ROUGH ROADS AHEAD

FIX THEM NOW OR PAY FOR IT LATER

AASHTO
The Voice of Transportation

TRIP
a national transportation research group

What's Wrong with Our Roads?

Killer potholes. In a flash they can dislodge a hubcap, shred a tire, or even worse, cause a driver to lose control of a car. But they can also be a symptom of a much deeper problem —deteriorating pavement that takes much more to repair than a simple patch.

As fundamental as our transportation system is to our daily lives, our highways and bridges are aging, under-funded, and inadequate to meet the demands we place upon them today, much less in the future. And across America motorists are paying the price.

For state departments of transportation, preserving the condition and performance of the transportation system we have built is the top priority.

In Pennsylvania, for example, work will begin later this year on more than 240 projects to repair and improve 608 miles of highway and 399 bridges. The projects will be financed with $1 billion in federal economic-stimulus money combined with about $2 billion in federal and state funds. This represents the most the Pennsylvania Transportation Department has ever committed to construction in a single year.

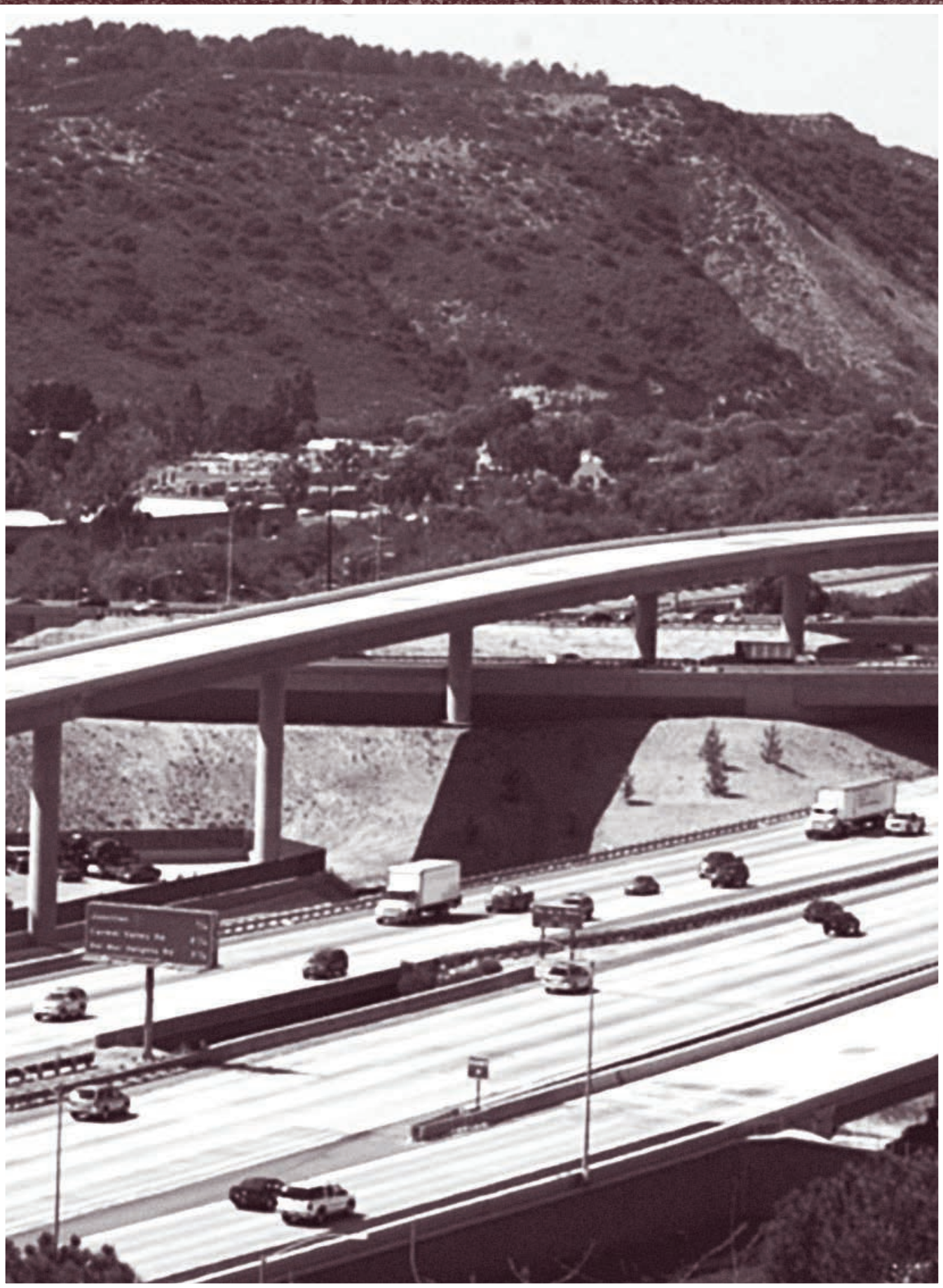
New technology, materials, and procedures are helping extend the life of our highways and bridges. States are also spending "smart" by making the investments needed to keep a road in good repair, rather than paying more later to address greater deterioration.

But the needs are enormous and poor-quality pavement is reflected in the increased operating costs that motorists must pay.

This report, developed by AASHTO in conjunction with TRIP, a national transportation research group, documents the preservation needs of the nation's highways and the solutions that can be applied. As we look to the next authorization of federal-aid surface transportation programs, rebuilding and improving our nation's core transportation infrastructure must be a fundamental goal.

Allen D. Biehler

Allen D. Biehler
Secretary, Pennsylvania Department of Transportation
President, AASHTO



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Rough Roads Ahead, Fix Them Now or Pay for It Later, is a joint product of AASHTO, the American Association of State Highway and Transportation Officials, and TRIP.

AASHTO is the "Voice of Transportation" representing State Departments of Transportation in all 50 states, the District of Columbia, and Puerto Rico. A nonprofit, nonpartisan association, AASHTO serves as a catalyst for excellence in transportation. TRIP is a national highway research group based in Washington, DC.

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Cover photo: Valerie Sinco

Executive Summary

ROUGH ROADS AHEAD: SAVING AMERICA'S HIGHWAYS

America's $1.75 trillion public highway system is in jeopardy. Years of wear and tear, unrelenting traffic, an explosion of heavy trucks, deferred maintenance, harsh weather conditions, and soaring construction costs have taken their toll on America's roads.

While the American Reinvestment and Recovery Act of 2009 will provide $27 billion for highway projects, that money will barely make a dent in highway maintenance, preservation, and reconstruction needs. The recent AASHTO *Bottom Line* report documented the need for all levels of government to invest $166 billion each year in highways and bridges. More than half of that amount would be needed for system preservation.

Saving America's highways demands more than short-term stimulus funds and quick fixes based on available funding. It will require a greater and smarter investment of transportation dollars to ensure a new and better transportation program.

A Snapshot of Rough Roads

- Only half of the nation's major roads are in good condition.
- One in four urban roads is in poor condition.
- Major urban centers have the roughest roads—some with more than 60 percent of roads in poor condition.
- Rural roads are in better condition than urban roads. In 2007, 60 percent of rural roads were in good condition.
- Overall, 72 percent of the Interstate Highway System is in good condition. But age, weather conditions, and burgeoning traffic—particularly multi-axle trucks—are eroding ride quality. In eight states, 20 percent of the Interstate highways were rated as mediocre or poor.

ROUGH ROADS LEAD TO HIGHER COSTS

Only half of the nation's major roads are in good condition, based on an analysis of recent Federal Highway Administration data. The situation is worse in high traffic, urban areas where one in four roads is in poor condition. In some major urban centers, more than 60 percent of roads are in poor condition.

The American public pays for poor road conditions twice—first through additional vehicle operating costs and then in higher repair and reconstruction costs. For the average driver, rough roads add $335 annually to typical vehicle operating costs. In urban areas with high concentrations of rough roads, extra vehicle operating costs can be as high as $746 annually.

Sustaining deteriorating roads costs significantly more over time than regularly maintaining a road in good condition. Costs per lane mile for reconstruction after 25 years can be more than three times the costs of preservation treatments over the same 25-year period.

CHALLENGES FACING AMERICA'S HIGHWAYS

Unrelenting traffic is tough on roads. Traffic growth has far outpaced highway construction, particularly in major metropolitan areas. The number of miles driven in this country jumped more than 41 percent from 1990 to 2007—from 2.1 trillion miles in 1990 to 3 trillion in 2007. Nearly 66 percent of that driving passed over urban roads, which are showing the most wear and tear. In some parts of the county, dramatic population growth

Courtesy of Missouri Department of Transportation.

has occurred without much of an increase in road capacity, placing enormous pressure on roads that, in many cases, were built 50 years ago.

Soaring construction costs during the past five years are straining state and local budgets. By the summer of 2008, asphalt prices were up 70 percent, concrete 36 percent, and steel 105 percent. Diesel fuel, used to operate heavy construction equipment, soared 305 percent, including a 63 percent jump in one year. Over time, these higher costs have eroded states' purchasing power on construction projects. In the past few months, however, the economic recession appears to have moderated some of these costs. In fact, many bids for stimulus projects are coming in below engineers' estimates.

The explosion of freight truck traffic is punishing aging highways. The Interstate system is bearing the brunt of truck traffic and showing the impact. Today, on average, every mile of Interstate highway sees 10,500 trucks a day. More than 80 percent of freight tonnage moving across the United States is carried by trucks driving on the 50-year-old Interstate system.

> "Managing a highway system is like playing chess. You have to look at the whole board, the whole system, not just the next move. Sure we do reactive things, but our best strategy is when we look down the road eight years or more, look at every section of road, and budget to keep those roads in good condition."
>
> —Gary Ridley, Director, Oklahoma Department of Transportation

Investment has not kept up with maintenance and preservation needs. Delayed and deferred maintenance leads to higher repair and reconstruction costs—pay me now or pay me more, lots more, later. Michigan DOT Director Kirk L. Steudle said, "It is important to slow the rate of decline in the good road so that it stays in good shape rather than slipping into fair or poor condition." Spending $1 to keep a road in good condition prevents spending $7 to reconstruct it once it has fallen into poor condition, he added. But soaring construction costs, tight budgets, and increasing needs make it hard for states to sustain preservation programs. That is why most states are using their stimulus funds to make up for lost time from deferred maintenance and preservation.

HIGHWAY MAINTENANCE NEEDS EXCEED AVAILABLE FUNDS

Keeping good roads in good condition is the most cost-effective way to save America's highways. But the needs are high and the available funding limited. For example:

- **Oregon** needs $200 million annually over the next 10 years to maintain roads at the current levels. It has $130 million available annually.
- **Texas** needs $73 billion during the next 22 years to maintain current conditions. The Department is spending $900 million per year and losing ground.
- **Rhode Island** needs $640 million annually to preserve its highway system and has only $354 million available each year.

Stimulus funds will fill in some of the gaps.

- **Oregon** will use half of its $224 million of stimulus funds for pavement resurfacing and preservation projects.
- **Texas** is spending $800 million in stimulus funds to stabilize pavement and bridge conditions for the next few years.
- **Rhode Island** will use its $137 million primarily for preservation and maintenance projects. The extra funds provide about 5 percent of the projected shortfall in preservation funds over the next 10 years.
- **South Dakota's** stimulus allocation will provide about one year's worth of preservation funding to help with the backlog of needs.



Courtesy of Pennsylvania DOT.

STRATEGIES FOR SAVING AMERICA'S HIGHWAYS

Use the best materials throughout the life of a road. From filling a pothole to reconstructing a major highway, using materials designed to meet specific climate and traffic conditions will extend the service life of a road and reduce costs over the long run. Research into new materials, constant monitoring of pavement conditions, and matching materials to traffic and weather conditions all contribute to long-term durability of a road.

Keep good roads good. Maintaining a road in good condition is easier and less expensive than repairing one in poor condition. Achieving that goal involves a carefully planned and consistently funded pavement preservation program that makes proactive improvements in good roads to keep them good. "You can spend too much time and money chasing after potholes while watching the system fall farther and farther behind," said Pennsylvania DOT Secretary Allen Biehler.

Create a multi-modal freight strategy. Ensuring that roads can handle the projected growth in freight-bearing trucks involves more than building sturdier roads. It will require a commitment to a multi-modal freight strategy that may include (1) building a network of dedicated truck lanes; (2) expanding rail capacity to sustain its share of freight movement; (3) fixing bottlenecks and reducing congestion in metropolitan areas; (4) improving conditions from ports and distribution centers to the Interstate and rail systems; and (5) a funding model that includes freight-related user fees to implement the strategy.

View highways as public assets to be managed rather than projects to be fixed. Asset management is a comprehensive approach to ensuring the most cost-effective return on investments for operating, maintaining, upgrading, and expanding transportation systems. It starts from the assumption that the nearly 4 million miles of public roads are a valuable national asset, essential to the vitality of the American economy.

Invest to save America's highways. When the Interstate system was first designed in the 1940s, lines were put on a map to describe the vision for a country connected by a network of limited access highways. "Planners said this is what we want it to look like. Now let's figure out how to pay for it," said Oklahoma DOT Director Ridley. "Now we work in the reverse. We say here's how much money we have, and let's decide what we want to do with that. That approach doesn't produce the best decisions." Rebuilding for the future requires a national commitment to significant and sustained investment in transportation infrastructure based on a vision of what we want our transportation system to look like in the 21st century and beyond.

It is time for a greater and smarter investment of transportation dollars to ensure a new and better transportation program.

Are we there yet? No—but we can be.

> "We as stewards of the transportation system have no choice but to drive home the message that maintaining an acceptable condition for our highways—preserving the system—is vital to our country's future."
>
> —Allen D. Biehler, AASHTO President;
> Secretary, Pennsylvania Department of Transportation

Highways to Everywhere

A well-connected highway system, maintained in good condition, is critical to the nation's economy. With a current value of $1.75 trillion, preserving the system of roads and highways so they last for generations and meet changing needs should be a top priority for all levels of government. Even with continued growth in public transit, enhanced rail services, and a national commitment to reduce greenhouse gas emissions from vehicles, roads remain a vital component of the system that moves people and goods throughout the country.

Roads are essential to everyday life.

- Nearly 24 million children—55 percent of the country's kindergarten through high school population—ride 450,000 school buses 180 days per year.
- Every year, 50,000 ambulances make 60 million trips—that is an average of 164,000 trips per day.
- A fire department responds in one or more vehicles to a fire alarm in the United States every 20 seconds.
- Trucks in the United States carry 32 million tons of goods valued at $25 billion every day.
- The country's 240 million registered vehicles travel more than 2.9 trillion miles annually.

Those vehicles, and the people who drive and ride in them, rely on the nation's nearly 4 million miles of public roads—from Interstate highways to neighborhood streets—to get somewhere to do something.

Highways are a backbone of American life, connecting people, goods, and services. But many roads, particularly in metropolitan areas and population growth centers, are in poor condition. Years of wear and tear, unrelenting traffic, an explosion of heavy trucks, weather conditions, and delayed maintenance because of tight budgets and soaring construction costs have taken their toll on America's roads.

Despite the recent downturn in travel in 2008, the number of miles driven on the nation's roadways has increased 41 percent from 1990 to 2007. Large commercial truck traffic, which places significant stress on pavements, has increased 50 percent during the same time frame.

In some parts of the country, dramatic population growth with minimal capacity expansion has placed enormous pressure on highways. For example, in Utah, between 1990 and 2007, population grew by 47 percent and miles driven by 71 percent—but highway capacity grew by only 4 percent.[1]

Transportation officials across the country are focusing on how to preserve and protect their part of this national asset by building smarter, investing in systematic maintenance programs, and using new technologies to produce longer-lasting roads.

This report examines the condition of America's roads and what it will take to save them.

THE NATION'S HIGHWAYS BY THE NUMBERS

Total miles of public roads—3,967,159

Total miles of roads by ownership
- Federal—128,378 miles (3.2 percent)
- State—783,643 miles (19.8 percent)
- Local—3,055,138 miles (77 percent)

Total miles of rural and urban roads
- Rural - 2,939,042 (74 percent)
- Urban - 1,028,107 (26 percent)

Total Interstate Highway miles—47,000

Annual miles driven in cars and trucks—2.9 trillion

Percent of miles driven on urban roads—65.6 percent

Tons of freight moved on America's highways annually—15 billion

Early History of United States Road Building

1625 Earliest known paved American road—Pemaquid, Maine

1795 First engineered American road—Philadelphia to Lancaster toll turnpike

1823 First macadam road constructed in America—Maryland

1872 First asphalt paved roads in North America—Pennsylvania Avenue in Washington, DC, and Fifth Avenue in New York, NY

1893 First rural brick road—Ohio

1906 First bituminous macadam road—Rhode Island

Hammond Surface Streets, Hammond, Indiana

Courtesy of Missouri DOT.

PennDOT workers power wash a bridge structure. Keeping the expansion areas and joints of bridges free of debris and salt accumulation from winter services is a critical maintenance function.

Courtesy of Pennsylvania DOT.

Chapter 1

Rough Roads—Facing the Facts

Potholes are the poster child for rough roads. They are a nuisance, a source of wear and tear on vehicle suspensions and tires, and a safety risk. They can also be indicators of serious road deterioration.

The traveling public values smooth roads. In addition to ride quality, smooth roads improve fuel efficiency, reduce vehicle wear and tear, improve driver safety, and last longer. But how smooth a road needs to be to keep the public happy can vary widely.

The Missouri Department of Transportation (MoDOT) relied on public opinion to shape its Smooth Roads Initiative. Key elements of the Missouri Smooth Roads Initiative were:

- SMOOTHER—pavements were resurfaced, where needed.
- SAFER—striping and delineation improvements were made at all sites in the program.
- SOONER—the entire program for improving 2,300 miles of roadway was completed in only two years.

MoDOT Director Pete K. Rahn said citizen input helped set priorities for transportation investments. "For example, we thought mowing all rights of ways regularly was very important. The citizens told us it wasn't a high priority for them," Rahn said.

Nearly 900 citizens participated in a series of road rallies to help the state determine how rough was too rough. Citizens rode in vans with a moderator who tracked their comments as they assessed ride quality along the way.

"What we thought was a rough ride sometimes wasn't," Rahn said. "We plan to use a second round of van assessments for our continuing smoothness program."

The program was launched after voters passed an initiative by a 4 to 1 margin to fund improvements in the state's highway system. Phase I improved 2,300 highway miles that account for 60 percent of all traffic on the state system, producing an 18 percent increase in Interstate smoothness over a two-year period. Phase II—Better Roads, Brighter Future—is addressing the remainder of the state's 5,600-mile major highway system. The goal is to bring 85 percent of Missouri's major highway system up to good condition.

> "A pothole is like a tooth cavity. Left untreated it gets more decayed, more painful, takes more time and money to care for, and sometimes you end up having to urgently call in a specialist. But like cavities, potholes can be prevented."
>
> "The Fine Art of Pothology: Preventing and Repairing Potholes"
> *Better Roads*, March 2009

RATING YOUR RIDE

States generally use the International Roughness Index (IRI) to rate road conditions. Those ratings are used to monitor pavement performance and schedule maintenance and rehabilitation plans. Roads with low IRI ratings are the smoothest. Roads with higher IRI ratings are likely to have cracked or broken pavements and may show significant distress in their underlying foundations.

To get a national perspective on road conditions, the Federal Highway Administration (FHWA) collects data from states annually and summarizes ride conditions using four categories—good, fair, mediocre, and poor. The categories are based partly on a study that measured driver reactions to various road conditions.[2]

Here's what the most recent data shows:

- Only half of the nation's major roads—Interstates, freeways, and other major routes—are in good condition. Unfortunately, 13 percent are in poor condition.
- Rural roads are smoother and in better condition than urban roads. In 2007, 61 percent of rural roadways were in good condition.
- Overall, 72 percent of the Interstate Highway System is rated in good condition. But, age, weather conditions, and burgeoning traffic are eroding ride quality in many states. In eight states, more than 20 percent of the Interstate highways were rated as mediocre or poor.
- One in four urban roads—which carry the brunt of national traffic—are in poor condition.
- Road conditions in urban areas actually improved between 2002 and 2006, but declined in 2007, when 26 percent were reported in poor condition. Factors that may have contributed to a higher percentage of rough roads include aging of urban roads, unrelenting traffic, heavier trucks carrying freight loads, and deferred or delayed maintenance because of tight budgets and soaring construction costs.[3]
- Major urban centers have the roughest roads—more than 60 percent of the roads in the Los Angeles, San Jose, San Francisco-Oakland, and Honolulu areas provide a poor-quality ride.[4]

Pavement Conditions of Urban and Rural Arterial Highways in 2007

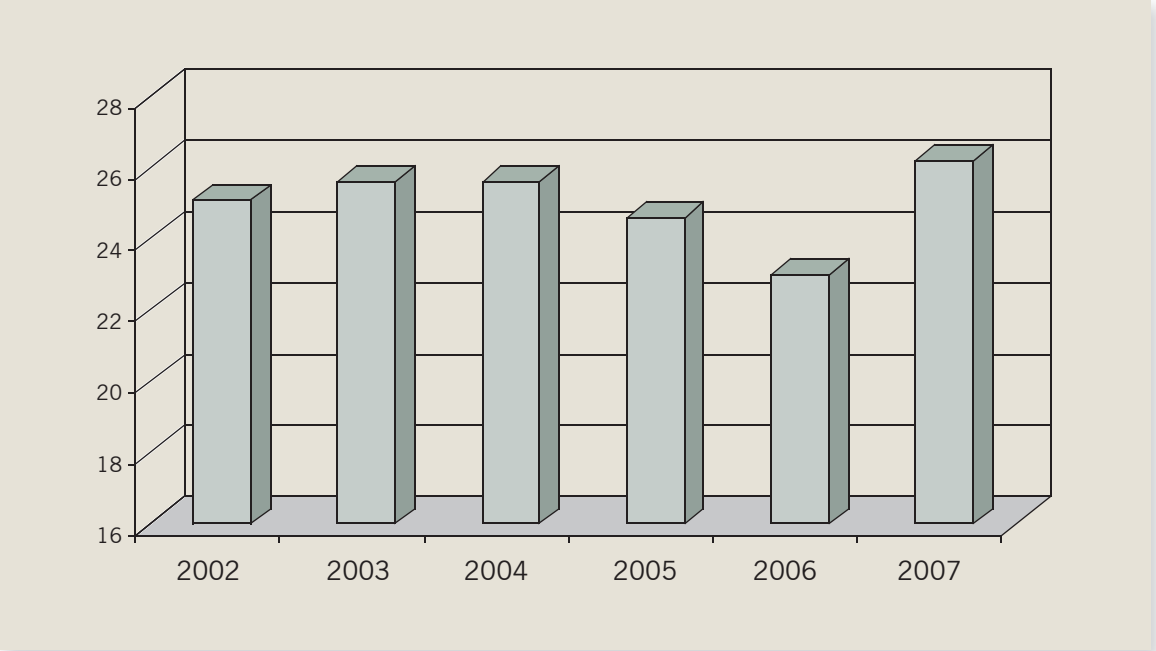
	Rural	Urban	All Major Roads
Poor	4%	26%	13%
Mediocre	15%	27%	20%
Fair	20%	11%	16%
Good	61%	36%	51%

Source: TRIP analysis of FHWA data.

URBAN ROADS MOST TRAVELED

The condition of the nation's major urban roadways is of particular concern to the nation's motorists because these roads and highways are the most heavily traveled in the nation. In 2007, 66 percent of the nation's vehicle travel was carried by its urban roads and highways.[5]

Percentage of Major Urban Roads with Pavements in Poor Condition, 2002 to 2007



Source: TRIP analysis of Federal Highway Administration data.

Although road deterioration is often accelerated by freeze-thaw cycles found most often in the nation's northern states, the urban areas with the highest share of poor pavement conditions in the nation actually include urban areas from a variety of regions.

Urban areas (population 500,000 or more) with highest share of roads in poor condition, 2007

Includes state, city, and county arterial networks in cities and surrounding suburbs

Urban Area	Pct. Poor
Los Angeles	64
San Jose	61
San Francisco - Oakland	61
Honolulu	61
Concord, CA	54
New York - Newark	54
San Diego	53
New Orleans	49
Tulsa	47
Palm Springs - Indio, CA	47
Riverside - San Bernardino, CA	44
Baltimore	44
Sacramento	44
Omaha	41
Oklahoma City	41
San Antonio	38
Mission Viejo, CA	37
Albuquerque	36
Philadelphia	36
Detroit	36

Source: TRIP analysis of Federal Highway Administration data.

Road conditions for urban areas with populations of 500,000 or greater can be found in appendix A. Road condition data for urban areas with populations from 250,000 to 499,000 can be found in appendix B.

Courtesy of National Concrete Pavement Technology Center.

THE COST OF ROUGH ROADS

The American public pays for poor pavement conditions twice—first through additional vehicle operating costs, and then in higher costs to restore pavement to good condition.

Driving on rough roads accelerates vehicle depreciation, reduces fuel efficiency, and damages tires and suspension. TRIP estimates that for the average driver, rough roads add $335 annually to typical vehicle operating costs. In urban areas with high concentrations of rough roads, extra vehicle operating costs are as high as $746.[6] Generally, larger vehicles have a greater increase in operating costs due to rough roads.

This cost estimate is developed using a model that factors in average number of miles driven annually and AAA's 2008 vehicle operating cost data.[7] Research on the impact of road conditions on fuel consumption by the Texas Transportation Institute (TTI) is also factored into the methodology.[8]

Urban Areas with Highest Additional Vehicle Operating Costs Due to Rough Roads, 2007

Includes cities and surrounding suburbs with populations of 500,000 or more

Urban Area	Additional Costs
Los Angeles	$746
San Jose	$732
San Francisco - Oakland	$705
Tulsa	$703
Honolulu	$688
San Diego	$664
Concord, CA	$656
New York - Newark	$638
Riverside - San Bernardino, CA	$632
Oklahoma City	$631
Sacramento	$622
New Orleans	$622
Palm Springs - Indio, CA	$608
Omaha	$592
Baltimore	$589
Albuquerque	$576
Mission Viejo, CA	$571
San Antonio	$529
Detroit	$525
Philadelphia	$525

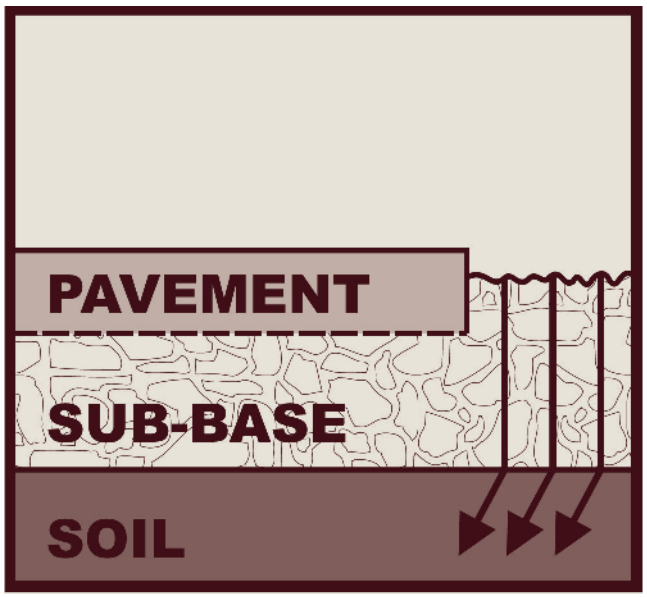
Source: TRIP analysis based on Federal Highway Administration data.

A STITCH IN TIME

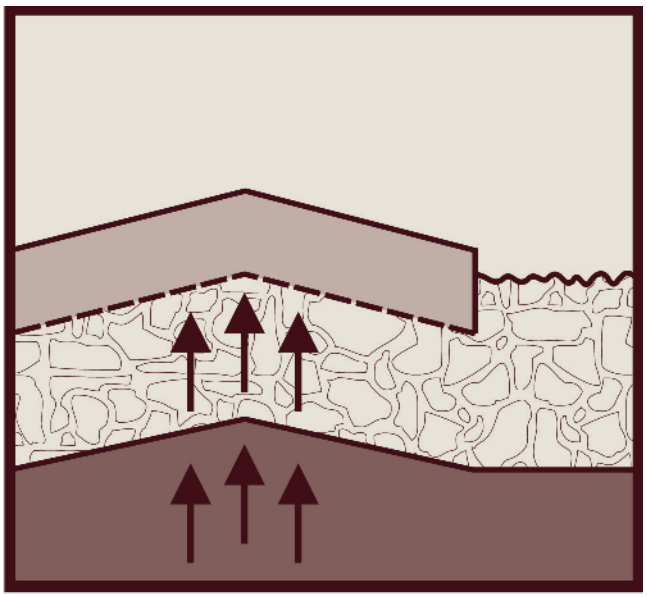
Age, weather, moisture, traffic, heavy trucks, and delayed maintenance cause roads to deteriorate. Old roads eventually wear out—particularly ones that were built 50 or more years ago with less sophisticated construction materials and lower traffic expectations. Moisture, freezing, thawing, and poor drainage also contribute to cracks, ruts, potholes, and foundation deterioration.

Potholes form when moisture from rain or snow works its way into road surfaces and the foundation bed, creating openings and cracks in the pavement that gradually grow larger as traffic passes over the surface. Road surfaces at intersections are especially vulnerable, since slow-moving, stopping, or starting traffic—particularly heavier vehicles—causes higher levels of pavement stress.

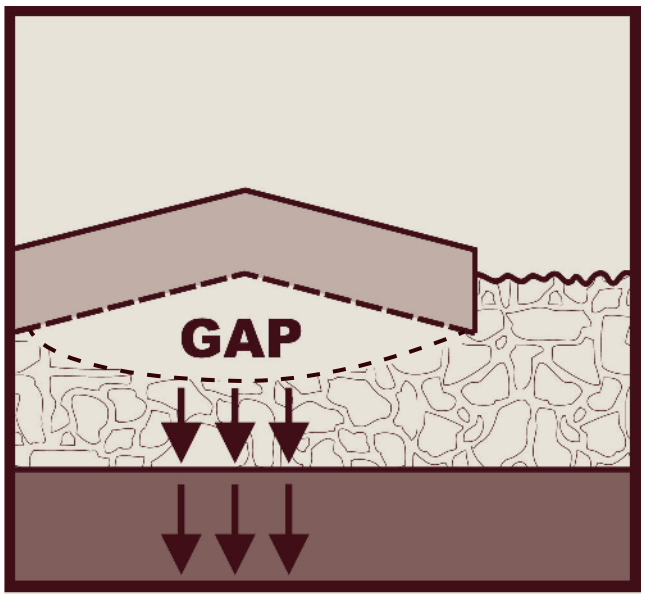
BIRTH OF A POTHOLE



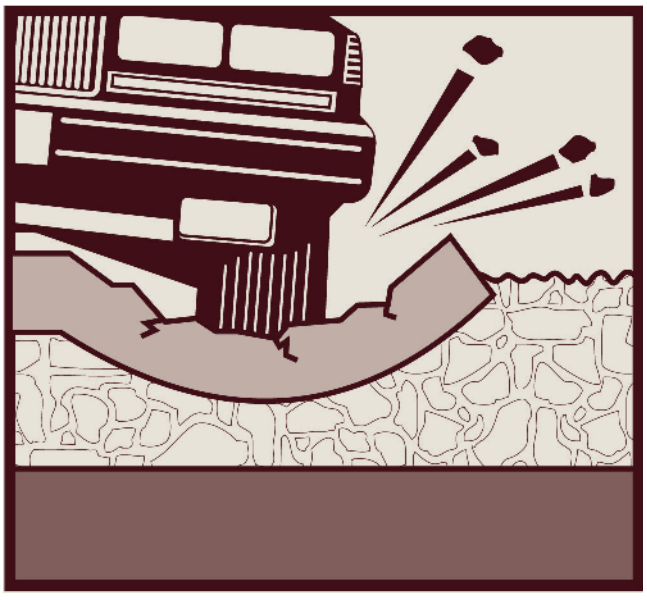
Potholes begin after rain or snow seeps into cracks and down into the soil below the road surface. The soil turns into mud and with no support, a hole can form under the pavement.



Repeated freezing and thawing or heavy traffic causes the ground to expand, pushing the pavement up.



As temperatures rise, the ground returns to a normal level but the pavement often remains raised. This creates a gap, or hollow space between the pavement and the ground below it.



When vehicles drive over this cavity, the pavement surface cracks and falls into the hollow space, leading to the birth of another pothole.

Courtesy of Michigan Department of Transportation.

Roads have five life cycle stages from initial design to disintegration and failure. Actions taken at each stage can affect the long-term durability of the road as well as maintenance and preservation costs. Higher quality investments earlier in the life of the road will save money over the long run because maintaining a road in good condition is less expensive than repairing or rebuilding one in poor condition.[9]

Reconstructing a road that has reached Stage 5 costs significantly more than preserving a road at Stage 3.

Life Cycle of a Road

1 **Design**—This stage deals with dimensions, type of materials, thickness of base and top surfaces, and the drainage system. Investments made at the design stage affect the long-term durability of the pavement surface. If, however, sufficient funding is not available to upgrade the design, the road starts out and stays mediocre.

2 **Construction**—A high-quality construction process produces a longer-lasting pavement surface.

3 **Initial Deterioration**—During the first few years of use, the road surface starts to experience some initial deterioration caused by traffic volume, rain, snow, solar radiation, and temperature changes. At this stage, the road appears in good condition, providing a smooth ride. Preservation strategies during Stage 3 will sustain the smooth ride, preserve the foundation, extend the life, and reduce the need for costly reconstruction later on.

4 **Visible Deterioration**—At Stage 4, visible signs of distress such as potholes and cracking occur. Repairs made at this stage using overlays and milling to eliminate ruts will restore a smooth ride and extend the life of the road.

5 **Disintegration and Failure**—Roads not maintained at Stage 3 and repaired at Stage 4, eventually will fail and need costly reconstruction. Once a road's foundation disintegrates, surface repairs have an increasingly short life.



Courtesy of Pennsylvania DOT

HOW ARE PAVEMENT CONDITIONS RATED?

Every year the Federal Highway Administration (FHWA) gathers data on the condition of the nation's major roads, including those maintained by federal, state, or local governments. This report presents the conditions on all arterial routes, including Interstates and limited-access freeways, as well as other major streets and routes within and between urban areas. Most of these routes have at least four lanes, although some key two-lane urban and rural roads, classified as "arterial routes" are included.

RATING YOUR RIDE

States use the International Roughness Index (IRI) to rate road conditions, although some also rate by the Present Serviceability Rating (PSR). The FHWA compiles these data to create an assessment of pavement conditions, rating the roads as poor, mediocre, fair, or good.

The FHWA findings are based partly on a study that measured driver reactions to various road conditions to determine what level of road roughness was unacceptable to most drivers.[10]

Drivers on roads rated as poor are likely to notice that they are driving on a rougher surface, which puts more stress on their vehicles. Roads rated as poor may have cracked or broken pavements. These roads often show significant signs of pavement wear and deterioration and may also have significant distress in their underlying foundation. Road or highway surfaces rated poor provide an unacceptable ride quality and are in need of resurfacing and some need to be reconstructed to correct problems in the underlying surface.

Roads rated as being in either mediocre or fair condition may also show some signs of deterioration and may be noticeably inferior to those of new pavements, but can still be improved to good condition with cost-effective resurfacing or other surface treatments, which will extend the roads' service life.

The FHWA has found that a road surface with an IRI rating below 95 provides a good ride quality and is in good condition; a road surface with an IRI from 95 to 119 provides an acceptable ride quality and is in fair condition; a road surface with an IRI from 120 to 170 provides an acceptable ride quality and is in mediocre condition; and a road with an IRI above 170 provides an unacceptable ride quality and is in poor condition.[11]

> "There is a point in the life of a road where you spend more money for less result. It is like a homeowner who knows he needs a new roof, but keeps patching it to save money. You end up spending way more money patching than it would take to install a new roof—or build a new highway."
>
> —Pete K. Rahn, Director, Missouri Department of Transportation

Pavement Conditions by State, 2007

Includes all Arterial Routes, including Interstates, freeways, and major urban routes

State	Percentage			
	Poor	Mediocre	Fair	Good
Alabama	4	12	11	73
Alaska	18	28	26	28
Arizona	7	14	12	68
Arkansas	9	23	30	38
California	35	31	16	18
Colorado	8	24	24	44
Connecticut	14	33	18	34
Delaware	10	17	29	44
Florida	2	11	10	76
Georgia	0	4	3	92
Hawaii	27	44	19	10
Idaho	11	14	18	57
Illinois	14	20	20	46
Indiana	11	18	15	56
Iowa	18	23	18	41
Kansas	10	5	9	75
Kentucky	3	16	26	55
Louisiana	22	22	17	38
Maine	10	19	17	54
Maryland	26	18	14	42
Massachusetts	18	23	12	47
Michigan	18	19	12	51
Minnesota	10	22	22	47
Mississippi	17	23	18	42
Missouri	16	18	27	39
Montana	3	8	13	76
Nebraska	7	17	14	62
Nevada	5	8	6	81
New Hampshire	13	14	13	60
New Jersey	46	32	13	10
New Mexico	10	12	15	64
New York	22	24	18	35
North Carolina	9	18	24	49
North Dakota	5	20	18	57
Ohio	8	17	16	59
Oklahoma	21	19	20	40
Oregon	4	14	20	62
Pennsylvania	15	29	23	33
Rhode Island	32	36	15	18
South Carolina	7	21	21	51
South Dakota	15	19	15	51
Tennessee	6	11	12	71
Texas	11	21	27	41
Utah	4	25	20	51
Vermont	15	25	15	45
Virginia	6	17	31	46
Washington	11	22	14	53
West Virginia	8	29	21	42
Wisconsin	9	21	17	53
Wyoming	4	14	27	55
U.S. Average	**13%**	**20%**	**16%**	**51%**

Source: TRIP analysis based on Federal Highway Administration data

Additional Vehicle Operating Costs Due to Rough Roads, by State, 2007

State	Additional Costs
Alabama	$162
Alaska	$324
Arizona	$207
Arkansas	$302
California	$590
Colorado	$292
Connecticut	$313
Delaware	$282
Florida	$126
Georgia	$44
Hawaii	$503
Idaho	$318
Illinois	$297
Indiana	$242
Iowa	$383
Kansas	$318
Kentucky	$187
Louisiana	$388
Maine	$250
Maryland	$425
Massachusetts	$301
Michigan	$370
Minnesota	$347
Mississippi	$394
Missouri	$410
Montana	$195
Nebraska	$278
Nevada	$227
New Hampshire	$250
New Jersey	$596
New Mexico	$279
New York	$405
North Carolina	$251
North Dakota	$238
Ohio	$209
Oklahoma	$457
Oregon	$166
Pennsylvania	$346
Rhode Island	$473
South Carolina	$262
South Dakota	$319
Tennessee	$180
Texas	$336
Utah	$176
Vermont	$308
Virginia	$249
Washington	$266
West Virginia	$280
Wisconsin	$281
Wyoming	$230
United States	$335

Source: TRIP



Courtesy of Mississippi DOT.

PennDOT workers engage in crack sealing to keep moisture from penetrating beneath the road surface. In Pennsylvania, which has a vigorous freeze-thaw cycle each winter, keeping moisture out of the area beneath road surfaces is a critical maintenance step.

Courtesy of Pennsylvania DOT.

Chapter 2

Investing to Save America's Highways

Building for the future requires a national commitment to significant and sustained investment in transportation infrastructure.

"In the end, everything ties back to money, and we need to invest enough to preserve this important asset," said Oklahoma DOT Director Gary Ridley.

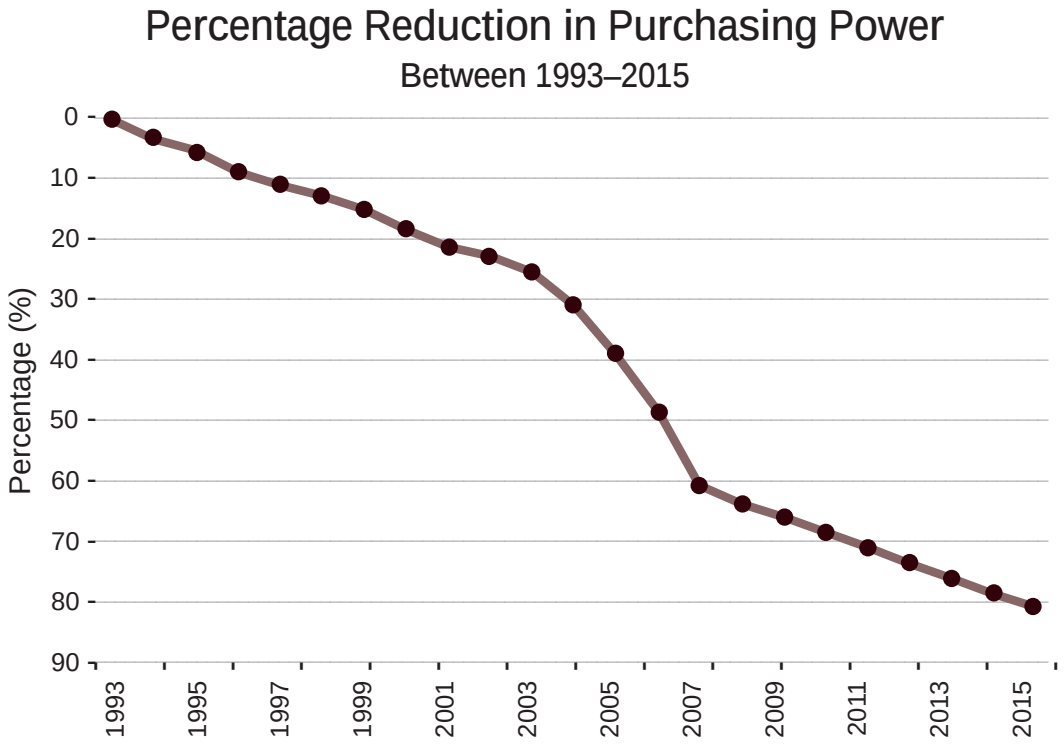
But the needs are high:

- The **Oregon DOT** needs $200 million per year to maintain current performance levels over the next 10 years compared with a current investment level of $130 million.
- The **Texas DOT** estimates that $73 billion will be required during the next 22 years to maintain current conditions. Today, the department is spending $900 million per year and losing ground. Officials say each one percent drop in good or better pavement condition is another 1,900 lane miles to fix and an additional $760 million in needs.
- The **Rhode Island DOT** needs $639.5 million annually to preserve its highway system. The state has only $354 million available each year to meet the need—leaving an annual funding gap of $285 million.
- **Alabama** needs an immediate investment of $1.4 billion to bring about 4,000 miles of deficient roadways to an adequate performance level. For Interstates, 70 miles must be resurfaced each year to maintain current levels at a cost of $140 million per year. The FY 2009 Interstate maintenance appropriation is $120 million.
- The **Pennsylvania DOT** pegs its need at $2.19 billion per year to maintain the entire state highway system at desired preservation cycles. That estimate does not include the current backlog of substandard pavements.

> "Envision a future with more transportation choices and efficiency than ever before. The stranglehold of congestion will be loosened by driving shorter distances, riding transit, and better utilizing our highways. Strategic investment in new lanes, new corridors, and new capacity for all modes will remove bottlenecks and connect America and the world."
>
> *Transportation: Invest in Our Future*
>
> American Association of State Highway and Transportation Officials, 2007

- The **Nebraska Department of Roads** estimates it will need $270 million annually to preserve its highway system. Faced with declining revenue and growing needs, NDOR decided to make asset preservation its top priority to keep roads and bridges at current performance levels. No funding will be allocated to capital improvements until all preservation needs have been met.

Soaring construction costs during the past five years are further straining highway investment budgets. Asphalt prices are up 70 percent; concrete 36 percent; steel 105 percent; and diesel fuel, which is used to operate heavy construction equipment, soared by 305 percent including a 63 percent jump in one year.[12] While price trends have leveled as a result of the economic downturn, overall the purchasing power of a transportation dollar will have declined by 80 percent from 1993 to 2015.



THE BOTTOM LINE FOR INVESTMENT

Research conducted for the American Association of State Highway and Transportation Officials (AASHTO) concludes that the average requirement for ***all*** capital investments for highways and bridges is $166 billion ***annually*** through 2015. Other recent national studies commissioned by Congress project annual investment needs of similar magnitude, ranging from $130 billion to $240 billion though 2020. These levels are significantly higher than the $78 billion invested in highway capital improvements by all levels of government in 2006. According to the 2006 *Conditions and Performance Report* by the U.S. Department of Transportation, some 52 percent (or $36.4 billion) of transportation capital spending by all levels of government in 2004 was dedicated to system rehabilitation.

STIMULUS PROVIDES SHORT-TERM RELIEF

Inadequate levels of transportation funding have resulted in an immense backlog of "ready-to-go" but unfunded projects in the states. A December 2008 AASHTO survey identified more than 5,000 projects valued at $64 billion that states could have underway within 180 days.

In February 2009, President Barack Obama signed the American Reinvestment and Recovery Act of 2009 that provided $48 billion for transportation infrastructure as a means of stimulating the nation's severe economic decline. Of that amount, $27.5 billion was made available for highway projects.

"Because of the need to push money into the economy through job creation, states have applied a good share of their funding for the backlog of preservation needs," said AASHTO Executive Director John Horsley. "Resurfacing projects, for example, extend the life of highways, and can be implemented very quickly to benefit many areas of a state," he explained.

The **South Dakota DOT** said the stimulus money will provide about one year's worth of preservation funding to help with its backlog of needs. "Although this helps in the short-term, it is not a long-term solution," said South Dakota DOT Director of Planning and Engineering Joel M. Jundt.

Virtually all of the **Rhode Island DOT's** $137 million in economic recovery funding is devoted to preservation and maintenance projects—resurfacing, bridge rehabilitation, striping, guardrail, and traffic projects. The extra funds represent about 50 percent of the state's funding shortfall for 2009—or about five percent of the shortfall for the next 10 years.

The **Idaho DOT** is using its stimulus allocation to pay for projects that would not be possible without extra federal funding. The projects include major highway widening, bridge replacement/relocation/realignment, and pavement restoration.

The $431 million that the **Maryland DOT** received will help offset some of the $1.3 billion cut from the state's highway capital program. The funds will be used primarily to keep roads in the best shape possible until the economy and federal and state revenues recover.

The **Alabama DOT** will spend $225 million on system preservation projects on non-Interstate routes, $70 million for an Interstate reconstruction project, and $8 million for bridge replacement and widening.

The **Texas DOT** is using a significant part of its stimulus funds to get its pavement preservation program back on track after three years of losing ground. Overall, pavement conditions in Texas were improving when the state spent $1.7 billion per year for rehabilitation and maintenance. Today, Texas spends about $900 million per year and has not been able to keep up with needed investments. Eight hundred million dollars in stimulus funds will help Texas stabilize pavement and bridge conditions for the next few years.

> "Resurfacing projects extend the life of highways, and can be implemented very quickly to benefit many areas of a state."
>
> —John Horsley, Executive Director, AASHTO

Courtesy of Alabama DOT.

Quick action by the Florida DOT and FHWA enabled replacement of the I-10 Escambia Bay Bridge on an accelerated schedule after it was destroyed in a 2004 hurricane.

Courtesy of Florida DOT.

Chapter 3

The Interstate System—An Aging Economic Engine

The Interstate Highway System has made a dramatic difference in how people and goods move across the country. The 47,000-mile system saves time, money, and lives, and has played a critical role in improving business productivity.

Construction of the Interstate system created jobs and produced new roads that expanded mobility for Americans. More importantly, the Interstate system helped create and continues to sustain the economy that has grown during the last 50 years.

"The initial investment in jobs during construction of the Interstate is far overshadowed by the economy that grew over the past 50 years as a direct result of that construction," said Gary Ridley, Director, Oklahoma Department of Transportation. "That's why preserving this asset is essential to our economic future."

TRAFFIC AND TRUCKS CAUSE WEAR AND TEAR

Although most Interstate highways today provide a good quality ride, the system is showing its age largely because of dramatic growth in car and truck traffic.

The 47,000 miles of Interstate highway represent only one percent of total highway mileage in the United States, but carry 24 percent of all traffic. Traffic growth during the past 50 plus years has far outpaced any growth projections made during the initial planning stages.

Much of the increase is due to truck traffic. On average, every mile of the Interstate system sees 10,500 trucks a day. By 2035, that number is expected to double, increasing to 22,700 trucks a day for each mile of Interstate highway.[13]

The surge in truck traffic on Interstate highways and its impact on traffic and road conditions are major factors in assessing the future of the Interstate Highway System. When construction began in the 1950s, the U.S. econ-

> "Our unity as a nation is sustained by free communication of thought and by easy transportation of people and goods. The ceaseless flow of information throughout the Republic is matched by individual and commercial movement over a vast system of interconnected highways crisscrossing the country and joining at our national borders with friendly neighbors to the north and south."
>
> —President Dwight D. Eisenhower, February 1955

Interstates Save Time, Money, and Lives

Interstates:

- Reduce total U.S. motor fuel consumption by 9.7 billion gallons annually
- Save Americans more than $320 billion annually and more than $1,100 per person in time and fuel
- Reduce the cost of transporting goods, which saves about $380 billion annually and $1,300 per person in consumer costs
- Save the average person 70 hours of time annually
- Are twice as safe as travel on other roadways because of safety features that include a minimum of four lanes, gentler curves, paved shoulders, median barriers, and rumble strips

Source: *The Interstate Highway System Saving Lives, Time, and Money TRIP, June 2006*

omy was largely self-contained. That has changed dramatically. The percentage of GDP represented by foreign trade increased from 13 percent in 1990 to 26 percent in 2000, and is expected to hit 35 percent in 2020. More than 80 percent of freight tonnage is generally carried by trucks driving on the Interstate Highway System.

Traffic growth during the past 50 years has been so great that most of the expansion capacity planned when the Interstate system was built has been used up. As a result, what was once wide open roadway is now increasingly congested.

Bottlenecks caused by stretched-to-the-limits Interstate interchanges delay commerce, cost consumers time and money, and further erode the Interstate network. In some parts of the country, the leaps in productivity and mobility that were hallmarks of the Interstate for much of its 50-year life are disappearing.

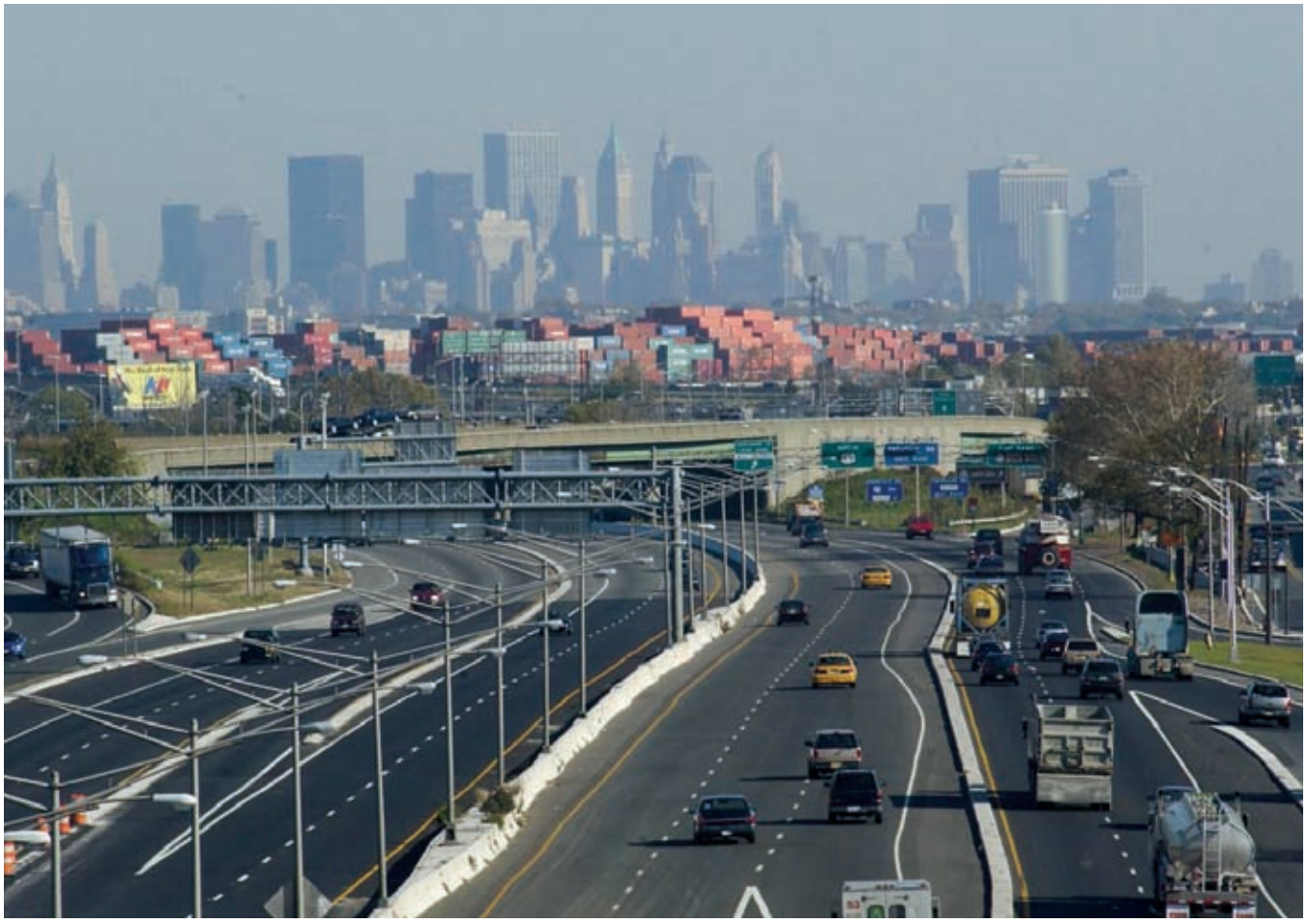
Interstate interchanges in metropolitan areas show the strain of traffic loads most dramatically. For example, the Marquette Interchange in Milwaukee, Wisconsin, was built in 1968 for $33 million to carry 155,000 vehicles per day. It was carrying 300,000 vehicles per day before construction began on a new interchange at a projected cost of $810 million.

Completed three months early in August 2008, the project is expected to be $10 million under budget. The Wisconsin DOT rebuilt the Marquette Interchange to include bridges with a life-span of 75 years. The project illustrates not only the cost of a major interchange reconstruction, but also the need to both preserve and renew such structures to meet traffic needs today and into the future.

Yet another example of a major Interstate replacement project is the Woodrow Wilson Bridge on Interstate 95 just south of Washington, DC. By the year 2000, the 45-year-old bridge had become a notorious bottleneck, carrying more than 200,000 vehicles a day, when it was built to accommodate only 75,000 vehicles a day. The new Woodrow Wilson Bridge was completed in 2008 at a cost of $2.5 billion, and was delivered on time and on budget. The new structure expands the bridge from 6 lanes to 12, two of which will be reserved for use by transit. Its new capacity of 300,000 vehicles a day is expected to accommodate traffic growth for many years to come.

INVESTING IN THE INTERSTATE'S FUTURE

States manage the Interstate Highway System, and they invest significant resources and research into preserving and restoring these critical highways. But they can't do it alone. In 1956, the idea of a federally defined,



Truck lanes on the New Jersey Turnpike just outside of New York City. *Courtesy of New Jersey DOT.*

built, and owned system was rejected in favor of the federal–state partnership that evolved and strengthened over 50 years.

Continuing to invest in restoring, rebuilding, and expanding the Interstate system is an important component of a **comprehensive highway preservation strategy** for the 21st Century.

- **Bridges**: The Interstate system has more than 55,000 bridges, many of which are reaching 40 to 50 years of age. Bridges and other structures of this age usually require substantial rehabilitation, and in another 20 to 30 years, require replacement.

- **Pavement**: The Interstates have approximately 210,000 lane-miles of pavement. As these pavement structures reach 40 and 50 years of life, major portions will need to have their foundations completely reconstructed.

- **Interchanges**: The Interstate system has almost 15,000 interchanges, and many do not meet current operational standards, creating bottlenecks or safety problems. Some of the most significant congestion on the system occurs at major interchanges not designed to carry the volumes of traffic that currently use them. Future traffic will only exacerbate these problems.

Lane expansion as part of rehabilitation is needed to improve freight logistics, reduce urban congestion, catch up to population growth centers, and connect growing metropolitan regions.

Absent significant expansion in the Interstate system, increased traffic, particularly in metropolitan areas, and dramatic growth in freight volumes will lead to more congestion and more wear and tear. Consistent pavement preservation strategies, carefully monitored performance measurements, and technological advancements can only do so much on roadways that are stretched far beyond capacity.

To obtain a clearer picture of coming investment requirements**, AASHTO has recommended** that the U.S. DOT and state DOTs jointly undertake two comprehensive needs assessments of the Interstate Highway System:

- To identify the costs of rebuilding or replacing the existing bridges, pavement foundations, and interchanges; and
- To identify long-term, system-wide expansion needs.

STATES FOCUS ON INTERSTATES

Preserving and reconstructing Interstate highway mileage is a top priority in every state.

Missouri DOT Director Pete K. Rahn said there is a "huge need" to reconstruct much of his state's Interstate system. In Missouri, reconstruction of Interstate 70, a major cross-country route, is projected to cost $3.4 billion, and Interstate 44, another national corridor, will cost $4 billion to rebuild. "We're holding them together with bailing wire and bubble gum through overlays and other repairs," Rahn said. "But we get less and less life out of rehabilitation treatments because the foundation needs to be rebuilt. An initial overlay might produce seven years of smooth rides, but after a while, potholes, cracks, and rutting will appear within three years."

The **Pennsylvania DOT** has 128 miles, or 10 percent, of its Interstate system in need of major rehabilitation and reconstruction. Funding is in place to complete work on 77 of those miles.

The **Iowa DOT** has several major Interstate rehabilitation and reconstruction programs underway including:

- A $45 million project to grade, pave, and construct 10 new bridges along with roadway improvements on the Interstate 35-80-235 system interchange near Des Moines. The three-year project, which is nearing completion, will improve overall interchange traffic operations and meet existing and expected short-term traffic growth. The state went with a less costly short-term solution because funds were not available for total reconstruction.
- Addition of one lane in each direction to a 7.3-mile segment of Interstate 80 along with replacement of the entire original 46-year-old pavement at a cost of $96.5 million.



Courtesy of Pennsylvania DOT.

The **Oregon DOT** is rehabilitating nine miles of pavement on a segment of Interstate 84 in the eastern part of the state. The section was originally built in the 1960s and has been resurfaced three times to address damage from increased traffic and environmental conditions.

Because truck traffic generally uses the slow lane in this rural part of Oregon, the $27 million project will reconstruct that lane—which is in poor condition—with new concrete pavement, and resurface the existing fast lanes with asphalt pavement. This "black and white" pavement type has been successfully used in three other locations in Oregon.

The **Nebraska Department of Roads** is working on a six-lane reconstruction of Interstate 80 between Omaha and Grand Island, the state's two largest cities, which serves thousands of travelers daily. Upgrading from four to six lanes will improve safety and ease congestion in the state's fastest growing corridor. The $37 million project will be completed in mid-2011. This project is one component in a needed—but unfunded—reconstruction of the entire length of I-80 in Nebraska at projected cost of $100 million per year.

The Woodrow Wilson Bridge has successfully eased traffic on a major East Coast bottleneck. *Courtesy of Eye Construction, Inc.*

> "The Interstate System will never be finished because America will never be finished."
>
> —Francis C. "Frank" Turner, Federal Highway Administrator, 1969–1972
> *Richmond Times-Dispatch*, August 19, 1996

A truck on the warm-mix test track at the National Center for Asphalt Technology.

Courtesy of National Asphalt Pavement Association/ Asphalt Pavement Alliance.

Chapter 4

Trucks and Highways—Working Together to Move Freight

Trucking is the backbone of the nation's freight transportation system—transporting virtually everything we eat, drink, or buy. And trucks drive on highways, streets, and roads. Nearly 80 percent of the 15 billion tons in goods transported through the nation's freight system in 2005 was carried on trucks. Freight tonnage moved in the United States is projected to nearly double over the next 30 years with trucks taking 84 percent of the growth.[14]

With this expected growth, creating a low-cost, efficient, and reliable freight system becomes increasingly critical to the country's economic health. And preserving the highway network is a vital piece of the long-term freight strategy for the nation.

But major challenges lie ahead:

- Increasing traffic congestion is costing the freight transportation network nearly $8 billion per year. Higher transportation costs mean higher consumer prices.
- Increased truck traffic contributes to wear and tear on highways. Pavement damage is related to a truck's axle loads rather than the total truck weight. A truck with more axles will have less weight per axle and, therefore, create less pavement damage.

Highways and trucks need to coexist successfully for the good of America's economy. To achieve that goal, a comprehensive action agenda to meet the country's freight needs is essential, including:

- Fixing freight bottlenecks;
- Maintaining durable highway surfaces; and
- Improving access to ports, airports, and distribution centers.

> "From any perspective the freight transportation challenge is formidable. Meeting it will require resolve and resources. Not meeting it will be a major national failure."
>
> —Larry L. "Butch" Brown, Executive Director, Mississippi Department of Transportation

FREIGHT BOTTLENECKS COST CONSUMERS

Bottlenecks occur when traffic routinely backs up because volumes exceed capacity of the roadway. The worst bottlenecks are at or near freeway-to-freeway interchanges.

Freight bottlenecks are found on highways that serve major international gateways such as the Ports of Los Angeles and Long Beach, California, at major domestic freight hubs such as Chicago, and in major urban areas where transcontinental freight lanes intersect congested urban freight routes.

Traffic congestion means increased travel times, increased costs, and less reliable pick up and delivery times for truck operators. Freight bottlenecks cause nearly 250 million truck hours of delay annually, costing direct users about $7.8 billion.[15] To make up for traffic delays, shippers add more trucks, which, in turn, creates more congestion. Eventually these increased costs of doing business are passed on to consumers.

BUILDING MORE DURABLE PAVEMENTS TO SUPPORT TRUCK TRAFFIC

Research into developing pavement materials and construction practices to provide more durable road surfaces that can tolerate increased traffic loads—including trucks—is part of the solution. Examples of advanced research include the use of geosynthetic reinforced soil, warm mix asphalt, polymer-based asphalt binders, and admixtures to improve the strength and workability of Portland cement concrete.

Terry Button has been driving the roads in his trucks for more than 29 years. An independent trucker based in Rushville, NY, Button drives up and down the East Coast delivering hay to dealers and suppliers. Button, who serves on the Board of Directors for the Owner Operator Independent Drivers Association, said the repercussions of rough roads are devastating for truckers.

Smooth pavement not only affects his bottom line, it also means a safer ride. “Smooth rides are critical for truckers. It’s easier on the equipment, easier on your health. Because with all the bumps, things wear out faster, air ride suspension hangers come off, ball joints wear out. Some night you might be going around a curve and something snaps, and your safety is at risk.”

Button said he sees rough roads in every state. “Road smoothness varies greatly—sometimes county to county. We have to make this a priority for this country. If we don’t have good transportation, we can’t get food to market, and there’s nothing more important than that.”

DEDICATED TRUCK LANES

Many states are looking at adding truck-only lanes to their Interstates to reduce congestion, improve safety, and move goods faster. Separating trucks from regular automobile traffic can improve highways and reduce truck-caused wear and tear on other roadways. The only completely separated truck lanes that currently exist are a 30-mile segment of the New Jersey Turnpike. California and Texas also have short segments of truck-only lanes.

The biggest obstacle to broad use of truck-only lanes is cost. For example, one state study estimated that constructing a new truck-only lane alongside an existing rural Interstate highway would cost approximately $2.5 million per lane-mile, plus land and acquisition costs.[16] The FHWA estimates that the cost of new highway lane miles ranges from $1.6 million to $3.1 million in rural areas and $2.4 million to $6.9 million in urban areas. The truck-only price tag raises red flags when states look at long lists of reconstruction and expansion needs at a time when highway construction funds are limited. As a result, higher fuel taxes, user fees, and tolls are options that states have considered to pay for dedicated truck lanes.

Courtesy of California DOT.

COMMERCE CORRIDORS FOR EFFICIENT FREIGHT MOVEMENT

Exclusive truck lanes at the state level are a subset of a bigger strategy needed to move freight more efficiently and preserve the nation's highways. Other elements being recommended by many groups, including AASHTO are: fix highway truck bottlenecks, improve intermodal access to ports and distribution centers, fund international gateways, and add capacity to priority trade corridors including a national network of truck-only lanes.

The program would be funded by freight-related user fees outside the Highway Trust Fund, with the federal government providing coordination and the states and Metropolitan Planning Organizations (MPOs) overseeing the planning.

Courtesy of Pennsylvania DOT.

PennDOT workers lay replacement drainage pipe as part of a road maintenance project. Proper drainage for streams that cross beneath roads is a critical maintenance step.

Courtesy of Pennsylvania DOT.

Chapter 5

Managing Highways as an Investment

With an estimated value of $1.75 trillion, highways, streets, and roads are an asset to be managed and preserved rather than a project to be built or fixed. Managing this valuable asset depends on:

- An investment in pavement preservation;
- An organizational commitment to asset management;
- Advancements in materials, maintenance techniques, and technology; and
- Sustained financial investment.

PAY ME NOW OR PAY ME LOTS MORE LATER

Good roads cost less. That is why pavement preservation is such an important part of asset management. The goal is to extend the service life of roads ***before*** they need major rehabilitation or replacement.

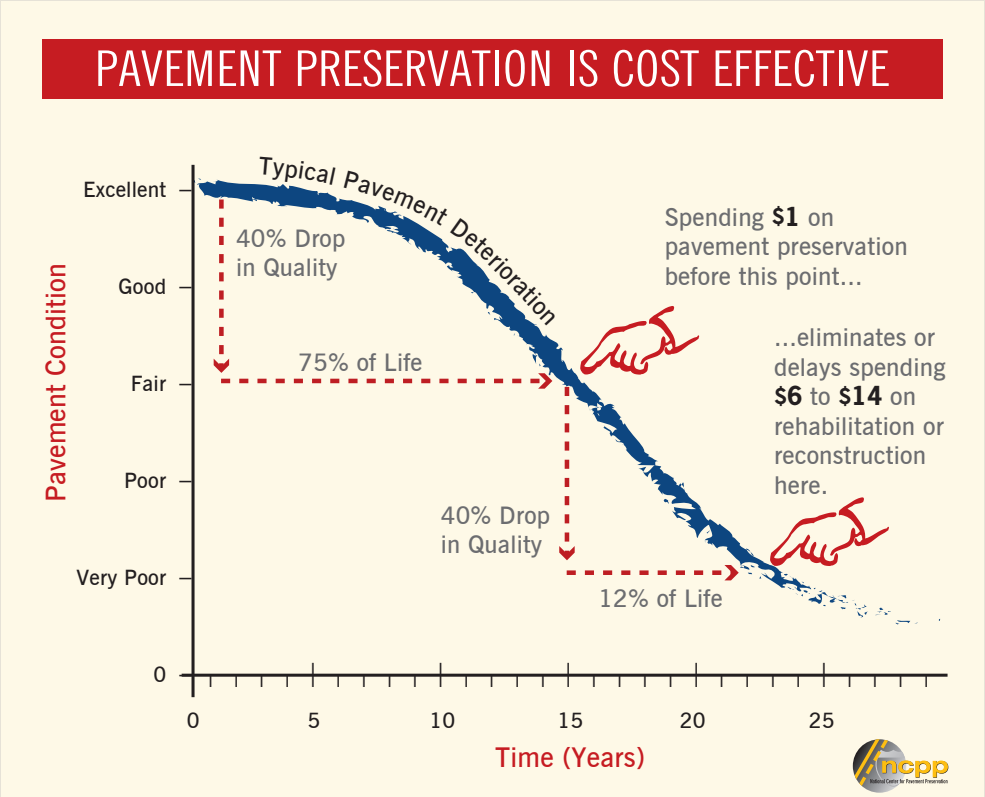
Maintaining a road in good condition is easier and less expensive than repairing one in poor condition. Costs per lane mile for reconstruction after 25 years can be more than three times the cost of preservation treatments over the same 25 years and can extend the expected service life of the road for another 18 years.

Timing is everything in pavement preservation. If rehabilitation is done too early, pavement life is wasted. If it is done too late, the road may require additional costly repair work.

Pennsylvania DOT Secretary Allen D. Biehler said the decision to use a large portion of highway funds for system preservation is one of the biggest challenges facing transportation leaders today.

"We as transportation stewards of the system have no choice but to drive home the message that maintaining an acceptable condition for our highways—preserving the system—is vital to our country's future," Biehler said.

> "There is no more fundamental transportation capital investment than system preservation—keeping existing infrastructure in good condition. If preservation investment is deferred, costs increase dramatically, leading to the saying 'pay me now or pay me more—lots more—later'."
>
> —Washington Department of Transportation 2007–2026 Highway System Plan



Source: National Center for Pavement Preservation.

"Our focus is fix it first—paying attention to basic day-to-day practices that help us be more successful. Otherwise, you can spend too much time and money chasing after potholes while watching the system fall farther and farther behind."

In Pennsylvania, less than 10 percent of the transportation budget is currently dedicated to expansion—compared with more than 20 percent in recent years.

The **Oregon DOT** has a chip-seal preservation program to treat about 780 lane miles of highway at a cost of $7 million per year. The program complements the department's $125 million preservation program, which resurfaces about 1,000 lane miles during the same period. The chip-seal program lowers the annual cost to maintain good pavement by increasing the time between higher-cost resurfacing treatments. Over the long-term, the preservation strategy will save $16 million per year in resurfacing costs.

The **Nebraska Department of Roads** recently implemented a Pavement Optimization Program (POP) to manage its highway network and allocate funds to keep the system at its current performance level. POP uses current pavement conditions, pavement deterioration rates, and cost/benefit ratios to develop budget scenarios to ensure effective allocation of funds. The department uses two recently purchased pathway profilers to collect data about the severity and extent of pavement distress to assist in making investment decisions.

The **Michigan DOT** uses a network pavement strategy that provides a "mix of fixes" to extend the life of the road. The three types of fixes are: reconstruction and rehabilitation; capital preventive maintenance; and reactive maintenance. Decisions about which fix to use are based on an assessment of the current pavement conditions and a projection of the number of years before it will require reconstruction or rehabilitation using a measure known as *remaining service life* (RSL).

Tight budgets force creative strategies for sustaining pavement preservation plans. In **Washington State**, the DOT has identified the need for $1.7 billion in concrete pavement restoration—but less than $20 million per year has been budgeted. To compensate for reduced funding, WSDOT uses a triage strategy—investing first in pavements whose life can be greatly extended if treated immediately, and deferring work on pavements that need complete replacement. The strategy improves and extends the life of the greatest number of lane miles with available funds. Despite budget constraints and soaring construction costs, pavement conditions have continued to improve over the years.

Shifting from Worst-First to Best-First Investments

How do you sell the idea that spending money on a road that looks to be in good condition is a better idea than spending it on one that is bumpy, rutted, rough, and obviously in need of repair? Very carefully, says Michigan DOT Director Kirk L. Steudle, who believes the shift from worst-first to best-first is a good strategy for long-term asset management.

"It is important to slow the rate of decline in the good road so that it stays good rather than slipping into fair or poor condition." Steudle added that spending $1 to keep a road in good condition prevents spending $7 to reconstruct it once it has fallen into poor condition.

Michigan always works on a five-year horizon in its pavement preservation program so, he said, it is important to show where plans to fix that poor road fit into the schedule.

"It is easy to fall into the worst-first strategy, particularly when money is tight," he said. "But that's when staying focused on keeping good roads good and minimizing the amount of deterioration is even more important."

MANAGING TRANSPORTATION ASSETS

Asset management is a strategic approach to managing infrastructure. It focuses on maintaining the condition and performance of ***public assets*** using business and engineering practices to allocate resources based on reliable information and well-defined objectives.

> "The highway system is owned by the public. Our daily focus is on preserving this asset that the public has entrusted to us. In many cases, we're not doing as good a job as we could."
>
> —Gary Ridley, Director, Oklahoma Department of Transportation

"Asset management is a very broad concept that focuses on getting the best return on the investment we put into our transportation system," said Kirk T. Steudle, Director of the Michigan Department of Transportation and Chair of the AASHTO Subcommittee on Asset Management. "It isn't a computer software program, finance and accounting practices, or a pavement preservation program. Asset management includes all that and more.

"We need to focus on operating, maintaining, upgrading, and expanding the entire asset with which we are entrusted in the most cost-effective and efficient way possible," Steudle said.

The **Michigan DOT** Asset Management program encompasses all the physical transportation assets in the state, including more than 9,700 miles of road, 5,679 bridges, 450,000 signs, 4,025 traffic lights, 8 million linear feet of guardrails, 83 rest areas, 13 travel information centers, 85 roadside parks, 27 scenic turnouts, and more. The program is built around five major functions: policy goals and objectives, information and data collection, planning and programming; program delivery, and monitoring and reporting.

Steudle said the program begins with setting a broad policy about the current condition of the asset and then setting a goal for where you want that asset to be within a specific time frame. For Michigan, the goal was to increase the condition of all its roads and highways, moving from 65 percent of state roads in good condition in 1997 to 90 percent in 2007. Pavement preservation was the primary tool for achieving that goal.

The department met its 90 percent goal and improved to 92 percent in 2008. A similar goal-driven asset management process is now underway for the state's bridges.

Michigan has a statewide Transportation Asset Management Council, which brings together all the agencies in the state that have jurisdiction over roads. Its purpose is to broaden the use of transportation asset management throughout the state and ensure that groups are working together, sharing methodology, collecting the same data, and speaking the same language.

Other state DOTs are developing asset management programs as well.

The **Washington State DOT** relies on data collection, analysis, and innovative reporting methods to manage its transportation assets, which include 20,000 lane miles of state roads and 3,000 bridges. The department uses data not only to assess project costs and benefits, but also to analyze tradeoffs in allocating limited funds between preservation and improvement programs and between highway construction and highway maintenance.

The department's *Measures, Markers, and Milestones* report is a critical part of the system, linking performance measures to overall strategic objectives. The state's efforts to communicate its performance led to public support for two funding increases—a five-cent gas tax increase in 2003 and a nine-cent gas tax increase in 2005.

The **Utah DOT,** which manages 6,000 miles of highway, uses dTIMS CT software to support its asset management, bridge management, and pavement management systems. These systems help the department identify the most efficient use of funding based on the current condition of the asset and available funding for preserving it. Because of recent funding limitations, however, the asset management model recommends work that has to be done instead of the work that should be done.

Courtesy of the National Asphalt Pavement Association/Asphalt Pavement Alliance.

TOOLS FOR SUCCESSFUL PAVEMENT PRESERVATION

Successful pavement preservation requires reliable tools for monitoring pavement conditions and the best materials to get the longest life from the roads. A number of different types of sealers and rejuvenators are available based on the existing pavement type and the problem being solved. The most common treatments include chip seals, slurry seals, fog seals, micro-surfacing, thin hot mix asphalt overlays, crack sealing, and joint sealing—all designed to maintain or improve pavement condition and extend its life.

The **Washington State DOT's** Materials Lab identified these tools for pavement preservation:

- **Dowel-bar retrofits** installed in aging concrete to improve smoothness and longevity and help traffic flow smoothly from one concrete slab to the next. State officials believe the technique could add 10–15 years to 30-year-old concrete highways.

- **Pavement recycling** using reclaimed asphalt from older, failed pavements and blending it into a new asphalt mix.

- **Warm-mix asphalt** using chemical additives that allow construction at lower temperatures resulting in lower emissions and improved construction.

- **Bonded concrete overlays** on an existing asphalt pavement to add structure and provide a longer-lasting surface. **Ultra-thin white topping** using a two-to-four inch thick layer of concrete over an existing asphalt road can be installed fairly quickly with minimal traffic disruption.

Reliable equipment to assess and monitor the condition of pavements is as important as the materials used.

The **Michigan DOT** has used ground-penetrating radar to assess conditions that could affect pavement life, such as locating sink holes, and mapping technology to help assess remaining service life on pavements. A laptop computer along with a GPS receiver are used to track road locations on a region map and quickly gather data about the previous service life rating, historic data on the road segment, and previous fix types.

The **Maryland DOT** uses an automatic road analyzer to collect information on roughness, rutting, and cracking as well as a skid truck to collect friction data. The data is fed into the pavement management system to identify targets for both pavement preservation and rehabilitation fixes.

Last summer, the **Oregon DOT** began assessing pavement conditions on a portion of the network using a vehicle equipped with a profiler to measure roughness and scanning lasers to measure rutting. All of the data was collected in a single pass of one vehicle at normal speeds.

Rhode Island uses an automated distress survey to assess pavement conditions and calculate crack density that helps define the appropriate preventive maintenance treatment. In addition, the RIDOT pavement management team selects 100-foot-long monitoring sections representing all of the different treatments, stress levels, and traffic volumes to visually assess effectiveness of the preservation strategy.

The **Minnesota DOT** evaluates its 14,000 miles of highway annually using a van equipped with lasers to measure the smoothness of pavement and cameras to help engineers evaluate the quality of the pavement. The state uses three indicators to report and quantify pavement conditions—*ride quality index,* which measures pavement roughness; *surface rating,* which measures pavement distress; and a *pavement quality index*.

Pothole Killer Streamlines Repairs

Dealing with potholes is part of a pavement preservation strategy. Generally quick fixes to deal with urgent needs—like a really big pothole on a major commuter route—may be needed. But quick fixes rarely last.

Pavement that is maintained in good condition and is designed for the traffic that uses it will usually remain pothole free—even during the toughest freeze and thaw cycles. Like any pavement repair processes, good materials installed properly will produce the best results.

One quick-fix approach that does produce longer-term results is the "Pothole Killer," an all-in-one vehicle that can repair up to 100 potholes a day with only one driver. A traditional four-person pothole crew can patch about 10–15 potholes a day. The Pothole Killer uses a three-step process—it blows the pothole clean of all debris, sprays a special fast dry asphalt emulsion into the hole, and then applies an asphalt aggregate mix on top. The entire process takes about six minutes.

Some cities and states lease rather than purchase the equipment to reduce the capital cost.

Courtesy of Patch Management Pothole Killers.

BUILDING FASTER, CHEAPER, SAFER

Construction strategies that speed up building projects without compromising quality can reduce traffic disruption, control labor costs, and minimize costs to commercial traffic.

Research shows that the traveling public is demanding increased mobility while showing less tolerance for construction delays and construction-related congestion.

Action strategies to build faster, cheaper, and more safely include:

- Innovative traffic management systems including full road closures to expand available work time;
- Accelerated construction management techniques to minimize construction time while enhancing quality and safety for major multi-phase projects; and
- Use of materials that reduce project schedules.

The **Indiana DOT**'s Hyperfix Project in 2003 provides an example of a successful fast-track Interstate renovation. The project involved reconstruction of two heavily traveled Interstates in Indianapolis. The highways carried 175,000 vehicles daily—compared with a design capacity of 61,000. Because of the magnitude of the reconstruction and expected traffic delays, the project team decided to close the highway completely and use a fast-track, round-the-clock construction plan.

The project was completed between two major races at the Indianapolis Speedway, which regularly draws 250,000 participants who use these highways. Work was completed in 55 days—30 days ahead of schedule, saving taxpayers an estimated $1 million in lost wages and lost productivity for each day that traditional construction would have added. Special commuter buses and parking lots were used to keep traffic moving without turning alternative routes into parking lots.

Keys to success included early planning, collaboration among local, state, and federal agencies, and community support. A series of community meetings were held well before construction began to ensure that everyone understood the plans and alternate commuter options. As a result, the public was prepared for traffic impacts long before blasting, drilling, milling, and paving began.

The team wrapped the public face of the entire project around a catchy brand name: Hyperfix. The name so captured the imagination of stakeholders that it became part of local language and lore with advertising billboards and radio talk shows proclaiming the need to "Hypermow" the lawn or "Hyperfix" one's thermostat. One citizen actually was inspired to write a song that celebrated the project's advances in words and music.[17]

The **Missouri DOT** challenges project engineers to use non-traditional project design methods to develop efficient solutions for today's needs. DOT officials say practical design is rooted in the principle that building a series of good, not great, projects will result in a great system. It maximizes the value of a project by ensuring that it is the correct solution for its surroundings.[18]

Before practical design, most projects followed strict guidelines based on road classification type and traffic volume. Now designers look at projects on a case-by-case basis with a goal of building to meet basic needs, rather than the highest standards. State officials estimate the new approach to design has saved taxpayers $400 million in its first two years.

GET IN, GET OUT, STAY OUT

Routine maintenance alone cannot sustain highways that have been in service for nearly 50 years. In many cases, pavement foundations need to be rebuilt to deal with the impacts of age and to modernize roads to meet current conditions.

Longer-lasting materials can make a big difference in the life of a road.

For example:

- Asphalt perpetual pavements can be designed and built to last longer than 50 years without requiring major structural rehabilitation or reconstruction. Longer-lasting asphalt pavement mixes combine smoothness and safety advantages of traditional asphalt with an advanced, multi-layer paving design that extends the life of a roadway with routine maintenance.[19]

- Superpave gives highway engineers and contractors tools to design and construct asphalt pavements that meet specific climate and traffic conditions. Although it has been in use since the 1990s, current research focuses on measuring resistance to ruts and cracks to come up with even longer-lasting mixes.

- Stone matrix asphalt, which is also called Gap-Grade Superpave, is a new mix that can be used to reduce splash and spray and may have some value in noise reduction. Its main advantage is its durability, providing a long-lasting pavement surface.

- Fast-track concrete pavement produces the strength benefits of traditional concrete with a much shorter preparation time—making it possible to be ready for opening in 12 hours or less after laying. Generally fast-track concrete provides good durability because it has a relatively low water content, which improves strength and decreases salt permeability which, in turn, contributes to deterioration.

- Roller-compacted concrete, another drier mix, can be installed using asphalt paving equipment and compacted with rollers. It has the strength to withstand heavy loads and can resist freeze-thaw cycles.[20]

Courtesy of National Pavement Association/Asphalt Pavement Alliance.

Chapter 6

Rebuilding for the Future

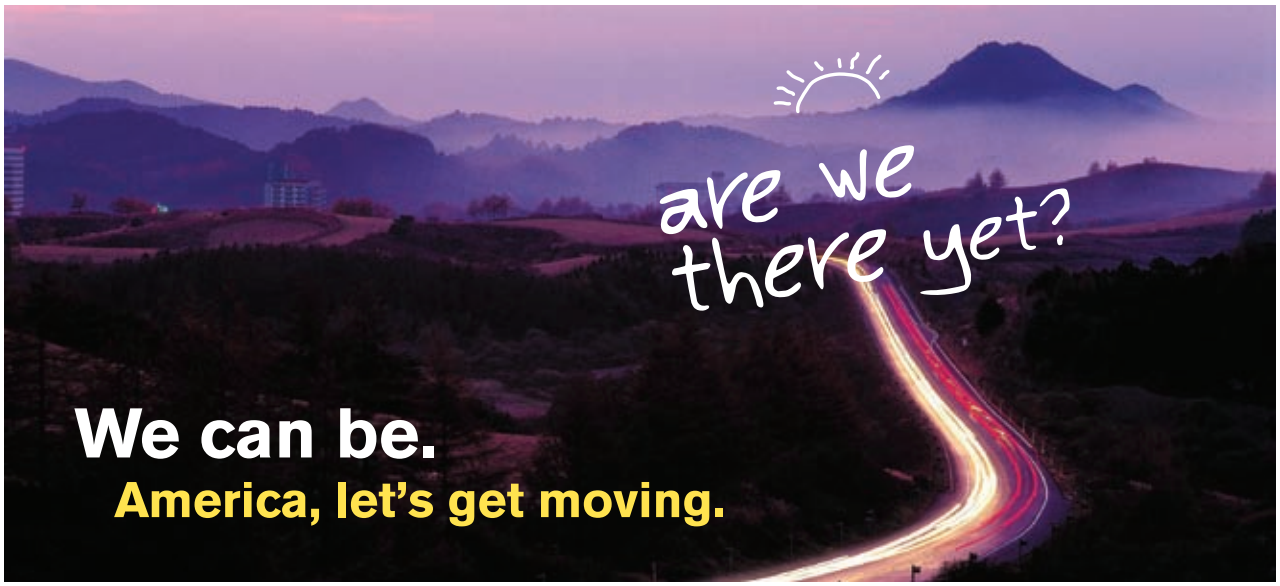
ARE WE THERE YET?

No—but we can be.

Improved management strategies, a focus on preserving essential public assets, better, longer-lasting materials, new approaches to building highways faster, cheaper, and sooner all will help get us there. But it does come down to money. It is time for a greater and smarter investment of transportation dollars to ensure a new and better transportation program.

Pennsylvania DOT Secretary and AASHTO President Allen D. Biehler said getting there also involves thinking differently about highways, land use, and our way of life.

"We need to maintain and preserve our highway system first and then begin to think about other influences at work—global warming, greenhouse gas emissions, where we live and work—that affect traffic congestion and our quality of life," Biehler said.



> "As fundamental as it is to our future, our current transportation system is aging, underfunded, and inadequate to meet the demands of tomorrow. States stand ready to meet the challenges with projects that create jobs and bring hope to communities—projects that not only preserve what we already have but expand our horizons..."
>
> —Allen D. Biehler, AASHTO President;
> Secretary, Pennsylvania Department of Transportation

Appendices

Appendix A—Pavement Conditions on State, City, and County Arterial Networks, 2007

Urban areas with populations of 500,000 and above, including cities and surrounding suburbs

Urban Area	Poor	Mediocre	Fair	Good
Akron	12%	18%	22%	48%
Albany	14%	34%	19%	33%
Albuquerque	36%	27%	13%	24%
Allentown-Bethlehem, PA	15%	35%	24%	26%
Atlanta	1%	9%	5%	85%
Austin	20%	17%	24%	39%
Bakersfield	5%	38%	33%	23%
Baltimore	44%	26%	11%	19%
Birmingham	17%	30%	10%	43%
Boston	22%	20%	8%	50%
Bridgeport-Stamford, CT	15%	27%	17%	41%
Buffalo	12%	19%	22%	47%
Charlotte	10%	17%	27%	46%
Chicago	18%	28%	15%	39%
Cincinnati	11%	26%	16%	46%
Cleveland	15%	25%	12%	48%
Colorado Springs	12%	29%	25%	34%
Columbus, OH	4%	17%	19%	60%
Concord	54%	19%	17%	9%
Dallas-Fort Worth	29%	39%	17%	15%
Dayton	8%	12%	18%	62%
Denver-Aurora	18%	27%	17%	38%
Detroit	36%	33%	7%	24%
El Paso	19%	30%	30%	21%
Fresno	28%	35%	14%	23%
Grand Rapids	23%	27%	14%	35%
Hartford	19%	33%	17%	30%
Honolulu	61%	27%	6%	6%
Houston	29%	26%	17%	28%
Indianapolis	26%	21%	7%	46%
Jacksonville, FL	2%	16%	13%	69%
Kansas City	31%	17%	14%	38%
Lancaster-Palmdale, CA	13%	40%	24%	23%
Las Vegas	10%	26%	19%	46%
Los Angeles	64%	28%	5%	3%
Louisville	14%	37%	21%	29%
Memphis	27%	23%	15%	34%
Miami	5%	19%	15%	62%
Milwaukee	25%	29%	18%	28%
Minneapolis-St. Paul	22%	30%	18%	30%
Mission Viejo, CA	37%	47%	5%	11%
Nashville	6%	18%	13%	62%
New Haven-Meridian, CT	12%	31%	14%	44%
New Orleans	49%	19%	16%	16%
New York-Newark	54%	28%	10%	8%
Oklahoma City	41%	24%	12%	23%
Omaha	41%	36%	12%	11%
Orlando	7%	13%	13%	68%
Palm Springs-Indio, CA	47%	28%	10%	15%
Philadelphia	36%	36%	17%	12%
Phoenix	10%	16%	14%	60%
Pittsburgh	26%	32%	23%	20%
Portland	9%	17%	17%	58%
Poughkeepsie-Newburgh, NY	9%	39%	36%	16%
Providence	28%	30%	13%	28%
Raleigh	19%	26%	23%	32%
Richmond	14%	35%	28%	24%
Riverside-San Bernardino, CA	44%	44%	7%	4%
Rochester	19%	15%	35%	32%
Sacramento	44%	44%	4%	8%
Salt Lake City	5%	20%	17%	58%
San Antonio	38%	19%	15%	28%
San Diego	53%	31%	6%	10%
San Francisco-Oakland	61%	22%	4%	13%
San Jose	61%	29%	8%	2%
Sarasota-Bradenton, FL	1%	22%	18%	59%
Seattle	21%	21%	13%	45%
Springfield, MA	14%	46%	9%	31%
St. Louis	10%	22%	20%	48%
Tampa-St. Petersburg	3%	16%	15%	67%
Toledo	17%	15%	13%	55%
Tucson	23%	47%	15%	14%
Tulsa	47%	29%	8%	16%
Virginia Beach	23%	28%	21%	28%
Washington, DC, MD, and VA Suburbs	31%	30%	13%	27%

Source: TRIP analysis of Federal Highway Administration data.

Appendix B—Pavement Conditions on State, City, and County Arterial Networks, 2007

Urban areas with populations of 250,000–499,000, including cities and surrounding suburbs

Urban Area	Poor	Mediocre	Fair	Good
Anchorage	14%	37%	14%	35%
Ann Arbor	20%	28%	12%	40%
Antioch, CA	58%	13%	9%	21%
Asheville, NC	22%	21%	27%	30%
Augusta, GA	2%	14%	14%	70%
Barnstable Town, MA	7%	20%	14%	59%
Baton Rouge	37%	23%	21%	18%
Boise	44%	28%	8%	20%
Canton, OH	13%	17%	21%	49%
Cape Coral, FL	2%	34%	9%	55%
Charleston-North Charleston	11%	31%	19%	39%
Chattanooga	6%	25%	14%	55%
Columbia, SC	26%	21%	19%	34%
Corpus Christi, TX	36%	19%	16%	29%
Davenport, IA	36%	19%	18%	28%
Daytona Beach	4%	21%	8%	66%
Denton-Lewisville, TX	17%	45%	22%	16%
Des Moines	39%	18%	18%	25%
Durham, NC	20%	33%	11%	36%
Eugene, OR	5%	12%	13%	70%
Fayetteville, NC	3%	23%	21%	52%
Flint	27%	22%	13%	37%
Fort Wayne	34%	9%	9%	48%
Greensboro, NC	22%	15%	17%	46%
Greenville, SC	20%	32%	19%	29%
Harrisburg	11%	32%	25%	32%
Hemet, CA	44%	53%	1%	2%
Hickory, NC	18%	20%	21%	41%
Jackson, MS	34%	41%	14%	12%
Kissimmee, FL	0%	9%	9%	82%
Knoxville	9%	8%	22%	62%
Lancaster, PA	20%	33%	26%	21%
Lansing	16%	22%	14%	49%
Lexington, KY	7%	45%	9%	39%
Little Rock	26%	34%	17%	23%
Lorain-Elyria, OH	7%	14%	28%	50%
Madison, WI	31%	29%	19%	20%
McAllen, TX	6%	18%	23%	54%
Mobile	15%	14%	17%	55%
Modesto, CA	34%	39%	17%	10%
Naples, FL	0%	31%	7%	63%
Ogden-Layton, UT	4%	14%	17%	65%
Oxnard-Ventura, CA	36%	45%	11%	8%
Palm Bay-Melbourne, FL	11%	14%	7%	67%
Pensacola, FL	1%	15%	26%	58%
Port St. Lucie, FL	2%	27%	10%	61%
Provo-Orem, UT	1%	40%	5%	55%
Reading, PA	18%	44%	24%	14%
Reno	40%	17%	7%	36%
Santa Rosa, CA	52%	39%	8%	1%
Scranton-Wilkes-Barre, PA	26%	40%	20%	13%
Shreveport	35%	40%	12%	13%
South Bend, IN	25%	29%	11%	34%
Spokane	31%	16%	9%	43%
Stockton	42%	34%	8%	16%
Syracuse	16%	14%	20%	50%
Temecula-Murrieta, CA	35%	53%	7%	5%
Trenton, NJ	49%	27%	15%	9%
Victorville-Hesperia, CA	37%	36%	15%	11%
Wichita	42%	21%	5%	32%
Winston-Salem	8%	30%	38%	24%
Worcester, MA	31%	32%	11%	26%
Youngstown, OH	9%	23%	26%	41%

Source: TRIP analysis of Federal Highway Administration.

Appendix C—Additional Vehicle Operating Costs Due to Rough Roads, 2007 *

Urban areas with populations of 500,000 and above, including cities and surrounding suburbs

Urban Area	Cost in Dollars
Akron	$249
Albany	$315
Albuquerque	$576
Allentown-Bethlehem, PA	$340
Atlanta	$68
Austin	$346
Bakersfield	$280
Baltimore	$589
Birmingham	$344
Boston	$320
Bridgeport-Stamford, CT	$290
Buffalo	$248
Charlotte	$247
Chicago	$333
Cincinnati	$261
Cleveland	$290
Colorado Springs	$300
Columbus, OH	$156
Concord	$656
Dallas-Fort Worth	$512
Dayton	$182
Denver-Aurora	$339
Detroit	$525
El Paso	$401
Fresno	$461
Grand Rapids	$394
Hartford	$352
Honolulu	$688
Houston	$463
Indianapolis	$400
Jacksonville, FL	$123
Kansas City	$457
Lancaster-Palmdale, CA	$350
Las Vegas	$246
Los Angeles	$746
Louisville	$355
Memphis	$436
Miami	$165
Milwaukee	$425
Minneapolis-St. Paul	$431
Mission Viejo, CA	$571
Nashville	$185
New Haven-Meridian, CT	$263
New Orleans	$622
New York-Newark	$638
Oklahoma City	$631
Omaha	$592
Orlando	$162
Palm Springs-Indio, CA	$608
Philadelphia	$525
Phoenix	$217
Pittsburgh	$430
Portland	$199
Poughkeepsie-Newburgh, NY	$307
Providence	$418
Raleigh	$372
Richmond	$354
Riverside-San Bernardino, CA	$632
Rochester	$318
Sacramento	$622
Salt Lake City	$187
San Antonio	$529
San Diego	$664
San Francisco-Oakland	$705
San Jose	$732
Sarasota-Bradenton, FL	$146
Seattle	$326
Springfield, MA	$339
St. Louis	$258
Tampa-St. Petersburg	$137
Toledo	$275
Tucson	$473
Tulsa	$703
Virginia Beach	$417
Washington, DC, MD, and VA Suburbs	$458

Source: TRIP.

* AAA reports that the average cost for a motorist traveling 15,000 miles per year is $8,100, although costs vary depending on the vehicle and location.

Appendix D—Additional Vehicle Operating Costs Due to Rough Roads, 2007 *

Urban areas with populations of 250,000–499,000, including cities and surrounding suburbs

Urban Area	Cost in Dollars
Anchorage	$304
Ann Arbor	$359
Antioch, CA	$652
Asheville, NC	$390
Augusta, GA	$124
Barnstable Town, MA	$178
Baton Rouge	$534
Boise	$597
Canton, OH	$256
Cape Coral, FL	$183
Charleston-North Charleston	$301
Chattanooga	$214
Columbia, SC	$424
Corpus Christi, TX	$509
Davenport, IA	$495
Daytona Beach	$156
Denton-Lewisville, TX	$424
Des Moines	$524
Durham, NC	$392
Eugene, OR	$130
Fayetteville, NC	$186
Flint	$413
Fort Wayne	$445
Greensboro, NC	$347
Greenville, SC	$401
Harrisburg	$288
Hemet, CA	$650
Hickory, NC	$340
Jackson	$638
Kissimmee, FL	$61
Knoxville	$182
Lancaster, PA	$384
Lansing	$298
Lexington, KY	$294
Little Rock	$462
Lorain-Elyria, OH	$200
Madison	$486
McAllen, TX	$196
Mobile	$272
Modesto, CA	$538
Naples, FL	$147
Ogden-Layton, UT	$150
Oxnard-Ventura, CA	$560
Palm Bay-Melbourne, FL	$205
Pensacola, FL	$134
Port St. Lucie, FL	$162
Provo-Orem, UT	$196
Reading, PA	$399
Reno	$497
Santa Rosa, CA	$684
Scranton-Wilkes-Barre, PA	$458
Shreveport	$552
South Bend, IN	$431
Spokane	$396
Stockton	$580
Syracuse	$260
Temecula-Murrieta, CA	$571
Trenton, NJ	$620
Victorville-Hesperia, CA	$552
Wichita	$540
Winston-Salem	$300
Worcester, MA	$450
Youngstown, OH	$253

Source: TRIP.

* AAA reports that the average cost for a motorist traveling 15,000 miles per year is $8,100, although costs vary depending on the vehicle and location.

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