	49	25.3%	59	30.4%	108	55.7%
Null	51	4	7.8%	20	39.2%	24	47.1%
Total	**117,510**	**6,152**	**5.2%**	**19,558**	**16.6%**	**25,710**	**21.9%**

Age Range of Interstate Bridges	Bridge Count	Structurally Deficient		Functionally Obsolete		All Deficient	
		Count	Percent	Count	Percent	Count	Percent
0–10 Years	3,537	27	0.8%	634	17.9%	661	18.7%
11–25 Years	5,878	63	1.1%	806	13.7%	869	14.8%
26–50 Years	39,137	2,212	5.7%	6,709	17.1%	8,921	22.8%
51–75 Years	6,253	529	8.5%	1,669	26.7%	2,198	35.2%
76–100 Years	168	18	10.7%	24	14.3%	42	25.0%
>100 Years	9	2	22.2%	1	11.1%	3	33.3%
Null	29	0	0.0%	15	51.7%	15	51.7%
Total	**55,011**	**2,851**	**5.2%**	**9,858**	**17.9%**	**12,709**	**23.1%**

Source: National Bridge Inventory, October 2009.

As an example, two structures built at the same time, using the same design standards, and in the same climate area can have very different serviceability levels. The first structure may have had increasing loads due to increased heavy truck traffic, did not have any maintenance of the deck or the substructure, and did not have any rehabilitation work. The second structure may have had the same increases in heavy truck traffic but received correctly timed preventive maintenance activities on all parts of the structure and proper rehabilitation activities. In this case, the first structure would have a very low serviceability level while the second structure would have a high serviceability level.

Transit System Conditions

The condition and performance of the U.S. transit infrastructure should ideally be evaluated by how well it supports the objectives of the transit agencies that operate it. Presumably these include fast, safe, and comfortable service that charges reasonable fares, requires a minimal subsidy from taxpayers, and takes people where they want to go. However, the degree to which transit service meets these objectives is difficult to quantify and involves trade-offs that are outside the scope of Federal responsibility. This section reports on the quantity, age, and physical condition of transit assets because these factors determine how well the infrastructure can support any agency's objectives and set a foundation for uniform, consistent measurement. The assets in question include vehicles, stations, guideways, rail yards, administrative facilities, maintenance facilities, maintenance equipment, power systems, signaling systems, communication systems, and structures that carry both elevated and subterranean guideways. Chapter 4 addresses issues relating to the operational performance of transit systems.

The Federal Transit Administration (FTA) uses a numerical condition rating scale ranging from 1 to 5, detailed in *Exhibit 3-21*, to describe the relative condition of transit assets. A rating of 4.8 to 5.0, 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 1.0 to 1.9, or "poor," indicates that the asset needs immediate repair and is not capable of supporting satisfactory transit service.

Exhibit 3-21

Definitions of Transit Asset Conditions

Rating	Condition	Description
Excellent	4.8–5.0	No visible defects, near new condition.
Good	4.0–4.7	Some slightly defective or deteriorated components.
Adequate	3.0–3.9	Moderately defective or deteriorated components.
Marginal	2.0–2.9	Defective or deteriorated components in need of replacement.
Poor	1.0–1.9	Seriously damaged components in need of immediate repair.

Source: Transit Economic Requirements Model.

FTA uses the Transit Economic Requirements Model (TERM) to estimate the conditions of transit assets. This model consists of a database of transit assets and deterioration schedules that express asset conditions principally as a function of an asset's age. Vehicle condition is based on an estimate of vehicle maintenance history and major rehabilitation expenditures in addition to vehicle age; the conditions of wayside control systems and track are based on an estimate of use (revenue miles per mile of track) in addition to age. For the purposes of this report, the state of good repair was defined using TERM's numerical condition rating scale. 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 condition rating value of 2.5 (the mid-point of the marginal range). 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 **State of Good Repair benchmark** presented in Chapter 8 represents the level of investment required to attain and maintain a state of good repair by rehabilitating or replacing all assets with estimated condition ratings that are less than this minimum condition value.

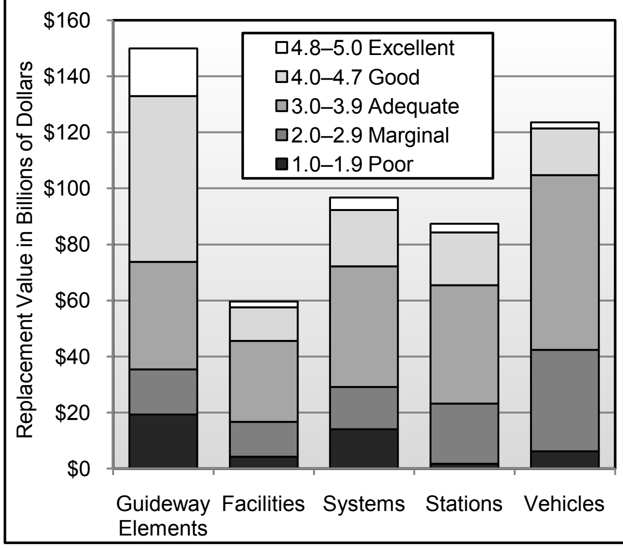
Typical deterioration schedules for vehicles, maintenance facilities, stations, train control systems, electric power systems, and communication systems have been estimated by FTA through special on-site engineering surveys. Transit vehicle conditions also reflect the most recently available information on vehicle age, use, and level of maintenance from the National Transit Database (NTD); the information used in this edition of the C&P report is from 2008. Age information is available on a vehicle-by-vehicle basis from the NTD and collected for all other assets through special surveys. Average maintenance expenditures and major rehabilitation expenditures by vehicle are also available on agency and modal bases. For the purpose of calculating conditions, agency maintenance and rehabilitation expenditures for a particular mode are assumed to be the same average value for all vehicles operated by that agency in that mode. Because agency maintenance expenditures may fluctuate from year to year, TERM uses a 5-year average.

The deterioration schedules applied for track and guideway structures are based on special studies. The methods used to calculate deterioration schedules and the sources of the data on which deterioration schedules are based are discussed in Appendix C.

Condition estimates in each edition of the C&P report are based on contemporary updated asset inventory information and reflect updates in TERM's asset inventory data. Annual data from the NTD were used to update asset records for the Nation's transit vehicle fleets. In addition, updated asset inventory data were collected from more than 40 of the Nation's largest rail and bus transit agencies to support analysis of non-vehicle needs. Since this data is not collected annually it is not possible to provide accurate time series analysis of non-vehicle assets. FTA is working to develop improved data in this area. Appendix C provides a more detailed discussion of TERM's data sources. *Exhibit 3-22* shows the distribution of asset conditions, by replacement value, across major categories of assets for the entire U.S. transit industry.

Exhibit 3-22

Distribution of Asset Physical Conditions by Asset Type for All Modes



Source: Transit Economic Requirements Model.

Condition estimates for assets in this report are weighted by the replacement value of each asset. This takes into account the fact that assets vary substantially in replacement value. So, a $1 million railcar in poor condition is a much bigger problem than a $1 thousand turnstile in similar condition. As an example of the calculation involved, consider: the cost-weighted average of a $100 asset in condition 2 and a $50 asset in condition 4 would be (100x2+50x4)/(100+50) = 2.67. The unweighted average would be (2+4)/2 = 3.

The Replacement Value of U.S. Transit Assets

The total replacement value of the transit infrastructure in the United States was estimated at $663.3 billion in 2008. These estimates, presented in *Exhibit 3-23*, are based on asset inventory information contained in TERM. The data collected for these efforts represent a significant improvement in data availability in terms of asset inventories and unit costs, and are significantly more comprehensive than data used in previous C&P reports. The estimates are reported in 2008 dollars. They exclude the value of assets that belong to special service operators that do not report to the NTD. Rail

Exhibit 3-23

Estimated Replacement Value of the Nation's Transit Assets, 2008

Transit Asset	Replacement Value (Billions of 2008 Dollars) Nonrail	Rail	Joint Assets	Total
Maintenance Facilities	$56.4	$33.2	$3.8	$93.4
Guideway Elements	$13.1	$234.5	$1.0	$248.6
Stations	$3.8	$84.8	$0.6	$89.1
Systems	$3.4	$107.5	$1.3	$112.2
Vehicles	$41.1	$78.5	$0.5	$120.1
Total	**$117.7**	**$538.6**	**$7.0**	**$663.3**

Source: Transit Economic Requirements Model.

assets totaled $538.6 billion, more than 80 percent of all transit assets. Nonrail assets were estimated at $117.7 billion. Joint assets totaled $7.0 billion; they consist of assets that serve more than one mode within a single agency and can include administrative facilities, intermodal transfer centers, agency communications systems (e.g., telephone, radios, and computer networks), and vehicles used by agency management (e.g., vans and automobiles).

Bus Vehicles (Urban Areas)

Bus vehicle age and condition information is reported according to vehicle type for 2000 to 2008 in *Exhibit 3-24.* The average condition rating for all bus types (calculated as the weighted average of bus asset conditions, weighted by asset replacement value) is near the bottom of the adequate range where it has been without appreciable change for the last decade. Average age is up slightly in all categories (except vans) as is

Exhibit 3-24

Urban Transit Bus Fleet Count, Age, and Condition, 2000–2008

Bus Fleet Component	2000	2002	2004	2006	2008
Articulated Buses					
Fleet Count	2,002	2,799	3,074	3,445	4,302
Average Age (Years)	6.6	7.2	5.0	5.3	6.3
Average Condition Rating	3.52	3.25	3.50	3.51	3.30
Below Condition 2.50 (Percent)	24.9%	16.6%	5.0%	2.1%	2.6%
Full-Size Buses					
Fleet Count	46,380	46,573	46,139	46,714	51,083
Average Age (Years)	8.1	7.5	7.2	7.4	7.9
Average Condition Rating	3.16	3.19	3.19	3.21	3.10
Below Condition 2.50 (Percent)	14.5%	13.1%	12.3%	11.3%	15.2%
Mid-Size Buses					
Fleet Count	7,203	7,269	7,114	6,844	7,009
Average Age (Years)	5.5	8.4	8.1	8.2	8.3
Average Condition Rating	3.44	3.11	3.13	3.08	3.06
Below Condition 2.50 (Percent)	8.3%	14.1%	13.2%	14.2%	12.4%
Small Buses					
Fleet Count	8,646	14,857	15,972	16,156	19,366
Average Age (Years)	4.2	4.5	4.6	5.1	5.1
Average Condition Rating	3.60	3.39	3.49	3.37	3.38
Below Condition 2.50 (Percent)	2.2%	8.8%	10.1%	10.3%	11.6%
Vans					
Fleet Count	14,583	17,147	18,713	19,515	26,823
Average Age (Years)	3.2	3.2	3.3	3.0	3.2
Average Condition Rating	3.84	3.74	3.75	3.77	3.76
Below Condition 2.50 (Percent)	0.2%	7.2%	6.7%	8.4%	8.0%
Total Bus					
Total Fleet Count	**78,814**	**88,645**	**91,012**	**92,674**	**108,583**
Weighted Average Age (Years)	6.5	6.2	6.0	6.0	6.2
Weighted Average Condition Rating	3.28	3.24	3.26	3.26	3.18
Below Condition 2.50 (Percent)	10.2%	11.8%	10.6%	10.4%	12.1%

Sources: Transit Economic Requirements Model and National Transit Database.

the percentage of vehicles below the state of good repair replacement threshold. For an asset with a 14-year life expectancy, like a full-size transit bus, structured asset management practices would typically indicate replacement of about 7 percent of fleet every year. About twice that many full-sized buses need replacement, with the result that the industry is slightly behind in keeping up with replacement needs.

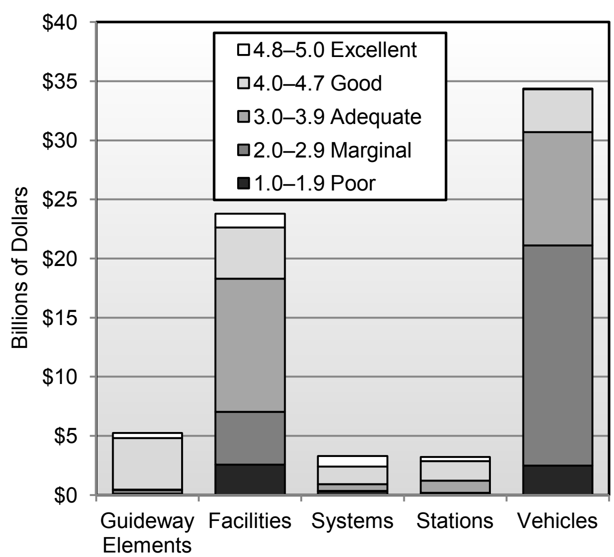
The number of vehicles reported is up 17 percent over the past 2 years—more growth than has been seen at any time in the last decade. This is particularly evident with articulated buses, whose numbers have grown by 25 percent. Discontinuities in the data for full-sized and mid-sized buses between 2000 and 2002 were caused by changes in the classification system that moved many older buses to the mid-sized category.

Other Bus Assets (Urban Areas)

The more comprehensive capital asset data described above allow us to report a more complete picture of the overall condition of bus-related assets. *Exhibit 3-25* shows TERM estimates of current conditions for the major categories of bus assets. Vehicles constitute half of all bus assets and maintenance facilities make up another third. Thirty percent of bus maintenance facilities are rated below condition 3.0. This finding stands in sharp contrast to the statistics for other types of U.S. bus transit assets, which show much lower percentages, and implies a major shortfall in reinvestment in such facilities. This is consistent with the common agency practice of prioritizing investments in "customer-facing" assets, such as vehicles, over those that customers never see, such as maintenance facilities.

Exhibit 3-25

Distribution of Estimated Asset Conditions by Asset Type for Bus



Source: Transit Economic Requirements Model.

Rail Vehicles

The NTD collects annual data on all rail vehicles; this data is shown in *Exhibit 3-26* broken down by the major categories of rail vehicle. With life expectancies in excess of 25 years, structured asset management practices would typically indicate replacement of about 4 percent of these vehicles annually, which is the amount currently seen in need of replacement (condition below 2.5). Even so, with these vehicles costing about $1 million each, and with a fleet of 23,463 vehicles, annual replacement costs should total about $1 billion. Because average conditions and ages have been quite stable over the last 5 years, the most significant aspect of this data is the recent growth in the vehicle fleet. The number of rail vehicles increased by 16 percent, in total and for each of the individual modes, between 2006 and 2008. This is the largest 2-year increase that has occurred over the past decade by far.

Exhibit 3-26

Urban Transit Rail Fleet Count, Age, and Average Estimated Condition Rating, 2000–2008

	2000	2002	2004	2006	2008
Commuter Rail Locomotives					
Fleet Count	576	709	710	740	991
Average Age (Years)	15.24	17.2	17.8	16.7	17.6
Average Condition Rating	4.51	3.72	3.72	3.98	3.89
Below Condition 2.50 (Percent)	5.7%	0.0%	0.0%	0.0%	0.0%
Commuter Rail Passenger Coaches					
Fleet Count	2,743	2,985	3,513	3,671	4,897
Average Age (Years)	17.49	19.2	17.7	16.8	17.7
Average Condition Rating	4.28	3.67	3.78	4.07	3.95
Below Condition 2.50 (Percent)	10.8%	0.0%	0.0%	0.0%	0.0%
Commuter Rail Self-Propelled Passenger Coaches					
Fleet Count	2,466	2,389	2,470	2,933	2,665
Average Age (Years)	25.24	27.1	23.6	14.7	17.9
Average Condition Rating	4.07	3.50	3.69	3.81	3.84
Below Condition 2.50 (Percent)	4.1%	0.0%	0.0%	0.0%	0.0%
Heavy Rail					
Fleet Count	10,028	11,093	11,046	11,075	12,759
Average Age (Years)	23.1	19.8	19.8	22.3	21.0
Average Condition Rating	3.21	3.39	3.35	3.28	3.34
Below Condition 2.50 (Percent)	4.8%	6.1%	5.6%	5.5%	6.1%
Light Rail					
Fleet Count	1,335	1,637	1,884	1,832	2,151
Average Age (Years)	15.8	17.85	16.5	14.6	17.1
Average Condition Rating	3.6	3.53	3.60	3.70	3.57
Below Condition 2.50 (Percent)	8.4%	11.8%	9.3%	6.4%	7.1%
Total Rail					
Total Fleet Count	**17,148**	**18,813**	**19,623**	**20,251**	**23,463**
Weighted Average Age (Years)	21.66	20.37	19.5	19.3	20.1
Weighted Average Condition Rating	3.53	3.47	3.51	3.55	3.47
Below Condition 2.50 (Percent)	6.0%	4.6%	4.1%	3.6%	4.0%

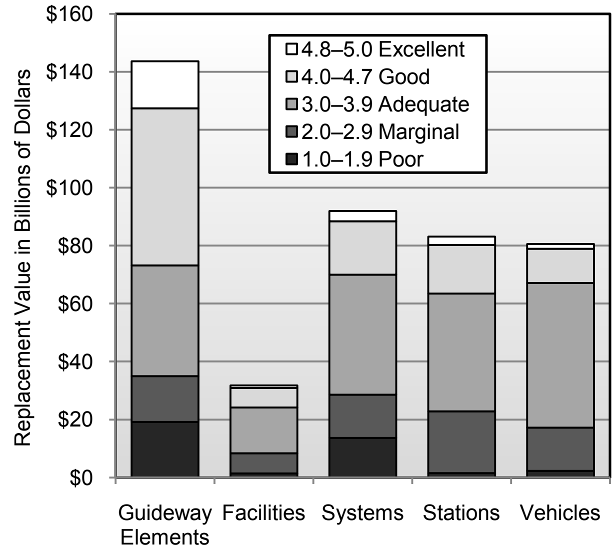
Sources: Transit Economic Requirements Model and National Transit Database.

Other Rail Assets

Non-vehicle transit rail assets can be divided into four general categories: guideway elements, facilities, systems, and stations. TERM estimates of the condition distribution for each of these categories as shown in *Exhibit 3-27*. The largest category by replacement value is guideway elements. These consist of tracks, ties, switches, ballasts, tunnels, and elevated structures. The replacement value of this category is $143.6 billion, of which $19.1 billion is rated below condition 2.0 (13 percent) and $15.8 billion is rated between condition 2.0 and 3.0. The next-largest category is systems, which consist of power, communication, and train control equipment. Assets in this category have a replacement value of $92.0 billion, of which $13.7 billion is rated below condition 2.0 (15 percent) and $18.9 billion is rated between condition 2.0 and 3.0. Stations have a replacement value of $83.0 billion with only $1.5 billion rated below condition 2.0 and $21.4 billion rated between condition 2.0 and 3.0. Facilities, mostly consisting of maintenance and administration buildings, have a replacement value of $31.8 billion with $1.4 billion rated below condition 2.0 and $6.9 billion rated between condition 2.0 and 3.0. The relatively large proportion of guideway and systems assets that are rated below condition 2.0, and the magnitude of the $38.2 billion investment required to replace them, represents a major challenge to the rail transit industry.

Exhibit 3-27

Distribution of Asset Physical Conditions by Asset Type for All Rail

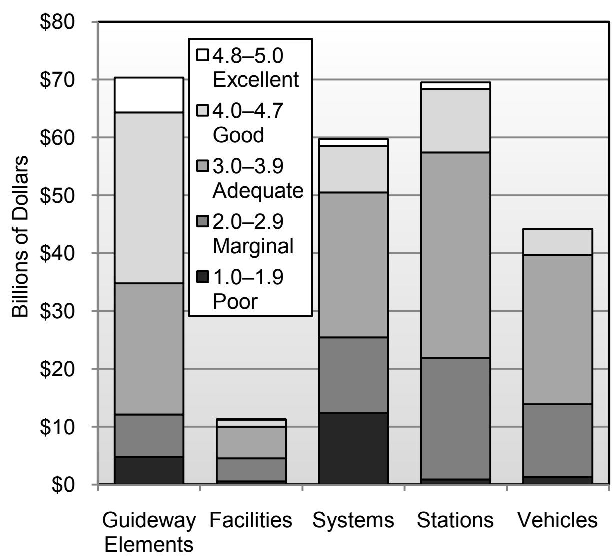


Source: Transit Economic Requirements Model.

Rail transit consists of heavy rail (urban dedicated guideway), light rail (operates in mixed traffic), and commuter rail (suburban passenger rail) modes. Almost half of rail transit vehicles are in heavy rail systems. Heavy rail represents $255 billion (59 percent) of the total transit rail replacement cost of $430 billion. Some of the Nation's oldest and largest transit systems are served by heavy rail (Boston, New York, Washington, San Francisco, Philadelphia, and Chicago). The distribution of asset conditions in U.S. heavy rail is shown in *Exhibit 3-28*. Most notable is the relatively larger proportion of the total replacement value that is in station and system assets and that 21 percent of system assets are rated below condition 2.0.

Exhibit 3-28

Distribution of Asset Physical Conditions by Asset Type for Heavy Rail



Source: Transit Economic Requirements Model.

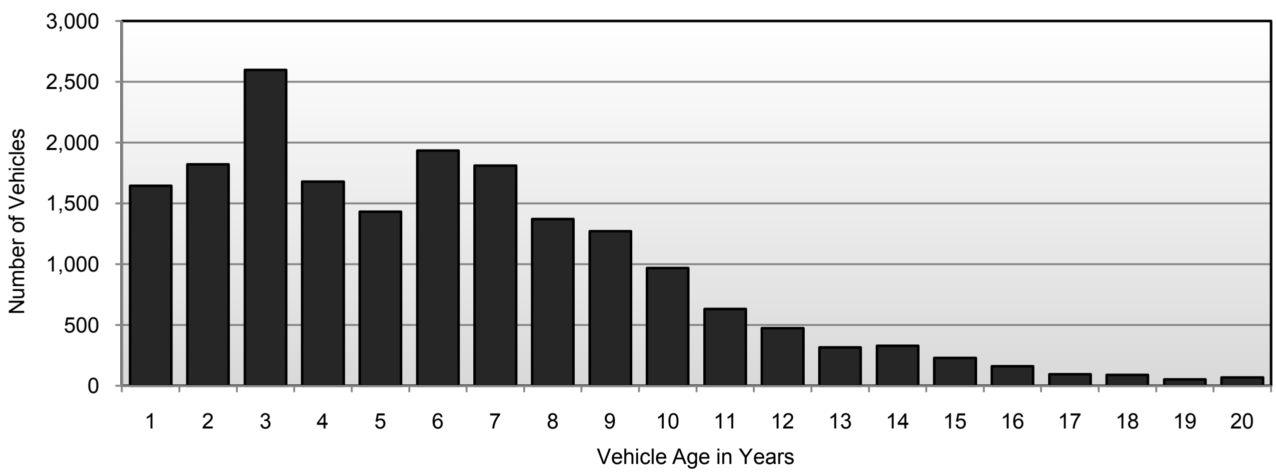
Rural Transit Vehicles and Facilities

Because rail transit does not serve rural areas, all rural transit vehicles are buses, vans, or other small passenger vehicles (see Chapter 2). Data on the number and age of rural vehicles and the number of maintenance facilities is now collected in the NTD, allowing FTA to report more accurately on rural transit conditions and on the 676 rural maintenance facilities that were reported. The age distribution of rural transit vehicles is summarized in *Exhibit 3-29*.

For 2008, data reported to the NTD indicated that 9.2 percent of rural buses and 19.2 percent of rural vans were past their life expectancy (14 years for buses and 8 years for vans). The rural transit fleet had an average age of 6.2 years in 2008; buses, with an average age of 6.3 years, were older than vans, which had an average age of 5.4 years. Half of the overall fleet was more than 5 years old.

Exhibit 3-29

Age of Rural Vehicles



Source: National Transit Database.