

Prepared for:
National Surface Transportation Infrastructure Financing Commission

“Where The Rubber Meets The Road”

Criteria for Assessing Funding and Financing Solution Sets that Address the
Projected Revenue Shortfall in the Highway Trust Fund’s Highway Account

Version 1.0

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Executive Summary

According to the Congressional Budget Office (CBO), the Highway Trust Fund (HTF) is facing a potential shortfall in 2009.¹ The National Surface Transportation Infrastructure Financing Commission (NSTIFC) was chartered to analyze future highway and transit needs and the finances of the Highway Trust Fund and to make recommendations regarding alternative approaches to financing transportation infrastructure. The primary purpose of this paper is to define an objective set of criteria for use in assessing funding and financing solution sets to the Highway Trust Fund projected shortfall.

The MITRE Corporation (MITRE) has defined the primary problem as Highway Trust Fund expenses (costs) equal the associated tax revenue (revenue) plus the projected shortfall (delta). A range of economic as well as political, operational, and technical factors impact cost and revenue. The literature MITRE reviewed tended to focus on individual solutions to address cost or revenue. MITRE argues that single solutions are not adequate to address all of the factors that lead to the projected shortfall. Rather, a set of solutions is necessary.

MITRE has objectively defined a comprehensive set of criteria for the NSTIFC to use in assessing different solution sets. MITRE recommends a process of applying weights and scores to the criteria that will facilitate commission members prioritizing recommendations they find viable and feasible.

1. Introduction

1.1 The Shortfall

The Highway Trust Fund (HTF) pays for construction, operation, and maintenance of the National System of Interstate and Defense Highways. The National Highway System (NHS) of the United States comprises approximately 160,000 miles of roadway, including the Interstate Highway System as well as other roads important to the nation's economy, defense, and mobility.² This includes the roadbed, culverts and drainage facilities, roadside landscaping, rest areas, traffic guidance and electrical maintenance, snow and storm response, and radio communication.

The Highway Trust Fund (HTF) was established by the Highway Revenue Act of 1956 (Public Law 84-627) to finance the National System of Interstate and Defense Highways. The Highway Revenue Act authorized that revenues from certain highway-user taxes could be credited to the HTF to finance the highway program enacted in the Federal-Aid Highway Act of 1956. (The Act was set to expire at the end of fiscal year 1972, but legislators passed an extension that lasted through September 30, 2005.) In 1983, the Highway Trust Fund was divided into two accounts: a Highway Account and a Mass Transit Account. The Transportation Equity Act for the 21st Century (TEA-21) was enacted in 1998 (Public Law 105-178). TEA-21 authorized the Federal

¹ CBO Testimony, Status of the Highway Trust Fund: 2007, March 27, 2007

² Federal Highway Administration, <http://www.fhwa.dot.gov/hep10/nhs/>, last modified October 15, 2007, downloaded November 9, 2007

surface transportation programs for highways, highway safety, and transit for the 6-year period 1998-2003. In 2005, the President signed the Safe, Accountable, Flexible, and Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU), which authorizes Federal surface transportation programs for highways, highway safety, and transit for 2005-2009. Unless the SAFETEA-LU is extended or replaced, funding of the NHS will cease before 2010. New legislation is needed to bring a shift from the traditional methods of funding in order to smooth out the variations in funding, bring them in line with the time-sequenced cost of the NHS, and remove the funding shortfalls for 2008 and beyond.

Tax revenues directed to the HTF are derived from excise taxes on highway motor fuel and truck-related taxes on truck tires, sales of trucks and trailers, and heavy vehicle use. Most excise taxes credited to the trust fund are paid to the Internal Revenue Service by the producer or importer of the taxable product. In 2006, HTF Highway account funds amounted to \$33.6B, with 60% coming from taxes on gasoline and gasohol, 24% coming from diesel and special fuels, and 16% coming from sales of trucks and truck tires and from use.³

According to the Congressional Budget Office (CBO), the Highway Trust Fund (HTF) is facing a potential shortfall in 2009.⁴ Federal Department of Transportation (DOT) officials are predicting that highway trust fund revenues from gas taxes won't cover projected expenses during 2008. The most desirable state would be to obtain equilibrium between costs and revenues by 2008. Given the current design of the HTF, this equilibrium will be difficult to achieve much less sustain over time. It is urgent that adjustments to revenue sources and spending be made over time to address the shortfall.

1.2 Costs and Revenue

There are two major causes for this projected shortfall – the rising costs of highway construction, operation, and maintenance on the one hand, and reduced revenues on the other.

DOT suggests that a number of factors contribute to the first major cause for the projected HTF shortfall, rising costs of highway construction, operations, and maintenance.⁵ Costs are the funds that are expended to build, maintain, operate, and retire the system of highways and its supporting infrastructure. Examples of factors contributing to rising costs include:

- **Material shortages of construction products** – The worldwide growth in the construction industry has caused shortages in some basic building materials, such as cement; the increased demand for materials has caused an abnormally large increase in its underlying cost.
- **Reduction in the number of prime contractors** – With increased consolidation in the construction industry, arising from the overhead costs in the industry and the changing regulatory environment affecting billing for management and administration, the prime contractors across the nation have been reduced in number, with a consequent decrease in the competitive nature of the market place. There is a concern that decreasing competition puts an upward pressure on cost.⁶

³ National Surface Transportation Infrastructure Financing Commission, Highway Trust Fund, April 2007

⁴ CBO Testimony, Status of the Highway Trust Fund: 2007, March 27, 2007

⁵ <http://www.fhwa.dot.gov/programadmin/contracts/price.cfm>

⁶ Material shortage reference needed

- **Usage** – The number of registered motor vehicles continues to increase steadily, from 192.6M in 1990⁷ to 243M in 2007.⁸ This has increased the need for operations and maintenance of highways.

According to DOT Federal Highway Administration data, the annual vehicle distance traveled by all motor vehicles has increased from 2,422,775 in 1995 to 2,989,807 in 2005.⁹

- **Increased construction market opportunities** – The increasing world population and economic growth rate abroad have presented increased opportunities for the construction industry, allowing them to capture more profitable work outside the road building and maintenance area and thereby creating increased competition and cost for national highway construction.
- **Technical and regulatory requirements** – Changes in the regulatory environment, restrictions (e.g., environmental permits and safety and labor requirements), and increased technical requirements in contracts have led to higher construction costs.

The second major cause of the projected shortfall in the HTF is the flattening of revenues from gas-tax user fees. Improved technology, coupled with strong public opinion, has resulted in more fuel-efficient vehicles and longer lasting tires. Thus while the number of miles driven is increasing, the amount of fuel and number of tires purchased is increasing at a lower rate.

Changes in oil prices and the economy are primary variables affecting future revenue projections. Legislation such as the CAFÉ standards that are driving the need to decrease consumption of fossil fuels is also contributing to the widening of the gap between projected costs and projected revenues from gas-tax user fees. President Bush has established a goal to reduce gas consumption by 20% within 10 years resulting in an adjustment by the EPA of the National Renewable Fuel Standard Regulations and the Corporate Average Fuel Economy legislation. The increasing use of alternative fuels and of specialized vehicles such as hybrids, electric vehicles, and fuel cell vehicles – because they may be taxed at a lower rate, untaxed, or given a tax credit – widens the gap even further.

Basing revenue on gasoline and tire sales requires the tax assessment to be adjusted periodically in order to maintain the revenue stream at the level required for highway construction, operation, and maintenance. Advisors and decision-makers recognize that raising tax assessments is unpopular with industry and the public, but putting off such adjustments results in decreasing revenues and increasing costs and an increasing tax gap.

1.3 The National Surface Transportation Infrastructure Financing Commission

The National Surface Transportation Infrastructure Financing Commission (NSTIFC) was established by Section 11142(a) of SAFETEA-LU and on August 10, 2005, the Secretary of Transportation charged it to analyze future highway and transit needs and the finances of the

⁷ DOT, Highway Statistics Summary

⁸ DOT, Research and Innovative Technologies Administration

⁹ DOT, FHWA Annual Vehicle Distance Traveled In Miles and Related Data Report

HTF and to make recommendations regarding alternative approaches to financing transportation infrastructure.

1.4 Scope and Objective

The primary purpose of this paper, produced by The MITRE Corporation at the behest of Commissioner Kathy Ruffalo-Farnsworth, is to define an objective set of criteria for use by the NSTIFC in assessing funding and financing solution sets intended to address the projected shortfall in the HTF.

2. An Overview of the Problem

2.1 Approaching Solutions

In its review of the current literature on this topic, MITRE found many recommendations and potential solutions to the projected HTF shortfall. But the literature tends to focus on comparing *one* solution to another, presents a new solution to replace an existing approach, or simply advocates for one solution. What MITRE believes the NSTIFC needs to fulfill its charter is a *combination* of solutions (a solution set) that collectively achieve budget equilibrium. For instance, the HTF historically uses a combination of gas tax, diesel tax, and tire tax to achieve the funding needs. Going forward, this combination may include cost-saving measures, revenue producing measures, or both. It also may include continuing to use old methods such as the tire tax, employing new methods such as Vehicle Miles Traveled (VMT), and replacing old methods with new ones (e.g., substituting VMT for a tax on fuel). The goal in its most basic form is to collect revenues to cover needed expenses.

Revenue = Costs

Tax policies (affecting revenue) and cost-saving measures (affecting costs) have social impacts and should be taken into account when considering financing and funding solutions. Policies result in changes in citizen behaviors. Legislation enacted to address the projected HTF shortfall may have important secondary impacts affecting related concerns of national importance. Traffic congestion, greenhouse gas emissions and air quality, and energy independence and national security/emergency preparedness are a few examples currently in the national spotlight. These national concerns shape the criteria that the commission members should consider when choosing solution sets, because, although a balanced budget is the goal, non-monetary effects have become increasingly important in these projects.

Because of these non-monetary effects, the NSTIFC needs a methodology and an objective set of criteria to guide it in assessing funding and financing solution sets. A Commissioner from the NSTIFC concurred that this would help NSTIFC's efforts and suggested that it would be most useful if this work were completed quickly, as the Commission had short deadlines for delivering its recommendations.

MITRE recognizes that, with legislative time constraints and the limitations of the NSTIFC's charter, the commission needs to move quickly to consider either adjustments to the existing funding and financing scheme or alternative ways to funding and financing the HTF. With a

longer time horizon, a broader vision creating greater value for citizens could be conceived and implemented.

2.2 The Economic Problem

The HTF receives 60% of its funds through gasoline and gasohol taxes (Gt), 24% from diesel and special fuels (Dt), and 16% from truck sales (Tst), tire sales (Tt), and use (U). Or, stated in an equation:

$$\text{Baseline Revenue} = Gt + Dt + Tst + Tt + U$$

If all factors remain constant, projected revenues are not anticipated to meet budget requirements beginning in late 2008 or 2009, creating a delta:

$$\text{Expected Revenue} - \text{Actual Revenue} = \Delta$$

The solution set, a combination of revenue generating and cost savings measures, needs to meet the existing budget levels plus an amount equal to the size of this delta for every period in order to close the projected shortfall. The delta represents the estimated funds that need to be generated within a period to meet the budgeted needs.

$$\text{Solution Set} \geq \Delta$$

Solutions within a solution set are not necessarily additive. That is to say, two solutions taken together may not have as much impact on the delta as would their individual impacts added together. For example, two solutions that create revenue by taxing different items may collect equal amounts of revenue when implemented without the other, but when taken together the total amount collected may be less than twice either one of them because each may shift the buying or use patterns of the public away from other solution. A cost-savings measure to reduce investments in IT systems may negatively impact the contribution of a usage-based user fee that depends upon a sophisticated IT system to track vehicle movements.

Moreover, substituting a new revenue measure, such as a VMT tax, for an existing measure, such as a gasoline tax, requires the new solution set to make up the revenue lost from the old measure. The gas tax moves to the other side of the equation to represent lost revenues:

$$\text{VMTt} + Dt + Tst + Tt + U > \text{Baseline Revenue} + \Delta + Gt$$

Vehicle Miles Traveled Tax Gas Tax

2.3 The Political, Operational and Technical Problem

The NSTIFC has been charged with providing recommendations targeted at the economic aspects of this topic. The political, operational and technical aspects are addressed in the charter's statement, "study such other matters closely related to the subjects described."¹⁰ These additional aspects, as described below, have significant sway in the adoption of NSTIFC's recommendations.

When determining which solutions to include in a solution set, all solutions are not equal. Two solutions may provide equal rates of cost savings or revenue generation, but have different

¹⁰ NSTIFC Charter

political acceptability or social acceptability. Non-monetary criteria in addition to those that examine monetary aspects are needed to compare individual solution options.

3. Criteria

Criteria serve as standards, measures, rules, or tests on which the commission's judgments, decisions, and recommendations can be based. Political, operational, economic, and technical (POET) criteria are needed to fully assess the suitability of a candidate solution set.

3.1 Assumptions

The assumptions outlined in this section have been limited to those that narrow the discussion to the key issue of increasing the revenue base and/or decreasing the cost of maintaining and operating the highway system. They act as boundaries that set the limits of the discourse; they establish the context for the assessment criteria.

1. The beneficiaries of the highway system pay for the system. Some benefits can be assigned to vehicle owner/operators. There are also "Common Good" benefits, such as national defense, that can be assigned to all citizens.
2. The set of adopted solutions must solve the problem as comprehensively as possible with the least amount of financial and social costs.
3. States and local governments will follow the lead of the federal government and maintain current standardization in funding processes, technology, and design decisions, thereby holding down administrative and compliance costs to current levels.
4. There are interdependencies between laws. Introducing changes to tax legislation without considering those relationships will have unintended consequences.
5. The Commission has the time and resources to assess the alternative solutions.

3.2 Criteria for Assessing Alternative Solutions for Decreasing Costs

MITRE began its development of a comprehensive set of criteria for assessing solutions to the projected HTF shortfall by reviewing literature. The solutions MITRE found were only infrequently supported by defined criteria. However, articles often defended one solution and criticized another by pointing to positive aspects of the favored solution and the limitations of the disfavored one. MITRE interpreted these positive and negative aspects as implied criteria. Tables 1 and 2 in Appendix A summarize the sources examined and the stated or implied criteria.

The literature surveyed tended to focus on comparing one solution to another or simply advocating for one solution. As mentioned earlier, MITRE believes that to fill the projected shortfall, a *combination* of solutions, called a solution set, may be needed to collectively achieve budget equilibrium. For instance, historically, the HTF uses a combination of gas tax, diesel tax, and tire taxes to achieve the funding needs. This current solution set is projected to under-fund budgetary requirements for highway construction, operation, and maintenance. The Commission

should consider solution sets that provide the required funding requirements by adding new solutions to the existing set or creating new combinations within a solution set.

3.3 Sets of Criteria

Two sets of criteria may be necessary to complete the assessment – one for assessing solutions that focus on reducing costs and one for assessing solutions that focus on increasing revenues. In this paper MITRE has developed a comprehensive set that can be migrated to each of these different domains.

3.4 Types of Criteria

This paper also describes two types of criteria. The first is a *filter criterion*. A filter criterion is either met or not. If the criterion is one that must be present for a solution, then the solution must meet it. An example of such a filter would be not violating any existing laws.¹¹ The key here is that the criterion either passes or fails to pass the threshold. If the criterion does not meet the threshold then the solution is discarded without further evaluation or, if possible, adjusted until it meets the threshold. The second is a *scored criterion* to which a range of ratings applies (e.g. “poor to excellent,” “low to high,” “1 to 10”). Scored criteria have been categorized into construction, operation, and maintenance for the convenience of the reader. The term “cost” in this section applies to the potential reduction of required funds for construction, operation, or maintenance of the current highway system.

The scored criteria may also be weighted to apply a level of significance to them. This weighting and the final determination of the actual criteria are part of a repeatable process that should be used to make recommendations to the ultimate decision makers for the cost and revenue sides. The process helps bring to the forefront those solutions that are more appropriate and begins to define the risks associated with each potential portfolio of options.

3.5 Methodologies for Applying the Criteria

Many methodologies that can be used to evaluate the economic impacts of a solution set. These include simple rate of return, payback period, cost-benefit, net present value or worth, and internal rate of return. To evaluate political, operational, and technical impacts of a solution set, methods such as consensus decision-making, consensus-seeking decision-making, game theory, the Delphi method, forms of the Pareto method, and various multi-criteria ranking methods can be applied.

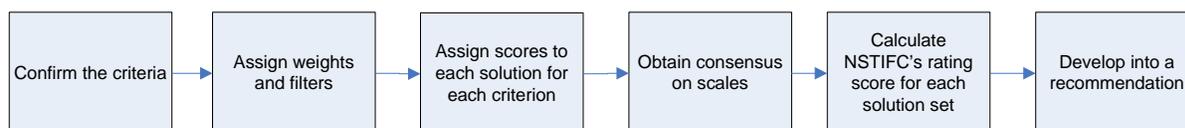
These may be completed by independent assessors, in facilitated sessions with the Commission members, or independently with the final results tabulated after blind evaluation by a group. Any of these methods will assess the value of solutions against the problem.

It is important to not take the final values from the system too literally. Depending on how the values are assigned, there will likely be error in each individual scoring, and any inconsistency or arbitrariness in the assignment of weights (if used) could lead to poor results. What is important is having thought through each of the solutions against the assessment criteria. For example, solutions with final scores that are within 5% of each other are not likely to significantly differ

¹¹ This criterion may not be the case as a recommendation to change some legislation may be possible.

from each other in effectiveness, and will offer similar outcomes against the problem. Those scores that are farther away may not offer similar outcomes.

Because of the short time frame in which a decision is needed, MITRE recommends that the NSTIFC members participate in a facilitated session in order to assign weights to the filter and scored criteria, score the alternative solutions against the criteria, and use the filter criteria to eliminate the non-starters, in accordance with the following process:



Following this methodology, one can generate a table such as the one below (in which fictional values have been entered for the sake of illustration).

Criteria	Weight	Solution Set					
		A		B		C	
		Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Economic							
Criterion 1	10	5	50	3	30	4	40
Criterion 2	20	5	100	3	60	1	20
Criterion 3	10	3	30	5	50	2	20
Criterion 4	5	2	10	3	15	3	15
Political							
Criterion 1	30	4	120	4	120	1	30
Criterion 2	10	3	30	5	50	2	20
Criterion 3	15	1	15	1	15	2	30
Criterion 4	25	5	125	2	50	3	75
Operational							
Criterion 1	30	3	90	1	30	5	150
Criterion 2	30	2	60	3	90	4	120
Criterion 3	25	4	100	3	75	3	75
Criterion 4	15	3	45	3	45	1	15
Technical							
Criterion 1	10	5	50	3	30	2	20
Criterion 2	5	4	20	3	15	4	20
Criterion 3	10	5	50	2	20	5	50
Criterion 4	5	4	20	3	15	3	15
Total Score	255		915		710		715

3.6 Criteria for Assessing Solution Sets

This section defines and describes an objective and comprehensive set of criteria that MITRE recommends the Commission use in evaluating solution options.

The following table names, defines, and describes criteria for assessing solution sets. The name of each criterion is intended to provide a short, unique title for reference purposes. The definitions provide the meaning for each criterion. The criteria can be rolled up and summarized for high-level analysis.

Note that the number of criteria is driven by the complexity of the problem faced. It is important that the interdependencies and potential down-stream consequences of selecting one solution set over another be fully examined before delivering a recommendation.

Criterion Focus	Criterion Name	Criterion Definition – <i>Within the solution set being considered, does the solution:</i>
Filter		
	Alignment	Align with other federal policies?
	Compliant	Adhere to Federal Privacy Regulations?
	Fuel Source Independent	Collect revenues from each user regardless of the user's means of propulsion?
	Government Vehicles	Include a means to account for federal, state, and local government vehicles?
	National Security	Ensure that national security interests are maintained?
	Net Cost Reduction	Offer a significant net cost reduction for the current state infrastructure?
	Rate Hike	Allow for adjustments in tax rates with minimal transition effort?
	Revenue Generation	Contribute to a sufficient annual rate of return to fund O&M requirements and new capital investment (Sufficient ROI, IRR, and acceptable break even point)?
	Technical Feasibility	Meet the required time frame for implementation?
Economic/Cost Scoring		
	Administrative Cost	Minimize the overhead cost to the government?
	Automation	Reduce costs by automating operations?
	Compliance Cost	Minimize the cost associated with ensuring compliance with federal regulations?
	Cost Reduction	Contribute significantly to cost reductions?
	Enforcement Cost	Minimize the cost associated with enforcement?
	Reportable	Support determining the level of collection across a wide range of attributes?
	Schedules	Shorten construction and maintenance schedules (reduce delays)?
	Transition Cost	Minimize the cost associated with transitioning from the current system?
Economic/Revenue Scoring		
	Balanced Funding	Balance funding from citizen funding for "common good" benefits of highways with individual vehicle owner/operator benefits from usage?
	Inflation	Produce the needed revenue over time without regard to the rate of inflation?
	Peaking	Automatically adjust to cyclic variations in revenue needs?
	Stable	Produce stable revenue for a minimum of 10 years?
	Timely	Produce the necessary revenue as it is needed?

Criterion Focus	Criterion Name	Criterion Definition – <i>Within the solution set being considered, does the solution:</i>
Political Scoring		
	Accurate	Ensure that the system correctly calculates individual taxes with a 99% level of confidence?.
	Encroachment	Avoid encroachment or erosion of individual's civil liberties?
	Exception Resistant	Resist exceptions for special interest groups or specific sectors of the population?
	Fair	Appear fair to the public?
	Safety	Ensure that the quality of construction is within safety margins per safety standards?
	Tax Equity	Provide equity across the socio-economic classes?
Operational Scoring		
	Adjustable	Allow for changes to the road network and its infrastructure?
	Auditable	Provide for independent inspection?
	Black Market Resistant	Resist hacking and the formation of black markets aimed at profiting from the system or circumventing the collection of revenue?
	Congestion Control	Provide a means to help control congestion?
	Enforceable	Have fraud detection mechanisms and produce detailed, actionable data to identify offenders?
	Environmentally Friendly	Does not discourage alternative fuels and fuel efficient vehicle use?
	Evasion	Minimize possibility for individual users to evade paying?
	Fault Detection	Allow for quick detection of faults?
	Financial audit	Supports financial audits?
	Financial Controls	Incorporate adequate financial management controls?
	Geography	Allow adjustments in revenue according to the location traveled?
	High Value	Allow adjustments in revenue to account for areas of peak utilization?
	Maintenance	Minimize vehicle owner/operators maintenance burden?
	Operation	Minimize the complexity and cost for system operation?
	Politically Viable	Meet acceptability standards for the current political climate?
	Private Toll	Minimize the impact on currently available private toll roads?
	Public Transit	Reduce burdens on the public transit system?
	Third-Party Cost	Allow for compensation of third parties that perform routine administration or operation?
	Timing	Allow adjustments in revenue according to the time traveled?
	Traffic Flow	Facilitate the flow of traffic in any area?
	Transparency	Allow all users to determine exactly what they are paying in taxes?
	Wear & Tear	Allow adjustments in revenue according to the "amount of damage" delivered to the highway by different vehicle types and weights?
Technical Scoring		
	COTS	Use commonly available components rather than components unique to this revenue collection system?
	Ease of Use	Create a system that is easy to use and understand by the operators and the public?
	Fault Tolerant	Allow simple remediation for individual faults?
	Flexible	Support multidimensional tariffs and adjust to new tariffs over time?

Criterion Focus	Criterion Name	Criterion Definition – <i>Within the solution set being considered, does the solution:</i>
	Implementation Ease	Offer a simple implementation plan?
	Integration	Support legacy systems until they have been sunsetted?
	Interoperability	Interface with other systems?
	Intrusion Detection	Provide an easily identifiable means of determining if parts of the system have been breached or tampered with?
	Longevity	Support a long life time?
	Modern	Use state-of-the-art technology, techniques, and methods?
	Scalable	Provide a scalable model for growth across the nation?
	Security Audit	Provide security audit trail capability?
	Standards	Use standard communication protocols?
	Sustainability	Operate independently if other systems fail?
	Testable	Allow for ease of testing?
	Transition	Provide a realistic transition plan from the current system?

4. Conclusions

Falling revenues and increasing costs have led to projections of an HTF shortfall by or during 2009. There is limited time to address this gap, to which multiple factors, including increasing vehicle fuel efficiency and the increasing construction, operating, and maintenance cost of highways.

A review of the literature identified a weakness in how many authors are framing the solution to the projected shortfall. It did not show a comprehensive examination of any proposed solutions or offer a means to combine them with other solutions to eliminate the shortfall. Instead of addressing the complexity of the problem, authors often advocate for one-off solutions. What is needed are solution sets, multiple solutions working together to achieve the desired outcomes.

MITRE has provided comprehensive criteria to allow the Commission to identify and prioritize viable and feasible solution sets for eliminating the projected shortfall. Applying these criteria will ensure that the basis for the Commission's recommendations will be transparent and will be able to respond to changes in assumptions, economic, and legislative priorities.

MITRE continues to focus on creating lasting solutions to complex technical problems in the public interest. NSTIFC's challenge requires facing dynamic economic, political, operational, and technical issues in order to provide realistic and acceptable recommendations to our nation's federal agency and Congressional leadership. MITRE looks forward to continued participation in this endeavor.

Appendix A. The Literature

A.1 Cost Reduction Criteria Found in the Reviewed Literature

Cost Reduction Criteria from the Literature – Applies to the Current Infrastructure									
	Financing	Construction		Operations				Maintenance	
Highways for LIFE (FHWA)	Design for a longer life cycle	Design Build/Best Value approach for RFPs/ awards	Design uses high-performing materials					Warranty Clauses in Contract	
NCHRP Study #10-49: Improving Contracting Methods	Innovative contracting methods	Contractual Incentives and Disincentives						Maintenance Bonds	
Improving Efficiency and Equity in Transportation Finance, Wachs, Brookings Institute, April 2003	Use State Infrastructure Banks (SIB) for low-interest construction loans								
The Fuel Tax and Alternatives for Transportation Funding - SR 285, 2006 National Academies Transportation Research Board		Pavements designed to minimize construction costs	Low Estimated Start-Up Costs	Low (Estimated) Operating Costs					
Future needs of the Transportation System (TIF-1) AASHTO February 2007		Advanced construction techniques		Electronic pre-clearance for trucks				Longer-lasting materials to extend periods between maintenance and replacement	Advanced maintenance techniques
Accelerating Project Delivery (TIF-7) AASHTO August 2007		Innovative contracting for construction	Cross-Agency partnerships to streamline environmental review process					Innovative contracting for maintenance and repair	
Curbing Operational Costs of Road User Charging Schemes (Norway)		Competitive bidding		Design minimizes percent of total revenue estimated as operating costs	Design maximizes estimated percent of annual road construction budgets from revenue	% of tolls automated in design	Design with high traffic flow but fewer lanes		
FHWA Site - Priorities, Market-ready Technologies and Innovations		Prefabricated bridge elements and systems (PBES)							
NCHRP Report 377 Alternatives to Fuel Taxes for Financing Surface Transportation Improvements, Reno and Stowers, 1995				Simplicity - low Administrative Costs	Efficiency - Low Operating Costs				
NCHRP Report 561 - Alternatives to the Motor Fuel Tax, Rufulo, Bertini, Kimpel 2001					Electronic toll collection and enforcement				
AASHTO Technology Implementation Group (TIG)		Lower construction/ lifecycle costs by use of Automated Machine Guidance (AMG) with 3-D computer models							
Draft Lead States Team Marketing Analysis - the Use of Self Propelled Modular Transporters to Remove and Install Bridges - AASHTO TIG September 2007								Innovative maintenance (e.g., Rapid Bridge Deck Replacement using SPMTs)	Lower Insurance premiums due to better design for maintenance

Cost Reduction Criteria from the Literature – Applies to the Current Infrastructure								
	Financing	Construction		Operations			Maintenance	
Research Applications Laboratory/NCAR Research Project (Ongoing 2007)								Manage maintenance with Resource Allocation applications - e.g., Winter Maintenance Decision Support System (MDSS)

A.2 Revenue Solution Criteria Found in the Reviewed Literature

Revenue Solution Criteria from the Literature														
	Mode of Revenue Collection	Economic			Political Considerations/Externalities					Operations			Technology	
		Implementation Costs	Operational Costs	Enforcement Costs	Desirable effects	Acceptance	Fairness and Equity	Privacy Concerns	Externalities	Transparency	Effectiveness	Enforceability		
Chicago Transportation Funding Presentation, Jack Wells 2006	VMT		Ability to keep up with spending needs		Desirable incentive effects	Public acceptance	Fairness among users				Administrative simplicity	Enforceability		
Netherlands Kilometer Pricing	Tolls		Operational costs as low as possible proportionate to revenue and no more than 5 per cent (when combined with enforcement)	Enforcement costs as low as possible proportionate to revenue and no more than 5 per cent (when combined with operations)			Equity and Fairness (Primary)	Privacy	Environmental quality		Toll system accuracy must be sufficient for credibility (i.e. 99% of invoices less than 1% deviation)		The system must be scalable and flexible to support stepwise implementation and multidimensional tariff structure	Flexibility for changes in road network, tariff structure
National Evaluation of a Mileage-Based Road User Charge System	VMT					Public acceptance						Adequate prevention / detection of fraud		
Road Pricing in the Netherlands	Tolls		Easy to use and understand the scheme					Respects user privacy		Costs visible in the vehicle	Free-flow operation	Accuracy sufficient for credibility	Interoperability	Should support toll / point charges
Oregon Road User Fee Concept and Pilot Program, James Whitty	Users pay	Start up costs	Operation costs							Ease of Use	Creation of Zones eliminates location details	Collection enforcement	Integration with Current System	Redundancy
The Fuel Tax and Alternatives for Transportation Funding - SR285, NAP 2006	Align payments with true cost responsibilities (including hybrids and other new-technology vehicles)				Provide cost incentives for large trucks and other vehicles					Balance road-use costs for new -technology vehicles with original goals that incentivized these vehicles				
Financing Local Roads, David Forkenbrock							Tolls not equitable if funding the entire system							

Revenue Solution Criteria from the Literature														
	Mode of Revenue Collection	Economic			Political Considerations/Externalities					Operations			Technology	
		Implementation Costs	Operational Costs	Enforcement Costs	Desirable effects	Acceptance	Fairness and Equity	Privacy Concerns	Externalities	Transparency	Effectiveness	Enforceability		
NCHRP Report 377 Alternatives to Fuel Taxes for Financing Surface Transportation Improvements, Reno and Stowers, 1995	Adequate to fully fund		Efficiency - Low Operating Costs				Equity				Simplicity - low administrative costs			
New Directions in Transportation Finance, Regan	Value Pricing													
NCHRP Report 561 - Alternatives to the Motor Fuel Tax, Rufolo, Bertini, Kimpel 2001								Privacy						
Mileage Based Road User Charge Study, Iowa Public Policy Center								Privacy					The system can be integrated with existing options	Data Encryption techniques exist for privacy
Report to Local Assembly (Source TBD)		Start-up cost will be fully incorporated in pricing				Public acceptance will be sought during buy-in effort					VMT mileage traveled is accurate		Technology exists for all VMT data collection	
Illinois Transit Report			Budget Accountability								Congestion reduction	Enhance Market Efficiency		