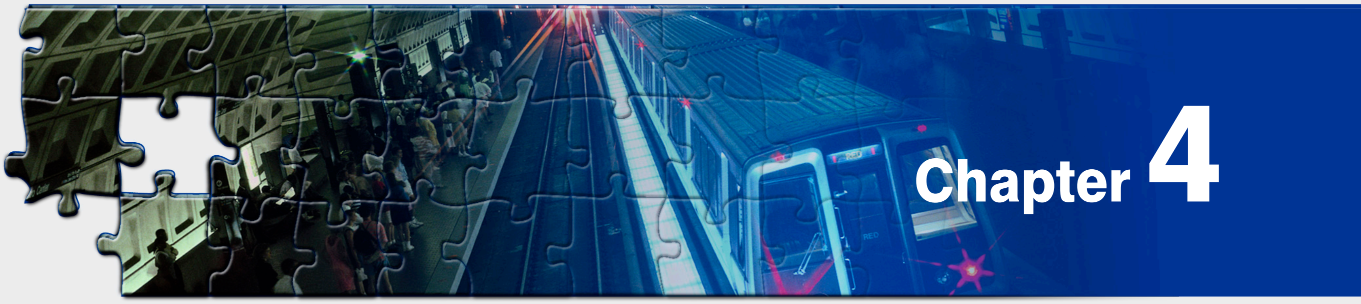


What Are the Long-Term Capital Investment Needs of the System?

Volume I of this report includes recommendations for the development of a strategic plan to improve the condition and performance of the Nation's surface transportation infrastructure. This plan would be based on a rigorous, systematic transportation planning process incorporating a strong economic analysis component to identify the relative benefits and costs of alternative potential investments, and would serve to provide a greater understanding of the investment needs of the system as a whole. In the absence of such a plan today, a series of analyses were conducted as part of this study to quantify capital investment needs using currently available data and analytical tools. These analyses are intended to convey a sense of scale of the overall needs and facilitate discussions of alternative financing options, but would ultimately be supplanted by the cost estimates developed as part of the recommended strategic plan.

"Avoid the temptation of 'solving' the funding problem without first understanding what it is we need to fund."
– Robert L. Darblenet, President and Chief Executive Officer of the American Automobile Association, at the Commission's Washington, D.C., field hearing.

Long term future surface transportation capital investment needs will be influenced by a number of key parameters, including:

- Future demographic and economic demands on the transportation system;
- External forces that may impact future travel demand; and
- Impacts that alternative transportation system program policies, financing strategies, or investment levels may have on traveler behavior.

Some factors that would influence future transportation demand, such as population growth and energy policies, fall largely outside the control of transportation agencies. For the purposes of this study, specific assumptions were made about these types of factors based on existing analyses available from other sources. Chapter 2 includes an extended discussion of drivers of future demand; additional resource material on these topics is available in Volume III.

Other factors that would influence future transportation demand are more directly under the control of the transportation community. These include decisions about where and how transportation investments are made, how these investments are financed, and the overall level of investment in different transportation modes. Such decisions have the potential to significantly impact the travel choices made by individuals. For these types of factors, this study includes analysis of various scenarios that incorporate packages of transportation policy options. These scenarios have been used to identify ranges of potential investment that would be expected to achieve different performance impacts at various points in time in the future.

The scenarios include a Base Case, which assumes a continuation of current institutions and technologies, and five thematically oriented alternative approaches. The scenarios include such program and policy features as (1) making maximum use of operational strategies to improve transportation system performance; (2) implementing strategies to reduce energy consumption and travel demand; (3) providing greater mobility and intercity connectivity through aggressive system expansion; (4) separating passenger from freight transportation in key highway and rail corridors; and (5) making the maximum use of technology to improve transportation system performance and safety.

INVESTMENT PRINCIPLES

Many components of our Nation's transportation infrastructure may represent impressive feats of engineering, worthy of admiration on their own. However, they were not meant to serve as monuments; they form part of a set of interconnected infrastructure assets that contribute to the well-being of the Nation's population and economy. The implication of this is that individual transportation infrastructure investments should not be made in isolation to achieve some arbitrary standard or political goal, but should instead be made as part of a broader framework of sound asset management principles with a focus on the investment's contribution to the broader performance of the network as a whole. This Commission has endorsed the following general principles in regards to infrastructure investment:

- Investments should be tied to specific desired systemwide performance objectives
- Potential investments should be subject to quantitative analysis to identify their benefits and costs
- Investment decisions should be influenced by economic, environmental, and energy considerations beyond the immediate transportation-related objectives.

To the greatest extent possible, these principles have been taken into account in developing the investment requirement estimates presented in this study, and are embodied in the overall recommendations of the study.

These scenarios were evaluated at multiple investment levels, ranging from current levels to much higher levels aimed at aggressively improving the system. The analytical assumptions and key findings pertaining to individual scenarios are described in Volume III of this report; this Chapter addresses the scenarios more generally, in terms of their collective implications and the

TECHNICAL CONSIDERATIONS

Part of the charge to this Commission was for the study to build on related work that has been completed, "to the maximum extent practical." Although various existing documents such as the Department of Transportation's *Status of the Nation's Highways, Bridges, and Transit: Conditions and Performance* report to Congress and other reports developed by the American Association of State Highway and Transportation Officials (AASHTO), the American Public Transportation Association (APTA), and other organizations shed some light on some of the relevant issues, none of these needs assessments extends 50 years or addresses the broad scope of activities within this Commission's charge. Further, recent sharp increases in construction cost inflation (the Federal-Aid Highway Composition Bid Price Index increased 43 percent between 2004 and 2006) have rendered moot many previous studies based on older cost data; inflation alone would presumably cause the findings of such studies to be significantly different if they were updated today using the same methodology and current year cost data.

Consequently, while the investment needs presented in this study were developed using some of the same analytical tools utilized in previous reports by the U.S. DOT and other organizations, these tools were customized to meet the unique requirements of this Commission and supplemented using additional analytical approaches developed specifically for this study. Thus, the investment requirements findings presented here cannot be directly linked back to any specific previous reports.

relative magnitude of future capital investment needs.

While the scenarios were designed as packages of multimodal strategies, the degree of quantitative analysis conducted varied widely by mode, reflecting the relative availability of data and appropriate analytical tools.

Observations

The demographic and economic trends projected over the next 50 years (see Chapter 2) have major implications for surface transportation investment requirements. Meeting the mobility needs of a significantly larger population in terms of access to housing, employment, and a broad range of services will present a significant and growing challenge over time, particularly in the largest urbanized areas where capacity expansion is limited by the scarcity and escalating cost of land. At the same time, major investments will be required to repair and replace our aging infrastructure assets. In short, improving the performance of the system while simultaneously accommodating higher travel volumes will pose tough challenges and carry a high price tag.

Highway and Bridge Findings

Based on the latest information available to this Commission, it is estimated that current financial and institutional structures could sustain an average annual level of capital investment on Federal-aid highways from all sources of approximately $68 billion per year in the short term, stated in constant 2006 dollars. The analyses developed by the Commission demonstrate that this level of funding would not be adequate to maintain the operational performance and physical condition of the nation's highway assets in the face of expected increases in highway travel, even if every dollar were utilized in the most effective manner.

Implications of Sustaining Current Levels of Highway Investment

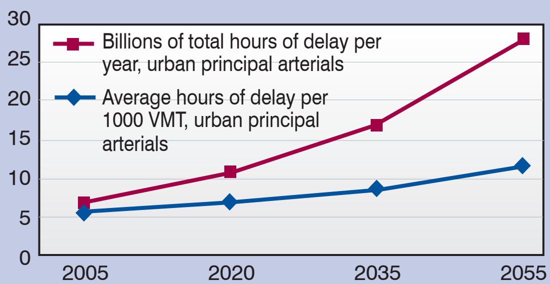
Assuming no changes in current technologies, financing mechanisms, and institutional

arrangements (these are the Base Case assumptions), and assuming that current funding levels are sustained in constant dollar terms for an extended period of time, it is projected that highway travel delay would continue to increase. Even under the best of circumstances, the level of delay experienced by the average traveler on urban principal arterial highways would be projected to increase by one-fifth by 2020, increase by one-half by 2035, and double by 2055, as shown in Exhibit 4-1. With VMT increasing over time, total delay on urban principal arterials would be projected to rise even more, growing by over one-half by 2020, more than doubling by 2035, and more than quadrupling by 2055. These billions of hours lost to delay each year would represent a serious drag on economic growth, translating to many billions of dollars of lost economic opportunity for both individuals and businesses.

The physical condition of the Nation's highway assets is also projected to deteriorate significantly, as shown in Exhibit 4-2, imposing additional costs on drivers in the form of higher vehicle maintenance costs, travel time costs, and crash costs. The extent to which existing inefficiencies in the investment allocation processes continue to exist would exacerbate these problems, since every dollar spent in a less than optimal fashion would reduce the funding available for more beneficial highway investments.

The performance results for the Base Case assuming current funding levels should serve as an urgent call to action to the Congress and the Nation's surface transportation leaders. On a limited scale, several strategies explored in the scenario analyses have the potential for improving this picture. Accelerated deployment of existing operations strategies and Intelligent Transportation System (ITS) technologies could achieve measurable performance benefits at a relatively low cost. Longer term improvements such as the deployment of advanced vehicle infrastructure integration (VII) technologies on a widespread basis have the potential to improve the effective capacity of the highway system, while aggressive travel demand management strategies have the potential to address the problem from

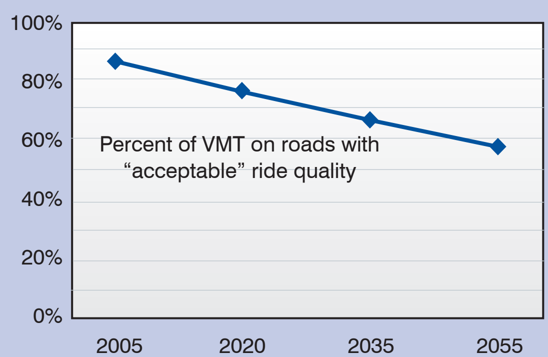
Exhibit 4-1. Projected average and total highway delay, base case—assuming current funding



This chart identifies the hours of delay per 1000 miles traveled on urban principal arterial highways that vehicles are expected to encounter if capital investment is sustained at current levels over time in inflation-adjusted terms. The exhibit also shows the total delay in billions of hours per year that all vehicles combined are projected to experience on urban principal arterials over time.

Source: Commission staff analysis.

Exhibit 4-2. Projected ride quality, base case—assuming current funding



This chart identifies the projected percentage of VMT that will occur on roads meeting a standard for ride quality that is described by the U.S. DOT as "Acceptable" for pavements on the National Highway System (NHS), assuming current funding levels are sustained over time.

Source: Commission staff analysis.

HIGHWAY METHODOLOGY

The highway investment requirements analysis conducted as part of this study was performed primarily by the staff of this Commission, with technical support of consultants paid by this Commission for this purpose.

These analyses rely heavily on the Federal Highway Administration's Highway Economic Requirements System (HERS), which applies a benefit-cost test at the individual highway section level, drawing upon data for a set of sample highway sections. This approach screens out potential investments that are not economically justified and allows other candidate investments to be ranked on the basis of their relative benefit-cost ratios. Based on this ranked list, a set of potential investments can be identified for any given funding level to yield the theoretical maximum systemwide benefits that could be obtained. For some scenarios, the HERS results were supplemented by the results of other analyses conducted outside of the model, which included some potential investments that were not subject to any benefit-cost screen.

Although HERS has been customized to address the specific analytical requirements of this study and supplemented with external analyses, the "High" funding level explored as part of this study is similar in nature to the "Maximum Economic Investment" scenario included in the U.S. DOT's biennial Conditions and Performance reports to Congress. However, the "Medium" funding level represents a much more aggressive performance target than the "Maintain User Cost" scenario included in U.S. DOT's reports, as it is designed to maintain or improve a set of individual measures of highway conditions and performance rather than to maintain an aggregate overall index (average user costs) while allowing individual measures of conditions and performance to vary above or below current levels.

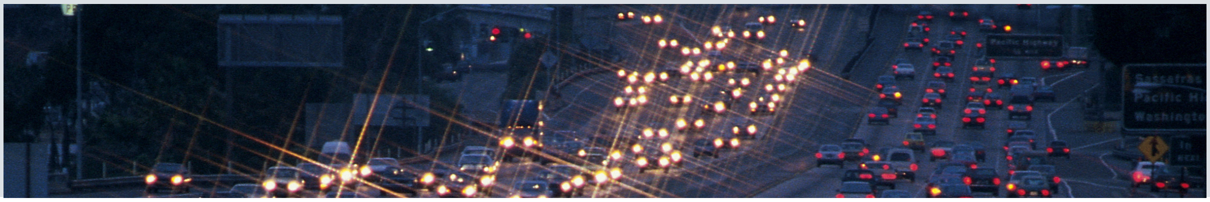
The highway investment analyses discussed here address only the higher-order functional systems (Interstates, arterials, and collectors) that are currently eligible for Federal aid. They do not include roads designed primarily to provide direct access to property in residential or commercial areas, or minor collector roads in rural areas.

the demand side. At current funding levels, such approaches are projected to have the potential to reduce average or total delay by more than about 40 percent over 50 years relative to the large increases in delay identified in Base Case figures. Although such a reduction represents a significant difference in projected future system performance, it would still result in a highway system with significantly more delay than is currently the case.

One might expect different combinations of strategies and other policy and institutional options to have even greater impacts on system conditions and operational performance than was observed in the specific scenarios analyzed as part of this study. However, the findings noted above suggest that future needs of the transportation infrastructure system cannot be addressed simply by optimizing the allocation of existing resources; we face the reality of considerable shortfalls in the overall level of resources currently devoted to transportation infrastructure.

The $68 billion currently sustainable funding level identified in the Base Case analysis for highways includes two components: (1) projected nominal dollar receipts for the Highway Account of the Federal Highway Trust Fund, converted into constant 2006 dollars; and (2) current amounts of State and local revenues being utilized for capital improvements to Federal-aid highways. While the purchasing power of these revenue sources will tend to be eroded by inflation over time, such effects would be largely offset in the short term by increases in revenues from financial mechanisms linked to rising overall travel volumes (such as fuel taxes).

In evaluating the relative system performance implications of alternative levels of future investment, it is important to note that maintaining current investment levels over the long term in constant dollars does not reflect a true "do nothing" alternative. In the medium and long term, the sustainability of current revenue



sources for highways will be more problematic as the growth in the use of alternative sources of energy for vehicle propulsion would lead to corresponding reductions in revenues from taxes on petroleum-based fuels. Consequently, some degree of changes in financing mechanisms would be required over time even to simply maintain current levels of investment. Issues pertaining to alternative revenue sources and financing mechanisms are discussed in more detail in Chapter 5.

Investments to Maintain and Improve Highways

The scenario analyses developed by this Commission also explored the impact that higher levels of funding could have on highway system performance, focusing on two particular levels: "Medium" investment levels intended to at least maintain specific separate measures of highway conditions and performance and "High" investment levels targeted at the maximum level of potentially cost-beneficial investment (where such determinations could be made). As shown in Exhibit 4-3, these analyses produced ranges of average annual capital investment from $130 billion to $240 billion (stated in constant 2006 dollars) for the 15-year period from 2005 to 2020, $133 billion to $250 billion for the 30-year period from 2005 to 2035, and $146 billion to $276 billion for the 50-year period from 2005 to 2055. These ranges shift upward over time due to the impact of cumulative VMT growth; accommodating travel demand in 2055 to a certain performance standard would be much more challenging (and expensive) than accommodating current travel volumes to the same performance standard.

The lower end of the ranges noted above reflects the estimated costs of maintaining key conditions and performance measures at current levels, assuming a combination of aggressive strategies to reduce energy consumption and travel demand and the adoption of new technologies to improve the operational performance of the highway system. One critical component of such strategies

Exhibit 4-3. Estimated impacts of alternative highway capital investment levels

	Current	2020		2035		2055	
		Medium	High	Medium	High	Medium	High
Average Annual Highway Capital Investment (billions of 2006 $) [2005 through the year 2020, 2035, or 2055]	$68	$130-166	$207-240	$133-188	$182-250	$146-195	$185-276
Vehicle Miles of Travel (VMT) on all roads (trillions)	3.0	4.1 - 4.1	4.3 - 4.3	5.2 - 5.4	5.5 - 5.6	6.9 - 7.4	7.3 - 8.0
Percent of VMT on roads with NHS-quality pavements	85%	85-86%	94-94%	86-87%	92-93%	83-84%	85-92%
Average Delay (hrs/1000 VMT) on urban principal arterials	5.8	5.1 - 5.3	4.1 - 4.2	5.8 - 5.8	4.1 - 5.2	5.7 - 7.8	5.5 - 6.5
Total Delay (billions of hours) on all Federal-aid Highways	12	16 - 17	15 - 15	22 - 24	20 - 23	28 - 39	29 - 37

This table identifies the projected impacts on certain key performance indicators of alternative highway capital investment levels. The high and low ends of the ranges shown represent the best case and worst case identified from a set of scenarios assuming alternative packages of future transportation policy options.

Source: Commission staff analysis.

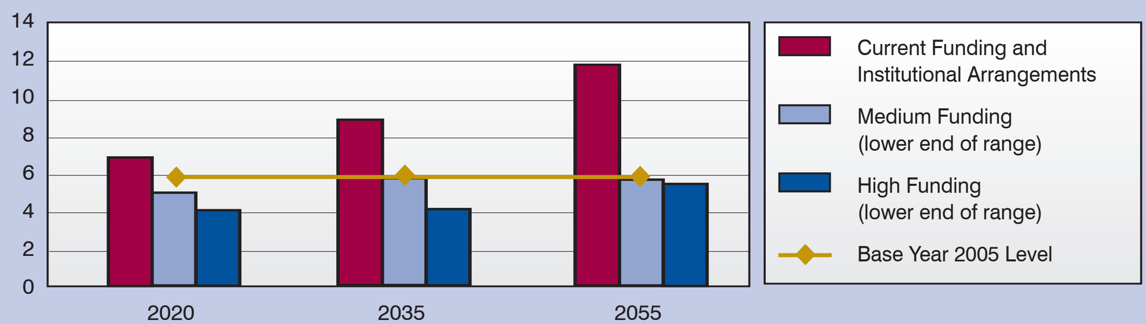
would be the adoption of congestion pricing on a widespread basis in the Nation's urban areas. The higher end of the ranges noted above represent the additional costs that could be incurred from aggressive expansions to the highway system for purposes of improving rural connectivity or separating freight traffic from passenger traffic via a nationwide system of dedicated truck-only lanes, beyond other highway capacity expansion modeled in the scenarios.

Although different combinations of strategies and other policy and institutional options (not explored as part of this study) might bring down the low end of these investment ranges, it is clear from the findings summarized in the table above that a significant gap exists between the level of investment that is currently sustainable from existing financing mechanisms and the amount that would be required to maintain or improve the conditions and performance of the highway system in light of increasing travel demand.

The high ends of the ranges shown above are also not definitive upper limits; a more rigorous analysis of specific proposed projects might cause this number to go up or down. These figures include broad estimates of the potential costs of aggressively adding new components to the system (such as new Interstate routes directly connecting more communities to the existing Interstate system and new truck-only lanes). However, these new components were not subjected to the same sort of benefit-cost analysis applied to the remainder of the highway system, and when examined on a corridor-by-corridor basis, some of these potential investments would likely be much more promising than others. Conversely, such detailed analysis at a local level may identify additional costs not captured by the national-level approach utilized in this study.

Exhibits 4-4 and 4-5 highlight the relative implications of the alternative funding levels on future highway operational performance and physical conditions. The implication of these findings is that if we are going to experience the economic and population growth we expect, it's going to cost a lot just to keep system performance at today's level, let alone improve it. However, while significantly higher levels of highway system investment combined with improved project selection, new technologies, demand management strategies, and strong land use decision making show significant potential for reducing average congestion levels through 2035, there are limits as to what can be achieved. Preserving these

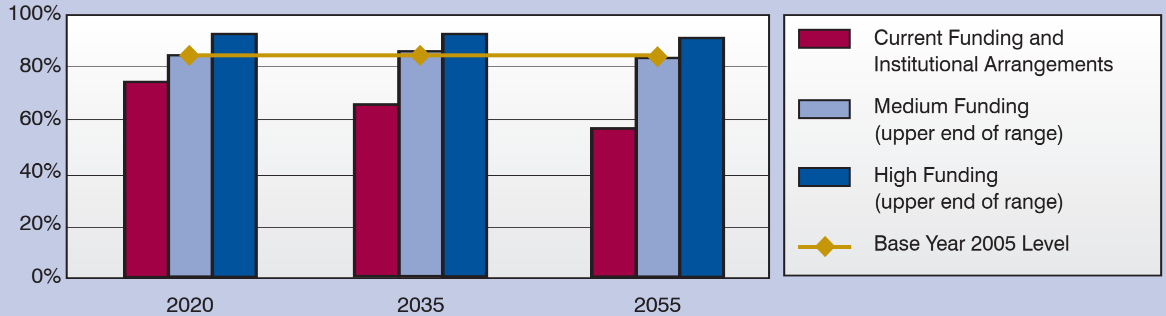
Exhibit 4-4. Projected average delay per 1000 VMT on urban principal arterials



This chart identifies the hours of delay per 1000 miles traveled on urban principal arterial highways that vehicles are expected to encounter if capital investment is sustained at current levels in inflation-adjusted terms, or increased to the "Medium" and "High" funding levels identified in Exhibit 4-3 (chart reflects the lower end of the projected delay ranges).

Source: Commission staff analysis.

Exhibit 4-5. Projected percent of VMT on pavements with acceptable ride quality



This chart identifies the projected percentage of VMT that will occur on roads meeting a standard for ride quality that is described by the U.S. DOT as "Acceptable" for pavements on the National Highway System (NHS), if capital investment is sustained at current levels in inflation-adjusted terms, or increased to the "Medium" and "High" funding levels identified in Exhibit 4-3 (chart reflects the upper end of the ride quality ranges).

Source: Commission staff analysis.

gains through the 2055 horizon will be extremely challenging since much of the projected future delay is expected to occur in the most heavily populated megaregions, where land available for transportation capacity expansion projects will become increasingly scarce over time. Smaller urbanized areas outside of the megaregions will also face significant increases in congestion during this period.

Although the costs of meeting these challenges and accommodating the transportation needs of a growing population and expanding economy are significant, the implied costs of inaction are also very high. Simply maintaining the status quo in terms of funding levels and program design would impose significant costs on the American public in the form of increased travel time and vehicle operating costs, and would negatively impact commerce and the potential for future economic growth. To the extent that well-chosen infrastructure investments can be implemented in a timely manner to reduce or at least slow the increase of such future costs, this would clearly be of benefit to both the current traveling public and to future generations.

Investments in Subsets of the Highway System

The "Medium" and "High" capital investment levels cited above pertain to all "Federal-Aid Highways," a term that includes all roadways that are currently eligible for Federal funding including all urban arterials and collectors and all rural arterials and major collectors.

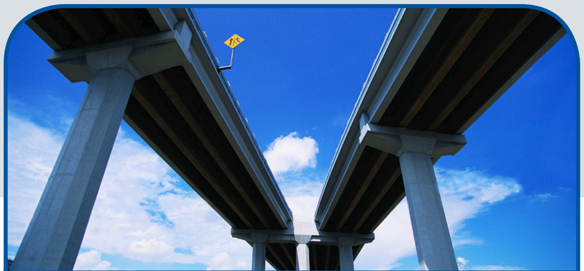
The Interstate Highway System represents one key subset of the overall highway system; although it represents just over 1 percent of overall mileage, it carries 24 percent of highway passenger and freight travel. The National Highway System (NHS) constitutes another important subset, encompassing the entire Interstate System plus other critical highway routes and connections to defense installations and intermodal terminals.

Of the $130 billion to $240 billion (stated in constant 2006 dollars) range of average annual capital investment identified earlier for the 15-year period from 2005 to 2020, approximately 25 to 30 percent would be devoted to the Interstate Highway System. The high end of this range assumes a significant expansion of the Interstate system to connect growing communities without direct Interstate connections. Another 21 percent of this total would be directed to other portions of the NHS. The remaining capital investment (approximately 49 to 54 percent) would be directed toward rehabilitating and expanding other rural and urban Federal-Aid Highways that are not designated as part of the NHS.

Of the $133 billion to $250 billion range of average annual capital investment identified earlier for the 30-year period from 2005 to 2035, approximately 24 to 29 percent would be directed to the Interstate System, and another 21 to 23 percent would be directed to other portions of the NHS, as shown in Exhibit 4-6. Of the $146 billion to $276 billion range of average annual capital investment identified earlier for the 50-year period from 2005 to 2055, approximately 24 to 26 percent would be directed to the Interstate System, and another 21 to 22 percent would be directed to other portions of the NHS.

Investments in Bridges

Each of the highway investment estimates presented above includes a component pertaining to potential future bridge rehabilitation and replacement investments aimed at addressing deficient bridge elements. These analyses indicate that simply maintaining the current overall level of bridge conditions at current levels (i.e., not allowing the backlog of existing bridge deficiencies



BRIDGE METHODOLOGY

The bridge investment requirements analysis conducted as part of this study was performed primarily by the staff of this Commission, with technical support of consultants paid by this Commission for this purpose.

These analyses rely heavily on the Federal Highway Administration's National Bridge Investment Analysis System (NBIAS), which applies a benefit-cost test at the individual bridge level. This approach screens out potential investments on specific bridges if the benefits to the traveling public of keeping the bridge open to traffic are less than the costs of replacing them. (Such situations may arise when a new bridge is built but an older bridge in the same area is kept open until the remainder of its useful life, and then closed to traffic). NBIAS also applies a benefit-cost test to specific improvement actions on individual bridges.

While NBIAS has been customized to address the specific analytical requirements of this study, the bridge component of the "Medium" and "High" funding levels explored as part of this study is similar in nature to the "Cost to Maintain" and "Cost to Improve" scenarios included in the U.S. DOT's biennial Conditions and Performance reports to Congress.

Exhibit 4-6. Average annual highway capital investment (billions of dollars)

	2005-2020 Medium	2005-2020 High	2005-2035 Medium	2005-2035 High	2005-2055 Medium	2005-2055 High
All Federal-aid Highways	$130-166	$207-240	$133-188	$182-250	$146-195	$185-276
Interstate Highways	$32-55	$49-73	$32-60	$42-73	$35-57	$42-73
Other National Highway System	$27-31	$43-51	$28-37	$37-57	$31-41	$39-60

This table identifies the portion of the highway capital investment levels presented in Exhibit 4-3 for all Federal-aid Highways that would be associated with two key system subsets: the Interstate System, and the portion of the National Highway System (NHS) that extends beyond the Interstate system.

Source: Commission staff analysis.

to grow above today's levels) would require a combined investment of public and private sector resources of $650 billion over 50 years in 2006 dollars, equating to an average annual investment level of $13 billion.

The cost of eliminating all existing bridge deficiencies and addressing all such deficiencies as they arise over the next 50 years (where cost-beneficial to do so) is estimated to be $850 billion in 2006 dollars, equating to an average annual investment level of $17 billion. Over this period, it is projected that a large percentage of existing structures would need to be replaced.

In 2004, the most recent year for which data are available, all levels of government invested a combined $10.5 billion in bridge rehabilitation and replacement—nearly 40 percent less than the annual optimal investment level.

Transit Findings

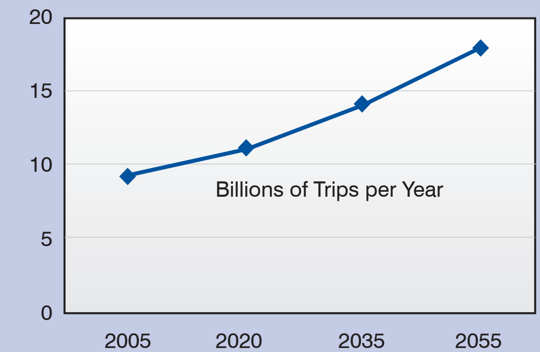
The latest information available to this Commission suggests that current financial and institutional structures could sustain an average annual level of total transit capital investment from all sources of approximately $13 billion per year, calculated in constant 2006 dollars.

Implications of Sustaining Current Levels of Transit Investment

If investment were sustained at this level, and assuming no significant changes in current institutional arrangements, it is estimated that transit ridership would grow from 9 billion passenger trips in 2005 to 11 billion in 2020, 14 billion in 2035, and 18 billion in 2055, as shown in Exhibit 4-7. The average condition of transit assets would be expected to gradually decline over time, from a rating of 3.9 on a 5-point scale in 2005 down to ratings of 3.7 in 2020, 3.6 in 2035, and 3.5 in 2055.

The projected transit ridership figures cited above imply a gradual decline in transit's market share over time, as shown in Exhibit 4-8. The values

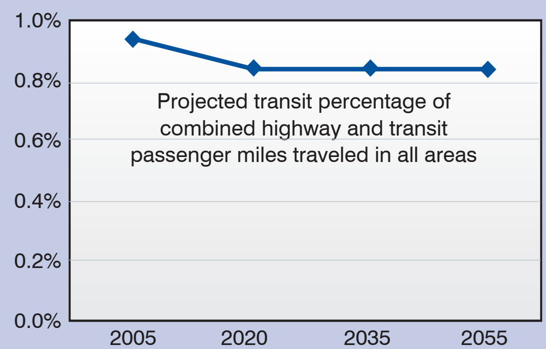
Exhibit 4-7. Transit ridership, base case—assuming current funding



This chart identifies projected transit ridership (in terms of numbers of trips) if capital investment is sustained at current levels over time in inflation-adjusted terms, and current program structures and policies are retained.

Source: Commission staff analysis.

Exhibit 4-8. Projected transit market share, base case—assuming current funding



This chart identifies transit's projected share of combined highway and transit passenger travel if capital investment is sustained at current levels over time in inflation-adjusted terms, and current program structures and policies are retained.

Source: Commission staff analysis.

TRANSIT METHODOLOGY

The transit investment requirements analysis conducted as part of this study was performed primarily by the staff of this Commission, with technical support of consultants paid by this Commission for this purpose.

These analyses rely heavily on the Federal Transit Administration's Transit Economic Requirements Model (TERM), which applies a benefit-cost test at an agency-mode level. This approach screens out all investments in particular types of transit service for particular transit providers if they are not projected to be cost-beneficial. However, because this test is applied at a systemwide level (due to the nature of the data available), it does not screen out investments in underperforming assets that may not be economically justified on their own, if these assets are part of a larger system for which investment is economically justifiable.

While TERM has been customized to address the specific analytical requirements of this study, the "Medium" and "High" funding levels for transit explored as part of this study are similar in nature to the "Cost to Maintain" and "Cost to Improve" scenarios included in the U.S. DOT's biennial Conditions and Performance reports to Congress.

are based on a compilation of long-term transit forecasts of Metropolitan Planning Organizations (MPOs), and they can be assumed to reflect what is likely to occur in the absence of significant new funding or institutional changes. As a relative shift in traffic away from transit toward highways would conflict with national interests in terms of energy independence and environmental considerations, the Commission has explored alternative strategies to increase transit's mode share. Both transit-driven approaches (improving transit connectivity within urbanized areas and increasing the frequency and quality of transit service to attract additional riders) and highway-driven approaches (increasing the price of highway use relative to transit use by imposing highway congestion charges on a widespread basis) were considered as potential levers to encourage additional transit ridership. More integrated land use decision making would have a significant impact on shaping future demand and encouraging growth in transit ridership.

Investments to Maintain and Improve Transit

The scenario analyses developed by this Commission explored "Medium" capital investment levels intended to maintain specific separate measures of transit conditions and performance and "High" investment levels targeted at bringing such measures up to a level of "Good". These analyses include widely different assumptions about future levels of transit passenger travel, producing wide ranges of average annual capital investment from $14 billion to $32 billion (stated in constant 2006 dollars) for the 15-year period from 2005 to 2020, $17 billion to $34 billion for the 30-year period from 2005 to 2035, and $20 billion to $46 billion for the 50-year period from 2005 to 2055. These ranges shift upward over time due to the impact of cumulative growth in passenger miles of travel (PMT); accommodating transit travel demand in 2055 to a certain performance standard would be much more challenging (and expensive) than accommodating current passenger travel volumes to the same performance standard. Details are provided in Exhibit 4-9.

The lower end of the ranges noted above reflects the estimated costs of maintaining the current level of physical conditions and operating performance assuming no fundamental shifts in institutional arrangements or existing policies. Under these assumptions, transit ridership would be expected to rise from 9 billion passenger trips to 20 billion over 50 years. While this represents an

Exhibit 4-9. Estimated impacts of alternative transit capital investment levels

	Current	2020		2035		2055	
		Medium	High	Medium	High	Medium	High
Average Annual Transit Capital Investment (billions of 2006 $) [for 2005 through the year 2020, 2035, or 2055]	$13	$14-18	$21-32	$17-25	$23-34	$20-40	$26-46
Transit Ridership (billions)	9	12-14	13-17	15-25	17-35	20-66	24-71
New Vehicles Added (thousands, cumulative)	–	26-51	51-96	66-186	112-232	121-710	194-783
New Rail Route Miles (thousands, cumulative)	–	1.1-1.5	3.0-4.4	2.4-3.5	5.5-8.0	4.6-6.7	9.1-12.5
Average Asset Condition (scale 1-5)	3.9	4.0-4.0	4.0-4.1	4.1-4.2	4.1-4.3	4.2-4.4	4.2-4.4

This table identifies the projected impacts on certain key performance indicators of alternative transit capital investment levels. The high and low ends of the ranges shown represent the best case and worst case identified from a set of scenarios assuming alternative packages of future transportation policy options.

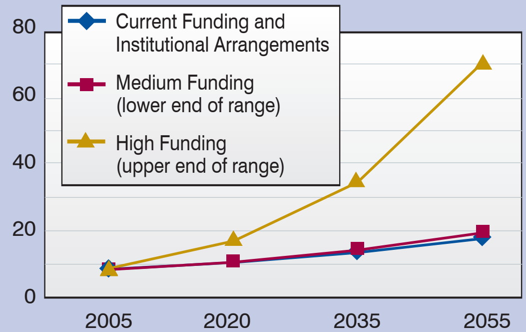
Source: Commission staff analysis.

improvement relative to the projected 2055 figure of 18 billion passenger trips cited earlier assuming no increase in transit spending above currently sustainable levels and a gradually declining level of transit system performance, it would not represent a significant increase in transit market share. Details are shown in Exhibits 4-10 and 4-11.

The higher end of the ranges noted above reflect the estimated costs of improving the current level of physical conditions and operating performance while accommodating significantly higher levels of transit trips inspired by a set of strategies aimed at changing the competitive mix between transit and highways (by increasing the extent, frequency, and quality of transit service and/or raising the price of highway use relative to transit use). Under these assumptions, transit ridership could nearly double over 15 years, nearly quadruple over 30 years, and increase by nearly 8 times over 50 years. In addition, the transit market share would increase by more than 50 percent over 30 years and could triple by 2055.

"If America is to compete internationally, it has to make dramatic investments in its metropolitan infrastructure systems. . . Our metropolitan regions can accommodate the projected increases in population in this country if we focus density around transit stations and continue to expand our transit systems. History has shown that, as public authorities invested in the safety, efficiency, and operation of these systems, the public has responded by riding transit more frequently." *– Robert D. Yaro, President of the Regional Plan Association, at the Commission's New York field hearing.*

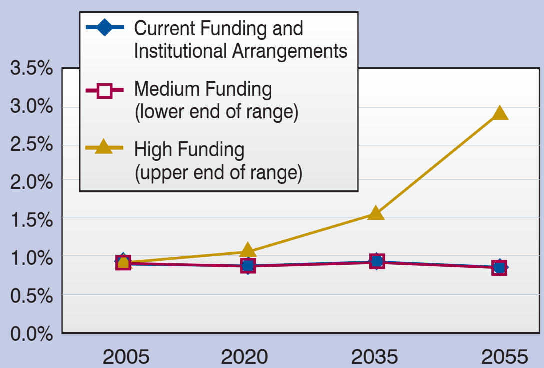
Exhibit 4-10. Alternative projections of future transit passenger trips



This chart identifies projected transit ridership (in terms of numbers of trips) if capital investment is sustained at current levels over time in inflation-adjusted terms or increased to the "Medium" and "High" funding levels identified in Exhibit 4-9 (chart reflects the lower end of the ridership range for the "Medium" funding level and the upper end of the ridership range for the "High" funding level).

Source: Commission staff analysis.

Exhibit 4-11. Alternative projections of future transit market share



This chart identifies transit's projected share of combined highway and transit passenger travel if capital investment is sustained at current levels over time in inflation-adjusted terms, or increased to the "Medium" and "High" funding levels identified in Exhibit 4-9 (chart reflects the lower end of the ridership range for the "Medium" funding level and the upper end of the ridership range for the "High" funding level).

Source: Commission staff analysis.

Freight Rail Findings

As described in Chapter 2, total ton-miles of freight movement in the U.S. is projected to increase by 92 percent over the next 30 years. If the freight rail system were to maintain its current market share of each freight commodity without expanding the capacity of the system, the overall performance of the system would be expected to degrade significantly.

As described in Chapter 3, approximately 88 percent of primary rail corridors are currently operating at levels below their theoretical capacity, leaving sufficient capacity available to accommodate periodic maintenance activities and to recover from incidents that interfere with routine operations. Approximately 9 percent of these corridors are currently operating near their theoretical capacity (with moderate capacity to accommodate maintenance and incidents), and 3 percent are currently operating at their theoretical capacity (with very limited capacity to accommodate maintenance and incidents).

Assuming no increases in capacity or changes in rail's market share, projected increases in freight rail demand would reduce the percentage of primary rail corridors operating below their theoretical capacity to 44 percent, as shown in

Exhibit 4-12. The percentage of corridors near capacity would rise slightly to 10 percent, while the percentage of corridors at capacity would rise to 15 percent. An estimated 30 percent of primary rail corridors would be operating above their theoretical capacity, and would be characterized by unstable flows and service breakdown conditions. Exhibit 4-13 identifies the corridors where these problems are expected to develop.

Investments to Improve Freight Rail While Sustaining Current Market Share Through 2035

An average annual total investment of $5.3 billion per year from all sources is expected to be adequate to accommodate projected freight rail demand in 2035 to a point at which 98 percent of primary rail corridors operate at a level below their theoretical capacity. This would provide sufficient flexibility to accommodate routine maintenance activities and to recover from incidents affecting the operation of the corridor. One percent of the primary rail corridors would be operating at a level near their theoretical capacity, 1 percent would be operating at capacity, and a small number (about 0.01 percent) would still operate at a level above their theoretical capacity. Details are provided in Exhibit 4-14.

This $5.3 billion average annual investment level is stated in constant 2007 dollars and translates to a cumulative level of $148 billion over a 28-year

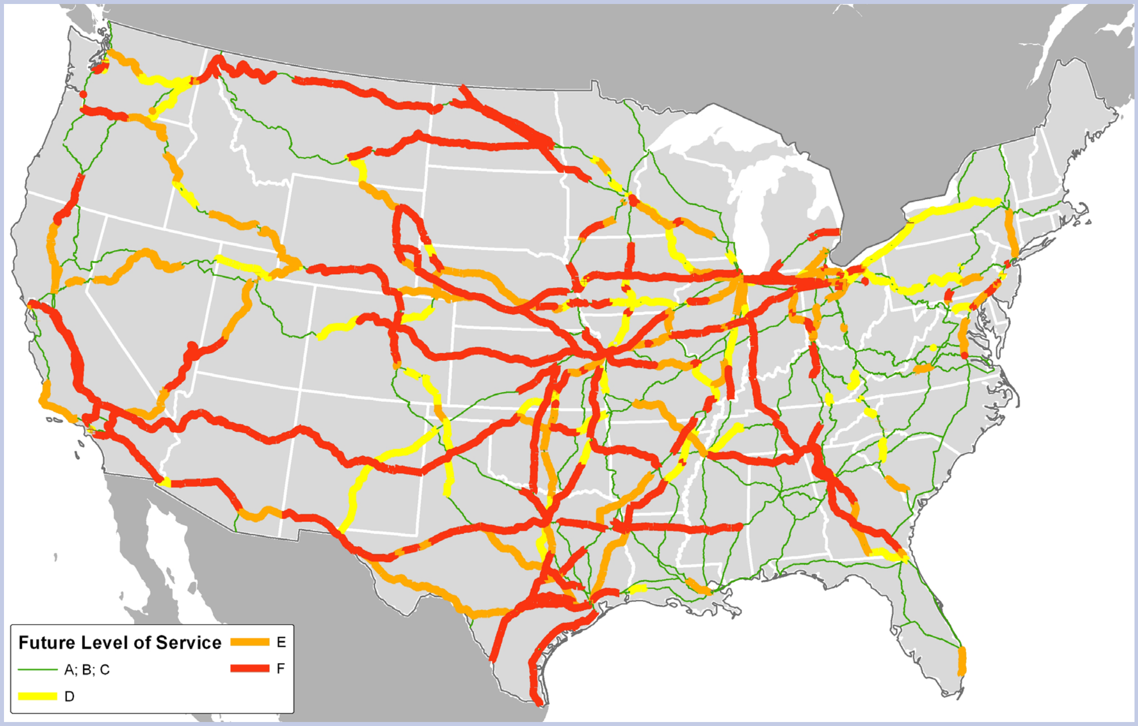
Exhibit 4-12. Freight rail level of service grades

			Current		Projected 2035 (If No New Capacity Added)	
		Level of Service	Miles	Percent	Miles	Percent
A, B, C	Below Capacity	Low to moderate train flows with capacity to accommodate maintenance and recover from incidents.	45,819	88%	23,229	44%
D	Near Capacity	Heavy train flow with moderate capacity to accommodate maintenance and recover from incidents	4,952	9%	5,353	10%
E	At Capacity	Very heavy train flow with very limited capacity to accommodate maintenance and recover from incidents.	1,461	3%	7,980	15%
F	Above Capacity	Unstable flows; service breakdown conditions	108	0%	15,778	30%
Total			**52,340**		**52,340**	

This table identifies the track mileage and percent of total track mileage falling into different level of service classifications based on current conditions and projected 2035 conditions if no new capacity is added.

Source: *National Rail Freight Infrastructure Capacity and Investment Study* prepared for the Association of American Railroads by Cambridge Systematics, Inc.

Exhibit 4-13. Projected 2035 train volumes compared to current train capacity



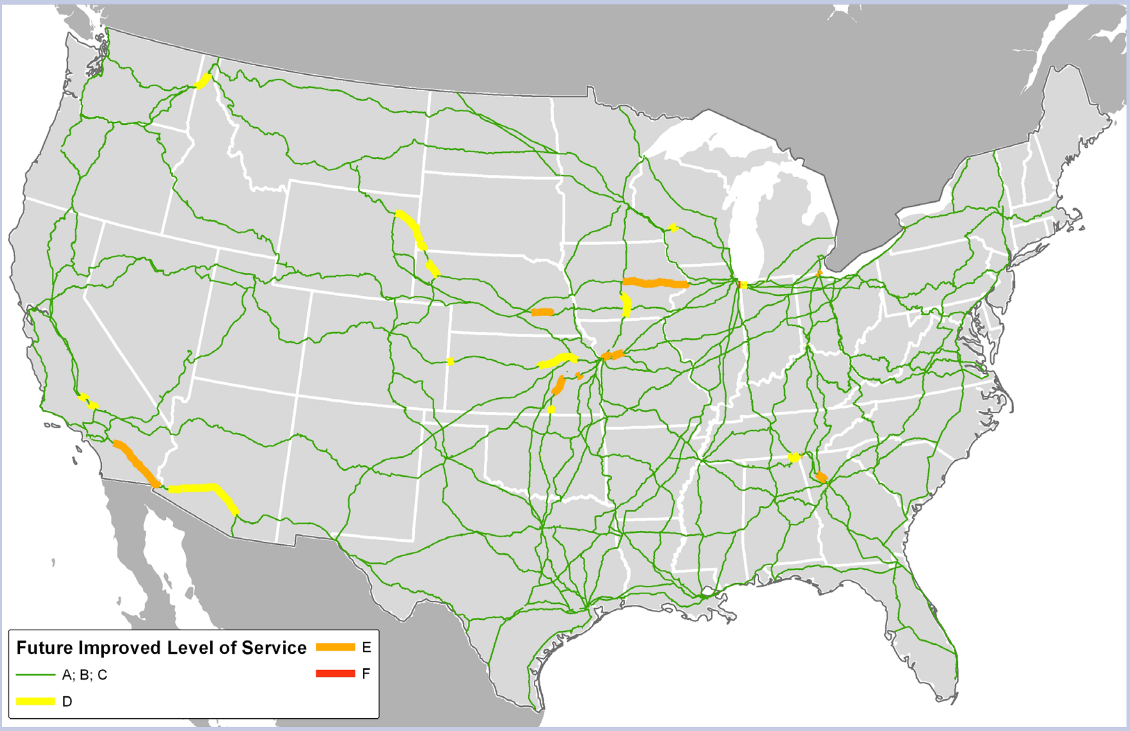
This map identifies the relationship between projected freight train volumes on an 85th-percentile day in 2035 with the theoretical capacity of individual rail sections, assuming that no additional capacity expansion occurs before that time. Levels of Service A, B, and C are all considered to be under capacity; Levels of Service D, E, and F are considered to be nearing capacity, at capacity, and over capacity, respectively.

Source: *National Rail Freight Infrastructure Capacity and Investment Study* prepared for the Association of American Railroads by Cambridge Systematics, Inc.

period from 2007 to 2035, of which the portion attributable to Class I railroads is projected to be $135 billion. This level of investment reflects the need for new tracks, signals, bridges, tunnels, terminals, and service facilities in the primary rail corridors. This estimate does not reflect the cost of acquiring additional property, the cost of buying additional locomotives and freight cars, or the cost of replacing and updating existing track, locomotives, and freight cars.

The *National Rail Freight Infrastructure Capacity and Investment Study* performed by the Association of American Railroads (AAR) assumes the Class I railroads will be able to generate approximately $96 billion of the $135 billion cumulative 28-year investment identified above through increased earnings from revenue growth, higher freight rail volumes, and productivity improvements. This would leave a gap of approximately $39 billion ($1.4 billion per year) to be funded from other sources in order to achieve performance improvements while maintaining the current rail market share of freight shipments for different commodities.

Exhibit 4-14. Projected 2035 train volumes compared to potential 2035 train capacity, assuming expansion to system



This map identifies the relationship between projected freight train volumes on an 85th-percentile day in 2035 with the theoretical capacity of individual rail sections, assuming that significant capacity expansion occurs before that time. Levels of Service A, B, and C are all considered to be under capacity; Levels of Service D, E, and F are considered to be nearing capacity, at capacity, and over capacity, respectively.

Source: *National Rail Freight Infrastructure Capacity and Investment Study* prepared for the Association of American Railroads by Cambridge Systematics, Inc.

Investments to Improve Freight Rail While Accommodating a Rising Market Share Through 2035

The $148 billion ($5.3 billion per year) identified in the preceding section represents the estimated freight rail capacity expansion investment that would be required for the period from 2007 through 2035 to achieve the level of performance identified in Exhibit 4-12, assuming 2.75 trillion annual rail ton-miles are carried on the primary rail corridors in 2035. However, if freight rail's market share were to increase, the level of investment required to accommodate this increased traffic would also increase, as demonstrated in Exhibit 4-15.

Extrapolating from the analysis conducted in the *National Rail Freight Infrastructure Capacity and Investment Study,* it is estimated that if total freight rail tonnage in 2035 were 20 percent higher than was assumed in that study, the estimated level of freight rail capacity expansion investment would rise 34 percent from $148 billion ($5.3 billion per

FREIGHT RAIL METHODOLOGY

The freight rail investment requirements analysis conducted as part of this study was performed by the Association of American Railroads (AAR) at the request of members of this Commission. The AAR released a separate publication in September 2007 documenting this analysis, the *National Rail Freight Infrastructure Capacity and Investment Study.*

This analysis was primarily demand-driven, and was intended to reflect the costs of maintaining freight rail's market share for the transport of a variety of individual commodities, given anticipated growth in freight shipments over the next 30 years. These demand forecasts were provided by Commission staff to AAR, drawing upon information in the Federal Highway Administration's Freight Analysis Framework. The individual investments implicit in the projected investment levels presented in this analysis have not been subject to benefit-cost analysis.

Unlike the highway, bridge, and transit estimates presented in this chapter, the freight rail estimates reflect only the costs of system expansion and do not cover the anticipated costs of system rehabilitation. The freight railroads are privately owned, and have not opted to release such information. However, it is anticipated that they would be able to fully address their ongoing system rehabilitation needs from operating revenues.

The cost estimates include upgrades and expansions to mainlines, branch lines, and facilities. However, these estimates do not include all line expansion costs for non-Class I railroads nor the costs of expanding tunnels, bridges, and service facilities on non-Class I railroads. Also excluded are the cost of acquiring new real estate, maintaining or replacing existing rail lines and facilities, and purchasing additional locomotives and rail cars. These estimates do not reflect capacity expansions associated with potential future increases in passenger rail traffic; these costs are reflected in the Passenger Rail Methodology section later in this chapter.

The estimates presented in this study assume that the future demand for rail freight transportation will be met using current technology and existing rail corridors. While significant changes in rail technology, major shifts in markets or trade patterns, and new innovations in railroad operations would all have the potential to significantly impact the results of this analysis, these potential effects have not been quantified.

The AAR also conducted some supplementary analyses looking beyond 30 years and considering potential increases in freight rail market share in response to follow-up questions posed by members of this Commission. These analyses are reflected in this study, but not in the AAR publication referenced above. Some additional extrapolations were made by Commission staff based on the material developed by AAR.

Exhibit 4-15. Impact of market share on annual freight rail investment requirements

	Rail Ton-Miles in 2035 (trillions)	Annual Investment Required ($ billions)
Reduce Current Market Share	2.46	$3.9
Maintain Current Market Share	2.75	$5.3
Increase Market Share 5%	2.89	$5.7
Increase Market Share 10%	3.03	$6.0
Increase Market Share 20%	3.30	$7.1

This table projects the capital costs required to accommodate alternative levels of rail ton-miles consistent with changes in freight rail's market share.

Source: Analysis conducted by Cambridge Systematics in support of the Commission.

year) to $198 billion ($7.1 billion per year). Such a shift from truck to freight rail would reduce the level of highway capacity investment required, but the impacts of these modal shifts would vary widely depending on the specific corridors in which they occur.

If the $39 billion investment gap identified in the preceding section is not addressed, it is estimated that the rail infrastructure would be able to accommodate only 2.46 billion rail ton miles on primary rail corridors in 2035, rather than the 2.75 annual rail ton-miles consistent with maintaining freight rail's market share. Traffic that could not be accommodated on the freight rail system would need to shift to truck or another freight mode.

Investments to Improve Freight Rail Through 2055

Extrapolating from the analysis conducted in the *National Rail Freight Infrastructure Capacity and Investment Study,* it is estimated that the level of investment required to accommodate projected increases in freight rail traffic and maintain current market share through 2055 would be $272 billion, or $5.7 billion per year for 48 years. These per year costs are higher than the $5.3 billion average annual figure cited above for the 28-year period through 2035, reflecting the fact that many of the less expensive capacity improvement options will have been exhausted by 2035, leaving only the more expensive options of adding full second, third, or fourth tracks.

It is likely that the incremental costs associated with increasing freight rail's market share by 20 percent would be at least as large proportionally as the 34 percent increase ($7.1 billion compared to $5.3 billion) for the period through 2035 reflected in the preceding section. Applying the same percentage to the $5.7 billion average annual figure through 2055 would yield an estimated average annual cost of $7.7 billion to accommodate a 20 percent increase in the freight rail market share over this period. Exhibit 4-16 summarizes these findings.

Note that the extrapolations from the *National Rail Freight Infrastructure Capacity and Investment Study* described here and in the preceding section

Exhibit 4-16. Freight rail capital investment requirements

		2035		2055	
	Sustainable Funding	Maintain Market Share	Increase Market Share	Maintain Market Share	Increase Market Share
Average Annual Freight Rail Capital Investment (billions of constant dollars) [2005 through the year 2035 or 2055]	$3.9	$5.3	$7.1	$5.7	$7.7

This table summarizes the estimated capital costs required to maintain freight rail's market share or increase freight rail's market share by 20 percent through 2035 and 2055. The sustainable funding level represents the average amount of freight rail investment projected to be sustainable based solely on increased earnings from revenue growth, higher volumes, and productivity improvements, assuming freight rail's market share is maintained through 2035.

Source: *National Rail Freight Infrastructure Capacity and Investment Study,* prepared for the Association of American Railroads by Cambridge Systematics, Inc., and supplemental analyses conducted by Cambridge Systematics in support of the Commission.

were not as analytically rigorous as the core analysis conducted as part of that study, and have not been subject to the same type of detailed review by the members of the AAR. However, these estimates are believed to be a good indication of the general magnitude of the impact of the changes that were analyzed.

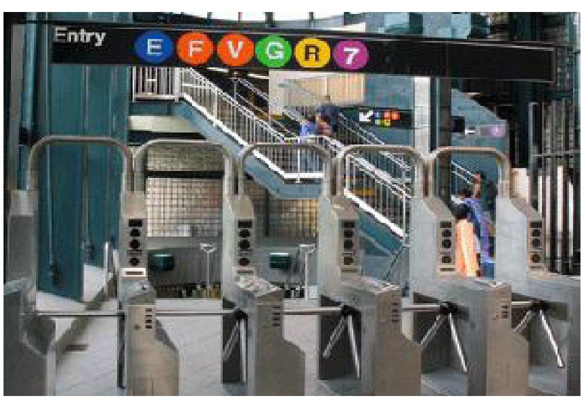
It is important to note that these estimates do not take into account any increase in passenger rail routes or frequencies above current levels. The intersection of increasing freight demand and increased passenger service would be reflected in potentially higher capital investment requirements for additional needed capacity, which should be provided by the public sector and accounted for in the national passenger rail plan.

Passenger Rail Findings

For short to medium distance trips of 100 to 500 miles, enhanced intercity passenger rail service can offer travel time savings relative to air and highway transportation. The requirements for air travelers to check in well before scheduled departure times coupled with rising rates of flight arrival delays give passenger rail a competitive advantage in many markets, particularly in situations where downtown rail stations are more accessible than airports located farther away from the city center. Intercity passenger rail can also provide a mobility alternative for travelers on our congested highway system.

As noted in Chapter 3, intercity passenger rail is also more energy efficient than many other modes of passenger transportation. The 2005 Energy Data Book produced by Oak Ridge National Laboratory shows that intercity passenger rail consumes 17 percent less energy per passenger mile than airlines and 21 percent less per passenger mile than automobiles. The average intercity passenger rail train produces 60 percent lower carbon dioxide emissions per passenger mile than the average auto, and half the carbon dioxide emissions per passenger mile of an airplane. In conjunction with urban transit systems, the city-center to city-center service offered by intercity passenger rail can also support dense, transit-oriented development in downtown areas, helping to reduce highway travel demand for both local trips and intercity trips.

Combining estimates of the long-term capital costs of maintaining existing AMTRAK operations with estimated capital costs associated with a set of new or upgraded passenger rail routes currently in the planning or early discussion stages and a set of potential additional intercity passenger rail connections yields a combined estimate of



PASSENGER RAIL METHODOLOGY

The passenger rail investment requirements analysis conducted as part of this study is based on a December 6, 2007, report, *Vision for the future: U.S. intercity passenger rail network through 2050,* which was developed by a Passenger Rail Working Group (PRWG). The PRWG was composed of intercity passenger rail experts and transportation professionals working under the direction of members of this Commission.

This analysis was not demand-driven in the same sense as the analysis conducted for the other modes covered in this study, in that it was not developed based on an independent national forecast of travel demand for this mode. Instead, individual potential passenger rail routes were identified based on existing corridor-specific studies and general knowledge of transportation patterns in specific areas, and assumptions were made about the potential ridership that could be attracted to these routes.

The PRWG's analysis combines estimates of capital costs relating to continued operations of the existing AMTRAK system, Federally designated operating rail corridors, corridors in planning or development stages, and potential future routes linking major urban areas. Costs pertaining to AMTRAK were developed in conjunction with AMTRAK staff, while costs pertaining to specific new corridors were obtained from planning studies, if available. In cases where planning efforts had not yet reached the stage at which reliable cost estimates were available, estimates of the average capital costs per mile for different levels of passenger rail service were applied. The estimates include capital costs relating to infrastructure, station costs, re-capitalization costs, and rolling stock. The inclusion of rolling stock is consistent with the approach taken in the transit analysis presented in this chapter; the freight rail and highway estimates do not include rolling stock, as the vehicles using these modes are typically privately owned.

The individual investments implicit in the projected investment levels presented in this analysis have not been subject to benefit-cost analysis. A rigorous quantitative analysis would need to be conducted before embarking on specific investments in the passenger rail system to assess the relative benefits and costs of such investments and compare them with alternative approaches to addressing mobility needs in these areas, including potential investments in the intercity bus, aviation, and highway modes.

The PRWG used 2015, 2030, and 2050 as breakpoints for its immediate-term, mid-term, and long-term estimates, which do not match the breakpoints used in the analyses for the other modes in this report. To avoid confusion, the estimates are identified in this report primarily using their verbal descriptors, rather than introducing a different set of dates into the discussion. In the combined figures for all modes presented at the end of this chapter, the immediate-term, mid-term, and long-term estimates for passenger rail have been combined with the costs through 2020, 2035, and 2055 that were computed for the other modes.

$357 billion of potential passenger rail capacity investments over a 44-year period, translating into an average annual investment of $8.1 billion, as shown in Exhibit 4-17. This expansion scenario is primarily focused on new and enhanced "regional service" in high growth intercity corridors.

It is estimated that the construction of such a network could potentially accommodate an expansion in intercity passenger rail use of 8 to 9 times above the current level of 5.5 billion annual passenger miles, resulting in a significant increase in passenger rail's market share, as shown in Exhibit 4-18. Assuming the trains

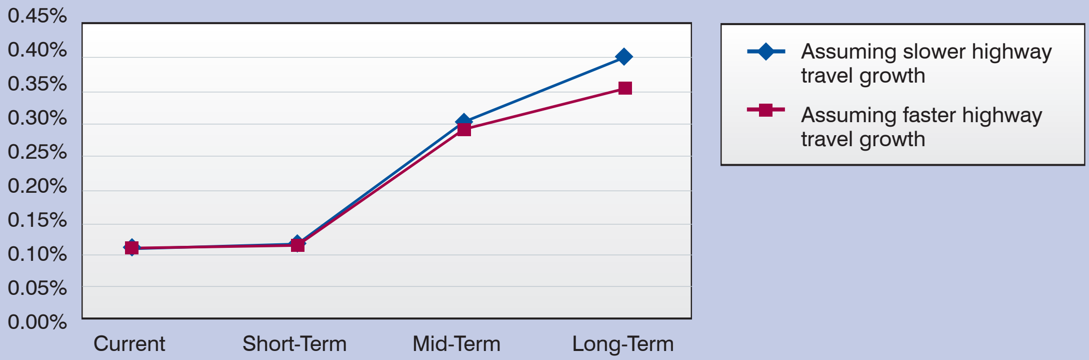
Exhibit 4-17. Estimated intercity passenger rail costs and travel

	Current	Short-Term	Mid-Term	Long-Term
Intercity Passenger Rail Capital Costs (billions of constant dollars), within time period	–	$66	$159	$132
Average Annual Capital Costs (billions of constant dollars), within time period	–	$7.4	$10.6	$6.6
Capital Costs (billions of constant dollars), cumulative through end of time period	–	$66	$225	$357
Average Annual Capital Costs (billions of constant dollars), based on cumulative costs	–	$7.4	$9.4	$8.1
Annual Passenger Miles of Travel (billions), assuming 45 percent load factor	5.5	8.2	26.9	46.7

This table shows estimated capital costs associated with the proposed intercity passenger rail network developed by the PRWG for the short-term (2007-2015), mid-term (2016-2030) and long-term (2031-2050). Costs within each time period and cumulative costs from the present through the end of each time period are identified. The table also shows projected annual passenger miles traveled for the system for each of these time periods, which assume that 45 percent of passenger rail seats would be filled on average.

Source: *Vision for the future: U.S. intercity passenger rail network through 2050* prepared for the Commission by the Passenger Rail Working Group.

Exhibit 4-18. Projected future passenger rail market share



This chart identifies passenger rail's projected share of combined highway and passenger rail travel, assuming construction of the passenger rail network described in this chapter. Both projections assume that 45 percent of passenger rail seats would be filled on average. The higher projected passenger rail market share assumes the widespread adoption of highway demand management strategies. The lower projected passenger rail market share assumes aggressive investments in the expansion of highway system connectivity that would tend to compete with passenger rail in some corridors.

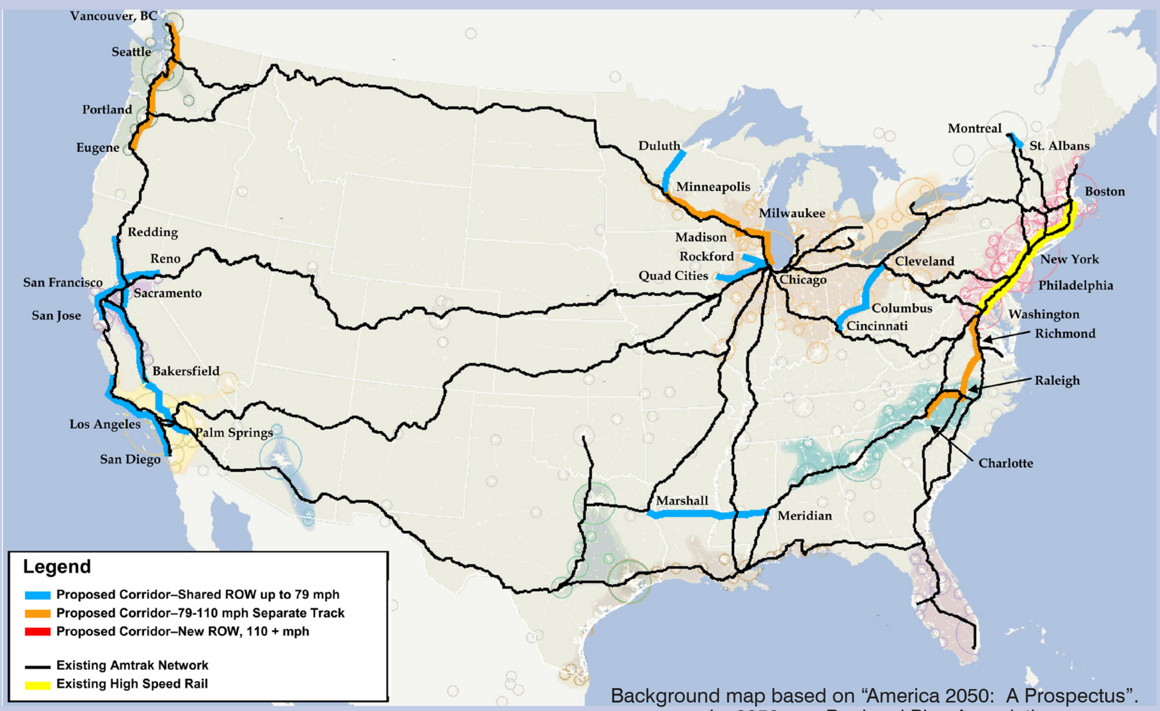
Source: Commission staff analysis.

operate with 45 percent of their seats filled, this would translate into approximately 46.7 billion annual passenger miles traveled by the end of the 44-year period. To the extent that these trips are diverted from other modes such as aviation and highways (as opposed to representing new trips that would not have otherwise occurred), this would tend to reduce the level of capital expansion investment required for these modes. However, the magnitude of these effects would vary widely by corridor.

The short-term passenger rail needs identified in Exhibit 4-17 reflect the costs of maintaining existing service, upgrading existing service where demand is greatest, and adding new service where environmental and engineering work are complete. It is estimated that a $66 billion investment over 9 years to construct the network identified in Exhibit 4-19 would accommodate approximately 8.2 billion passenger miles annually.

The mid-term passenger rail needs identified in Exhibit 4-17 reflect a period of significant expansion of the passenger rail network, as the majority of proposed new regional corridor routes would be added during this time period. It is estimated that a $159 billion investment over 15 years to expand the network to the extent identified in Exhibit 4-20 would accommodate

Exhibit 4-19. PRWG proposed 2015 intercity passenger rail network



Background map based on “America 2050: A Prospectus”. www. america2050.org. Regional Plan Association

This map identifies the passenger rail network that corresponds to the short-term capital costs and ridership projections identified in Exhibit 4-17. The PRWG describes this map as illustrative, as the exact routes that would be included in such a network could differ.

Source: *Vision for the future: U.S. intercity passenger rail network through 2050,* prepared for the Commission by the Passenger Rail Working Group.

Exhibit 4-20. PRWG proposed 2030 intercity passenger rail network

Background map based on "America 2050: A Prospectus". www. america2050.org. Regional Plan Association

This map identifies the passenger rail network that corresponds to the mid-term capital costs and ridership projections identified in Exhibit 4-17. The PRWG describes this map as illustrative, as the exact routes that would be included in such a network could differ.

Source: *Vision for the future: U.S. intercity passenger rail network through 2050,* prepared for the Commission by the Passenger Rail Working Group.

approximately 26.9 billion passenger miles annually.

The long-term passenger rail needs identified in the Exhibit 4-17 reflect the cost of completing the proposed passenger rail network. During this period, corridor routes would be added to connect regions and population centers. It is estimated that a $132 billion investment over 20 years to expand the network to the extent identified in Exhibit 4-21 would accommodate approximately 46.7 billion passenger miles annually.

Exhibit 4-21. PRWG proposed 2050 intercity passenger rail network

Background map based on "America 2050: A Prospectus". www. america2050.org. Regional Plan Association

This map identifies the passenger rail network that corresponds to the long-term capital costs and ridership projections identified in Exhibit 4-17. The PRWG describes this map as illustrative, as the exact routes that would be included in such a network could differ.

Source: *Vision for the future: U.S. intercity passenger rail network through 2050,* prepared for the Commission by the Passenger Rail Working Group.

Summary of Findings: All Modes

While there are significant differences in the analyses of the individual modes presented in this chapter, it is useful to combine them to get a better sense of scale of the overall surface transportation needs for the next 50 years. Exhibit 4-22 summarizes ranges of potential investment levels presented earlier in this chapter for different modes. This summary focuses on "High" capital investment levels; by comparison, the highway and transit analyses included both a "Medium" and a "High" range of funding levels, and the freight and passenger rail analyses each contain only a single set of projections which correspond to the "High" range of funding levels in the other modes.

Combining the low ends of the ranges of the period through 2035 reveals a combined average annual capital investment level for all modes of $220 billion, which is $134 billion higher than

SAINT LAWRENCE SEAWAY

In November 2007, the U.S. Department of Transportation, Transport Canada, and the U.S. Army Corps of Engineers released the "Great Lakes St. Lawrence Seaway Study," which assessed the future U.S. and Canadian infrastructure needs of the Great Lakes St. Lawrence Seaway System, specifically the engineering, economic, and environmental implications of those needs as they relate to the marine transportation infrastructure on which commercial navigation depends. The study provides U.S. and Canadian policymakers with a blueprint for what is needed to maintain the commercial navigation infrastructure at its current level of reliability over the next 50 years. The study identified more than $630 million in U.S. and Canadian infrastructure renewal needs through 2050 as part of a proactive program of upgrading and repairing the Great Lakes Seaway System's most critical infrastructure needs. Without this proactive approach, unplanned rehabilitation costs for those same critical needs are estimated at $1.8 billion over the same time period.

the $86 billion combined amount of currently sustainable annual funding identified for all modes. Dividing this figure by the total highway motor fuel gallonage associated with the highway investment level produces an equivalent per-gallon figure of $0.63, indicating that an increase in motor fuel taxes of this magnitude would generate this amount of revenue. Combining the high end of the ranges through 2035 reveals an average annual investment level of $301 billion, which is $215 billion higher than the combined currently sustainable funding level. This equates to the revenue that could be generated by a $1.00 increase in the motor fuel tax.

The inclusion of per-gallon comparisons in the table above is intended to provide a sense of scale regarding the large investments that are needed; this should not be misconstrued to mean that the motor fuel tax should necessarily be the primary source of all future transportation funding by all levels of government. Future revenue options are discussed in more detail in Chapter 5, but it is worth noting here that different revenue sources are more amenable to certain types of investment. In particular, investments in new capacity may provide opportunities to draw upon a broader array of financing options than investments in system rehabilitation. Of the $220 billion identified above as the low end of the combined "High" funding level range, nearly one-half is associated with system rehabilitation improvements, as shown in Exhibit 4-23.

Combining the upper and lower ends of the investment ranges for the individual modes has some conceptual shortcomings. For example, the low ends of the highway ranges through 2035 and 2055 are associated with a scenario incorporating aggressive demand management strategies including the widespread adoption of congestion pricing. This scenario would not be consistent with the low end of the transit ranges, as it explicitly assumes sharp increases in transit ridership. Thus, the range of investment required to achieve the goals of the high investment levels in terms of improving key condition and performance measures for each mode may be narrower than what is implied in Exhibit 4-22. It is also important to note that the computation of investment gaps does not involve deducting out potential revenues associated with policy strategies incorporated in some of the analyzed scenarios. The aggressive congestion pricing strategy associated with the low ends of the highway ranges was estimated to have the potential to generate $69 billion annually through 2035 and $103 billion through 2055.

Exhibit 4-22. Summary of range of "high" average annual capital investment levels analyzed for all modes

Range of "high" capital investment levels analyzed (billions of constant dollars)

	Currently Sustainable[1]	Range Through 2020		Range Through 2035		Range Through 2055	
		From	To	From	To	From	To
Highway	$68	$207	$240	$182	$250	$185	$276
Transit	$13	$21	$32	$23	$34	$26	$46
Freight Rail	$4	$5	$7	$5	$7	$6	$8
Passenger Rail	$1	$7	$7	$9	$9	$8	$8
All Modes Combined[2]	**$86**	**$241**	**$286**	**$220**	**$301**	**$225**	**$338**

"Gap" between high capital investment levels and currently sustainable revenue (billions of constant dollars)[3]

	Currently Sustainable	Range Through 2020		Range Through 2035		Range Through 2055	
		From	To	From	To	From	To
Highway		$139	$172	$115	$182	$117	$208
Transit		$8	$19	$10	$21	$13	$33
Freight Rail		$1	$3	$1	$3	$2	$4
Passenger Rail		$6	$6	$8	$8	$7	$7
All Modes Combined		**$155**	**$200**	**$134**	**$215**	**$140**	**$252**

Investment "gaps" stated in constant cents per gallon of highway motor fuel[4]

	Currently Sustainable	Range Through 2020		Range Through 2035		Range Through 2055	
		From	To	From	To	From	To
Highway		$0.71	$0.88	$0.54	$0.85	$0.49	$0.85
Transit		$0.04	$0.10	$0.05	$0.10	$0.06	$0.13
Freight Rail		$0.01	$0.02	$0.01	$0.01	$0.01	$0.02
Passenger Rail		$0.03	$0.03	$0.04	$0.04	$0.03	$0.03
All Modes Combined		**$0.79**	**$1.02**	**$0.63**	**$1.00**	**$0.59**	**$1.03**

1 The estimated "Currently Sustainable" funding for highways and transit is based on short-term Federal Highway Trust Fund revenue projections and assumes State, local, and private funding remains steady in constant dollar terms (i.e., growth equals inflation), while the estimate for freight rail assumes that private freight rail capital investment keeps pace with revenue growth. The amount shown for intercity passenger rail assumes estimated current capital investment by Amtrak and State governments remains steady in constant dollar terms.

2 The combined figures do not account for cross-modal impacts.

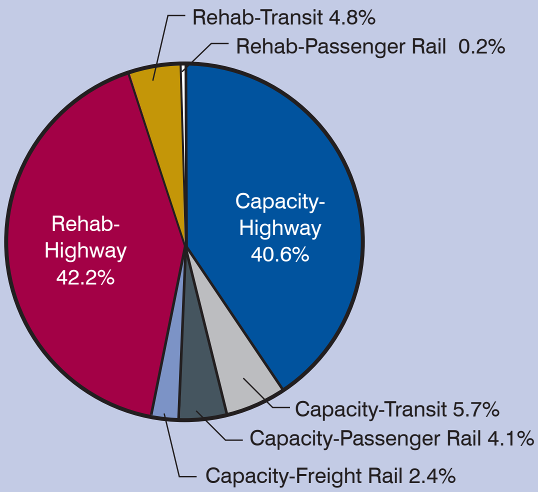
3 "Gaps" reflect the difference between the "High" and "Currently Sustainable" capital investment levels.

4 The implied cents per gallon for the lower and upper ends of the range for each time period are based on the estimated fuel consumption derived from the highway scenario consistent with the highway funding level in each column.

This table shows the range of potential annual investment levels in highways, transit, freight rail, and passenger rail and the equivalent fuel tax increase that would be required to fill the gap between current sustainable investment levels and the high investment levels shown in the table. Each range represents average annual amounts from the current year through the date shown.

Source: Commission staff analysis.

Exhibit 4-23. Capital improvement type distribution for $220 billion of average annual investments through 2035



This chart identifies the distribution by mode and improvement type of the $220 billion representing the lower end of the range of investment levels through 2035 identified in Exhibit 4-22. Amounts shown for system rehabilitation include some improvements that are primarily oriented to safety and other enhancements to the existing system. No amount is shown for freight rail rehabilitation, as the freight rail needs analysis presented in this chapter only includes capacity expansion needs.

Source: Commission staff analysis.

Despite the difficulties that arise when dealing with diverse and complex data such as these, it is clear from the analysis that there are significant gaps between current sustainable funding and the combined level of public investment required to improve the performance of the transportation system, particularly in the face of a growing population and an expanding economy. Because these values are stated in constant dollar terms, it would be necessary to increase investment over time above the levels shown to keep pace with construction cost inflation and achieve the performance impacts associated with these investment ranges.

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