Commission Briefing Paper 3G-02

Baseline Highway Needs Assessment: Additional Benchmarks and Analyses of System Components

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Introduction

This paper is part of a series of briefing papers to be prepared for the National Surface Transportation Policy and Revenue Study Commission authorized in Section 1909 of SAFETEA-LU. The papers are intended to synthesize the state-of-the-practice consensus on the issues that are relevant to the Commission's charge outlined in Section 1909, and will serve as background material in developing the analyses to be presented in the final report of the Commission.

Section 1909 requires the final report of the Commission to include an assessment of future needs over 15-, 30-, and 50-year time horizons. The papers in Module III are intended to facilitate this effort by developing a baseline needs assessment, which can then serve as a basis for subsequent supplementary analysis and scenario development. This paper deals with needs for the highway system in the U.S. Needs assessments for other modes will be covered under task area III-H (transit); III-I (freight and passenger rail); and III-J (other components, including intercity bus; inland and coastal waterways; and intermodal transfer facilities).

Key findings on highway finance and investment requirements from the 2006 Conditions and Performance (C&P) report are covered in briefing papers 3A-01, 3C-01, 3C-02, and 3E-01.

This paper extends the baseline highway needs analysis presented in briefing paper 3G-01, showing the distribution of the baseline investment estimates among different components of the highway system and providing estimates for additional investment/performance benchmarks. Estimates are also provided for the impact that the funding highway capital investment at the baseline highway needs estimate level would be projected to have on highway conditions and performance. The approach and key assumptions applied in the analyses of this paper are covered in more detail in paper 3G-01.

Background and Key Findings

- Approximately 26 percent of the investment in system rehabilitation and system expansion under the maximum economic investment scenario used in the baseline needs assessment is on the Interstate System, and approximately 47 percent is on the National Highway System.

- Over the shorter 15-year time horizon, the cost of maintaining conditions and performance on the Federal-aid highway system is less than half the maximum economic investment level. Over longer time horizons, however, increasing traffic levels make it much more expensive to maintain the operational performance of the system; over 50 years, the cost of maintaining average delay on Federal-aid highways is only slightly less than the maximum economic investment level.

- If this current funding levels for highway rehabilitation and expansion were to be maintained in constant dollar terms, growing only with inflation, the HERS model projects that both highway conditions and performance would be expected to deteriorate significantly over time. Average pavement roughness would increase by almost 35 percent, and average delay by almost 40 percent. Households driving an average of 30,000 miles annually would face increased user costs (including the costs of travel time, vehicle operation, and crashes) of $2,000 per year in today's dollars.

- It should be noted that this baseline assessment assumes the continuation of existing travel growth trends, technologies and financing mechanisms. Significant changes in any of these assumptions would affect the future performance of the highway system at any level of funding.

Investment by Highway System Component

Exhibit 1 shows how the capital investment portion of the maximum economic investment scenario used in the baseline highway needs estimate presented in Exhibit 1 of briefing paper 3G-01 is distributed among different components of the Nation's highway system.

Investments on the Interstate comprise approximately 26 percent of total outlays for system rehabilitation and system expansion under the maximum economic investment scenario, totaling $630 million over 15 years; $1.3 trillion over 30 years; and $2.4 trillion over 50 years, stated in constant 2005 dollars. Investments on the National Highway System (which includes the Interstate System and other principal commercial routes) total $1.1 trillion over 15 years and $4.3 trillion over 50 years (also stated in constant 2005 dollars), representing roughly 47 percent of total rehabilitation and expansion investments.[1]

Urban and Rural Areas

Of the $3.8 trillion in total highway rehabilitation and system expansion investment requirements over 30 years on the Federal-aid system estimated by HERS, approximately 21 percent is in rural areas; 54 percent is in major urbanized areas over 1 million in population; and 25 percent is in other urban and urbanized areas. The distribution of investment in HERS for the 15- and 50-year analyses among urban and rural areas shows a similar pattern.

[1] In nominal dollar terms (assuming a 2.5 percent average annual rate of inflation), the baseline estimates for the interstate system are $750 million over 15 years; $1.9 trillion over 30 years; and $4.9 trillion over 50 years. The nominal dollar estimates for the NHS (assuming the same 2.5 percent inflation rate) are $1.35 trillion over 15 years and $8.7 trillion over 50 years.

Exhibit 1
Capital Investment Requirements by System Component
(trillions of constant 2005 dollars)

	15-year 2005-2020	30-year 2005-2035	50-year 2005-2055
Highway Rehabilitation and System Expansion[1]			
Interstate System	0.57	1.18	2.21
National Highway System[2]	1.04	2.12	3.94
Federal-aid Highways[3]	1.88	3.78	6.92
All highways[4]	2.21	4.46	8.16
Bridge Rehabilitation and Replacement[5]			
Interstate System	0.06	0.11	0.19
National Highway System	0.09	0.19	0.34
All Bridges[6]	0.21	0.49	0.87
System Rehabilitation and System Expansion (Total)			
Interstate System	0.63	1.29	2.39
National Highway System	1.13	2.32	4.28
Federal-aid Highways	2.09	4.27	7.79
All highways	2.42	4.96	9.04

Notes:

1\ Modeled in HERS for Federal-aid Highways

2\ Includes the Interstate System and other principal commercial routes

3\ Includes the NHS and other roads eligible for Federal-aid

4\ Includes rural minor collectors and rural and urban local roads, which are not eligible for Federal-aid, and are not directly modeled in HERS

5\ Modeled in NBIAS

6\ All bridges on public roads are eligible for Federal-aid, and are modeled in NBIAS

Other Investment/Performance Benchmarks

The baseline highway needs estimate in briefing paper 3G-01 effectively represents a level of funding that would improve the highway system to its maximum extent, while only investing in cost-beneficial projects. While this concept provides one plausible definition for highway revenue "needs," other benchmarks are also plausible targets, and thus worthy of note.

The performance benchmarks found in Exhibit 2 are based on maintaining the current state of the system, in the sense that future values of the particular condition and performance measures cited here at the end of each of the three time horizons will match their current levels. The three benchmarks cited in this analysis are:

- Maintain Average Delay per VMT. This measure is intended as an indicator of the operational performance of the highway system

- Maintain Average User Costs. This benchmark corresponds to maintaining conditions and performance, as reflected by the impact that this has on highway users via travel time, safety, and vehicle operating costs.[2]

- Maintain the Percent of VMT on Roads with Acceptable Ride Quality. This measure is intended as an indicator of the physical condition of the highway system, emphasizing the impact that this has on users. A road with acceptable ride quality (defined as having an International Roughness Index of 170 inches per mile or lower) is one that can generally be considered to be in a state of good repair.

Since projections for these performance benchmarks are derived exclusively from HERS, the estimated levels shown in Exhibit 2 reflect only the investment that would be used for the types of capital improvements (highway rehabilitation and system expansion) and types of roads (Federal-aid highways) that are directly modeled in HERS.

Exhibit 2

Baseline Highway Needs Estimate: Other Investment Benchmarks[1]
(trillions of constant 2005 dollars)

Benchmark	15-year 2005-2020	30-year 2005-2035	50-year 2005-2055
Maximum Economic Investment (baseline)	1.88	3.78	6.92
Maintain Average Delay	0.92	2.74	6.16
Maintain Average User Costs	0.86	2.27	4.93
Maintain Percent of VMT on Roads with Acceptable Ride Quality	0.89	1.99	3.75

Notes:
1\ Figures include only capital investment in highway rehabilitation and system expansion on Federal-aid highways

One caveat concerning the estimates for these benchmarks is whether the specified performance goal could actually be attained at this level of capital investment. While the HERS analysis assumes that projects would be carried out strictly in descending order of benefit-cost ratio, this is unlikely to be the case in reality. While the model focuses on engineering impacts and economic benefits, other factors do in fact influence project selection. If some projects with lower BCRs were carried out instead of projects with higher BCRs, then the actual amount required to achieve this performance objective would be higher.

Over the 15-year time horizon, the projected cost to meet each of the three benchmarks is approximately $900 billion (in constant 2005 dollars). This amount is less than half the comparable level from the baseline needs estimate. Over the shorter time frame, the cost of maintaining conditions and performance on the highway system is significantly lower than the cost of implementing all cost-beneficial improvements.

For the longer time horizons, the estimated funding levels for the performance benchmarks diverge significantly from one another. The cost to maintain average delay over 30 years is

[2] This measure does not include taxes and tolls, which, can *affect* conditions and performance (by raising the costs of travel to drivers and thus discouraging highway usage), but do not *reflect* conditions and performance

almost 40 percent higher than the cost of maintaining the physical condition of the highways, and over 50 years this difference widens to 65 percent. The amount of investment required to maintain average delay also increases much more rapidly over longer time horizons than do the estimates for the other benchmarks, becoming close to the maximum economic investment level for the 50-year analysis.

These estimates reflect the increasingly difficult task of accommodating increases in population and highway travel over long periods of time. Total VMT on Federal-aid highways under the baseline scenario estimate would be projected to grow from 2.6 trillion in 2004 to 3.6 trillion in 2020; 4.5 trillion in 2035; and 5.9 trillion in 2055, while the total U.S population is projected to grow from 300 million in 2005 to 435 million by 2055.[3]

Impact of Investment on Highway Conditions and Performance

The HERS model also projects future highway condition and performance for a given pattern of capital investment. Exhibit 3 shows the impact of highway investment on certain key indicators of physical condition and operational performance for each of the three time horizons, compared with base year values, for two scenarios: the baseline highway needs estimate, and maintain current spending.

Baseline Highway Needs Estimate

At the level of funding for the highway capital improvements identified in the baseline highway needs estimate in briefing paper 3G-01, significant improvements would be achieved in the physical condition of the highway system. Average pavement roughness on Federal-aid highways would be projected to decline by over 26 percent over 15 years, and over 22 percent over 50 years. Over 94 percent of all travel on the Federal-aid system would occur on roads with acceptable ride quality at all time horizons.

Significant improvements would also be achieved in highway operational performance over the shorter time periods, though these improvements would be smaller over the longer horizons. Average effective speeds on Federal-aid highways would increase from 42.7 miles per hour to 44.4 miles per hour by 2020, and to 43.5 miles per hour by 2055. Average delay would be reduced by 16.3 percent over the 15-year horizon, and by 1.2 percent at the end of 50 years. Average highway user costs would decrease by 3.7 percent over 15 years; by 2.7 percent over 30 years; and by 1.6 percent over 50 years.

While these percentages are small, it should be noted that one-percent of user costs (which include the costs of travel time, vehicle operation, and crashes) translates to approximately one-cent per mile. For a household averaging 30,000 miles of vehicle use per year, each one percent savings would represent savings of approximately $300 annually in today's dollars.

[3] VMT growth under the other benchmarks, which achieve lower levels of performance than under the baseline needs scenario estimate, would be correspondingly lower. For the Maintain Percent of VMT on Roads with Acceptable Ride Quality benchmark, annual VMT on Federal-aid highways would be projected to reach 5.6 trillion by 2055.

Maintain Current Spending

This benchmark reflects the impact of maintaining highway capital investment at current levels would have on future highway conditions and performance. In 2005, highway capital outlay in the U.S. totaled $75.2 billion (of which $47.8 billion was devoted to the types of spending modeled in HERS). If this level of funding were to be maintained in constant dollar terms, growing only with inflation, the HERS model projects that both highway conditions and performance would be expected to deteriorate significantly over time, as shown in Exhibit 3.

At current funding levels, the percent of travel on the Federal-aid system on roads with acceptable ride quality would steadily decrease over time, to 81.4 percent by 2020; 77.2 percent by 2035; and 72.7 percent by 2055. Average pavement roughness in 2055 would be over 34 percent higher.

Highway operational performance would also deteriorate, particularly in later years. Average highway user delay would be projected to increase by 5.7 percent over 15 years, and by almost 39 percent over 50 years.[4] Average highway speeds would be projected to drop to less than 40 miles per hour by 2055, and average user costs would increase by 6.6 percent. A household driving 30,000 miles per year would face additional costs in increased travel time, vehicle operating costs, and increased crash costs of $2,000 per year in today's dollars.

Exhibit 3
Projected Changes in Measures of Highway Condition and Performance over Different Time Horizons at Different Funding Levels[1]

Scenario	Pct Change in Avg IRI	Pct VMT on Roads with IRI<170	Pct Change in Avg Delay	Average Speed	Pct Change in Avg User Costs
Base Year[2]		84.8		42.7	
Baseline Highway Needs Estimate					
15-year (2020)	-26.6%	95.7	-16.3%	44.4	-3.7%
30-year (2035)	-24.8%	95.4	-8.3%	43.9	-2.7%
50-year (2055)	-22.2%	94.4	-1.2%	43.5	-1.6%
Maintain Current Spending[3]					
15-year (2020)	6.9%	81.4	5.7%	42.1	1.0%
30-year (2035)	16.5%	77.2	22.9%	40.9	3.5%
50-year (2055)	34.6%	72.7	38.9%	39.7	6.6%

Notes:

1\ Reflects capital investment in highway rehabilitation and system expansion, on Federal-aid highways only

2\ Base year values based on 2004 data, using 2005 costs

3\ Current capital investment levels in highway rehabilitation and system expansion maintained in constant dollars

[4] Note that this scenario assumes accelerated deployments of ITS technologies and operations strategies over the first 20 years of the analysis, which has the effect of reducing non-recurring incident delay. Recurring congestion delay would increase over 70 percent under the maintain current spending benchmark.