Work Zone Road User Cost Calculation Guidance

Suri Sadasivam

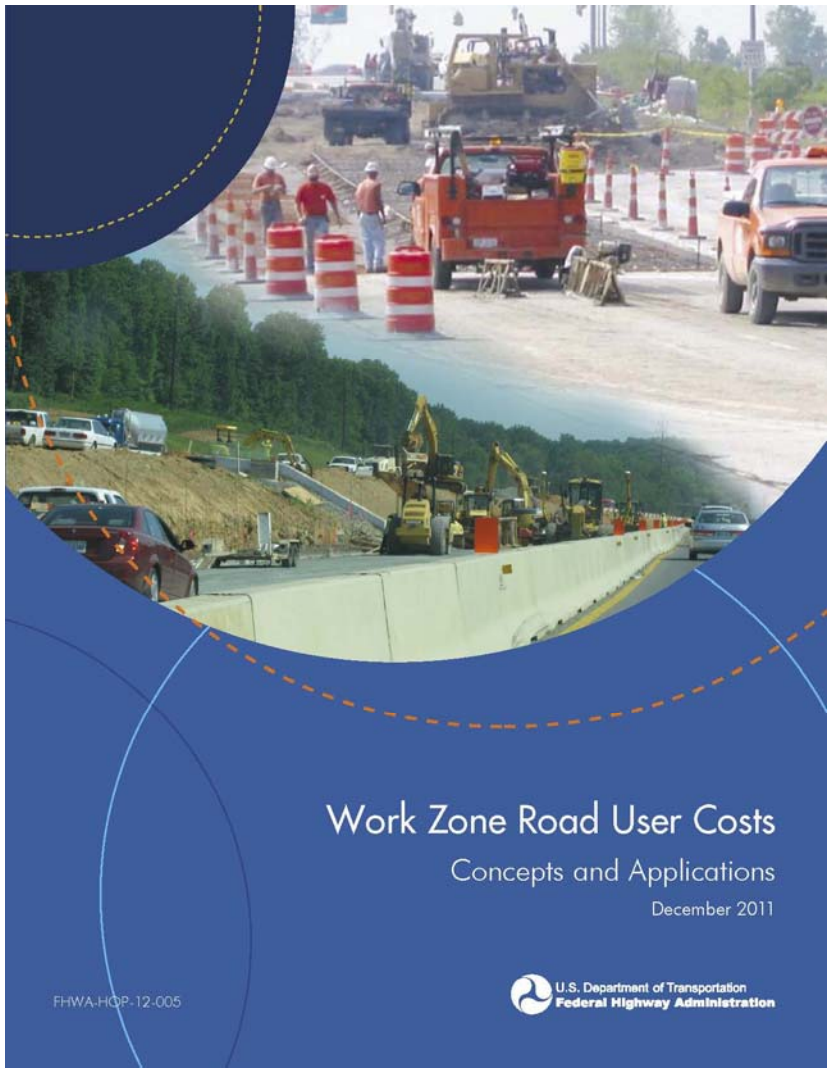
Presentation Outline

- **Work Zone Road User Costs (WZRUC) Concepts and Applications – FHWA Office of Operations Document**
- **WZ RUC: Definition, Components and Computation**
- **Applications of WZ RUC**
  - MOT Alternate Analysis
  - Contracting/ Project Delivery Methods
  - Benefit-Cost Analysis

Work Zone Road User Costs Concepts and Applications Document

- **Released in December 2011**
- **Publication #: FHWA-HOP-12-005**
- **Authors: Jag Mallela & Sadasivam**
- **COTR: Jawad Paracha**

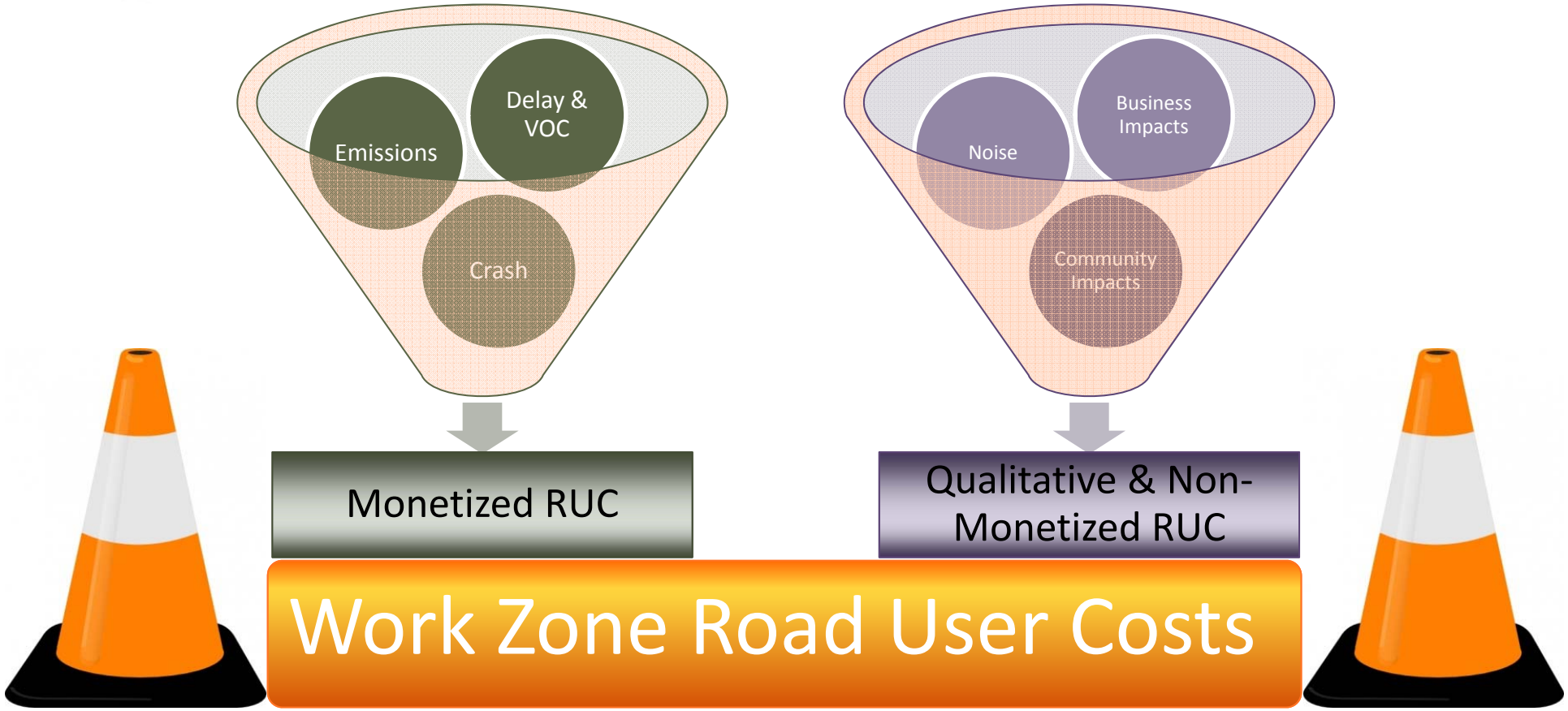
- **Key aspects:**
  - Synthesis of current RUC practices and tools
  - Establish a framework for WZ RUC analysis
  - Guidance on RUC applications:



WZ RUC DEFINITION COMPONENTS AND COMPUTATION

WZ RUC Definition

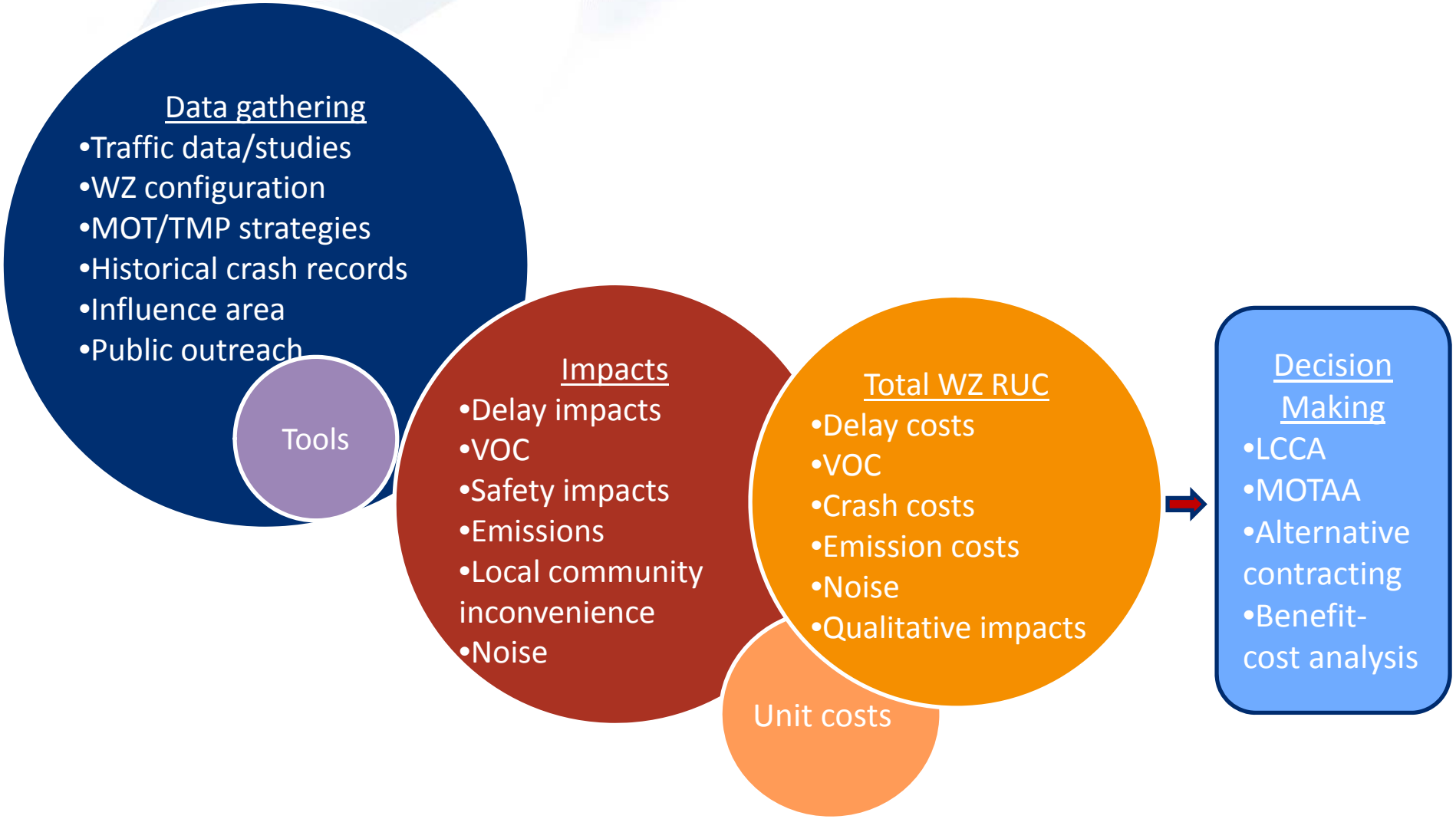
- **"WZ RUC is the additional cost borne by the motorists and local communities due to work zone activity."**



Applications of WZ RUC

- **System preservation and improvements**
  - e.g. life cycle cost analysis of pavements, bridges and pavement markings
- **MOT strategy selection**
  - e.g. selection of work zone MOT strategies
- **Operational efficiency of work zones**
  - e.g. post-construction mobility and safety performance review
- **Benefit-cost analysis of capital investments**
  - e.g. economic efficiency of construction innovations
- **Contract administration**
  - e.g. determination of incentives and disincentives

WZ RUC Computation Process



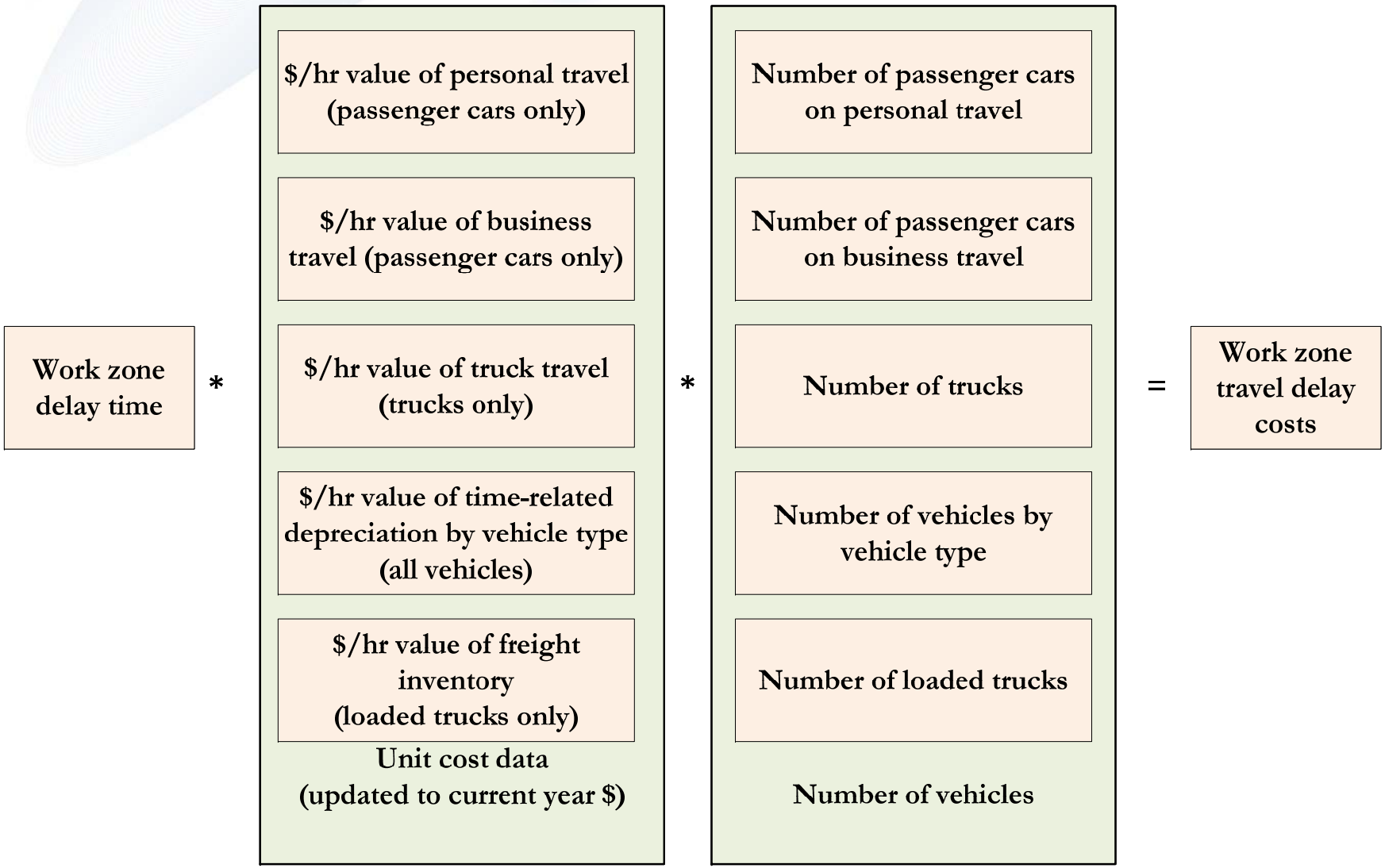
Tools for WZ RUC Computation

- **Work Zone Traffic Impact Analysis Tools**
  - Sketch-planning tools
    - State-specific tools (e.g. Michigan's CO3, Colorado's WorkZone-RUC)
    - QUEWZ-98
    - Quick Zone
    - CA4PRS
  - Simulation tools
    - Macroscopic (e.g. PASSER)
    - Mesoscopic (e.g. DYNASMART)
    - Microscopic (e.g. CORSIM)
- **Economic analysis tools**
  - Life cycle cost analysis (RealCost)
  - Benefit cost analysis (HERS-ST, MicroBENCOST, Cal B-C, BCA.Net)

3 Steps to Estimate Monetary Components

1. **Estimate work zone impacts**
   - Mobility impacts (e.g., delay, VOC) → traffic/economic analysis tools
   - Crash rates/frequency → project-specific historical records
   - Emission rates → static or dynamic emission factor models
2. **Derive unit costs for each impact (use the Bureau of Labor Statistics economic indices for unit cost adjustments)**
   - Mobility → monetary value of travel time & vehicle operating costs
   - Crash → human & comprehensive costs by crash severity
   - Emissions → air pollutant damage costs ($/ton)
3. **Monetize impacts**

Estimating Travel Delay Costs



Estimating Personal Travel Delay Costs (Autos)

1. **Determine the proportion of passenger cars on personal travel**
   - National averages may vary with local or intercity travel
2. **Establish the average vehicle occupancy (AVO) of cars**
   - National averages from National Household Travel Survey (NHTS)
3. **Estimate per person-hr value of personal travel time**
   - Uses median annual income reported by the U.S. Census Bureau (OST guidelines)
4. **Compute per vehicle-hr value of travel time (=Step 2*Step 3)**
5. **Compute travel delay costs for passenger cars (=Step 4*total delay time estimated from traffic studies/modeling)**

Estimating Vehicle Operating Costs

- **VOC components**
  - Fuel and engine oil consumption
  - Tire-wear
  - Repair and maintenance
  - Mileage-related depreciation

Estimating Vehicle Operating Costs

- **Work zone through traffic (includes forced flow condition)**
  - Speed change, stopping and idling conditions
  - VOC models
    - NCHRP Report 133 (implemented in RealCost)
    - Texas R&D Foundation – Zaniewski et al (e.g. MicroBENCOST)
    - HERS-ST – modified Zaniewski equations
- **Detour traffic (assuming no forced flow on detour routes)**
  - Per-mile costs
    - VOC models (at constant speed conditions)
    - AAA Your Driving Costs
    - American Transportation Research Institute -ATRI (for trucks)

Steps for Estimating VOC

- **Traffic flowing through work zone**
  1. Estimate speed change cycles and idling time using traffic analysis tools
  2. Update the unit cost data used in the VOC models
  3. Estimate cost impact of speed change and idling time using VOC models
  4. Estimate the total VOC
- **Detour traffic**
  1. Determine additional distance traveled due to detour
  2. Use VOC models to consider speed differential for detour conditions
     - For simpler calculations, use AAA/ATRI or equivalent estimates
  3. Estimate the detour VOC

Steps for Estimating Crash Costs

1. **Determine the pre-construction crash rate for "influence area"**
   - Sort by crash severity—3-year to 5-year averages
2. **Estimate WZ crash rate using a Crash Modification Factor (CMF)**
   - Typical WZ CMFs can be found at *CMF Clearinghouse* website
   - Use of agency-derived CMFs reflecting local trends is strongly recommended
3. **Estimate the measure of WZ exposure (typically in MVMT)**
   - Defined by the WZ influence area, vehicle miles traveled and the WZ duration
4. **Compute unit cost for crashes**
   - Human capital & comprehensive costs (by crash severity)
     - Crash cost estimates presented in the report FHWA-HRT-05-051
     - Use of agency-derived unit costs are recommended
5. **Compute aggregated WZ crash cost estimates for the project**

Steps for Estimating Emission Costs

1. **Estimate emissions rates (by emission type)**
   - Static emission factor OR Dynamic instantaneous emission models
2. **Determine Unit Costs for Emissions**
   - No consensus on emission costs
   - Available unit cost estimates: HERS-ST & Caltrans – typically based on the economic analysis of health impacts caused by emissions
3. **Determine emission costs**

   = ∑ (VMT x Emissions Rate x Cost/ton) by Emissions Type

Non-monetary & Qualitative Impacts

- **Predict construction noise levels**
  - Estimate noise levels for various construction operations, e.g., FHWA Roadway Construction Noise Model
- **Impacts of local communities and business**
  - Impact studies, surveys, public outreach and community awareness programs to identify needs and concerns

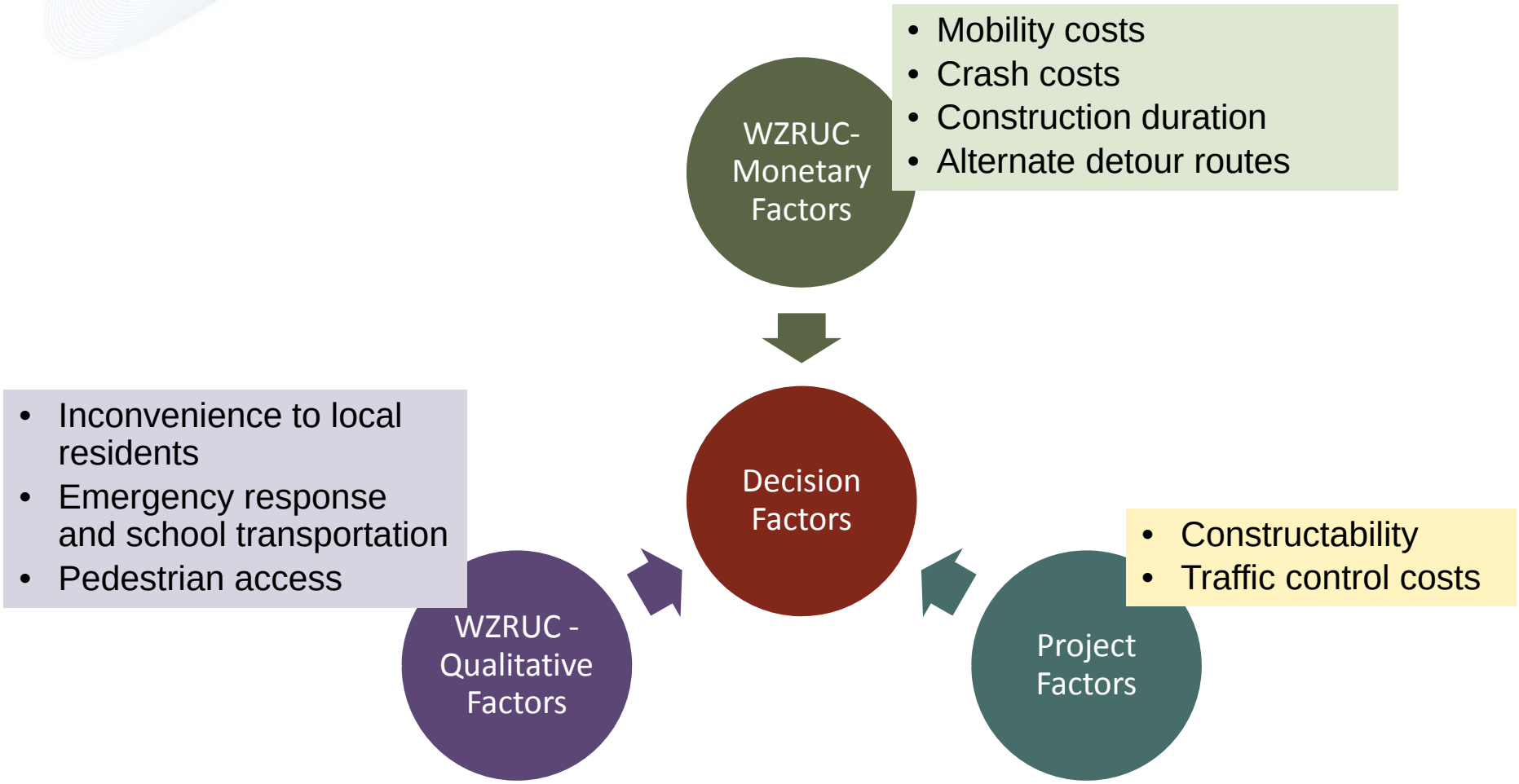
APPLICATIONS OF WZ RUC

WZ RUC in MOT Alternative Analysis

- **WHAT – Process for identifying the best MOT strategy**
- **WHEN – Recommended when the agency-set performance thresholds are exceeded**
- **HOW – Comparative evaluation of potential benefits, costs, and constraints**
  - Requires consideration of both quantitative and qualitative impacts
  - Use of decision analysis tools
  - Involves the following broad set of actions:
    - Identify **evaluation criteria** and prioritize them
    - Identify candidate alternatives
    - Evaluate MOT alternatives against set-criteria
    - Select the preferred strategy

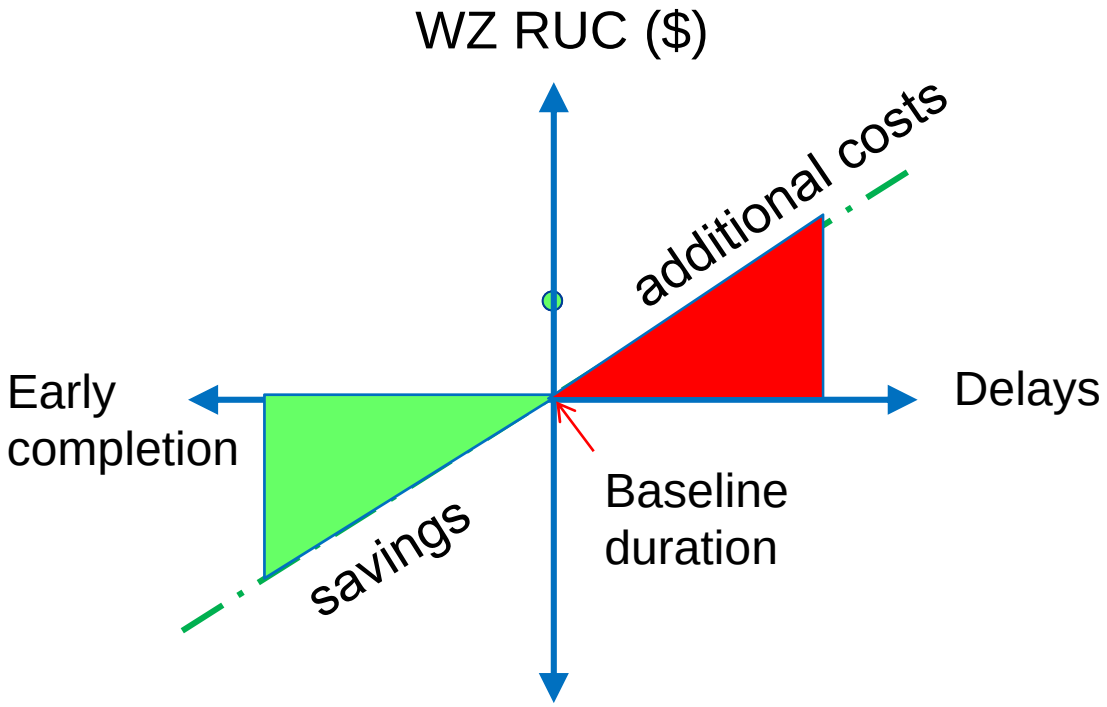
WZ RUC in Alternative Analysis

Defining Decision Criteria – Focus on WZ RUC



WZ RUC in Contracting/Project Delivery

WZ RUC vs Project Completion Time



WZ RUC in Contracting/Project Delivery

Key Application Areas

- **Justifying the need for schedule acceleration**
  - Expediting project completion costs money
  - Not required for every project
  - Identify the need based on project conditions and WZ road user impacts
- **Selecting the most appropriate project delivery strategy**
  - Design-Bid-Build, Design-Build, CMGC
- **Establishing time-related contract provisions (e.g. I/D)**
  - Incentive/Disincentives
    - Daily I/D = Discount Factor * Daily WZ RUC
  - A+B bidding
    - Bid value = (A) + (B x Daily WZ RUC)
  - Lane Rental
    - Rental fee = difference in WZ RUC between actual and allowable closure periods

WZ RUC in Contracting/Project Delivery

Why Accelerated Road Work ?

Typical Questions to establish the need for acceleration ?

- Heavy traffic volume ?
- Located in urban area ?
- Commuter route ?
- Network level impacts ?
- Early completion required ?
- Time-sensitive project ?
- Lacks viable detour alternatives ?
- Located in tourist or economically sensitive area ?
- Political interests ?
- Affects local community and business ?
- Safety issues for construction workers ?
- Safety issues for motorists ?

Application of WZ RUC in Benefit-Cost Analysis

- **To evaluate the economic efficiency of a decision**
  - Compare costs & benefits
    - e.g. economic value of construction innovation
  - How an alternative compare with others
    - e.g. accelerated construction vs cast in-place techniques
  - Agency costs & WZ RUC

Illustrative Examples:
Economic Analysis of Council Bluffs and Keg Creek ABC Projects

Questions