

# NCHRP 20-24(79)

## *Specifications for a National Study of the Future 3R, 4R, and Capacity Needs of the Interstate System*

*presented to*

At the Request of the  
Transportation Research Board

*presented by*

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CAMBRIDGE SYSTEMATICS



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# Today's Presentation: Our Work on Scoping Study

- ④ Share with you the insights developed under NCHRP 20-24(79) *Specifications for a National Study of the Future 3R, 4R, and Capacity Needs of the Interstate System*
  - » Describe our charge and approach
  - » Explain our technical findings
  - » Present the recommendations contained in the report
- ④ Answer your questions as you prepare to undertake the Section 6021 FAST Act Study.

# Study Background

- ④ National Cooperative Research Program (NCHRP) 20-24 Series
- ④ AASHTO CEO Sponsored
- ④ Directed by Study Panel
- ④ TRB Staff Andrew Lemer
- ④ Conducted during 2013

Project Panel	Project Team
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Tony Kane, AASHTO liaison	

# The 2013 NCHRP Study

- ④ Addressed the features of a major National Study which would estimate costs and benefits for:
  - » 3R – resurfacing, restoration, and rehabilitation as defined in Federal-aid Highway Act of 1976
  - » 4R – resurfacing, restoration, rehabilitation, and reconstruction as defined in Federal-aid Highway Act of 1981
  - » New Capacity
    - Lane additions, interchanges and extensions
    - Systems operations, new technology
- ④ To provide, in anticipation of a major national study, an understanding of
  - » The methodologies for estimating costs and benefits
  - » How the strategies for maintaining and enhancing the Interstate could be addressed
  - » The pros and cons of alternative methodologies

# Build on best practices, look to the future

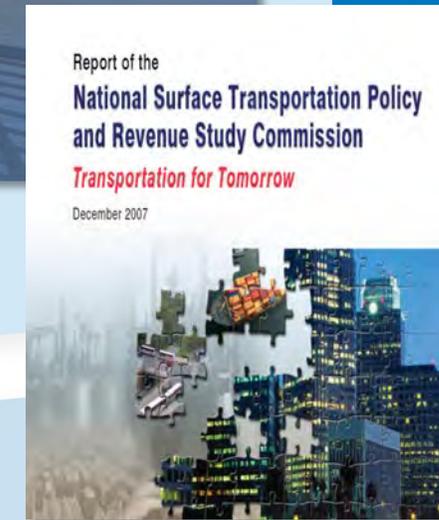
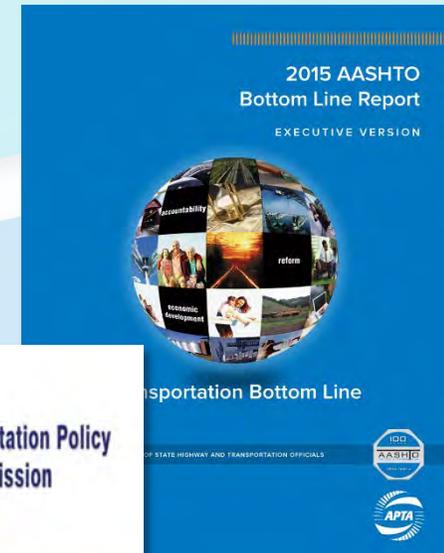
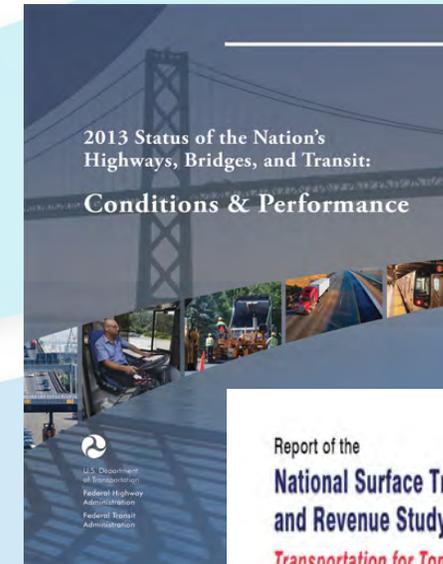
- ④ A National “needs study” to inform future Interstate investment policy
  - » Systematic, credible needs analyses to capture costs and benefits to preserve and improve the Interstate system, in light of potential future demand
  - » Rich literature rooted in the *Conditions and Performance Reports* by FHWA/USDOT, NCHRP *Future Options* studies, and *Commission Transportation for Tomorrow* analyses
- ④ Technically and methodologically focused – not a ‘visioning’ study nor a strategic plan
  - » Structured to assess costs and benefits for a wide range of potential future use and facilities
  - » Work plan proposed to advance consideration of alternative scenarios and major changes
- ④ Identified and recommended approaches to fill methodological gaps and respond to relevant issues

# Three Phased Approach (per the RFP)

- ④ Phase I – Critical Review of Data and Assessment Methodologies
- ④ Phase II – Define Approach and Evaluate Alternative Methodologies
- ④ Phase III – Detail the Selected Approach and Final Report

# Prior National Studies

- ④ USDOT Conditions and Performance Reports
  - » Congressionally mandated; covers highways and transit
  - » 2004 edition contained a chapter specifically devoted to the Interstate System
- ④ National Surface Transportation Policy and Revenue Study Commission Report *Transportation for Tomorrow* authorized by S. 1909 SAFETEA-LU
- ④ AASHTO's and APTA's "Bottom Line" Series
- ④ NCHRP 20-24(52) Future Options for the National System of Interstate and Defense Highways



# Major Considerations Going Forward

- ④ Lessons learned from national studies and application of methodologies
- ④ Look to emerging trends to address the future
- ④ The technical analyses are critical – informed by the study environment
  - » Outreach to a wide variety of system users and beneficiaries across modes (particularly important for goods movement, new technologies, multi-modal perspective, impacts)
  - » Adopt scenario planning and performance management techniques
  - » The long-term future is uncertain – facilitate “what if” analyses through scenarios, sensitivity analyses and risk analysis techniques

# Phase I

## *Critical Review of Data and Methodologies*

### ④ Primary Data Sources

- » Highway Performance Monitoring System
- » National Bridge Inventory

### ④ Additional Data Sources

- » National Household Travel Survey
- » Commodity Flow Survey
- » Fatality Analysis Reporting Systems and state crash databases
- » State unit cost databases
- » State pavement management and bridge management systems and inventories

### ④ Primary Tools/Models

- » Highway Economic Requirements System (HERS)
- » National Bridge Inventory Analysis System (NBIAS)

### ④ Additional Tools

- » Transportation Operations Benefit-Cost (TOPS-BC)?
- » ITS Deployment Analysis System (IDAS)?
- » Economic models
- » Freight models

# Key Strengths of Current Methodologies for Interstate Analysis

- ④ Strong history with HERS and NBIAS applications provides practical, available, systematic approach appropriate for National scale
- ④ Reliable and robust basic coverage of Interstate system in national data sets – collaboration with data owners will be key
- ④ Industry experience with outputs of these major models
  - » Fosters discussion of ultimate findings on “common ground” – focuses the debate on the assumptions and alternatives investigated, interpretation of their implications
  - » Technical experience with data and models can focus attention on overcoming model and data problems
  - » Capability to adjust features to address gaps and updates on a limited basis as time allows

# Key Limitations of Current Methodologies for Interstate Analysis

- ⦿ Evaluations by highway segment/bridge are incremental and not by system
- ⦿ Focus on capital expenditures and user costs – does not address operational costs, costs of planning and design, risk mitigation, administrative costs
- ⦿ Focus on existing network (mostly defined 60+ years ago) – does not address possible new facilities and new corridors
- ⦿ Does not address adaptation or resiliency – a “5<sup>th</sup> R?”
- ⦿ Data – perception of reliability and consistency, degree of detail, time lags
- ⦿ Misses needs driven by freight and goods movement and quick moving market forces

*These can be addressed*

# Example of Addressing a Limitation: *Accounting for Cumulative Deterioration of An Aging System*

- ⦿ Treatment of long-term, evolving, cumulative need for major reconstruction is inconsistent with HERS incremental decision algorithms
- ⦿ Task 14 of NCHRP 20-24(52) *Future Options for the National System of Interstate and Defense Highways* was undertaken to investigate concerns and potential adjustments to address:
  - » Underestimation of costs to replace aging facilities?
  - » Realistic lifetimes for overall pavement structures?
  - » Overemphasis on surface conditions as opposed to underlying structural conditions?
- ⦿ Case studies will help conceptually address these methodology issues
  - » Identify criteria, validate against sample forensic analyses/case studies
  - » Develop restoration cost estimates and incorporate into HERS

# Pushing the Boundaries

## *Commission Needs Analyses*

- Modeled Needs Analyses are not “cookie cutter” nor do they lead to precise answers about the long term future. They can be successfully applied to provide a sense of scale and implications of options

*Summary of range of “high” average annual capital investment levels analyzed for all modes  
Range of “high” capital investment levels analyzed (billions of dollars)*

	Currently Sustainable	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
<b>All Modes Combined</b>	<b>\$86</b>	<b>\$241</b>	<b>\$286</b>	<b>\$220</b>	<b>\$301</b>	<b>\$225</b>	<b>\$338</b>

# Domestic and International Methodologies

## ④ State interviews – Wide diversity in facilities and approaches

- » Kansas: Tiered approach combines “worst first” and optimization tool for pavement preservation. Operations and system management needs derived externally
- » New Jersey: System preservation and reconstruction needs generally based on distress and roughness measurements with a 10-year, performance oriented project selection
- » Utah: Comprehensive pavement condition informs selection of optimization strategies over 7-10 years based on benefit-cost analyses; Capacity needs, operations, and system management needs are derived externally

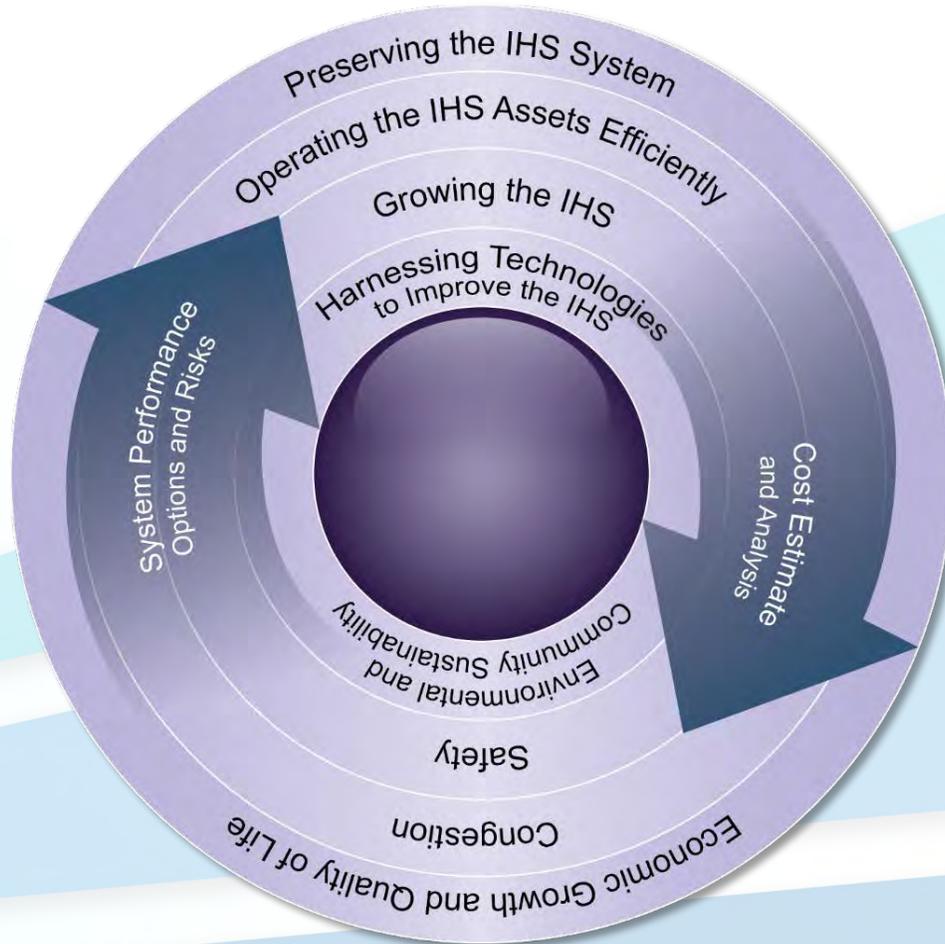
## ④ International – South Korea, Germany, Japan, China

- » Notable practices were gathered but not directly relevant to needs methodologies
- » Provide context for discussion of enhancements and alternative strategies

# Preliminary Methodology Conclusions

- ④ Systematic approach superior to “wish lists” or catalogues
  - » Comprehensive, systematic, peer-reviewed; sophisticated methods now incorporate economics
  - » HERS and NBIAS models represent a framework that captures the vast majority of needs
- ④ Credibility issues based on lack of understanding of application at national level
  - » “Sticker shock” and “skepticism” can undermine
  - » Argues for better understanding of methodologies and communication of findings
  - » Treatment of variation in regional practices and policy drivers
- ④ A hybrid approach may work best to overcome data and modeling limitations
  - » Tap the “best of both worlds” – adopt rigorous, systematic modeling enhanced by case study findings
  - » Complimentary and supplemental techniques that time and budget allow
  - » Update unit cost inputs
  - » Gather cost data based on new technologies

# Phase II Explore options and direction



## Proposed Project Framework

- » Modular
- » Performance Based
- » Scalable

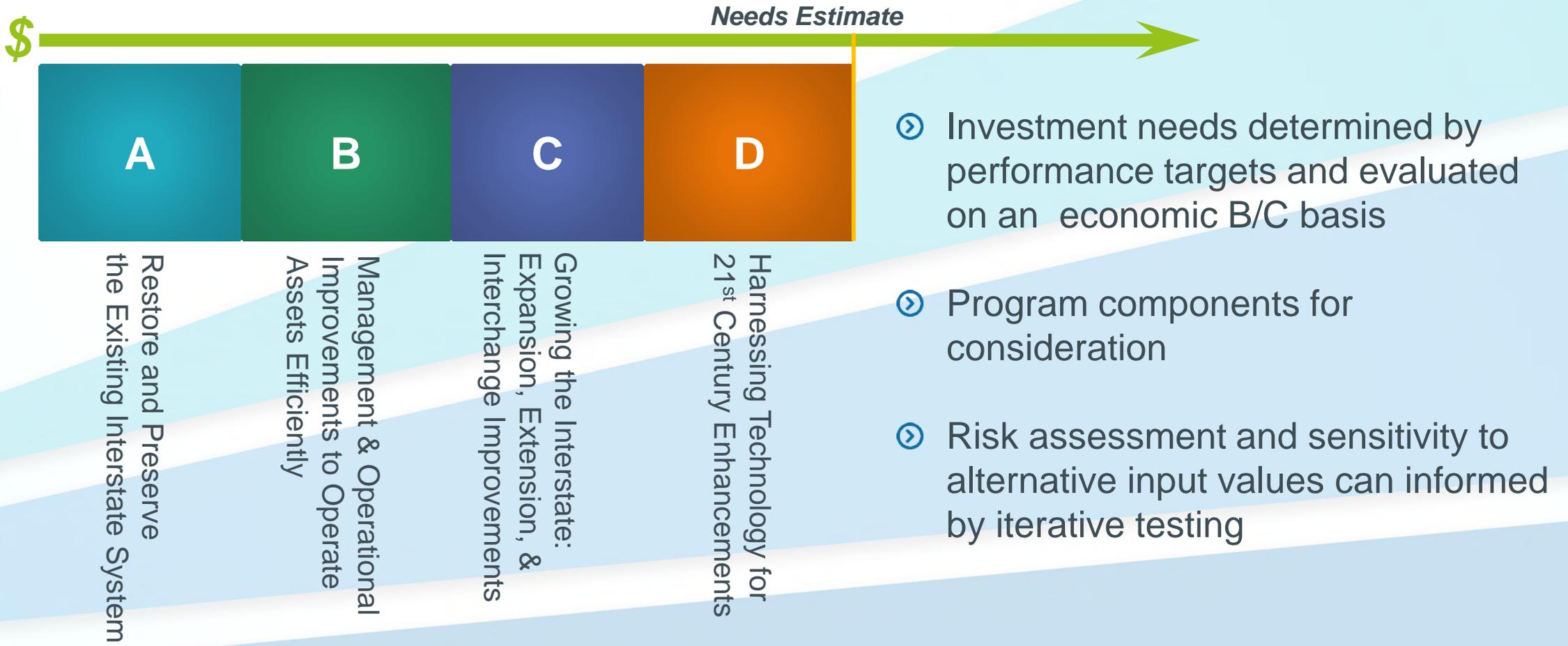
## Study Structure

- » Range of Scenarios and Components
- » Determine Treatment of Extent
- » Model Baseline
- » Iterate with Changes

## Work Plan

- » Measures and Targets
- » Input Selection and Gap Identification
- » Case Study Analyses
- » Integrate and Test

# Relationship between Scenarios and Needs



# A. Restore and Preserve the Existing Interstate System

What Improvement Types are Included?

- *Resurfacing*
- *Rehabilitation*
- *Reconstruction*

Define the Extent of the Investment

- *Existing interstate*
- *Scale back existing interstate?*
- *Expand interstate?*

Establish Costs Using a Performance Approach

- *Condition-based performance targets*
- *Tiered performance targets*

## B. Operate Assets Efficiently *with Management/Operations*

### What Improvement Types are Included?

- *Geometric improvements*
- *Customer service-based features*
- *ITS / system monitoring technologies*

### Define the Extent of the Investment

- *Traffic volume-based?*
- *Economic analysis-based?*
- *System wide?*

### Establish Costs Using a Performance Approach

- *Recurring and non-recurring congestion and reliability-based performance targets*
- *Incident management performance targets*
- *Safety-based performance targets*

# C. Growing the Interstate

## *Expansions, Extensions, and Interchange Improvements*

### What Improvement Types are Included?

- *Expansions / Lane additions*
- *Extensions*
- *Interchange improvements and additions*

### Define the Extent of the Investment

- *Existing Interstate*
- *Interstate plus portions of NHS*
- *Expand based on criteria (capacity analysis, connecting communities, freight, military, etc.)*

### Establish Costs Using a Performance Approach

- *Economic analysis*
- *Reliability-based performance targets*
- *Connectivity-based performance targets*

# D. Harnessing Technology for 21<sup>st</sup> Century Enhancements

## What Improvement Types are Included?

- *Service life improvements*
- *Changes to speed/throughput*
- *New technology (connected vehicles, driverless cars)*
- *Others?*

## Define the Extent of the Investment

- *Entire system*
- *Population-based / urban only*
- *VMT-based*

## Establish Costs Using a Performance Approach

- *National congestion and reliability-based performance measures*
- *Safety-based measures*

# Four Basic Questions to Translate to Needs

## How Do We Define the System Scope?

A. Existing system, condition & performance?

B. Consider modern operational efficiency?

C. Consider growing the Interstate?

D. Harnessing new technology?

## What Types of Strategies Would Be Deployed?

- Preservation
- Rehabilitation
- Reconstruction

- Management
- Operations

- Expansion
- Extensions

- New tech features
- New practices

## To What Level?

What are the relevant performance targets?

## At What Cost?

What unit costs should be used in estimating the cost of improvements?

# Alternative Approaches Were Considered

	<b>METHOD 1: Model Needs with Existing Analytical Tools</b>	<b>METHOD 2: Case Study approach to develop sample segment cost estimates</b>	<b>METHOD 3: Supplement analytical tools with Case Studies (Hybrid of Methods 1 and 2)</b>	<b>METHOD 4: State-assessed needs combined with unit costs</b>
Strengths				
Weaknesses				
Effort				
Reliability				

See  
NCHRP  
20-24(79)  
Appendix  
A.1 & A.2  
report for  
details)

# Hybrid Approach *Strengths and Weaknesses*

	<b>METHOD 3: Supplement Analytical Tools with Case Study Findings (Hybrid of Methods 1 and 2)</b>
Overall Strengths	<ul style="list-style-type: none"><li><input type="checkbox"/> Case studies could be used to adjust the models' parameters and data</li><li><input type="checkbox"/> Helps to improve understanding and credibility of national needs</li></ul>
Overall Weaknesses	<ul style="list-style-type: none"><li><input type="checkbox"/> Extensive and in-depth case studies required to cover range of conditions</li><li><input type="checkbox"/> Variability among state agencies related to cost and data collection</li><li><input type="checkbox"/> Learning curve with any new models may delay their use and acceptance</li></ul>

Excerpt from Table 3.2 NCHRP 20-24(79)

# Application of Hybrid Approach

	<b>Level of Effort</b> Extract from Table 3.3	<b>Reliability of Estimates</b> Extract from Table 3.4
A. Restore and Preserve the Existing Interstate System	Moderate to High	High
B. Operate Assets Efficiently <i>with Management and Operational Improvements</i>	High	High
C. Growing the Interstate <i>Expansions, Extensions, and Interchange Improvements</i>	Moderate to High	High
D. Harnessing Technology <i>for 21<sup>st</sup> Century Enhancements</i>	Moderate	Moderate

# Phase III Detailed Recommendations

- ④ Hybrid approach - leverage strengths, address limitations and gaps
- ④ Communications and Participation
  - » Achieve a common understanding of the approach being adopted in order to bring together the disciplines and perspectives needed to inform the analyses
  - » Foster broad-based collaboration across wide stakeholder base – but keep it real.
- ④ Cost -- \$3-4 Million minimum
  - » Based on C&P budgets, \$2-\$3 M of contract support for modeling over 2 years
  - » Additional costs for case study research, communications, collaboration
- ④ Time – highly dependent upon scale of case studies and scenarios
  - » 2-3 months to refine workplan including adopting scenarios
  - » 9 months to conduct case studies in parallel with baseline modeling
  - » 2 months of adaptation of models/6 months of model simulation
  - » 6 months report writing and ground testing

# Conclusions

- ④ NCHRP 20-24(79) provided a methodological “springboard” to hit the ground running for the Section 6021 Future Interstate study
- ④ Methodology can respond to a variety of scenarios and policy options
  - » Treat a range of travel demand and modal share forecasts
  - » Preservation and safety investment needs for existing system under alternative performance goals
  - » Capacity and operations investment needs for existing/potentially expanded system under alternative goals for mobility and reliability
  - » Incorporate resilience and adaptation goals to recognize climate change/ extreme weather events.
  - » Implications of short-term as well as far-reaching technology innovations
- ④ While recommended schedules and budgets will need to be trimmed, the recommended approach is still the best of the options

**We are happy to  
take questions.**

**Susan Binder  
Hal Kassoff**