Climate Change/Extreme Weather Infrastructure Vulnerability Assessment:

Federal Highway Administration (FHWA) Pilot Study for the Dallas-Fort Worth Region

October 23, 2014

Association of Metropolitan Planning Organizations
2014 Annual Conference – Atlanta, GA

Dallas-Fort Worth Regional Characteristics

"The Big Picture"

- Population and employment in the Dallas-Fort Worth (DFW) region expected to grow nearly 50% between now and 2035
- Vehicle miles of travel and annual cost of congestion projected to increase at greater rates
- Mobility 2035 – 2013 Update identifies just 1/4th of funding necessary to eliminate the worst congestion by 2035
- Existing infrastructure burdens:
  - Increasing age and wear
  - Damage from accidents
  - Changes in environmental conditions
  - Impacts to reliability/level of service
  - Redevelopment and access needs

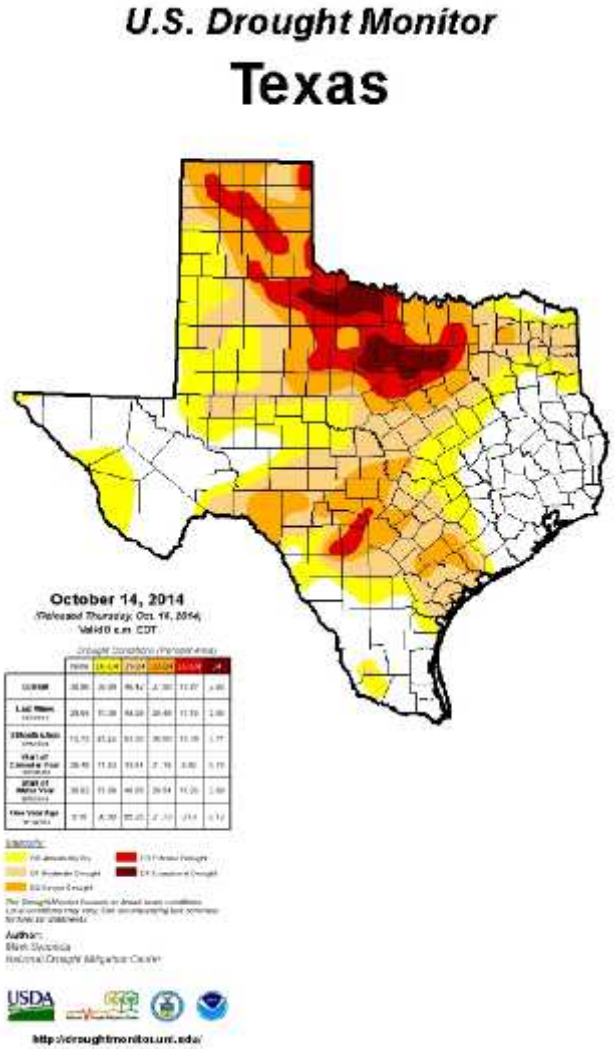
Capital/Operations Asset Management System

Data-Driven Project Solutions and Prioritization

Climate Change/Extreme Weather Effects *(cont.)*

Recent Conditions and Issues

- Eight of the DFW top-ten warmest years have occurred after 1998
  - #1 – 2006; #2 – 2012; #3 – 2008/2011
  - Summer 2011:
    - 71 days = High temperatures > 100 degrees
    - 55 days = Low temperatures > 80 degrees
- Through September 30th, DFW recorded the 9th least year-to-date rainfall total for 2014 (15.97 inches)
- Since 2010, period-to-date rainfall deficits exceed 40 inches at many sites
- Reservoir storage < 65% capacity with record-low levels at multiple lakes



Climate Change/Extreme Weather Effects

Challenges to Mobility and Functionality


Frisco


Palo Pinto County

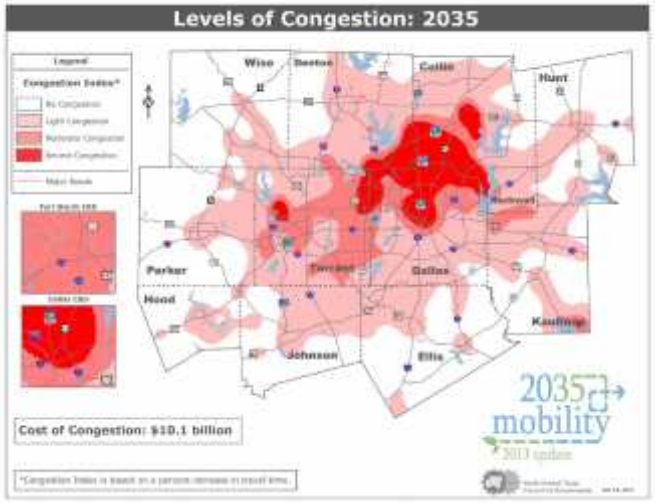

Fort Worth


Euless

NCTCOG Vulnerability Assessment Pilot Study

Project Overview

- Conduct multi-modal risk assessment of critical transportation facilities in the North Central Texas region
- Determine potential mobility, economic, and quality of life effects resulting from impacted facilities
- Identify methods to incorporate vulnerability parameters into the traditional planning process
- Relate conclusions to performance data affecting project prioritization



NCTCOG Vulnerability Assessment Pilot Study *(cont.)*

Project Partners and Roles

- City of Dallas (Streets, Emergency Management, & Police Departments)
  - Provide jurisdictional performance data and reference historical weather-related reports at vulnerable roadway locations
- Fort Worth Transportation Authority
  - Provide maintenance data/reports for the Trinity Railway Express
- University of Texas at Arlington (Colleges of Engineering, Science, & Urban and Public Affairs)
  - Retrieve and analyze regional climate and hydrologic data
  - Examine regional heat island effects and integration possibilities
- Texas Department of Transportation
  - Provide asset sufficiency reports/research and maintenance data
  - Identify/define potential exposure magnitudes and ranges of facility effects

NCTCOG Vulnerability Assessment Pilot Study *(cont.)*

Vulnerability Assessment Scoping

1. DEFINE SCOPE

Identify Key Climate Variables

- Climate impacts of concern
- Sensitive assets & thresholds for impacts

Articulate Objectives

- Actions motivated by assessment
- Target Audience
- Products needed
- Level of detail required

Select & Characterize Relevant Assets

- Asset type
- Existing v. Planned
- Data availability
- Determine added delineations

NCTCOG Vulnerability Assessment Pilot Study *(cont.)*

Define Vulnerability Assessment Parameters

- Parameters determined through initial Partner Coordination meetings (Summer 2013)
- Geographic Area:
  - Dallas and Tarrant Counties
- Transportation Assets:
  - Limited-access roadway facilities
  - Select major thoroughfares
  - Rail lines (transit and freight)
- Climate Stressors:
  - Periods of extreme heat
  - Heavy rain/flooding events
  - Drought conditions

Dallas


Carrollton

NCTCOG Vulnerability Assessment Pilot Study *(cont.)*

Challenges – Detailed Data and Institutional Knowledge

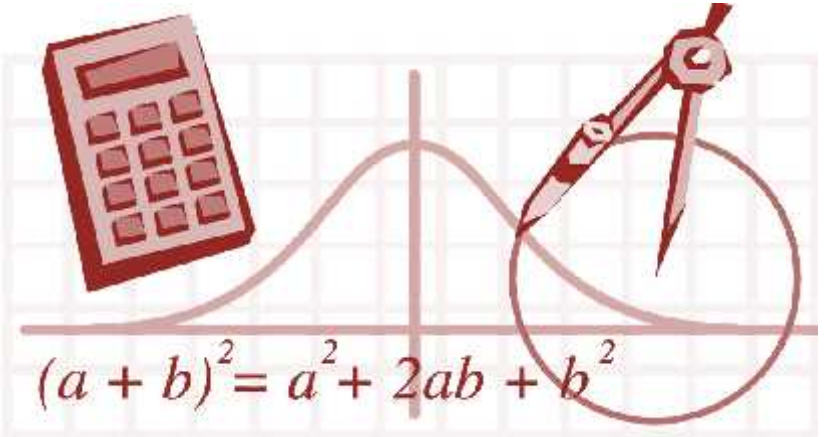
- "Last Mile" Data is Expensive
  - Set up analysis to collect only the most essential data
  - Cost-benefit analysis of data collection process itself

- Implicit vs. Explicit Knowledge
  - Qualitative assessments by practitioners is common
  - Set up framework to evolve from qualitative assessments to quantitative analysis

NCTCOG Vulnerability Assessment Pilot Study *(cont.)*

Challenges – Limited and/or Scattered Data

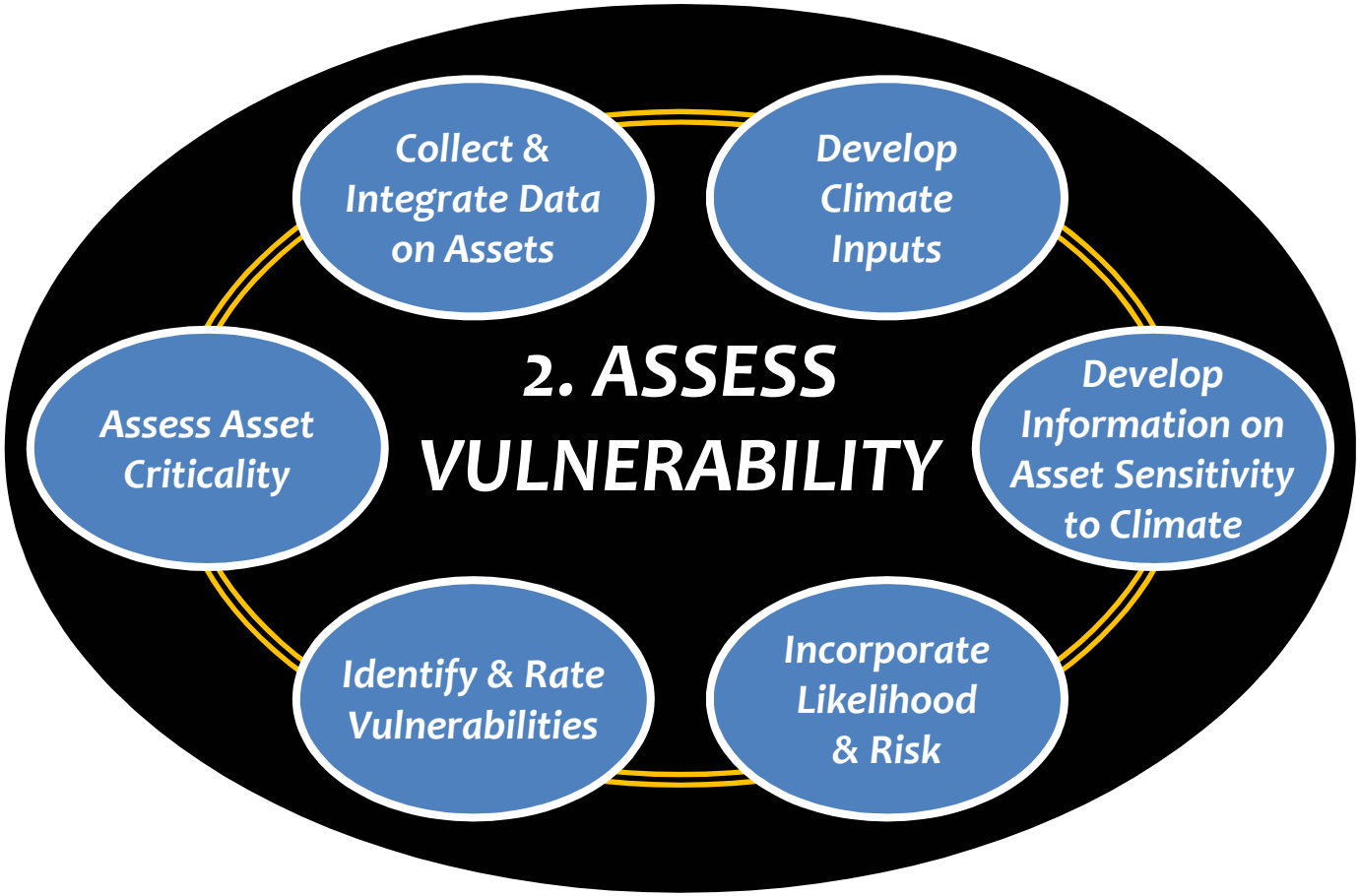
- Data Reliability (Accuracy/Precision/Integrity)
  - Transparency
  - Openness
  - Humility



- Distributed Data Ownership
  - Communication
  - Cooperation

NCTCOG Vulnerability Assessment Pilot Study *(cont.)*

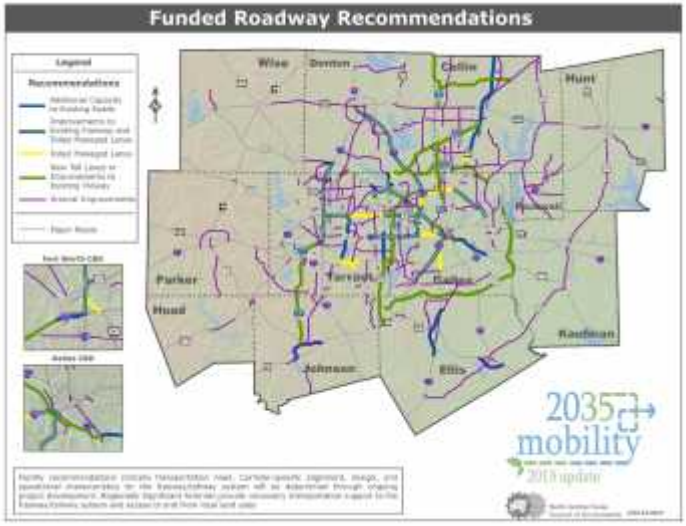
Vulnerability Assessment Elements



NCTCOG Vulnerability Assessment Pilot Study *(cont.)*

Criticality of Transportation Assets

- Develop comprehensive index of regional criticality based on:
  - Functional Classification
  - Project Prioritization
  - Congestion Management Process
    - System demand/reliability
    - Availability of alternative roadway and/or modal options
  - Safety/Security Criteria
    - Hazmat/Evacuation Routing
    - Urban Area Security Initiative
  - Other Performance Measures
    - Factors from other FHWA Pilot Studies
    - Local recurring repair/incident reports



NCTCOG Vulnerability Assessment Pilot Study *(cont.)*

Determine Asset Sensitivity to Climate Change

- Thresholds establish the relationship between asset categories, stressors, and performance effects/impacts
- Threshold variances:
  - Exceedance severity and/or duration
  - Materials and design
  - Geographical issues
- Particular attention focused on soil moisture content
  - Regional differences in types and effects
  - Provides bridge between drought and flash flooding

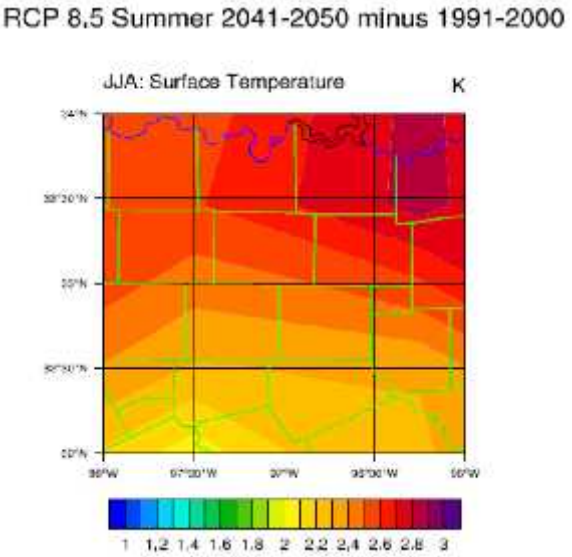

Denton

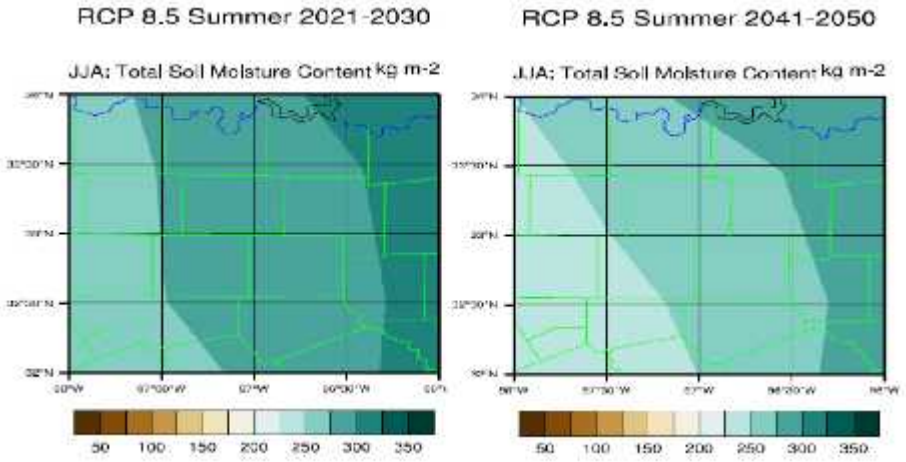

Fort Worth

NCTCOG Vulnerability Assessment Pilot Study *(cont.)*

Regional Climate/Soil Moisture Projections

- "Business-as-Usual" scenario indicates a substantial rise in average temperature by mid-century
- Combined with projected reduction in soil moisture content, potential infrastructure distress will become more common:
  - Longitudinal cracking
  - Transverse and block cracking
  - Edge failures
  - Deformation and shifting
  - Reduced load-bearing limits



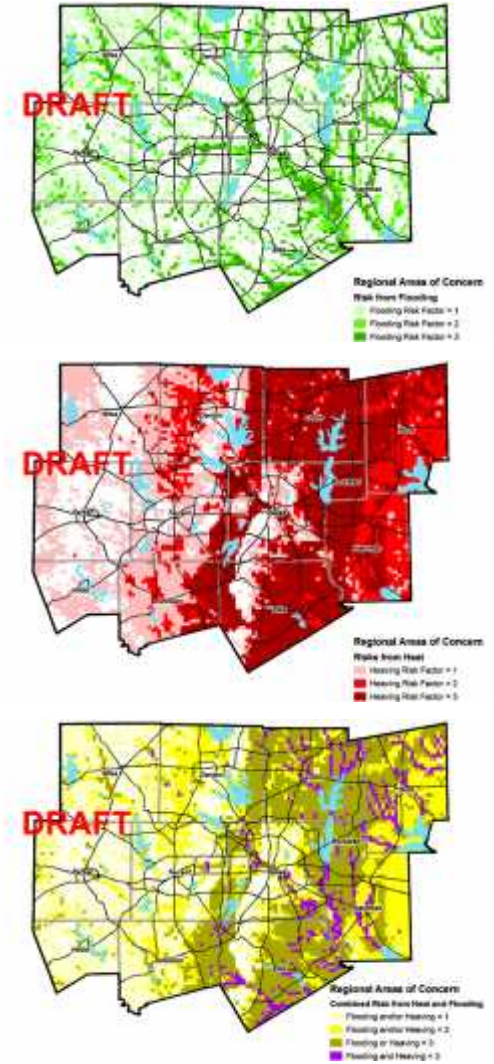


Winguth and Kelp, 2014

NCTCOG Vulnerability Assessment Pilot Study *(cont.)*

Screening for Flooding and High-Plasticity Soil Vulnerability

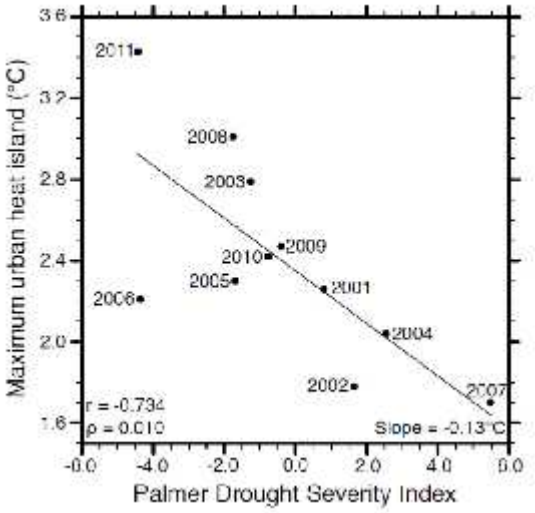
- Based on USDA soil data and FEMA floodplain mapping
- Ranking based on regional averages:
  - Flooding – Length/Area of streams, lakes, floodplains, & hydric soils
  - Heat/Drought – Range of linear expansivity
  - Composite Vulnerability
- Identifies locations where increased maintenance/mitigation may be required:
  - Subgrade/Base stabilization
  - Permeability controls
  - Reinforcement and/or raising of structures

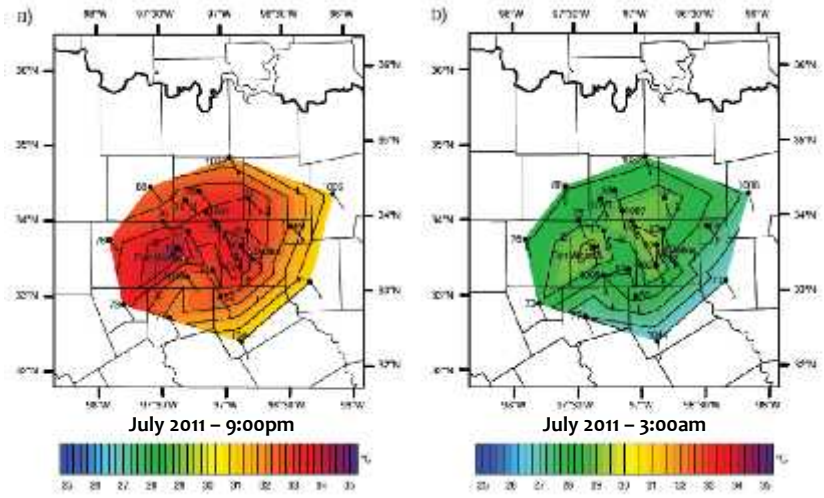


NCTCOG Vulnerability Assessment Pilot Study *(cont.)*

Intensity of Urban Heat Island Effects

- Recent studies indicate correlation between urban heat island intensity and drought severity
- Local zones/areas of influence based on wind patterns and sprawl features
- Summer 2011:
  - Maximum temperature variations exceeded ten degrees at times
  - Strong differences in effects to precipitation events and drainage characteristics



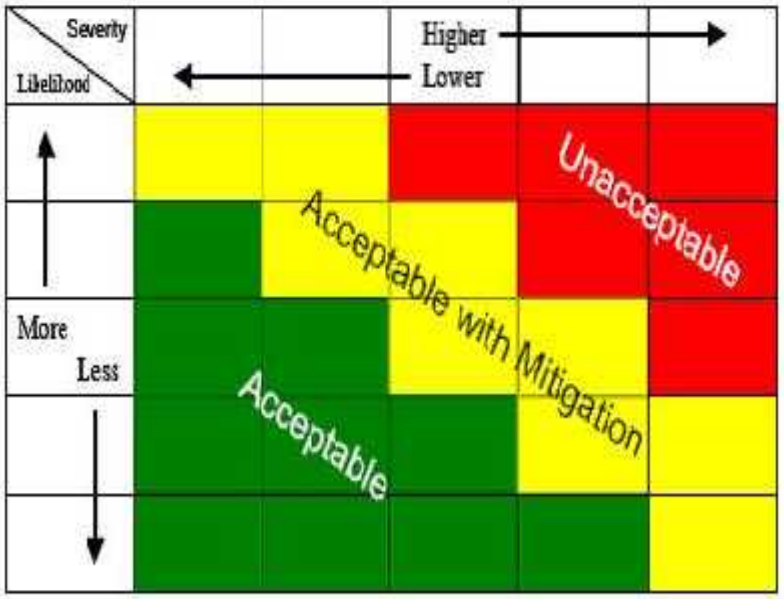


Winguth and Clark, 2013

NCTCOG Vulnerability Assessment Pilot Study *(cont.)*

Identify Risk and Potential Impacts

- Risk Assessment Matrix
  - Identifies most vulnerable assets
  - Risk severity informs potential consequences
  - Tool for project prioritization
- Asset-Specific Risk Analysis
  - Outlines climate stressors
  - Nature of potential impacts
- Maximizing Asset Life-Cycle
  - Potential concepts for focused future studies and resilience incorporation
  - Mitigation vs. Replacement



NCTCOG Vulnerability Assessment Pilot Study *(cont.)*

Vulnerability Assessment Outcomes

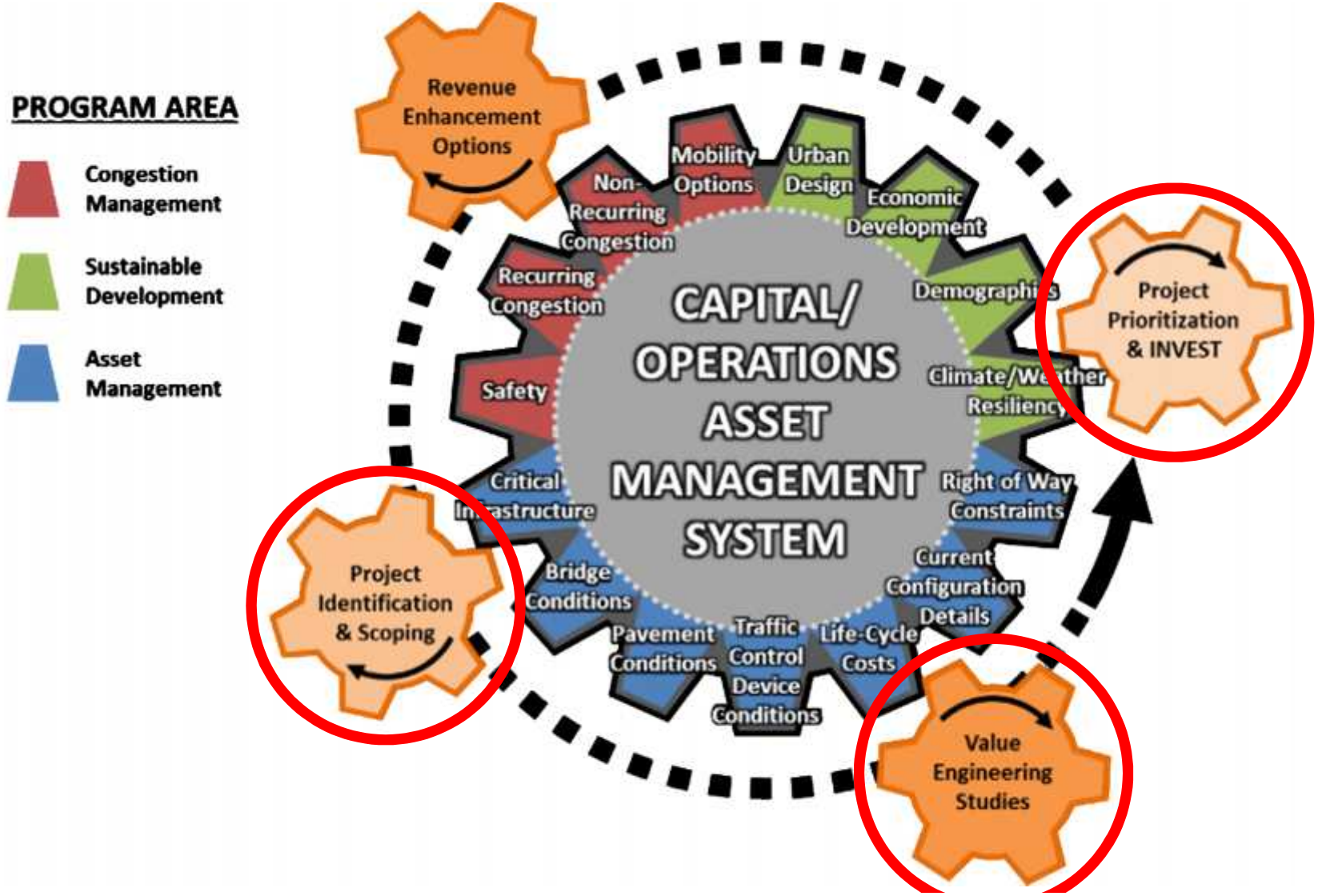
3. INTEGRATE INTO DECISION MAKING

- Incorporate Into Asset Management
- Integrate Into Emergency & Risk Management Planning
- Contribute To Long Range Transportation Plan
- Assist In Project Prioritization
- Identify Opportunities To Improve Data Collection, Transportation Operations, & Infrastructure Designs
- Build Public Support For Adaptation Investment
- Educate/Engage Staff & Decision-Makers

- List of vulnerable assets
- Repeatable methodology
- Multiple risk-based investment scenarios
- Partnerships
  - UTA Center of Excellence
  - Regional Asset Management Working Group

Capital/Operations Asset Management System

Engaging Prioritization, Mitigation, and Adaptation Efforts



Climate Change/Extreme Weather Implications

Anticipated Future Needs/Actions

- Conduct a similar assessment for the remainder of the 12-county Metropolitan Planning Area
- Incorporate research, results, and lessons learned into the upcoming Mobility 2040 Plan development process
- Develop partnerships with providers to update design manuals with improved focus on infrastructure resiliency
- Provide linkages for preparation of future State Preparedness Reports (NCTCOG Emergency Preparedness)
- Perform post-evaluation of resiliency strategies through INVEST
- Identify and/or improve best practices/measures in the monitoring and evaluation of vulnerability factors
- Investigate climate change and weather-related impacts among various transportation system investment strategies

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