U.S. Department of Transportation
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Federal Transit Administration

Benefit/Cost Analysis for Operations Planning

NTOC Webinar

March 4, 2012

Overview of FHWA B/C Analysis Desk Reference Project

Operations B/C Analysis Desk Reference Project

U.S. Department of Transportation
Federal Highway Administration
Federal Transit Administration

- Sponsored by the FHWA Office of Operations under the "Planning for Operations" Initiative in recognition of multiple needs:
  - Operations personnel are increasingly being required to conduct B/C, yet many are unfamiliar with the basic process
  - Many Operations strategies require unique analysis that may be taxing to even seasoned B/C analysts

B/C Supports Planning for Operations

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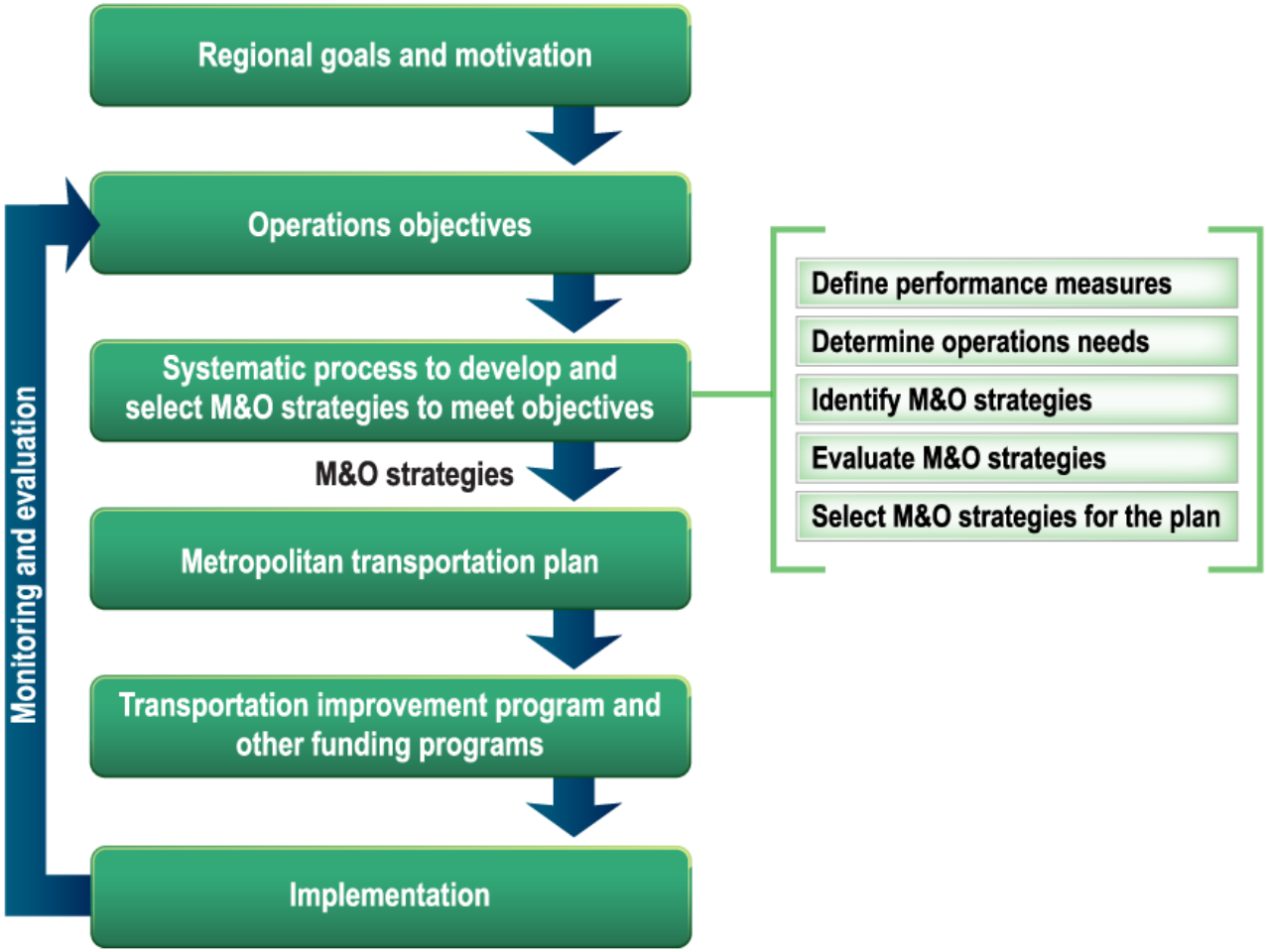

Expected Project Outcomes

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- Two primary outputs:
  - Desk Reference Document
  - Supporting “Tool for Operations Planning Benefit/Cost (TOPS-BC)”
  - Interim versions available
  - Outreach effort initiated
  - Training/Workshops

B/C Cost Analysis Agenda

U.S. Department of Transportation
Federal Highway Administration
Federal Transit Administration

- Introduction to B/C Analysis
- B/C Analysis of KC SCOUT
- Specific Challenges of B/C Analysis for Operations
- New and Emerging Performance Measures
- Comparing ITS/Operations Strategies with Traditional Capacity Projects

Agenda (continued)

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Federal Transit Administration

- Availability of Analysis Tools/Methods for Conducting B/C of Operations Projects (Selection of the Appropriate Tools/Methods)
- Measurement of Benefit Performance Measures in Florida (District 4)
- Overview of Guidance Available in the Desk Reference
- Demonstration of Analysis Capabilities of the TOPS-BC Tool
- Questions/Discussion

Introduction to B/C Analysis

What is B/C Analysis?

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- Benefit/Cost (B/C) analysis provides a systematic process for calculating and comparing benefits and costs of a project for two purposes:
  - Determine if the investment is sound (justification/feasibility); and
  - Compares it with alternate projects (ranking/priority assignment)
    - Prioritizing different operational strategies
    - Comparing operational strategies with traditional strategies

What is B/C Analysis?

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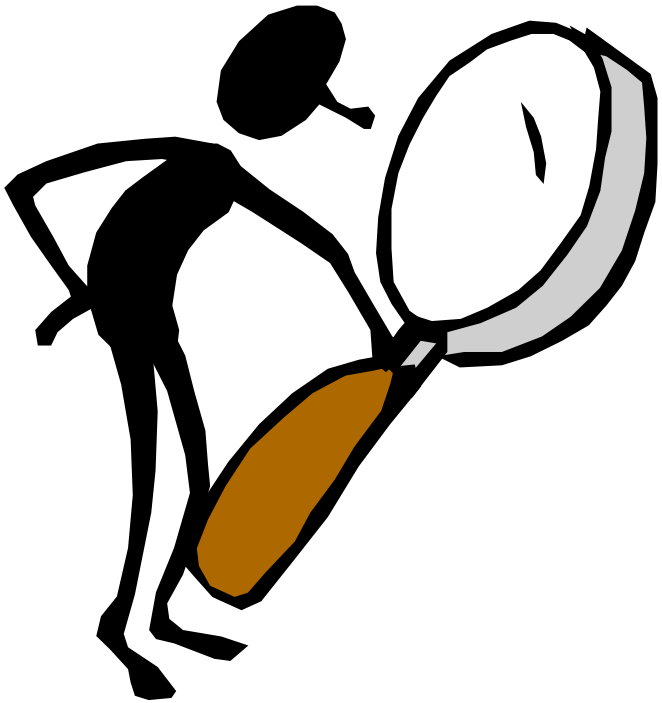
- B/C analysis can either be:
  - Forward looking (forecasting benefits)
  - Backwards looking (evaluation of benefits received)



B/C Analysis is Not the Same as "Economic Impact Analysis"

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- B/C Analysis
  - Considers the *direct* impacts of the project on measures of effectiveness (MOEs):
    - Travel time
    - Safety
    - Emissions
    - Fuel costs
    - Productivity
- Economic Impact Analysis
  - Focused on more broad regional economic activity and jobs
  - Considers *the direct, indirect and induced* impacts of the project

What is B/C Analysis?

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- In structuring your B/C analysis, it is important to:
  - Select comprehensive measures of effectiveness
    - Include both positive and negative impacts
    - Avoid double counting
    - Avoid considering *transfers* as benefits

What is B/C Analysis?

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- Include estimates of the full lifecycle costs
  - Up-front capital costs
  - On-going Operations and Maintenance (O&M) costs
  - Supporting infrastructure costs
- Consider difficult to quantify benefits and costs
  - Qualitative assessment if necessary
- Select an appropriate geographic scope

What is B/C Analysis?

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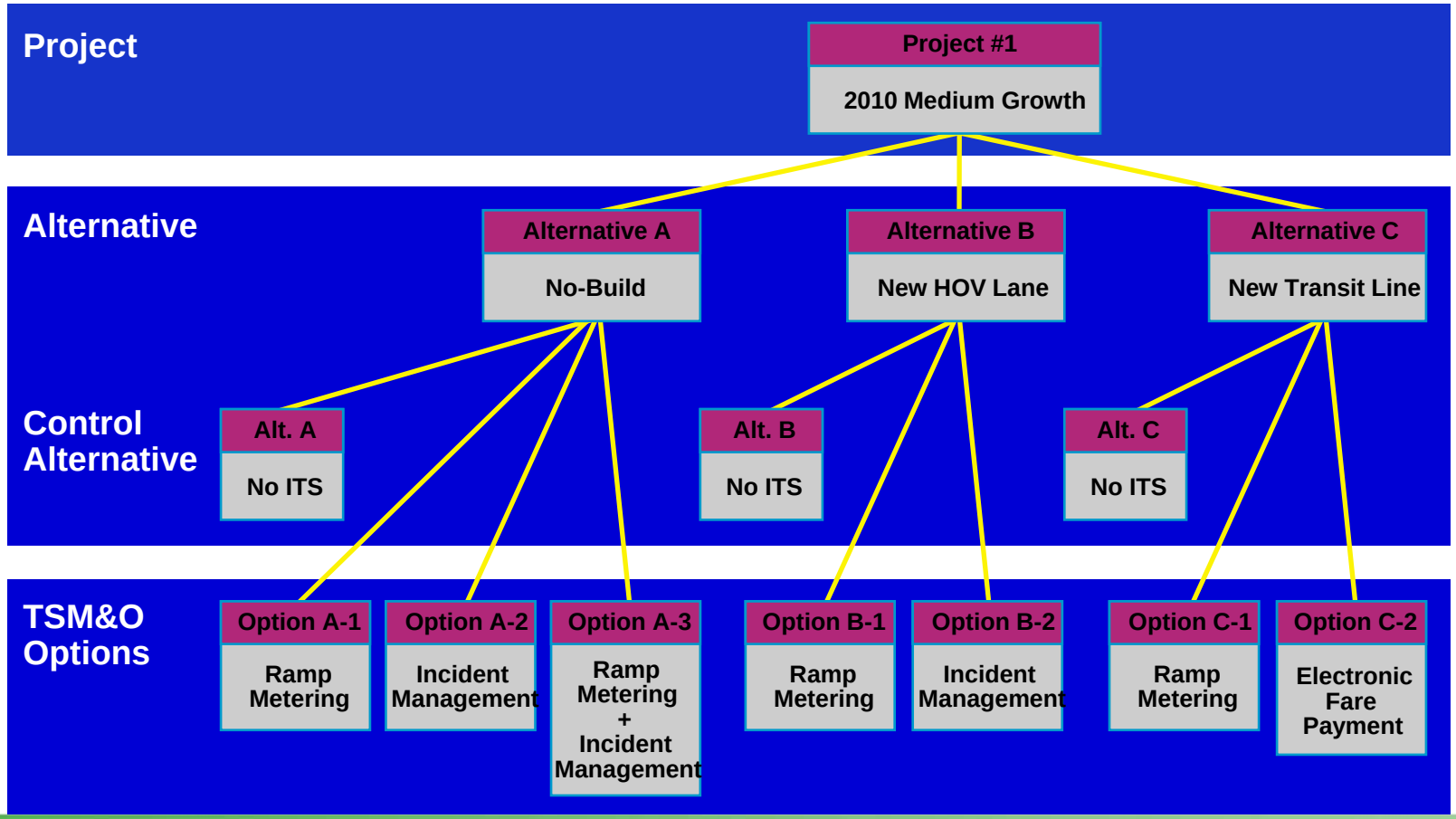
– Identify appropriate baselines and alternatives



KC SCOUT EXAMPLE

Specific Challenges of B/C Analysis for Operations

Specific Challenges of B/C Analysis for Operations

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- Structure Based Challenges – Traditional vs. Operations Focus
  - Existing measures of effectiveness may not be sensitive to the unique benefits of operations
  - Specified data may be inappropriate for assessment of operations benefits
  - Required analysis methods or tools may not be capable of capturing the full benefits of operations strategies
  - Cost estimation parameters and framework may be inadequate

Specific Challenges of B/C Analysis for Operations

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- Strategy Based Challenges
  - Limited field data on impacts for new and emerging strategies
  - Challenge of assessing strategies targeted at non-recurring conditions
  - Effect and value of traveler information
  - Assigning costs for backbone infrastructure
  - Analysis challenges of non-physical improvements (e.g., ATDM, interagency coordination)

Assessing the Synergistic Benefits of Integration

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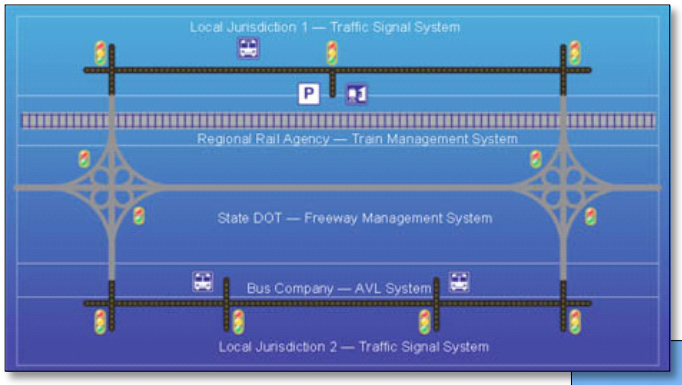
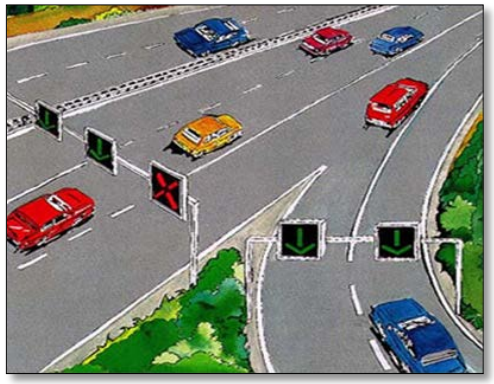
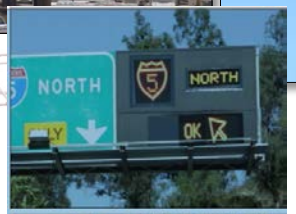
Federal Transit Administration





SFpark
CIRCLE LESS, LIVE MORE



Assessing Non-Typical Conditions

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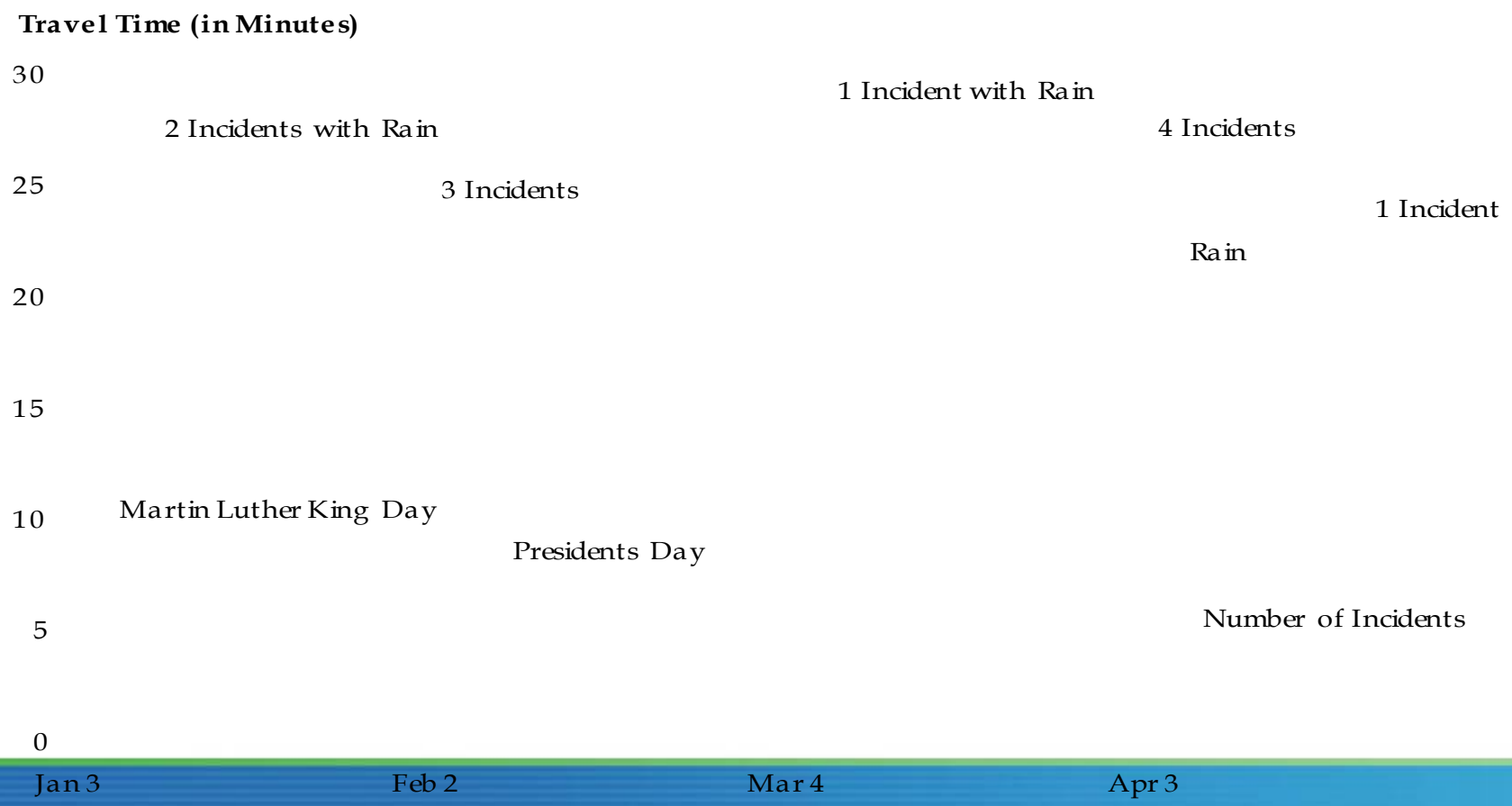
Weekday Travel Times

5:00-6:00 P.M., on State Route 520 Eastbound, Seattle, WA



New and Emerging Performance Measures

New and Emerging Performance Measures

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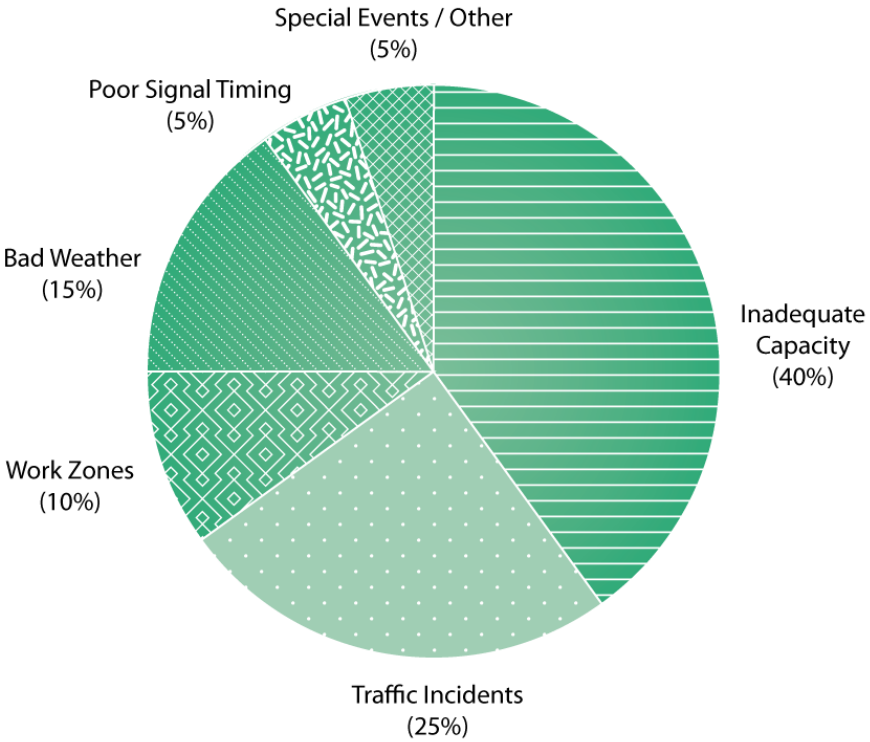
- Travel Time Reliability
  - Many new "index" measures available
  - B/C analysis requires quantifiable measure
    - Incident delay
    - Total travel delay
  - SHRP2 and other efforts developing enhanced measurement and analysis methods



New and Emerging Performance Measures

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- Consumer Surplus
  - More traveler based than network based
- Green House Gas Emissions
  - Valuations fluctuate significantly

Comparing Operations and Traditional Capacity Projects

Comparing Operations and Traditional Capacity Projects

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- B/C analysis provides a vehicle for “apples-to-apples” comparison, but only if:
  - Measures of effectiveness are sensitive to the unique benefits of the strategies
  - Data inputs are appropriate for assessment
  - Required analysis methods or tools are capable of capturing the full benefits of operations strategies
  - Appropriate cost estimation parameters and framework

Comparing Operations and Traditional Capacity Projects

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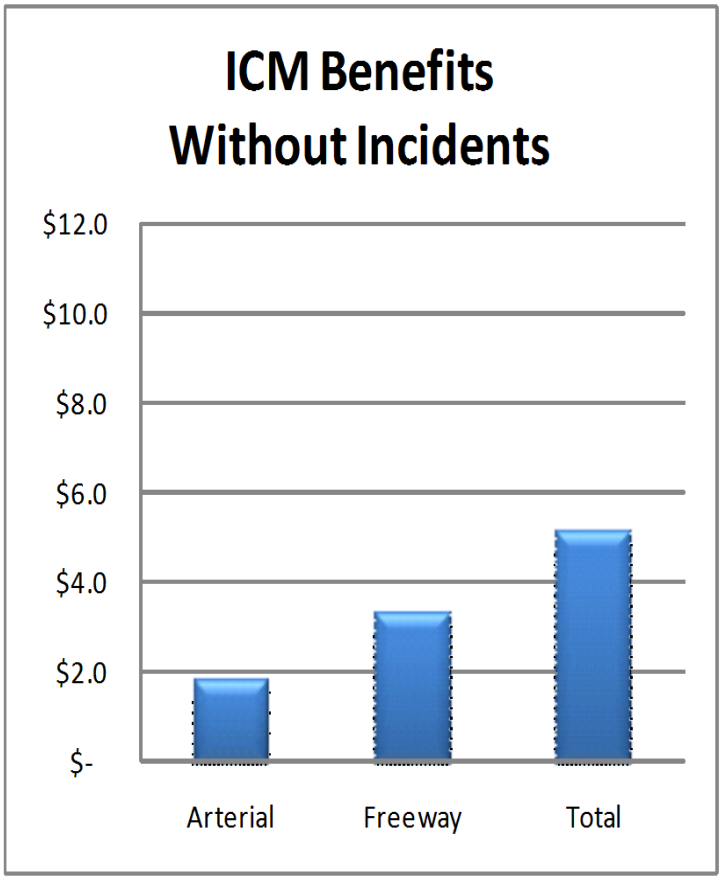

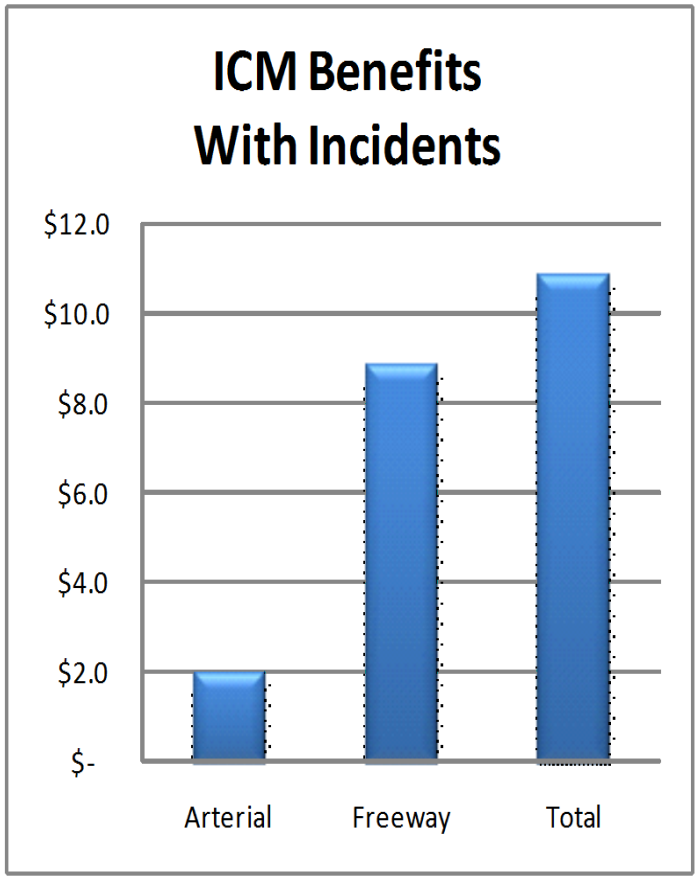

Availability of Analysis Tools/Methods for Conducting B/C of Operations

Tools/Methods for Conducting Ops B/C

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- Wide range of tools and methods available
  - Research and decision support tools
  - Sketch planning tools
  - Post-processing tools
  - Multi-resolution / multi-scenario tools
- Analysis tool/method selected should be appropriate to the objectives of the analysis

Tools/Methods for Ops B/C

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- Research and Decision Support Tools
  - TOPS-BC
  - ITS JPO Benefit Cost Database
- Assist practitioners in identifying the appropriate impacts of costs of strategies and analysis parameters

Tools/Methods for Ops B/C

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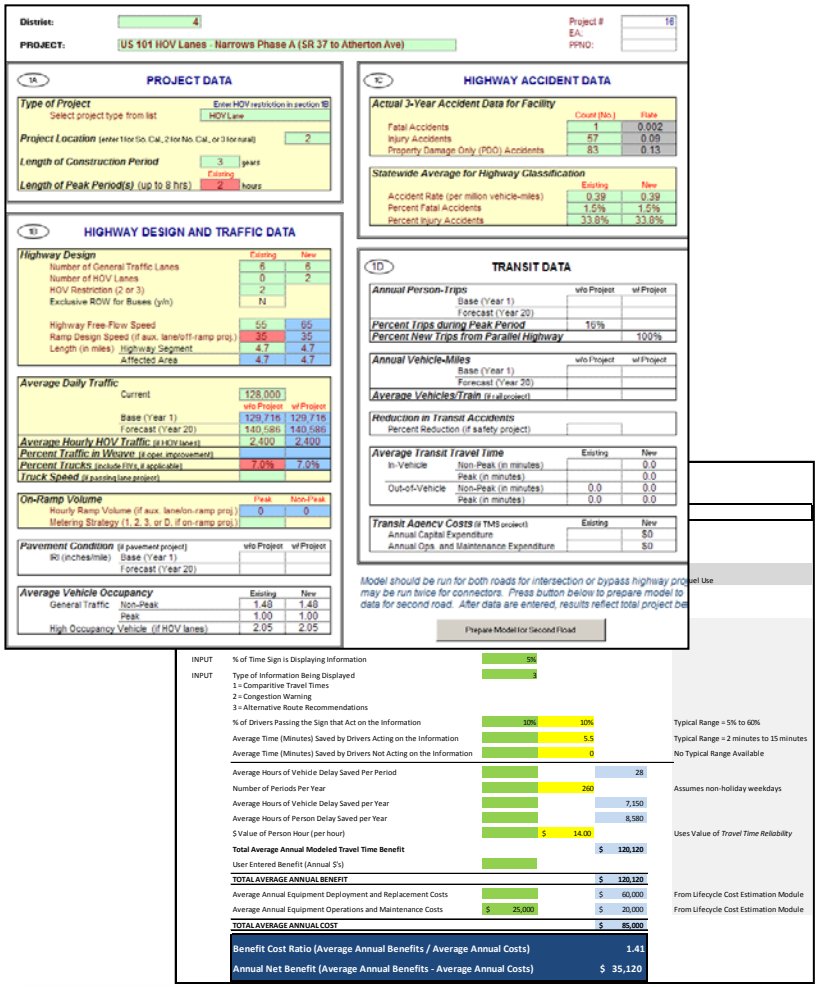
- Sketch planning tools
  - TOPS-BC
  - Cal-BC
  - SCRITS
  - VDOT Spreadsheet Analysis
- Provide quick, order of magnitude estimates of benefits and costs of many operational strategies



Tools/Methods for Ops B/C

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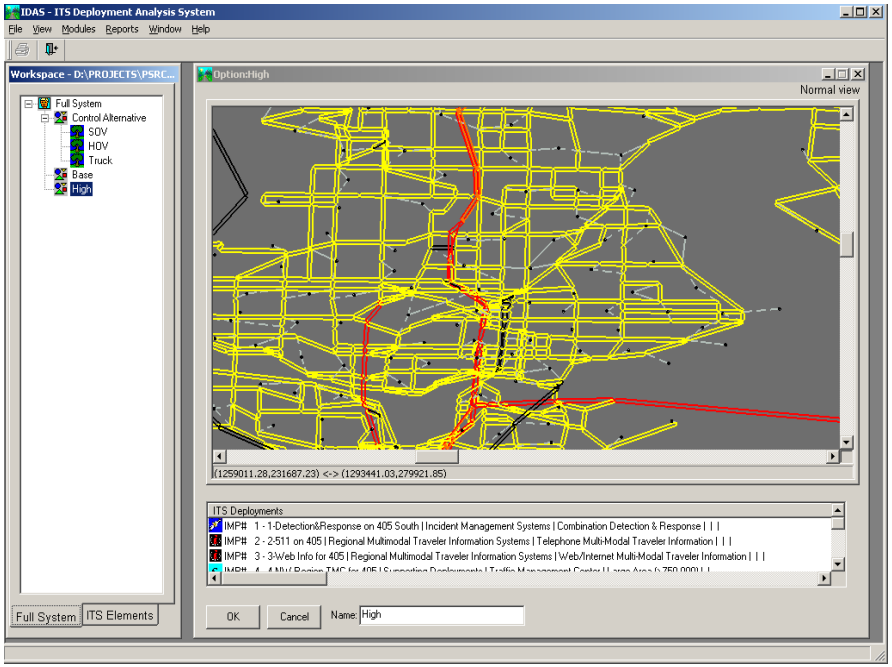
IDAS
ITS DEPLOYMENT ANALYSIS SYSTEM

- Post processing tools
  - IDAS
  - FITSEval
- Integrate with travel demand model data to provide enhanced analysis of operational strategies



Tools/Methods for Ops B/C

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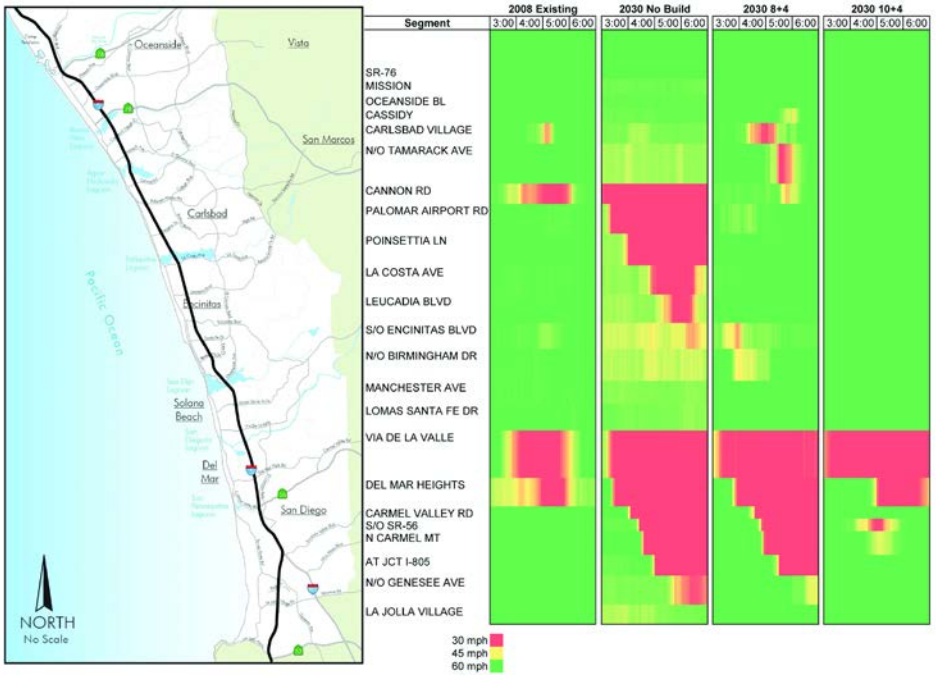
- Simulation Models
  - Allow for the assessment of discrete conditions and traveler behaviors (route diversion)
  - Resource intensive development and analysis



Tools/Methods for Ops B/C

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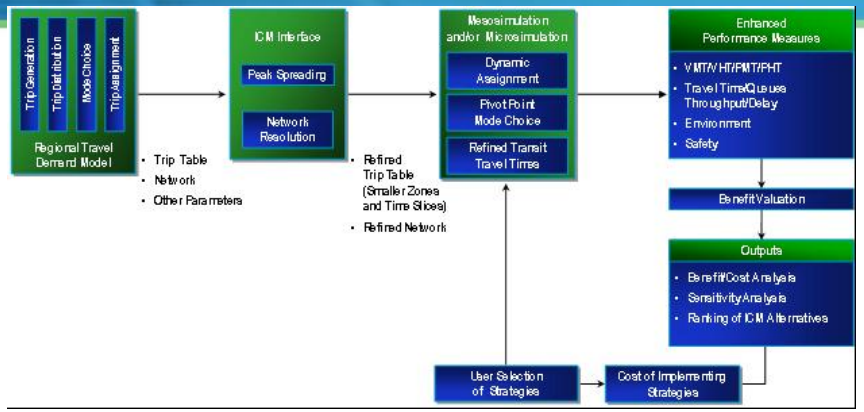
- Complex multi-resolution and multi-scenario methods
  - ICM AMS framework
  - HCM ATDM structure
- Provide the most detailed results
- Most appropriate approach for strategies focused on non-recurring conditions



Capacity Reduction		5% Demand	20% Demand	50% Demand	80% Demand	95% Demand	Row Totals
No Incidents, Good Weather	0%	6.04%	15.10%	18.12%	15.10%	6.04%	**60.40%**
Single Lane Closure, Good Weather	42%	2.16%	5.40%	6.48%	5.40%	2.16%	**21.60%**
Dual+ Lane Closure, Good Weather	75%	0.07%	0.19%	0.22%	0.19%	0.07%	**0.74%**
No Incidents, Bad Weather	7%	1.26%	3.15%	3.78%	3.15%	1.26%	**12.60%**
Single Lane Closure, Bad Weather	49%	0.45%	1.13%	1.35%	1.13%	0.45%	**4.50%**
Dual+ Lane Closure, Bad Weather	82%	0.02%	0.04%	0.05%	0.04%	0.02%	**0.16%**
Column Totals		**10.00%**	**25.00%**	**30.00%**	**25.00%**	**10.00%**	**100.00%**

TOPS-BC: Select Methodology

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FHWA Tool for Operations Benefit/Cost (TOPS-BC)

Guidance on Appropriate Benefit/Cost Methods

Instructions: Please indicate the needs of your analysis associated with the following criteria then press "GO".
A list of appropriate methodologies will be displayed to the right and will change in response to your answers to the input analysis criteria.

INPUT CRITERIA

Go

1 What is the geographic scope of the analysis? (Select 1)
- ● Do not care
- ● Statewide
- ● Regional
- ● Corridor
- ● Isolated Location
- ● Other

2 What is the desired accuracy of the analysis results? (Select 1)
- ● Do not care
- ● High (extremely accurate)
- ● Medium
- ● Low (order of magnitude)

3 What TSM&O strategy(ies) do you want to analyze?

Arterial Management Systems

Corridor Traffic Signal Coordination Strategies (Choose multiple)
- ☐ Pre Set Timing
- ☐ Traffic Actuated Timing
- ☐ Centrally Controlled Timing

Traffic Signal Priority Strategies (Choose multiple)
- ☐ Transit Priority

Freeway Management Systems

Ramp Metering Strategies (Choose multiple)
- ☐ Pre Set Timing
- ☐ Traffic Actuated Timing
- ☐ Centrally Controlled Timing

Guides users to appropriate analysis methodology based on their analysis needs

Tools meeting ALL criteria

- TOPS-BC
- BCA.net
- CAL-BC
- EMFITS
- FITSEval
- HERS-ST
- IDAS
- MicroBENCOST
- Redbook Wizard
- SCRITS
- SPASM
- STEAM
- Travel Demand Model Methods
- Simulation Methods

Measurement of Benefit Performance Measures in Florida (District 4)

Overview of Guidance Available in the Desk Reference

Guidance Available in the Desk Reference Document

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Federal Highway Administration
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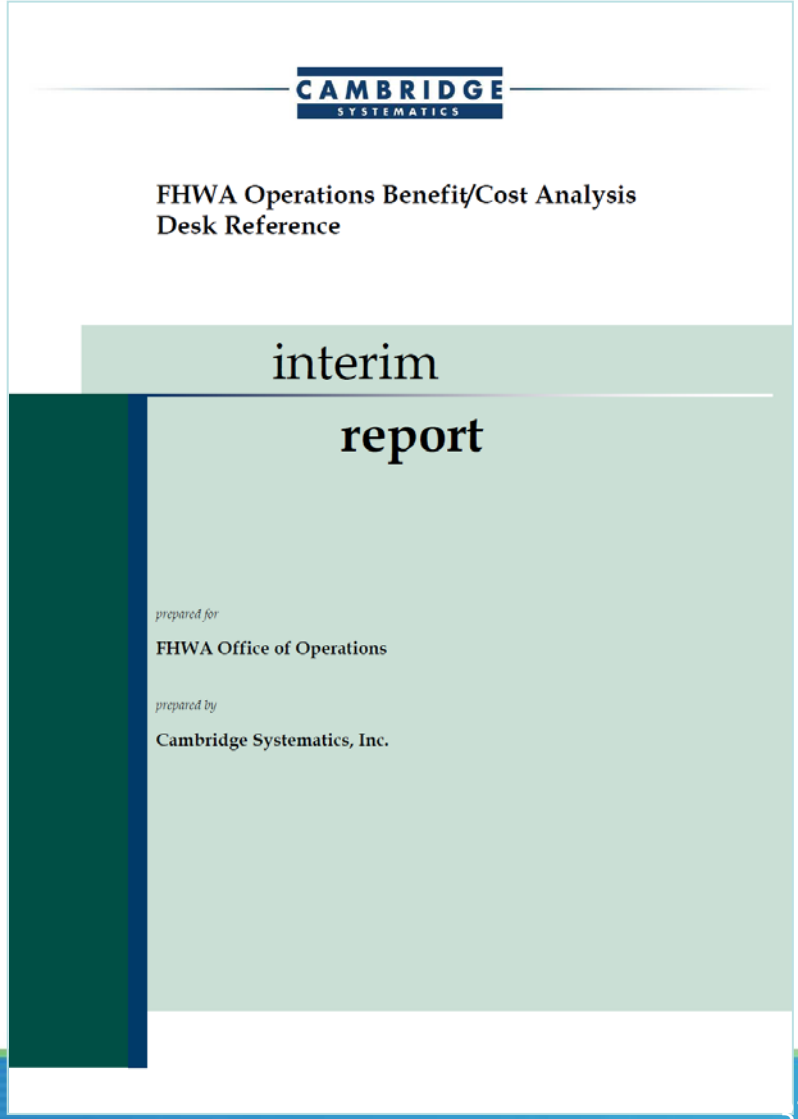
- Interim Report available
- Document and other products anticipated to evolve as a result of outreach efforts


CAMBRIDGE SYSTEMATICS

FHWA Operations Benefit/Cost Analysis
Desk Reference

interim
report

prepared for
FHWA Office of Operations

prepared by
Cambridge Systematics, Inc.

Desk Reference Document

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- Provides comprehensive, one-stop-shopping for B/C information related to TSM&O
- Serves as a primer for Operations personnel unfamiliar with B/C analysis
- Advanced guidance to support analysis of more difficult to quantify issues

Guidance Available in the Desk Reference Document

U.S. Department of Transportation
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- B/C analysis primer information
- Definition of Ops strategies and their likely impacts
- Available tools/methods and selection criteria
- Strategies for addressing identified challenges of B/C analysis for operations
- Methodologies for assessing travel time reliability
- Discussion of multi-scenario analysis methods

Desk Reference Document

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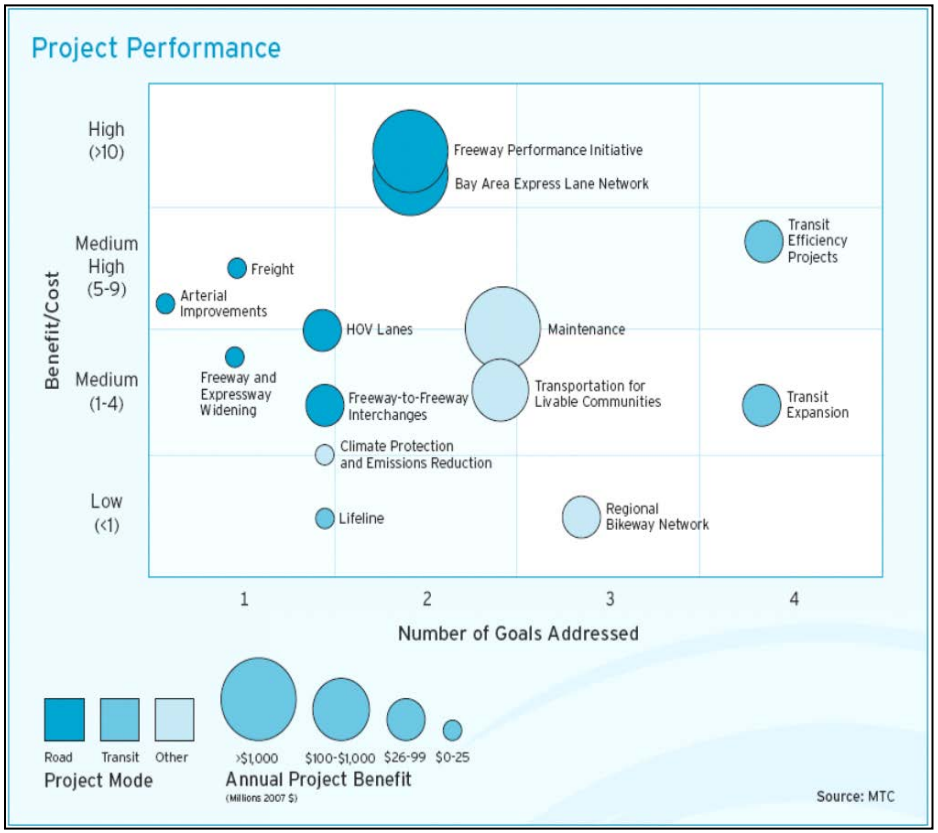
- Innovative presentation of results



Example of Analysis Capabilities Available in the TOPS-BC Tool (Demo)

FHWA Tool for Operations Planning Benefit/Cost Analysis (TOPS-B/C)

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- Investigate the Range of Expected Values Associated with Various TSM&O Strategies
- Map Different Benefit/Cost Methodologies to Your Organization's Needs
- Estimate Life-Cycle Costs of TSM&O Strategies
- Conduct Simple Spreadsheet-Based Benefit-Cost Analysis for Selected TSM&O

TOPS-BC

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Federal Highway Administration
Federal Transit Administration

- Requirements
  - Macro-driven spreadsheet environment
  - Designed to be intuitive to use
  - Default figures are documented and understandable
  - Formulas are reviewable
  - Easy maintenance and customization
- Four Key Capabilities…

TOPS-BC: Investigate Impacts

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Investigate the Range of Impact Values Associated with Various TSM&O Strategies

Navigation Screen

Instructions: Please select the "TSM&O Strategy" and the "Impact Category" you are intersted in from the list below. If sufficient data is available, a range of expected impacts will be shown below. Click on the hyperlink to be taken to a table displying the datapoints comprising the range.

TSMO Strategy Selected:

Freeway Management System : Ramp Metering : Pre-set Timing

Impact Category:

Travel Time and Speed

Provides database and look-up function for the observed impacts of many TSM&O strategies

Data Source

Typical Range of Expected Impacts

Noted Impacts

Expected travel time reductions range between 10% and 45%. Expected percent speed improvements between 10% and 55%.Expect delay reductions between 15% and 20%.

TOPS-BC: Estimate Lifecycle Costs

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Estimates life-cycle costs of many TSM&O strategies – Average Annual Costs and Stream of Costs over time

FHWA Tool for Operations Benefit/Cost (TOPS-BC)

te Lifecycle Costs of TSM&O Strategies

L - ESTIMATE AVERAGE ANNUAL COST

Traveler Information - DMS

	Useful Life	Capital / Replacement Costs (Total)	O&M Costs (Annual)	Annualized Costs
uipment				
e for Information Dissemination	5	$ 7,500	$ 375	$ 1,875
e for Information Dissemination	5	$ 20,000	$ 1,000	$ 5,000
ntegration	20	$ 100,000	$ 5,000	$ 10,000
			$ 100,000	$ 100,000
tructure Cost		***$ 127,500***	***$ 106,375***	***$ 116,875***
nt Equipment				
(Per Sign Location)				
Communication Line	25	$ 750	$ 900	$ 930
Variable Message Sign	25	$ 92,500	$ 4,400	$ 8,100
Variable Message Sign Tower	25	$ 125,000	$ 275	$ 5,275
TOTAL Incremental Cost		***$ 218,250***	***$ 5,575***	***$ 14,305***

INPUT	Enter Number of Infrastructure Deployments	1	**$ 116,875**
INPUT	Enter Number of Incremental Deployments (# of Signs)	2	**$ 28,610**
INPUT	Enter Year of Deployment	2012	
	Average Annual Cost		**$145,485**

TOPS-BC: Benefits Estimation

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FH[redacted]ool for Operations Benefit/Cost (TOPS-BC)

Estimate Benefits of TSM&O Strategies

Strategy: Dynamic Message Signs

Notes: For additional information on this analysis method, please see Section X.X.X of the *Desk Reference*
For information on alternative methods for performing analysis of this strategy, please see Section X.X.X of the *Desk Reference*

Primary Benefits Estimated by this Method:	Travel Time Reliability
Other Benefits that may be Considered:	Safety, Customer Satisfaction, Agency Efficiency, Emissions, Fuel Use

	Impact	User Input	Default	Modeled	
INPUT	Average Number of Vehicles Passing Sign Location(s) (per period)	60,000			
INPUT	Average Vehicle Occupancy	1.2			
INPUT	% of Time Sign is Displaying Information	5%			
INPUT	Type of Information Being Displayed 1 = Comparitive Travel Times 2 = Congestion Warning 3 = Alternative Route Recommendations	3			
	% of Drivers Passing the Sign that Act on the Information	10%	10%		Typical Range = 5% t
	Average Time (Minutes) Saved by Drivers Acting on the Information		5.5		Typical Range = 2 mi
	Average Time (Minutes) Saved by Drivers Not Acting on the Information		0		No Typical Range Av
	Average Hours of Vehicle Delay Saved Per Period			28	
	Number of Periods Per Year		260		Assumes non-holida
	Average Hours of Vehicle Delay Saved per Year			7,150	
	Average Hours of Person Delay Saved per Year			8,580	
	$ Value of Person Hour (per hour)		$ 14.00		Uses Value of *Trave*
	Total Average Annual Modeled Travel Time Benefit			**$ 120,120**	
	User Entered Benefit (Annual $'s)				
	TOTAL AVERAGE ANNUAL BENEFIT			**$ 120,120**	
	Average Annual Equipment Deployment and Replacement Costs			$ 60,000	From Lifecycle Cost Estimation Module
	Average Annual Equipment Operations and Maintenance Costs	$ 25,000		$ 20,000	From Lifecycle Cost Estimation Module
	TOTAL AVERAGE ANNUAL COST			**$ 85,000**	

Benefit Cost Ratio (Average Annual Benefits / Average Annual Costs)	**1.41**
Annual Net Benefit (Average Annual Benefits - Average Annual Costs)	**$ 35,120**

Sketch planning B/C framework provided for many TSM&O strategies. Users may enter data and estimate B/C directly or use as a framework to develop their own customized analysis.

TSM&O Strategies Covered

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TSM&O Strategy	Discussed in Desk Reference	*TOPS-BC* Analysis Capability
Physical Strategies		
Arterial Signal Coordination	●	●
Arterial Transit Signal Priority	●	●
Transit Automatic Vehicle Location	●	●
Ramp Metering	●	●
Incident Management	●	●
Pretrip Traveler Information	●	●
En-route Traveler Information	●	●
Work Zone Management	●	●
HOT Lanes	●	●
Speed Harmonization	●	
Hard Shoulder Running	●	●
Travel Demand Management	●	●

TSM&O Strategies Covered (continued)

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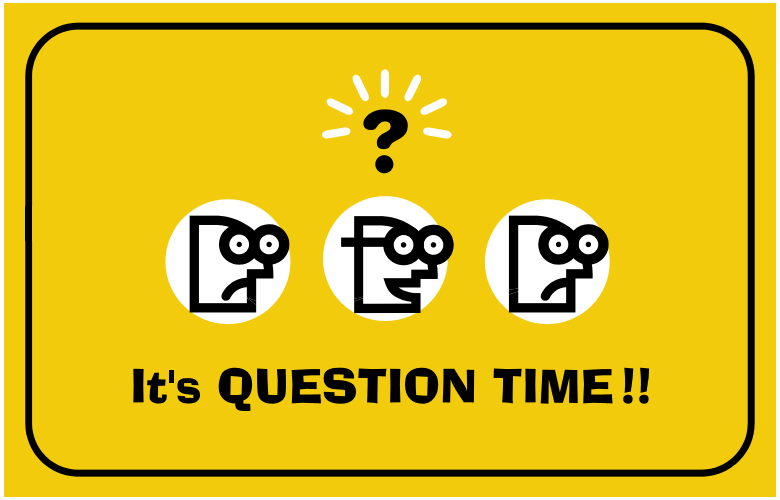
TSM&O Strategy	Discussed in Desk Reference	*TOPS-BC* Analysis Capability
Supporting Strategies		
Traffic Surveillance	●	$
Traffic Management Centers	●	$
Communications	●	$
Non-physical Strategies		
Active Transportation and Demand Management (ATDM)	●	
System Integration	●	
Interagency Coordination	●	
Regional Concepts for Transportation Operations	●	


It's QUESTION TIME!!

For More Info on B/C Analysis

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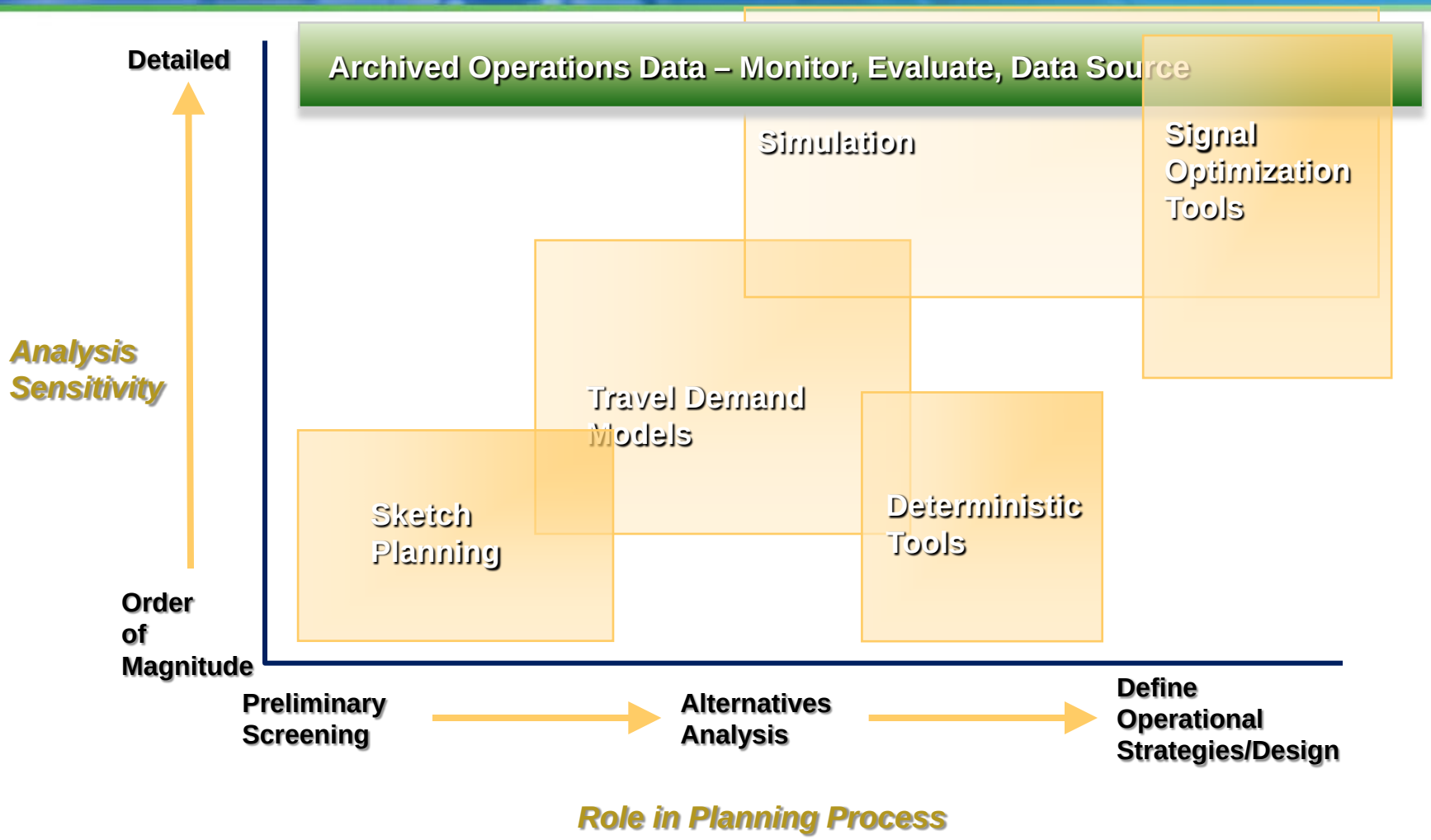
- Interim Draft of the Desk Reference Document Available
  - http://www.camsys.com/kb_pubs_oper.htm

Comparison of Tool Capabilities



Multi-Scenario Methods

Current Methods and Tools

Multi-Scenario Methods

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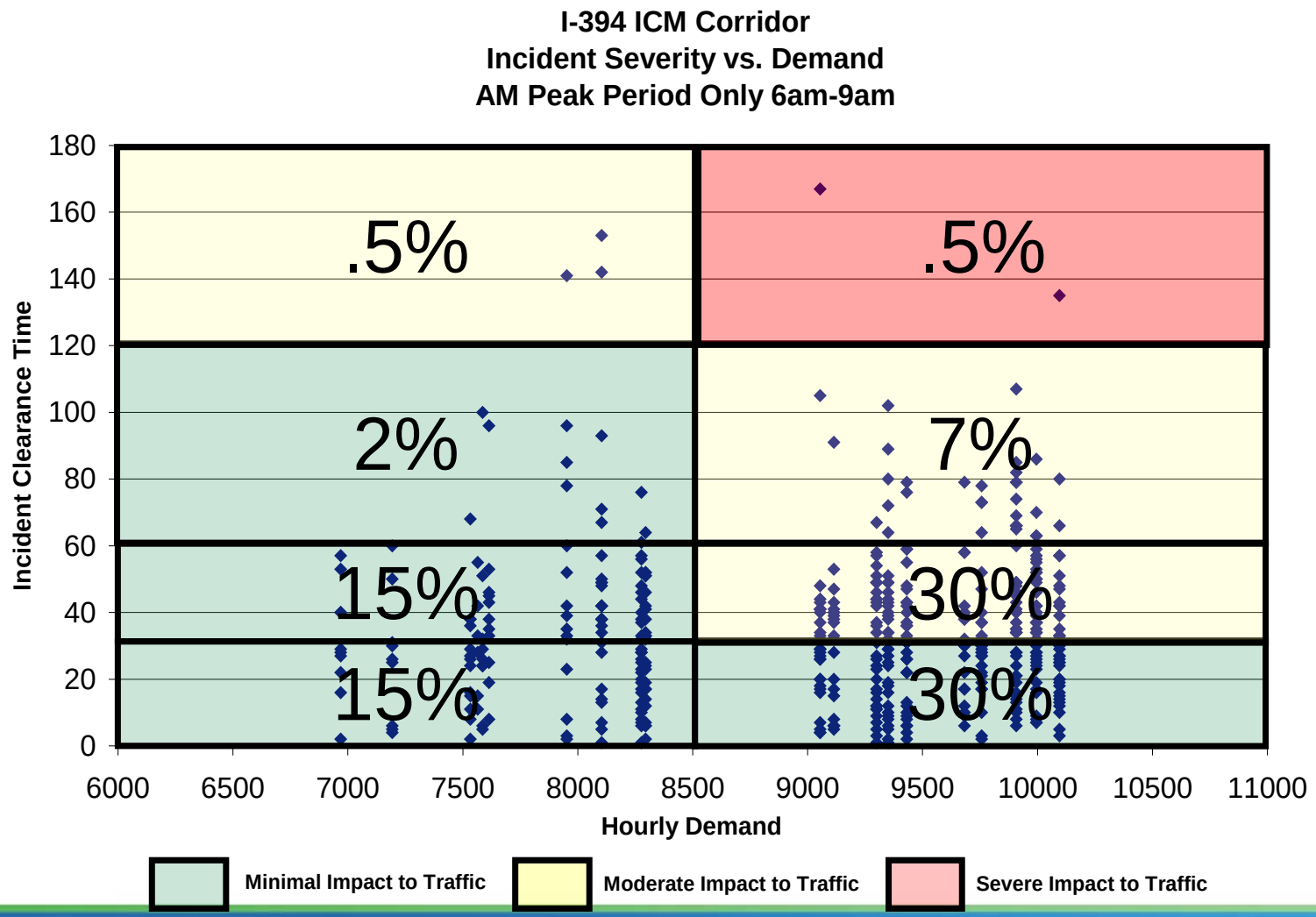
- Used to assess impacts during non-typical days
- Frequency of non-recurring conditions is identified
- Different analysis scenarios are developed to represent these non-recurring conditions
- May be applied to most of the tools and methods discussed

Current Methods and Tools

Multi-Scenario Methods



Current Methods and Tools

Multi-Scenario Methods

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- Frequency used to develop distribution of scenarios

Capacity Reduction		5% Demand	20% Demand	50% Demand	80% Demand	95% Demand	Row Totals
No Incidents, Good Weather	0%	6.04%	15.10%	18.12%	15.10%	6.04%	**60.40%**
Single Lane Closure, Good Weather	42%	2.16%	5.40%	6.48%	5.40%	2.16%	**21.60%**
Dual+ Lane Closure, Good Weather	75%	0.07%	0.19%	0.22%	0.19%	0.07%	**0.74%**
No Incidents, Bad Weather	7%	1.26%	3.15%	3.78%	3.15%	1.26%	**12.60%**
Single Lane Closure, Bad Weather	49%	0.45%	1.13%	1.35%	1.13%	0.45%	**4.50%**
Dual+ Lane Closure, Bad Weather	82%	0.02%	0.04%	0.05%	0.04%	0.02%	**0.16%**
Column Totals		**10.00%**	**25.00%**	**30.00%**	**25.00%**	**10.00%**	**100.00%**

Summary

U.S. Department of Transportation
Federal Highway Administration
Federal Transit Administration

- There is no one analytical tool that can do everything or solve every problem
- Method or tool should be consistent with planning objectives and matched with budget and resource requirements
  - Using a too-sophisticated tool results in poor use of resources
  - Using a too basic tool results in inaccurate or unreliable results