Commission Briefing Paper 3G-01
Baseline Highway Needs Assessment

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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. The relationship between this baseline analysis and the C&P investment analysis is described in greater detail below.

Briefing paper 3G-02 extends the analysis presented here, including estimates for other investment/performance benchmarks and disaggregation of the investment analyses for different components of the highway system in the U.S.

Background and Key Findings

- The baseline needs estimate represents a level of investment sufficient to improve the condition and performance of the highway system, anywhere that it is cost-beneficial to do so. It includes both capital and non-capital highway expenditures. The analysis also assumes that increases in investment beyond current funding levels would be financed by non-user sources (such as general revenues). The baseline assessment includes scenarios covering 15-, 30-, and 50-year time horizons.

- Total highway expenditure "needs" under this scenario are estimated at $4.9 trillion through 2020; $10.0 trillion through 2035; and $18.3 trillion through 2055, stated in constant 2005 dollars. Stated in nominal dollars (assuming a 2.5 percent average annual inflation rate), the scenario estimates are $5.9 trillion through 2020; $14.9 trillion through 2035; and $37.2 trillion through 2055.

- The baseline highway needs assessment represents simply the first step in the development of the needs analysis component of the Section 1909 Commission's work. The next phase will involve a number of supplemental analyses that will address the impact of altering many of the assumptions that this initial analysis is based upon, including alternative assumptions about travel growth, technologies, and revenue mechanisms.

Approach and Key Assumptions

As noted previously in presentations to the Commission (and as discussed in briefing paper 3C-01), There is no absolute definition of what constitutes an investment "need". In general, "needs" simply represent the level of investment that would be required to reach a particular goal. Such goals can be defined in either performance terms or economic terms based on benefit-cost analysis. In this context, the definition of a need becomes somewhat subjective, as it first requires the choice of a particular performance target. While the terms "needs estimate" and "needs assessment" are used throughout this analysis, and are used in conjunction with specifically identified funding levels, the reader should note that the term is intended to be understood in this looser sense.

In keeping with the stated vision of the Commission to "create and sustain the preeminent transportation system in the world," the approach used to estimate the capital investment component of this baseline needs assessment represents a funding level sufficient to improve the condition and performance of the highway system, anywhere that it is cost-beneficial to do so. This approach is analogous to the Maximum Economic Investment (Cost to Improve) scenario presented in the C&P report. The economic approach to highway investment analysis is further discussed in briefing paper 3C-01 and in the Introduction to Part II of the 2006 Conditions and Performance report.

There are several caveats that should be considered in regard to such a performance target. For example, simply increasing spending to the Maximum Economic Investment level would not in itself guarantee that these funds would be expended in a cost-beneficial manner. Achieving the projected results for this scenario would require a combination of increasing spending and modifying Federal highway program requirements and State and local government practices to ensure that no project would be implemented unless its estimated benefits exceeded its estimated costs. There may also be some projects that, regardless of their economic merits or impact on conditions and performance, may simply be infeasible for political or other reasons. As a result, the supply of feasible cost-beneficial projects could possibly be exhausted at a lower level of investment than is indicated by this scenario. Briefing paper 4K-05 discusses economic analysis in public infrastructure investment decision-making in more depth.

Estimates of the highway investment levels that would be required to reach other condition and performance benchmarks are presented in briefing paper 3G-02. The benchmarks considered there include maintaining average highway user costs; maintaining average highway user delay; and maintaining the current percentage of highway travel on roads with acceptable ride quality. That paper also projects the condition and performance impacts if highway capital outlay were to be maintained at 2005 levels in constant dollars, increasing only with inflation.

Scope

The investment analyses presented in the biennial Conditions and Performance report pertain to capital expenditures only, in keeping with the focus of that report on highway infrastructure investment. The mandate of the Section 1909 Commission, however, is much broader, as it is charged with addressing both anticipated future funding needs and the financing mechanisms that could be used to raise the corresponding levels of revenue. The scope of this baseline needs analysis has thus been expanded to cover other highway-related expenditures beyond capital outlay, including maintenance an operations; administration; and highway patrol and safety.

The Commission is also required to consider other modes that are not included in the Conditions and Performance report, including freight rail; intercity passenger rail; intercity bus; and intermodal transfer facilities. These areas are addressed in the briefing papers under task areas III-I and III-J.

This more expansive mandate for the Commission's needs analysis also suggests a different approach to the breadth of potential highway expenditures that should be included in the needs analysis. The biennial C&P report takes a very narrow, measured approach to modeling highway investment requirements, focusing on elements for which there are sufficient data to credibly analyze future investment. This also helps to meet the legislative requirement of continuity and comparability among different editions of that continuing report series. The Section 1909 Commission's report, however, is a stand-alone effort, for which the greater risk is understating the revenue streams that would be required to accommodate future needs. As a result, the analyses being conducted on behalf of the commission will take a broader, more inclusive approach in their assessment of needs, including some items that are not typically considered in the current C&P investment analyses.

It should also be noted that this analysis covers highway-related expenditures from all sources, including Federal, state, and local governments, and the private sector. Assigning responsibility for these needs to any particular entity or level of government is beyond the scope of this particular analysis, though it would be a necessary step for any subsequent analyses that might focus specifically on future Federal program structures and revenue mechanisms.

Investment Modeling

The highway and bridge capital investment portions of this baseline highway needs assessment use the same analytical tools that are used in the Conditions and Performance report. The Highway Economic Requirements System (HERS) is used to model investment in pavement resurfacing and reconstruction and in highway capacity expansion. It uses data inputs from the Highway Performance Monitoring System (HPMS) Sample, which includes data on all functional classes that are eligible for Federal-aid. Bridge rehabilitation and replacement is modeled using the National Bridge Investment Analysis System (NBIAS), which draws on data from the National Bridge Inventory (NBI), a dataset that includes information on all highway bridges on public roads in the U.S.

Other types of highway expenditures are not directly modeled. As in the C&P report, the assumption is made that these expenditures' share of future needs is the same as their share of current highway spending. In 2005, 54.4 percent of highway spending (excluding bond

retirements and interest on debt) was for capital outlay, while the remainder was for non-capital expenditures including maintenance and traffic services; administration and research; and highway patrol and safety.

Time Horizons and Discounting

The future investment analyses in the C&P report cover a period of 20 years from the base year of the data used in the analysis. Section 1909, however, specifically directs the Commission to consider 15-, 30-, and 50-year time horizons.1 It should of course be recognized, however, that projections over longer time horizons are subject to a much greater degree of uncertainty than are shorter-term projections, due to both the inherent nature of forecasts (whose error margins will increase over time) and to the greater potential for radical changes in technology and the nature of travel demand that the distant future holds.

The HERS analysis also requires assumptions about future deployments of ITS technologies and highway operations strategies. For this analysis, the aggressive deployment scenario developed for the analyses of the 2006 C&P report was used. However, since this scenario only covers the 20-year time frame of that analysis, this analysis effectively assumes no additional impact of ITS deployments after 20 years. The supplemental needs analyses will employ longer-term ITS deployment scenarios, and will also attempt to address the impacts of future technologies.

The benefit-cost analysis procedures employed in the HERS and NBIAS models also require a discount factor to be applied in order to compare the future benefit streams produced by a highway improvement with the initial cost of that improvement.[2] For the C&P investment analyses, a 7 percent discount rate is used, in accordance with the guidelines for Federal infrastructure investment analyses under OMB Circular A-94. For this baseline needs analysis, however, a 4 percent discount rate has been applied. This is both more consistent with typical practice in analyses performed by state and local governments (including the HOT Networks study cited in Commissioner Heminger's *Metro Mobility* presentation), and is in line with the real interest rates recently experienced in the U.S. (which reflect the opportunity cost of making additional capital investments at the margin).[3]

Future Travel Growth

One of the key inputs into the analysis of future highway investment is projections of future highway travel. The HPMS sample data include a daily traffic projection approximately 20 years into the future. For this analysis, these same baseline traffic projections were used, with traffic growth simply extrapolated where necessary to cover the longer time horizons (the extrapolation assumes linear growth, which implies a declining annual growth rate). The supplementary needs analyses will use more refined projections of future highway travel.

Costs

[1] The C&P analytical models have recently been updated to accommodate these longer time frames.
[2] The discount factor (often stated as a discount rate) reflects the fact that income or benefits received in the future are worth relatively less today, due to the time value of resources.
[3] For example, a 4 percent real discount rate was assumed in the HOT Networks study cited in Commissioner Heminger's *Metro Mobility* presentation. The impact that assuming a 7 percent rate has on the baseline needs scenario estimates is noted below.

The HERS and NBIAS investment analyses are performed in constant, base year dollars; the 2006 C&P report used a 2004 base year. For this baseline analysis, these costs have been updated to 2005 dollars, reflecting the significant escalation in highway construction costs that occurred in that year.

The C&P investment scenario estimates are also presented in constant, base year dollars. Since the purpose of the Commission's work, however, is to align revenues with needs, and revenues are calculated in nominal (or "year of expenditure) dollars, it is necessary to translate the constant-dollar estimates into nominal terms. Exhibit 2 shows the impact of alternate assumptions about future inflation in highway expenditures on the baseline scenario estimate.

Revenue Mechanisms

As has been noted in previous presentations to the Commission (and discussed in the 2006 Conditions and Performance report), investment requirements are not independent of the revenue mechanisms that would be used to finance a given level of spending. Financing mechanisms that would increase levies on highway users would increase the cost of using the system, and thus the level of demand, which would in turn affect the need for additional investment. The form of the user fee can also make a significant difference, with direct, time-varying, congestion-based charges having a much more significant impact on highway use than would flat user fees (such as fuel taxes) or vehicle fees.

Since the evaluation of alternative revenue mechanisms will be a central feature of the supplemental needs analysis and Commission scenario development, this baseline analysis uses the most neutral revenue assumption possible, which is that increases in highway expenditures would be financed by non-user sources. As a result, this baseline analysis will tend to overstate future needs relative to a system that finances future expenditures with increased user fees or alternative mechanisms. The magnitude of this impact would depend on the particular financing mechanism used.

Baseline Highway Needs Estimate

Exhibit 1 presents the baseline estimate of future highway needs. The table includes both the estimates directly modeled in HERS and NBIAS, and estimates of the different non-modeled components of highway expenditure needs.

Total highway expenditure needs are estimated at $4.9 trillion through 2020; $10.0 trillion through 2035; and $18.3 trillion through 2055, stated in constant 2005 dollars. Investment requirements for highway rehabilitation and system expansion (modeled directly in HERS) total $1.9 trillion over 15-years; $3.8 trillion over 30 years; and $6.9 trillion over the full 50 year period. Investment requirements for bridge rehabilitation and replacement (modeled in NBIAS) are $210 billion over 15 years; $490 billion over 30 years; and $870 billion over 50 years.

Briefing paper 3G-02 includes additional information about the distribution of investment under this needs scenario among different components of the highway system. It also describes the projected highway condition and performance impacts of funding highway capital improvements at the level in this needs scenario, and provides scenario estimates for other highway condition and performance benchmarks.

Exhibit 1
Baseline Highway Needs Estimate
(trillions of constant 2005 dollars)

	15-year 2005-2020	30-year 2005-2035	50-year 2005-2055
Capital Expenditures			
Highway Rehabilitation and System Expansion			
Federal-Aid Highways[1]	1.88	3.78	6.92
Other Functional Classes[2]	0.33	0.68	1.25
Bridge Rehabilitation and Replacement[3]	0.21	0.49	0.87
Other Capital[4]	0.24	0.49	0.90
Non-Capital Expenditures[5]	2.23	4.57	8.34
Total	**4.89**	**10.02**	**18.27**

Notes:
1\ Modeled in HERS
2\ Rural minor collectors and rural and urban local roads
3\ Modeled in NBIAS
4\ Includes safety enhancements; traffic signals; and environmental enhancements
5\ Includes maintenance and traffic services; administration and research; and highway patrol and safety

System Expansion and Rehabilitation

Of the $2.09 trillion in highway investment through 2020 modeled in HERS and NBIAS, 54% is for capacity expansion, while the remainder is for rehabilitation and reconstruction/ replacement of existing pavements and bridges (note that this is not the same as the system expansion share of total capital investment described in the C&P report, since it does not include capital outlay for system enhancement). The share of investment devoted to capacity expansion increases for the two longer time horizons, to 56% of the combined HERS and NBIAS investment over 30 years and 60% of investment over 50 years, due to the impact of steadily increasing traffic volumes.[4]

In 2005, there were 8.4 million lane miles of public roads in the U.S., of which 2.3 million were on Federal-aid highways. The highway capacity expansion modeled in HERS under this analysis would add 156,000 effective lane miles of capacity on Federal-aid highways over 15 years; 309,000 lane miles over 30 years; and 558,000 lane miles over 50 years.

Adjustment for Inflation

As noted above, aligning future revenues with future needs requires the needs estimate to be stated in nominal dollars, which in turn requires assumptions about future levels of inflation in highway expenditures. Exhibit 2 shows the impact of three alternative assumptions (2.0, 2.5, and 3.0 percent) about average annual inflation rates on the baseline highway needs estimate. The

[4] Assuming a 7 percent discount rate would reduce the estimated levels of the constant dollar baseline estimate by 11 percent over 15 and 30 years, and by 9 percent over 50 years, since the future benefits associated with highway improvements would be valued less relative to their expenditures (which would be borne at the time the improvement is made). The impact is relatively greater for capacity expansion improvements, reducing the capacity shares of investment to 53, 55, and 59 percent over the 15-, 30-, and 50-year horizons, respectively.

impacts of alternate assumptions about inflation are naturally much larger on the longer 50-year estimates.

Exhibit 2
Impact of Alternative Assumptions About Future Inflation on the Baseline Highway Needs Estimate
(trillions of current dollars)

Average Annual Inflation Rate	15-year 2005-2020	30-year 2005-2035	50-year 2005-2055
2.0%	5.7	13.7	32.0
2.5%	5.9	14.9	37.2
3.0%	6.1	16.2	43.4

Supplemental Needs Analysis

As has been noted previously, this baseline highway needs assessment represents simply the first step in the development of the needs analysis component of the Section 1909 Commission's report. The next phase will involve a number of supplemental analyses that will address the impact of altering many of the assumptions that this initial analysis is based on, as well as analyzing the impact of alternative policy options (this is identified as Module VI in the Commission work plan). Such alternatives will include:

- Alternative assumptions about highway financing mechanisms, potentially including fuel taxes; VMT taxes; and congestion pricing
- Development of one or more ITS deployment scenarios, including the potential impacts of new technologies in the future.
- Alternative VMT growth forecasts
- Estimates for highway capacity improvements that may only partially be captured in this analysis, including investments to address major bottlenecks (such as freeway interchanges) and investment in new limited-access highways.
- Special analyses of system components (such as intermodal connectors) that represent a very small share of total road mileage and investment, but which are very important.

This phase will rely on information from other sources to provide the necessary inputs for supplemental analysis, including the briefing papers produced under Modules IV and V. Papers from the following task areas are expected to be particularly useful in this effort:

- Demographic Changes: Impacts on Passenger Travel (IV-A). This task area will include alternative projections of future travel demand, which could be used directly in the supplemental analysis. Travel demand impacts are also discussed other task areas, including Potential Energy Issues and Concerns (IV-C); Alternatives to Address Environmental Concerns (IV-D); and Travel Demand Management (IV-H), and these papers could be used to produce additional alternative forecasts.

- Changes in the Nature of the Economy: Impacts on Freight and Passenger Transportation (IV-B). The impact of shifting trade patterns or modal shares due to larger economic changes, addressed by the papers in this task area, could affect the level and pattern of future investment needs.

- Potential Energy Issues and Concerns (IV-C). The energy price forecasts from these papers could also be applied directly in the investment analysis.

- Future Traffic Operations/Performance Capabilities (IV-G). Materials from this task area could be used to develop new deployment scenarios and impacts estimates for current and future highway operations strategies and technologies.

- Advanced Materials, Asset Preservation, and Aging Infrastructure (IV-I). These papers discuss the impact of advanced materials and techniques for the Nation's highway infrastructure; these impacts could potentially be modeled in the investment analysis. The discussion of aging infrastructure concerns could also point to means by which this could be reflected in the investment analysis in different ways than it is currently done.

- Future Infrastructure Design Policies and Standards (IV-J). The implications of such revised standards for the cost of implementing infrastructure improvement projects could be incorporated into the analyses.

- Targeted Investment in Addressing Bottlenecks and Critical Corridors (IV-L). These papers could be used to develop additional estimates of the costs associated with potential new corridors and improvements at major bottlenecks.

- Significant Systematic Changes to Transportation Infrastructure Capacity (IV-M). The models and techniques used for the baseline and supplemental needs analyses may also be employed in further analysis of the proposals and concepts developed under this task area.

Another potential key input to the supplemental needs analyses is the currently ongoing NCHRP Project 20-24(52), Future Options for the Interstate System. Materials and analytical techniques developed under this project could be used to analyze potential investments in new Interstate routes and other expansions to the system, as well as issues associated with potential future major rehabilitation and reconstruction work and system management options.

CONSOLIDATED COMMENTS FROM MEMBERS OF THE BLUE RIBBON PANEL OF TRANSPORTATION EXPERTS - PAPER 3G-01

One reviewer commented as follows:

The “Supplemental Needs Analysis” section inventories assumptions and task areas that put the baseline assumptions in a broader context. Three areas probably included in these analyses but not mentioned specifically are as follows:

- The influence of federal Clean Air Act mandates in limiting or shaping the nature of highway system improvements in metropolitan areas that are in non-attainment or anticipate difficulties in sustaining compliance;

- The role of specific highway segments or crossings as critical elements of surface transportation access to gateway facilities including maritime cargo terminals, airports, and intermodal rail facilities. The fourth bullet in the first series in this section (system components that are “very important” – including intermodal connectors); and

- The influence of federal and state historic preservation requirements in shaping project alternatives, implementation schedules, and costs for major infrastructure projects. This is a particular concern in the greater New York-New Jersey metropolitan region and other older metropolitan urban centers, which include many examples of functionally outmoded but historically notable highways and crossings that provide critical linkages in metropolitan and intercity transportation networks. The analysis should aim for a better understanding of the interplay between federally-mandated historic preservation reviews and the goals embodied in the Commission’s charge to promote more cost-effective investment and improved performance for critical transportation systems.