Data Driven Safety Analysis

DDSA

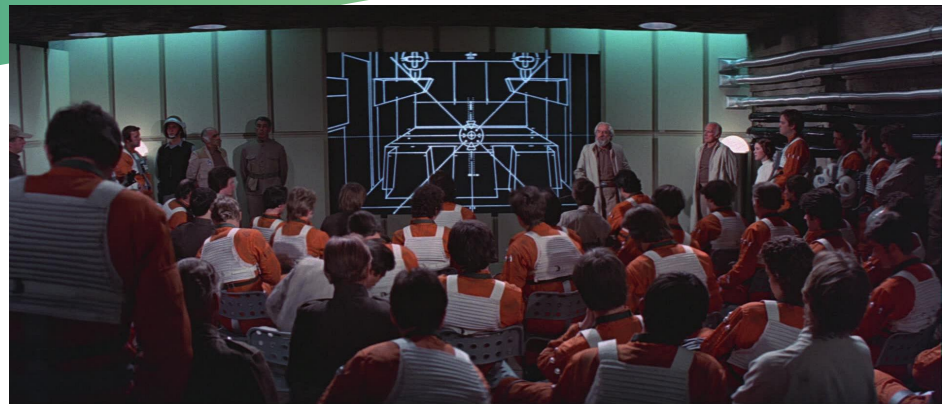
improving safety on our roadways

in Planning

Stephen De Witte, P.E.

2019 partnering CONFERENCE acec-ky·fhwa·kytc

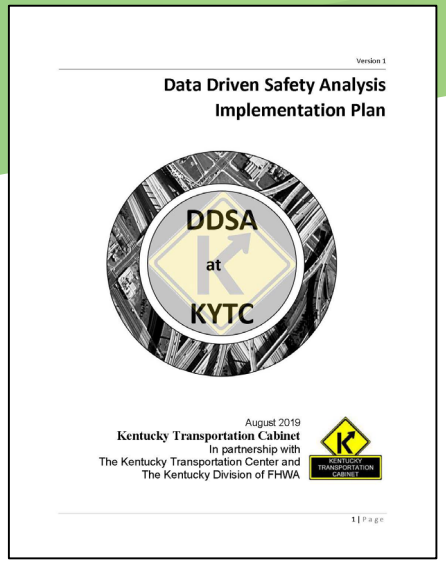
KYTC Mission



Mission

To provide a safe, efficient, environmentally sound and fiscally responsible transportation system that delivers economic opportunity and enhances the quality of life in Kentucky.

DDSA Implementation Plan



- Version 1 Released Late Aug.
- Living Document
- Roadmap for how Data Driven Safety is happening in Kentucky
- Data, Project Development, PD&P, Tools, Training, Marketing

Maintenance and Operations

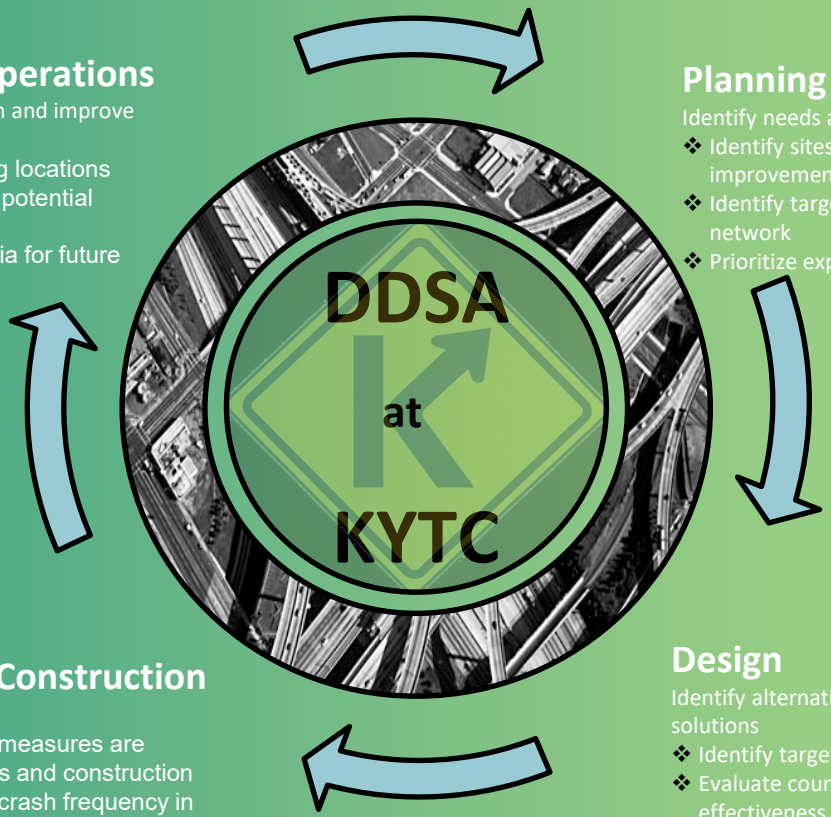
Modify existing conditions to maintain and improve safety and efficient operations

- ❖ Identify crash patterns at existing locations
- ❖ Evaluate safety effectiveness of potential countermeasures
- ❖ Modify policies and design criteria for future planning and design

Planning

Identify needs and program projects

- ❖ Identify sites most likely to benefit from safety improvements
- ❖ Identify targeted crash patterns for the network
- ❖ Prioritize expenditures for efficiency



Construction

Build projects

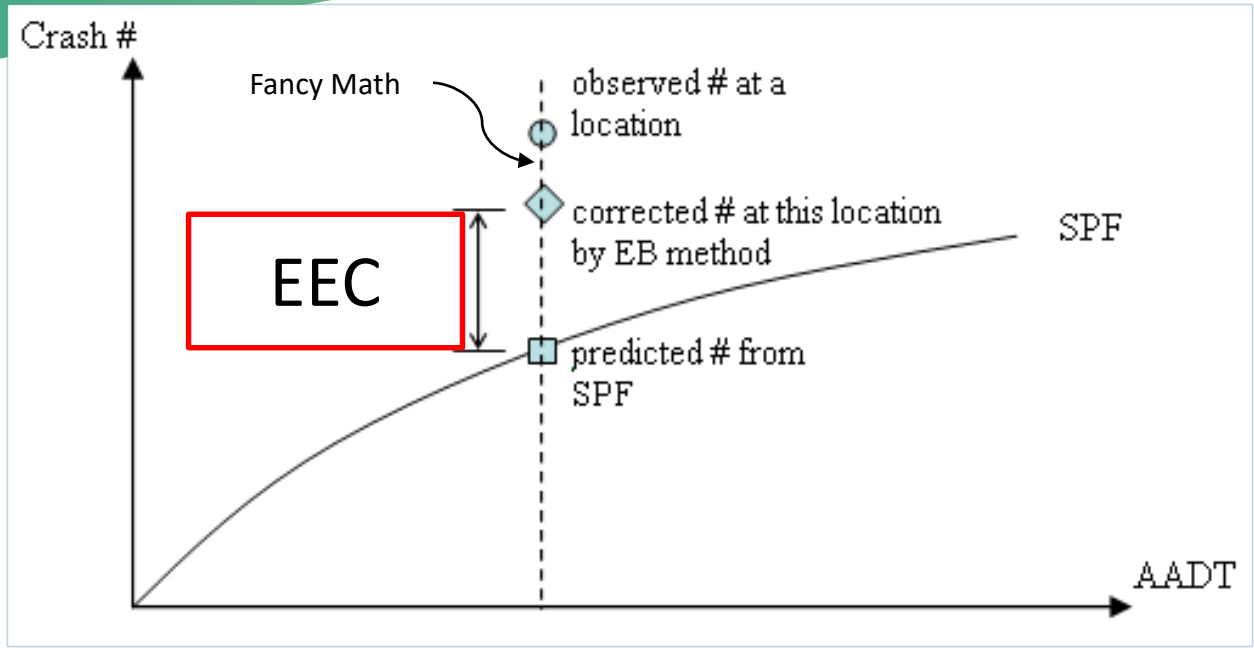
- ❖ Evaluate how performance measures are impacted by design changes and construction
- ❖ Assess potential change in crash frequency in work zone

Design

Identify alternatives, choose and design preferred solutions

- ❖ Identify targeted crash patterns for projects
- ❖ Evaluate countermeasures' costs and effectiveness
- ❖ Compare change in crash frequency to predict safety effect of alternatives

Excess Expected Crashes



Planning Focuses

- Network Screening
- Project Prioritization (SHIFT)
- Draft Purpose & Need / Project Types
- Planning Studies
  - Examples
- Implementation Timeline

Network Screening

- GIS-based tool developed in tandem with SHIFT 2020
- Shows EEC and VHD (congestion) values
- Working on online GIS-based tool

Safety and Congestion Network Screening - ArcMap

File Edit View Bookmarks Insert Selection Geoprocessing Customize Windows Help

1:1,554,048

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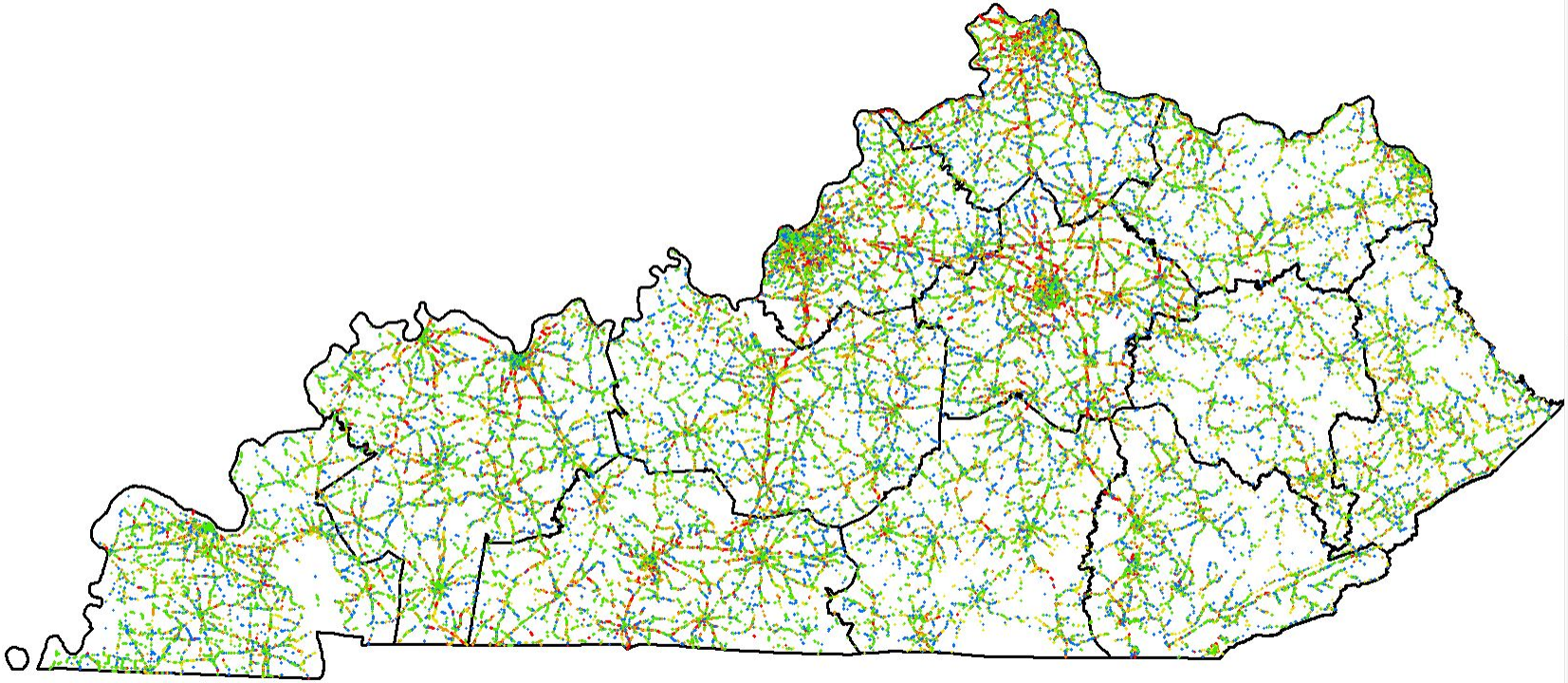
- Safety and Congestion Netv
  - EEC > 0
    - Rural two-lanes
    - Rural Interstate/Parkw
    - Rural multilane divide
    - Rural multilane undiv
    - Urban two-lanes
    - Urban Interstate/Parki
    - Urban multilane divid
    - Urban multilane undiv
    - Intersection_EEC
  - EEC < 0
  - KYTC Districts
  - MPO Planning Boundarie
  - ADD Boundaries
  - Congestion VHD
  - Congestion VHD < = .1
  - CHAF



Catalog Search

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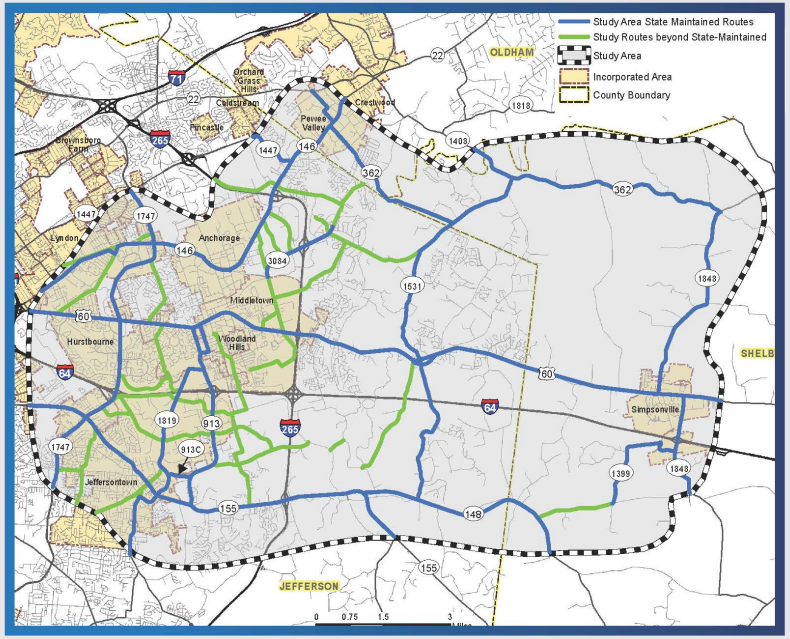
MIDDLETOWN to SIMPSONVILLE

NEEDS ANALYSIS STUDY



FINAL REPORT

JULY 2019

In Partnership With

KENTUCKY TRANSPORTATION CABINET

QK4 Engineering Planning

Groundbreaking by Design.

Middletown-Simpsonville Needs Analysis Study

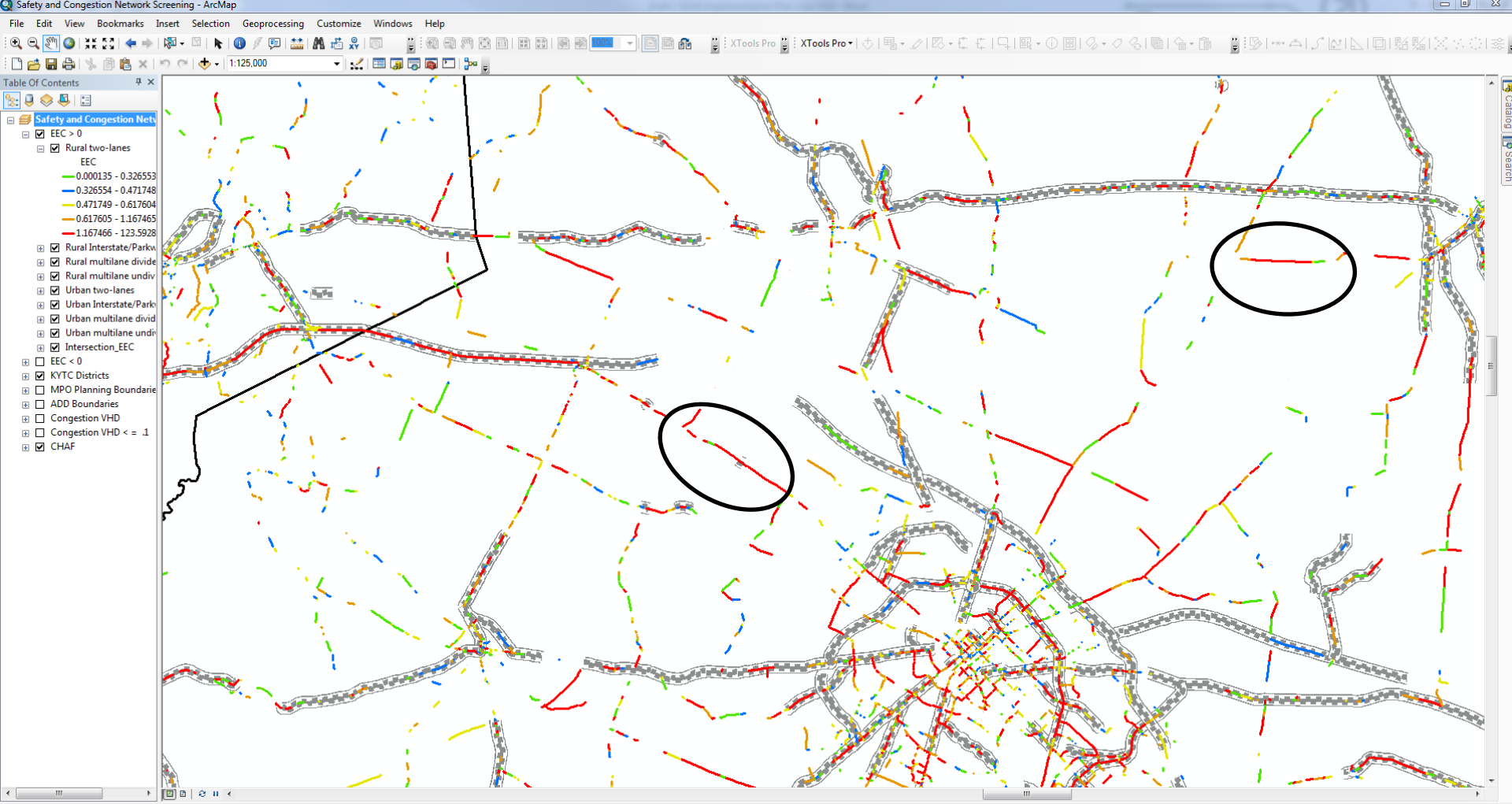
Table ES-1: Stage 1 Matrix — Middletown to Simpsonville Needs Analysis Study

Project ID	Other IDs	County	Route	BMP	EMP	Description of Improvement	Conceptual Project for Modeling & Cost Estimate	Other Notes	Existing Conditions: 2018 ADT	2018 % Trucks	2018 LOS	2018 V/C	Delay	2040 No Build ADT	2040 No Build LOS	2040 No Build V/C	7/15-6/18 Crashes (F/I/PDO)	High CCRF Sites	EEC Seg Int	Substandard Geometry	Improvement Info: 2040 Build Summary	Project Development Status	Total Remaining Cost Estimate	Bike/Ped
Statewide Significance (Interstates & NHS Routes)																								
CHAF IP20160174	Item 5-537.00/01/02 MTP # 958	Jefferson	I-265	23.409	34.727	SIX LANE PRIORITY SECTION OF I-265 BETWEEN TAYLORSVILLE ROAD AND I-71.	Major Widening (six lanes)	Priority 1-2-4 in 2015 Programming Study. Ranked 1st statewide in 2018 SHIFT.	48,500-86,500	10-11			L-H MH 2.6 mi H 0.2 mi	56,000-95,000					2.6 mi 0 int	N/A	64,000-115,000 ADT -7,027 VHT | +11,242 VMT	Design ongoing	$147,310,000	N/A
CHAF IP20150080	Item 5-558.00 MTP # 959	Jefferson	I-265	17.300	23.100	IMPROVE SAFETY AND REDUCE CONGESTION ON I-265 FROM US-31E (BARDSTOWN RD) TO KY-155 (TAYLORSVILLE RD).	Major Widening (six lanes)	Priority 5 of 5 in 2015 Programming Study. Ranked 29th statewide in 2018 SHIFT.	66,000-71,000	9-12			ML-M	77,000-83,000					2.6 mi 0 int	N/A	87,000-93,000 ADT -2,716 VHT | +6,774 VMT	Pre-design	$85,730,000	N/A
CHAF IP20150184	Item 5-549.00/.01 MTP # 179	Jefferson	I-265	24.600	26.400	RECONSTRUCTION OF THE I-265/I-64 INTERCHANGE. (2016BOP)	Reconstruct I-265/I-64 Interchange	Priority in 2015 Programming Study. Ranked 33rd statewide (#5-549) and 22nd regionally (#5-21.2) in 2018 SHIFT.	48,500	10.6			L-H MH 0.7 mi H 0.3 mi	56,000-111,000					3.4 mi 0 int	N/A	57,000-111,000 -347 VHT | -3,001 VMT	Design ongoing	$41,330,000	N/A
			I-64	18.600	19.200				60,000-95,000	9.5														
						Improve safety and reduce																		

- Study initiated in September 2019 with Qk4
- Prioritize existing projects and aid in decision-making process
- Used network screening tool as part of existing conditions and gap analysis

Network Screening - Future

- Identify gaps not covered by ongoing projects before SHIFT 2022
- Work with HDOs, ADDs, and MPOs to develop improvement options


Safety and Congestion Network Screening - ArcMap
File
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Bookmarks
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Geoprocessing
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Windows
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Safety and Congestion Net
EEC > 0
Rural two-lanes
EEC
0.000135 - 0.326553
0.326554 - 0.471748
0.471749 - 0.617604
0.617605 - 1.167465
1.167466 - 123.5928
Rural Interstate/Parkw
Rural multilane divide
Rural multilane undiv
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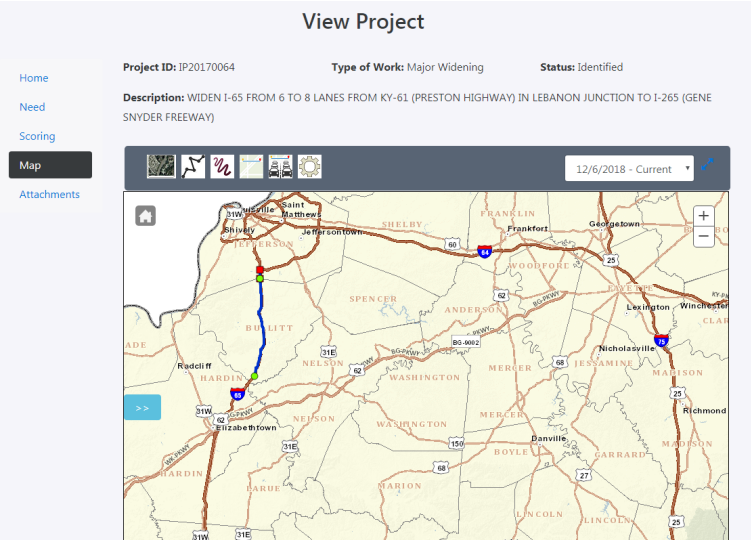
MPO Planning Boundarie
ADD Boundaries
Congestion VHD
Congestion VHD < = .1
CHAF
5172236.304 3976834.724 Feet

Continuous Highway Analysis Framework (CHAF)



- Successor to PIF
- Much more interactive, dynamic tool
- Interfaces with HIS, SHIFT, other databases
- Will pull CDAT outputs automatically, and update when SPFs are updated

Prioritization

- Incorporate DDSA into SHIFT Process
- Use EEC instead of CRF for Safety Measure
- Benefit/Cost using Safety Benefit Factors

SHIFT
KENTUCKY AHEAD

SHIFT Crash History Formulas

Statewide: 15% Regional: 15%

$$\sum (EECs)_{\dagger scaled}$$

Measure	Description	Summary Method All crash data summarized over 5 yrs. 2013-2017	Source
EEC	Excess Expected Crashes	Expected Crashes – Predicted Crashes	Crash Database HIS

†Scaled - The percentile rank of the value. Converts value to score of 0 to 100.

$0.5 \times (\frac{BTTS}{C_{PROJ}})_{\dagger Scaled} + 0.5 \times$

Benefit / Cost Formulas

Statewide: 20% Regional: 15%

Statewide Score = 20% X (Benefit / Cost) Measure (BCM) :

Regional Score = 15% X (Benefit / Cost) Measure (BCM) :

$$0.5 \times (\frac{BTTS}{C_{PROJ}})_{\dagger Scaled} + 0.5 \times (\frac{BSAF}{C_{PROJ}})_{\dagger Scaled}$$

Measure	Summary Method	Source
BTTS: Travel Time Savings Benefit $	(††Travel Time Savings) X (sum of delay costs by vehicle type)	KY Statewide Model HCM Method Jackelope HIS
BSAF: Safety Benefit $	(Safety Benefit Factor of improvement type) X (crash costs over last 5 yrs, 2013-2017)	Crash Database CHAF
CPROJ: Family Project Cost Phases R,U & C	Summary	SYP CHAF

†Scaled - The percentile rank of the value. Converts value to score of 0 to 100.

†† Travel Time Savings for major improvements were calculated using the Kentucky Statewide Model. Travel Time Savings for smaller improvements are calculated via HCM iterative formulas.

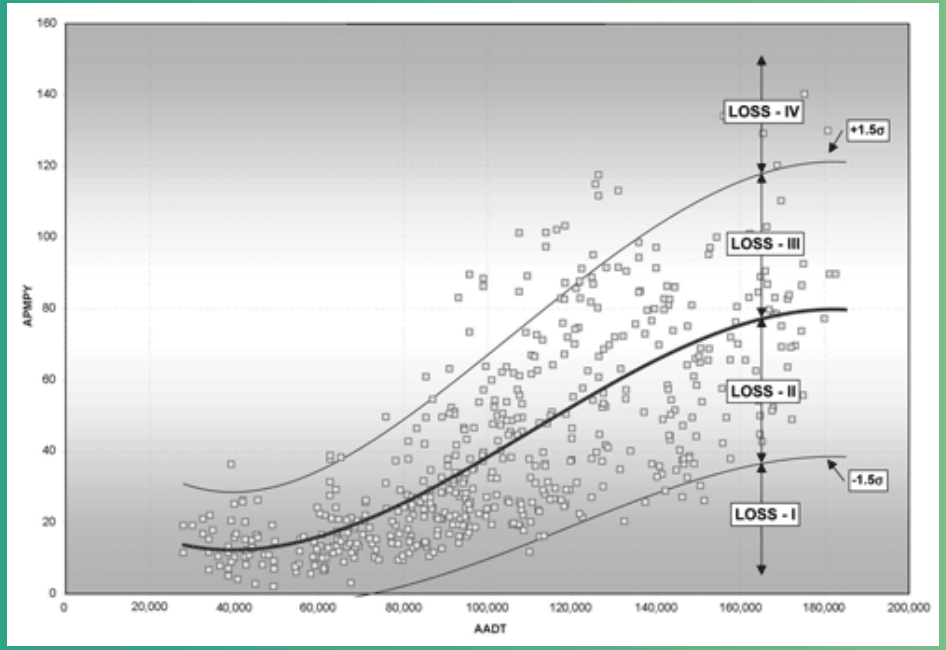
Safety Benefit Factors

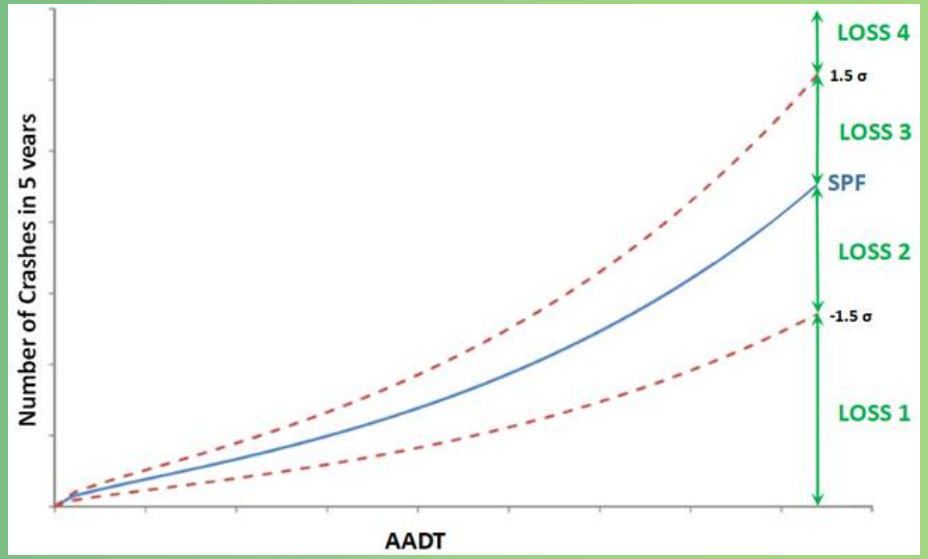
- Derived from Kentucky-specific Crash Modification Factors (CMFs)
- Tied to improvement type in CHAF
- No data for constructing new roadways

$$CMF_{PL} = \frac{(1 - SBF)}{100}$$

Install Two-Way Left Turn Lane	Add TWLTL to Two-Lane Road	0.72
Install Two-Way Left Turn Lane	Road Diet (4-Lanes to 2-lanes plus TWLTL)	0.63

Level of Service of Safety (LOSS)



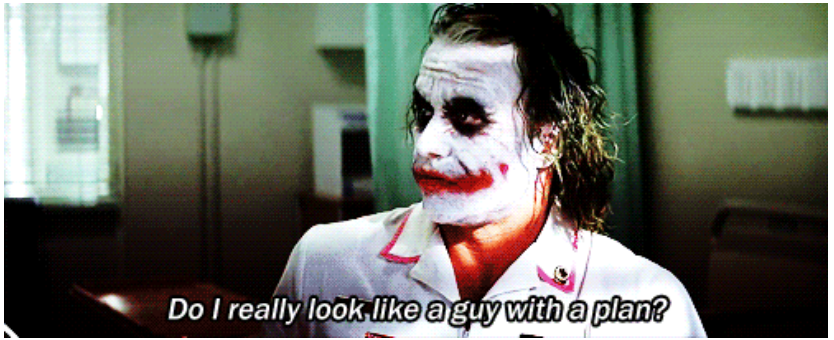


Draft Purpose & Need

- Let the data drive the process
- “Safety” included immediately at LOSS 3 and 4
- Reduction of specific crash type/situation called out if prevalent
- Draft until environmental document – more data can always change things!

Planning Studies

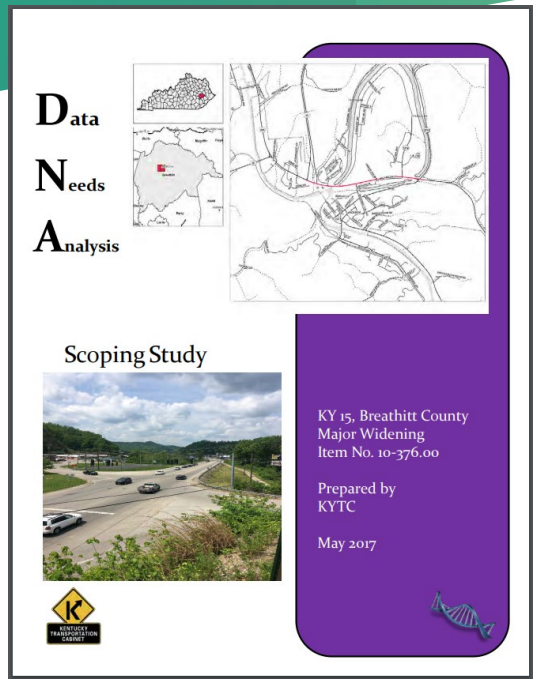
- Initiate the Project Development Process
- Can range from small DNA to large IJS
- ~2.5 Levels of Safety Analysis



Planning Level 1

- Use of CDAT to derive EEC and crash type information
- Every study and every potential project gets this look
- Included for all CHAFs and DNA Studies.

Data Needs Analysis (DNA)



- High-level planning document
- Typically completed before design advertisements with no prior planning
- Preliminary Purpose & Need defined, with “safety” included at LOSS 3 or 4.

Planning Level 2

- Uses CDAT to derive EEC and crash type information
- Uses EEC as a screening tool to hone in on potential issues
- Uses CMFs/SBFs for basic benefit-cost analysis of potential improvement options
- Scoping/Corridor Studies, SUAs, SWCP

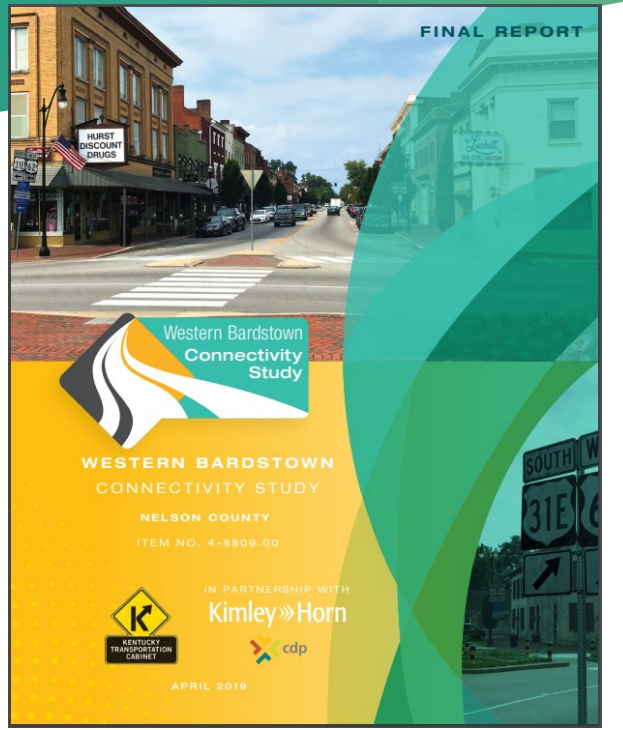
Basic Benefit-Cost

- Use KY Comprehensive Costs by Crash Severity and Crash Reduction Factors
- All-phase planning-level cost estimate
- Travel Time Savings if applicable
- No Discount rate

The **COMPREHENSIVE COST** ($18.9 billion) was derived from the following formula:

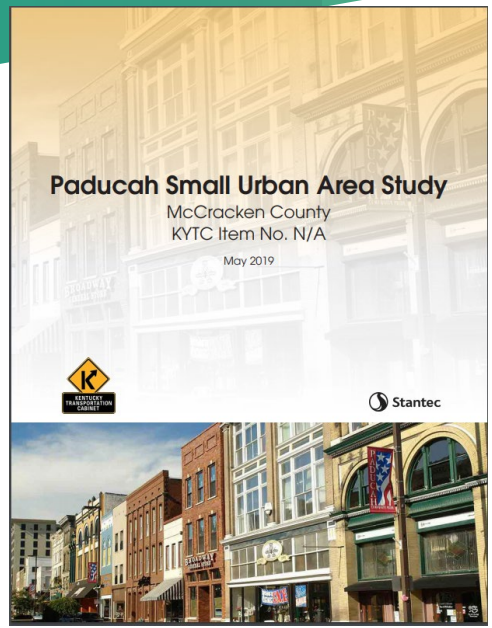
COST PER	X	NUMBER REPORTED	=	ESTIMATED COST
Fatalities				
$10,080,000	X	763	=	$7,691,040,000
Incapacitating Injuries				
$1,100,000	X	3,114	=	$3,425,400,000
Non-Incapacitating Injuries				
$304,000	X	12,493	=	$3,797,872,000
Possible Injuries				
$140,000	X	21,740	=	$3,043,600,000
Property Damage Only				
$8,500	X	114,780	=	$975,630,000
TOTAL COMPREHENSIVE COST ESTIMATE				**$18,933,542,000**

Scoping/Corridor Studies



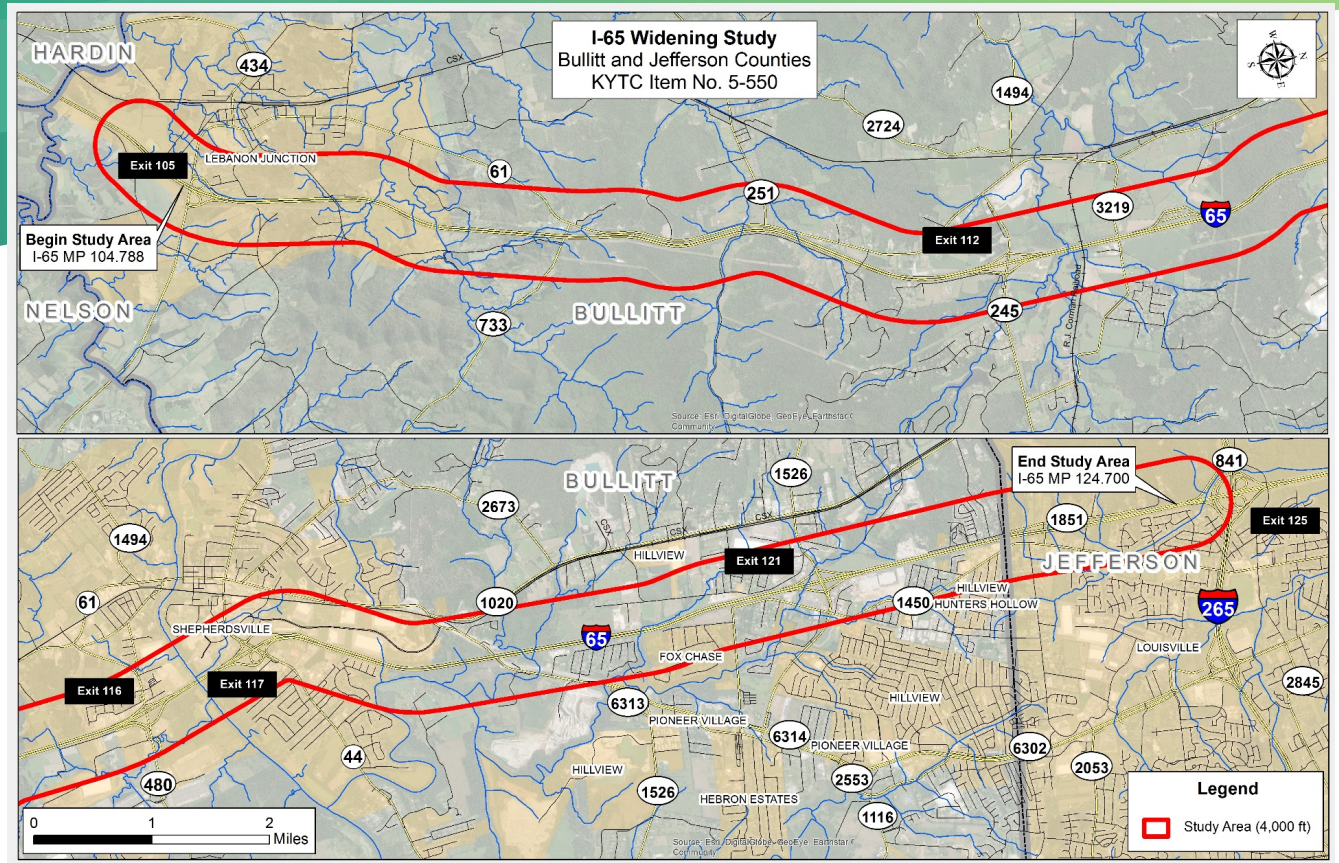
- In-depth examination of potential project area
- Existing Conditions, Environmental Analysis, Improvement Options, Public Involvement
- EEC for screening and CMF/SBF for benefit-cost of improvement options

Small Urban Area (SUA) Study



- Thorough examination of network serving population between 5k and 50k
- Long- and short-term improvements on state, local, private roadways
- Network screening with EEC, and basic benefit-cost for improvement options

EEC Replacing CRF Example



EEC Replacing CRF Example

Crash Analysis

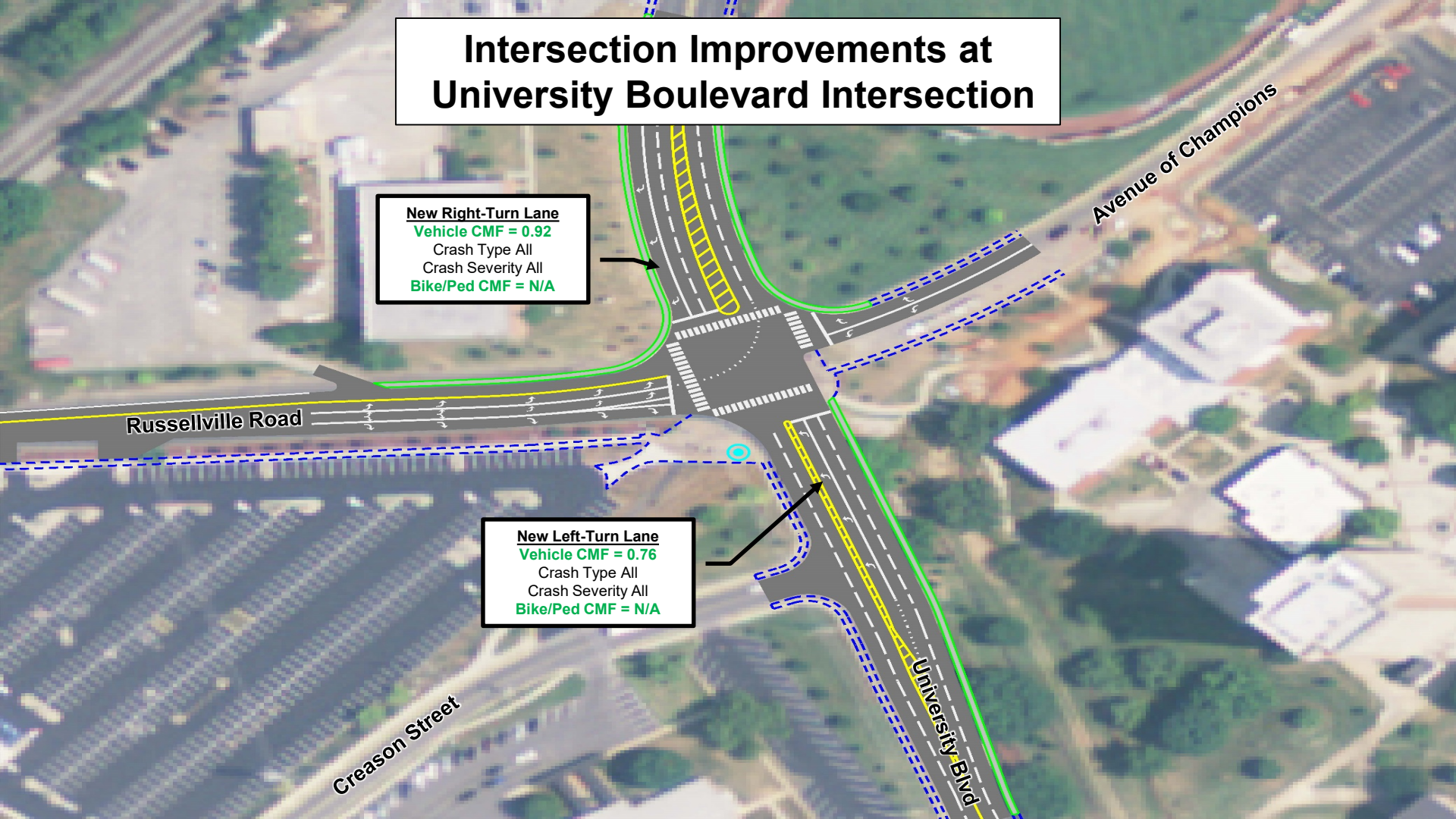
Segment	County	Type	Beg MP	End MP	Existing AADT	3-year Observed Crashes	KY SPF*	Estimate of Expected Crashes	Excess Expected Crashes
South of Exit 105	Bullitt	Rural	103.3	105	65,779	37	45	40	-3
Between Exits 105 & 112	Bullitt	Rural	105	112	64,018	197	182	208	-11
Between Exits 112 & 116	Bullitt	Rural	112	116	81,054	244	128	247	-3
Between Exits 116 & 117	Bullitt	Urban	116	117	95,760	91	37	91	0
Between Exits 117 & 121	Bullitt	Urban	117	121	94,062	257	310	262	-5
North of Exit 121	Jefferson	Urban	121	124.7	110,103	250	352	255	-5

* KTC SHIFT Safety Performance Functions (SPFs) and Adjustment Factors

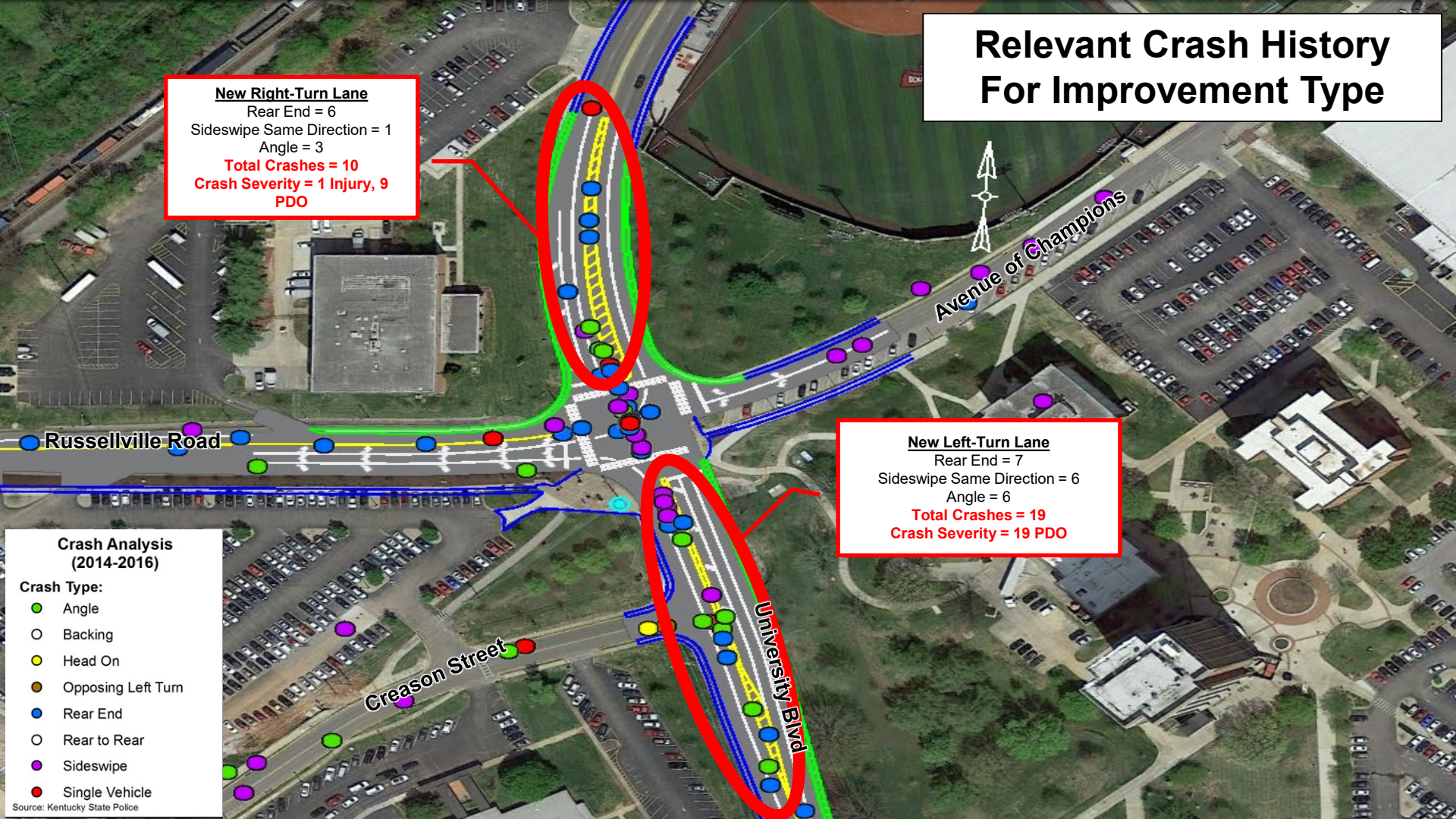
Positive Excess Expected Crashes (EEC) indicates a potential for improvement:

- **Because we are getting negative EEC's, this section of I-65 is experiencing fewer crashes than the model predicts.**

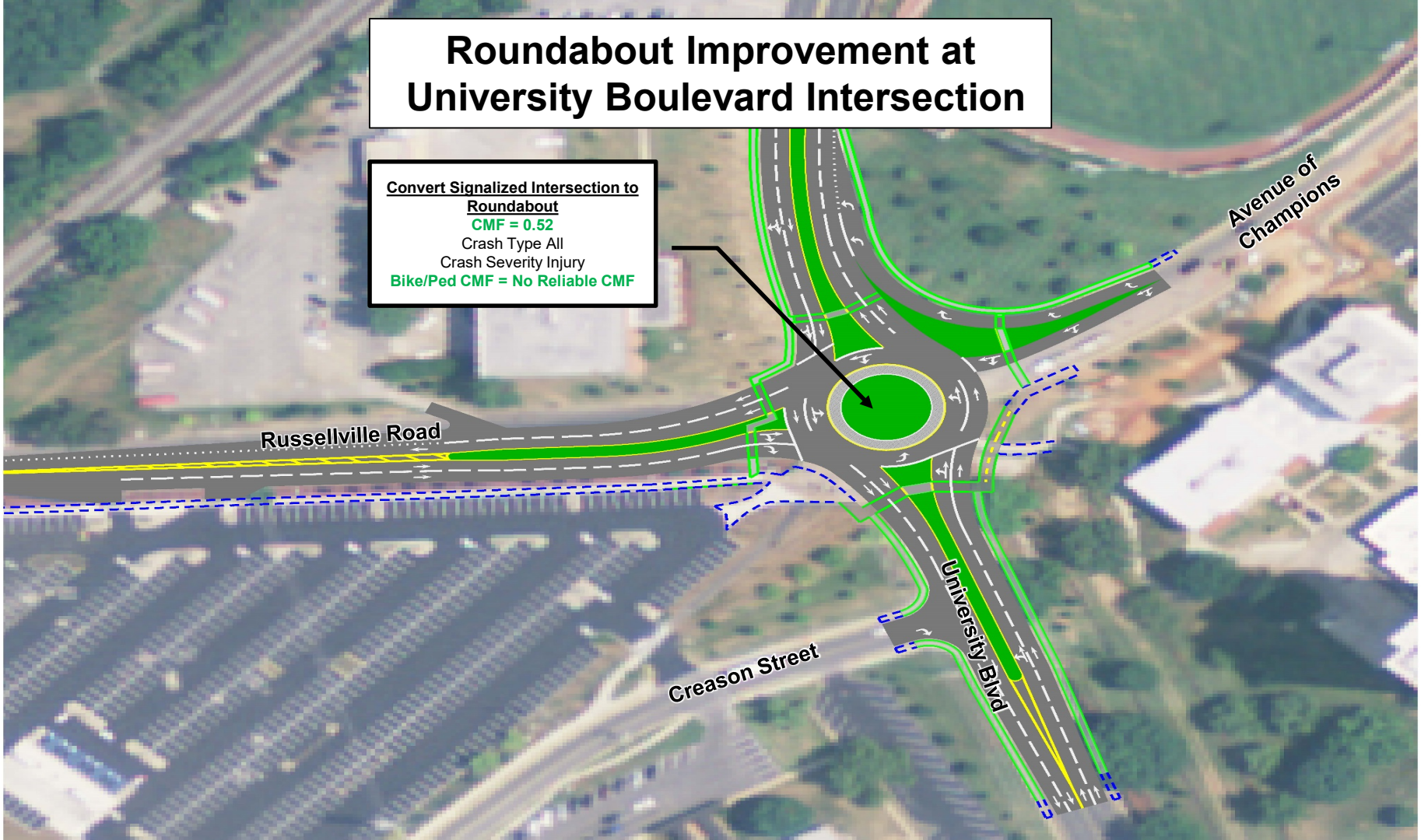
CMF and Benefit-Cost Example


Intersection Improvements at University Boulevard Intersection
New Right-Turn Lane
Vehicle CMF = 0.92
Crash Type All
Crash Severity All
Bike/Ped CMF = N/A
New Left-Turn Lane
Vehicle CMF = 0.76
Crash Type All
Crash Severity All
Bike/Ped CMF = N/A
Avenue of Champions
Russellville Road
University Blvd
Creason Street

Relevant Crash History For Improvement Type

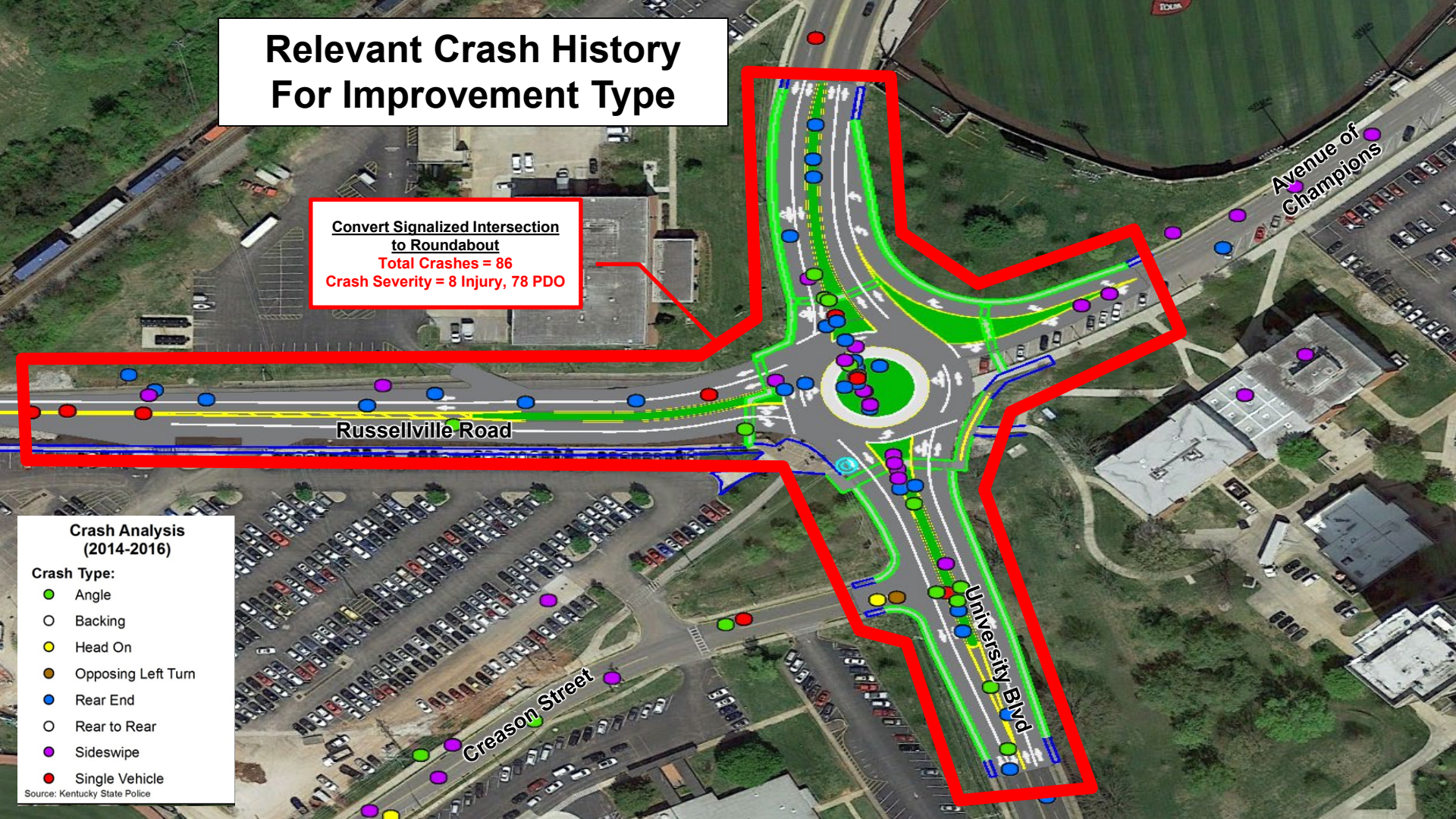


Roundabout Improvement at University Boulevard Intersection



Relevant Crash History For Improvement Type

Convert Signalized Intersection to Roundabout
Total Crashes = 86
Crash Severity = 8 Injury, 78 PDO



Crash Analysis (2014-2016)

Crash Type:

- Angle
- Backing
- Head On
- Opposing Left Turn
- Rear End
- Rear to Rear
- Sideswipe
- Single Vehicle

Source: Kentucky State Police

CMF and Benefit Cost Example

Intersection Improvements:

Location	Improvement	CMF	Crashes (2008-2017)				Cost per Crash			10-Yr Benefit
			Fatal	Injury	PDO	Total	Fatal	Injury	PDO	
University Blvd. Intersection	New left-turn lane	0.76	0	3	49	52	$10,080,000	$274,905	$8,500	$297,900
	New right-turn lane	0.92	0	2	19	21	$10,080,000	$274,905	$8,500	$56,900
Russellville Rd.	Install sidewalk (to avoid walking along roadway)	0.35	0	2	1	3	$10,080,000	$274,905	$8,500	$362,900
										$717,700

Roundabout Improvement:

Location	Improvement	CMF	Crashes (2008-2017)				Cost per Crash			10-Yr Benefit
			Fatal	Injury	PDO	Total	Fatal	Injury	PDO	
University Blvd. intersection	Convert signalized intersection	0.52	0	17	192	209	$10,080,000	$274,905	$8,500	$3,026,600
Russellville Rd.	Install sidewalk (to avoid walking along roadway)	0.35	0	2	1	3	$10,080,000	$274,905	$8,500	$362,900
										$3,389,500

CMF and Benefit Cost Example

Russellville Road (US 68X and US 231X) Planning Study Evaluation Matrix and Cost Estimates														
Alternative Description	**Traffic at Russellville Rd / University Blvd Intersection**				**Bike/Ped Facilities on Russellville Road**		**2018 Cost Estimates (millions)**					**10 Year Benefit-Cost Ratio (BCR)**		
	Year 2018 PM Peak Hour		**Year 2040 PM Peak Hour**											
	Intersection Delay (sec)	**Intersection LOS [1]**	**Intersection Delay (sec)**	**Intersection LOS [1]**	**Pedestrain Accomodations**	**Bicycle Accomodations**	**Design**	**Right-of-Way**	**Utility**	**Construction**	**Total**	**Crash Reduction (millions)**	**Congestion Relief [2] (millions)**	**BCR**
No-Build	76	E	117	F	No	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Alternative 2 Intersection Improvements at University Boulevard and Sidewalk on Russellville Road	36	D	74	F	Yes	No	$0.2	$2.0	$0.5	$1.0	$3.7	0.7	11.0	3.16
Alternative 3 Roundabout at University Boulevard with Signalized Midblock Pedestrian Crossing and Sidewalk on Russellville Road	27	D	50	E	Yes	No	$0.3	$2.4	$1.9	$2.5	$7.1	3.4	7.5	1.54

Statewide Corridor Plan (SWCP)

- New initiative to identify and examine KY's significant corridors, with a future plan for each
- Focus on mobility and accessibility
- EECs for each corridor identified
- Benefit-Cost for high priority corridors

Planning Level 2+

- Further planning phase analysis
- Interchange studies (IJS/IMR)
- IHSDM, ISATe tools used
- Predictive safety and benefit-cost

Timeline for Delivery

- **EEC Interactive GIS Tool:**

  Late Fall 2019

- **Purpose and Need Guidelines:**

  End of September, 2019

2019 partnering CONFERENCE acec-ky·fhwa·kyt

Data Driven Safety Analysis DDSA improving safety on our roadways

Timeline for Delivery

- **SHIFT:**

  Completed for SHIFT 2020, Adjustments by Summer 2021 for next cycle

- **Planning Studies:**

  Implemented

Questions?

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