Route 160 Widening

Before-and-After Study with Driving Simulator

July 15, 2020

CMT

CMT Webinar

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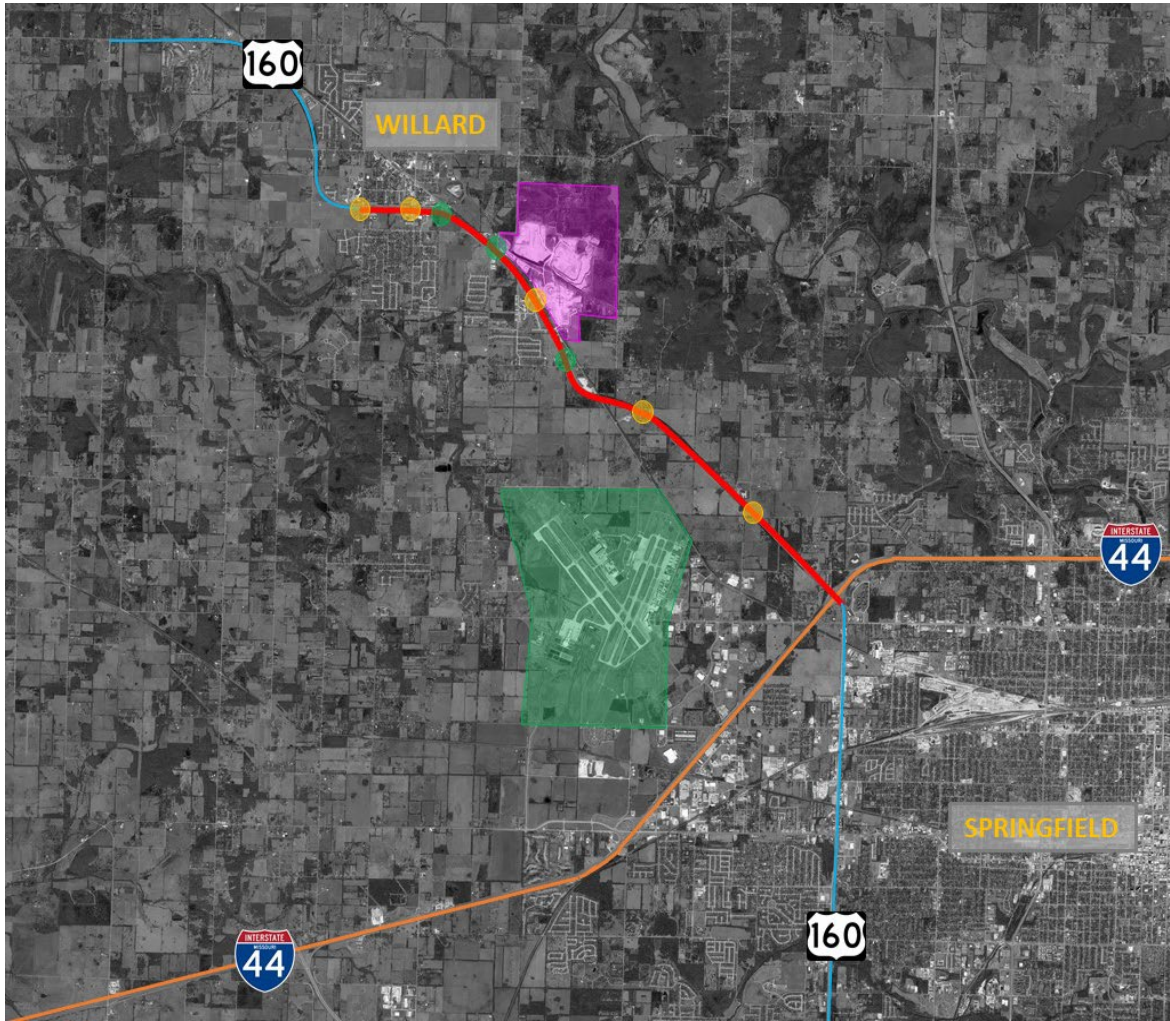
PURPOSE & NEED

Project Location & Goals

- ✓ Widen Route 160 to 4-Lane Divided Highway
- ✓ Improve Intersection Safety
- ✓ Accommodate Pedestrian-Friendly Access to Frisco Highline Trail
- ✓ Accommodate significant Heavy Truck Traffic from Rock Quarry

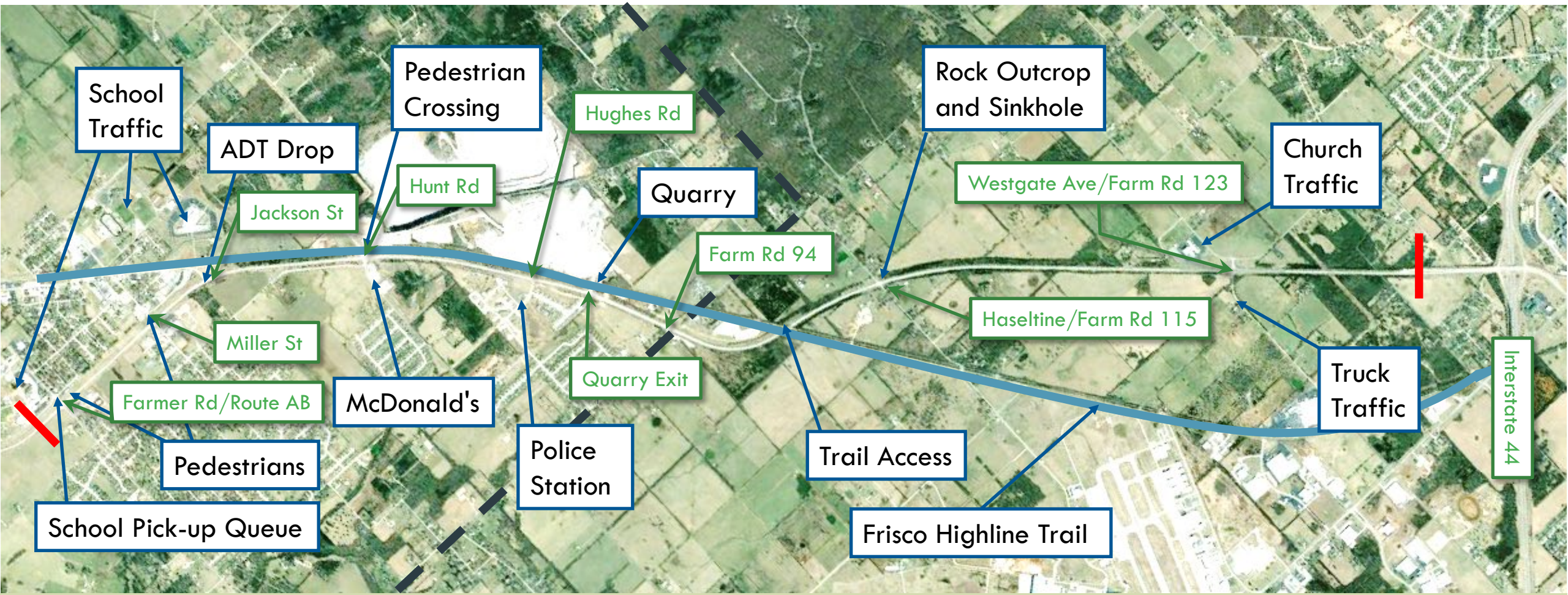
9 **Existing Intersections**
4 Signalized &
5 Stop-Controlled

6 **Miles on Route 160**
From I-44 to Rte AB in Willard



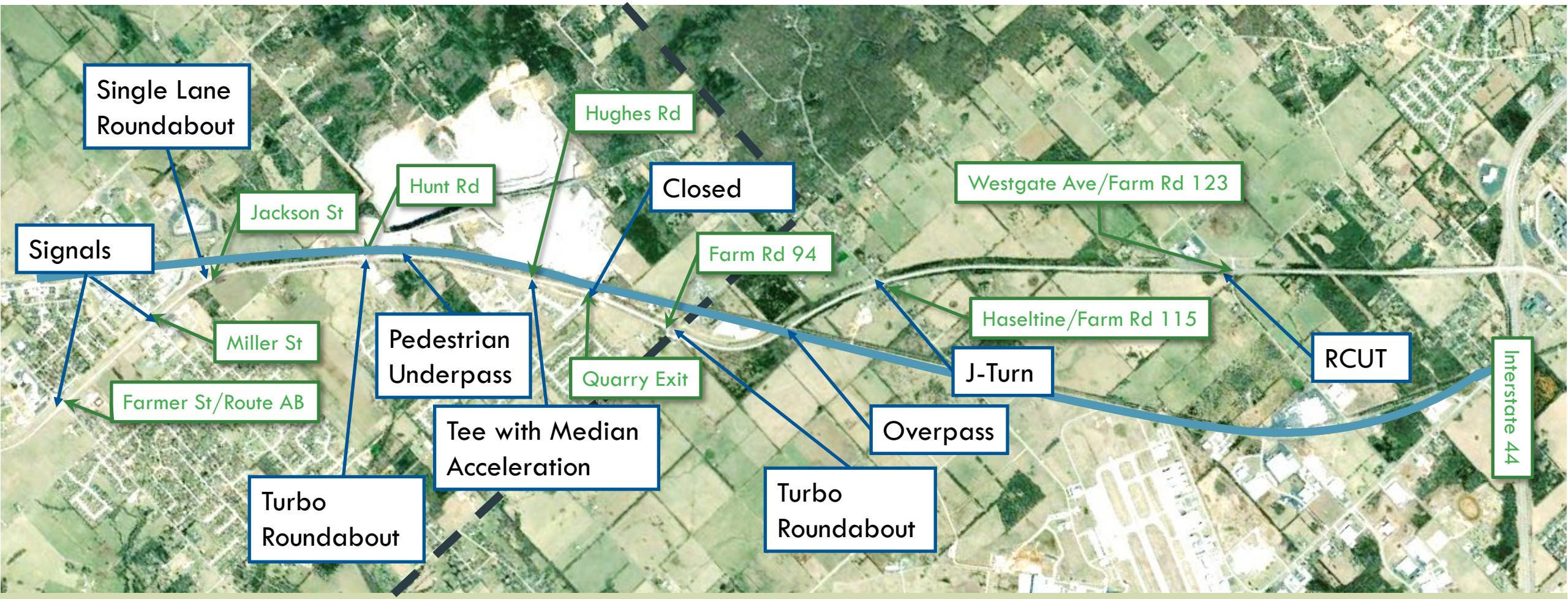
ROUTE 160 WIDENING

Design Challenges & Considerations



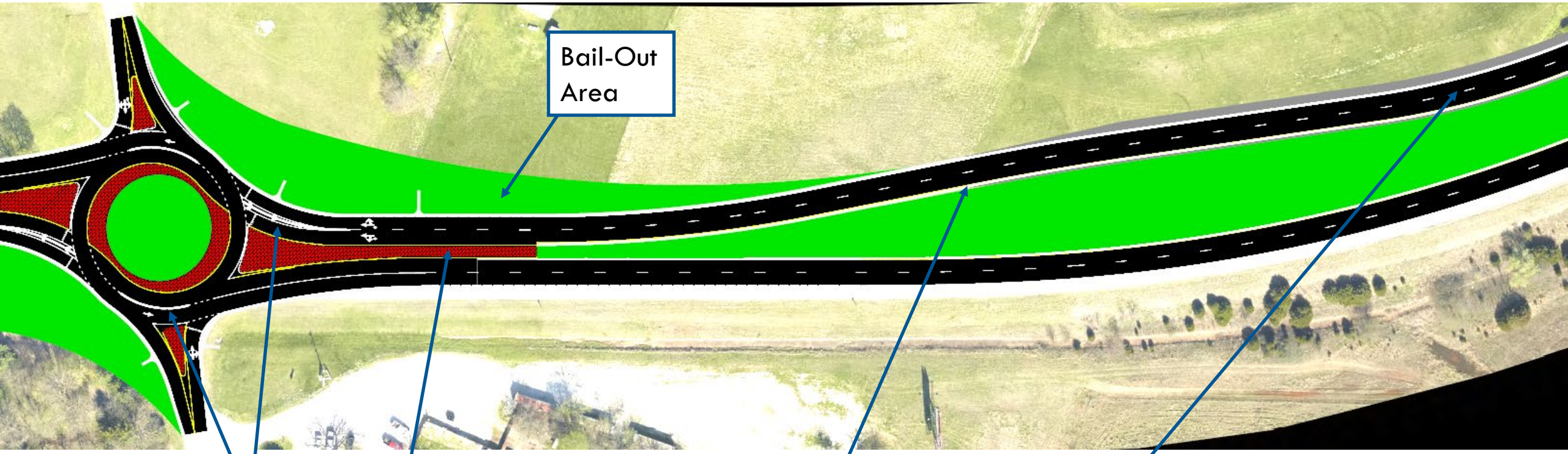
ROUTE 160 WIDENING

Improvement Plan



ROUTE 160 WIDENING

Roundabout Refinement



MODELING DESIGN COLLABORATION

Valued Partnerships

Safety of the Traveling Public

MoDOT

CMT ⟷ Missouri S&T

Missouri S&T

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NEWS AND EVENTS

Students use a driving simulator to test roadway design before construction

Posted by Sarah Potter

On May 14, 2019

ROADS&BRIDGES

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ROAD DESIGN

Missouri students use driving simulator to test roadway design

The students used the simulator to evaluate a roadway design for the $18.6 million Route 160 widening project before its construction

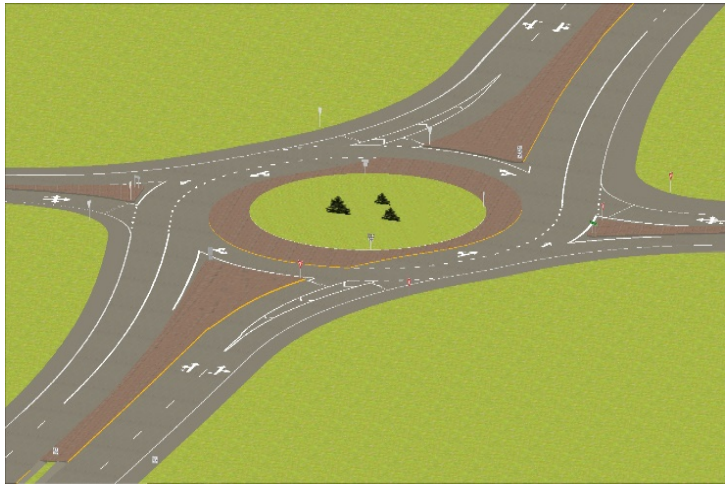
MAY 15, 2019

Two undergraduate students at Missouri University of Science and Technology (S&T) used a driving simulator to help a civil engineering firm evaluate a new roadway design for the $18.6 million Route 160 widening project from Springfield to Willard, Missouri.

The students worked with Crawford, Murphy & Tilly Inc. (CMT), a civil engineering firm with an office in Springfield, which designed the expansion of Route 160 to widen it from two lanes to four and replace some intersections with roundabouts. The company completed the design for the Missouri DOT (MoDOT).

VISUALIZING & EVALUATING DESIGNS

Missouri S&T Driving Simulator



VISUALIZING & EVALUATING DESIGNS

Missouri S&T Driving Simulator

SOFTWARE

- Blender 3D (Python)
- Directly Input 3D CAD Designs

SIMULATED ROADWAY

- Apply Textures (Pavement/Islands)
- Add Realistic Features – Signs, Buildings, Traffic, & Signals

VEHICLE INTERACTION

- Use Actual Steering Wheel, Brake & Gas Pedals

VISUALIZING & EVALUATING DESIGNS

Realistic & Consequence-Free Evaluation

- Evaluate Functionality, Effectiveness & Safety of Corridor
- Utilize Driving Simulator to compare Existing & Proposed Corridors
- Identify Potential Concerns & Develop Safety Enhancement Recommendations
- Data-driven Analytics prior to Construction

VISUALIZING & EVALUATING DESIGNS

Simulator Data Collection

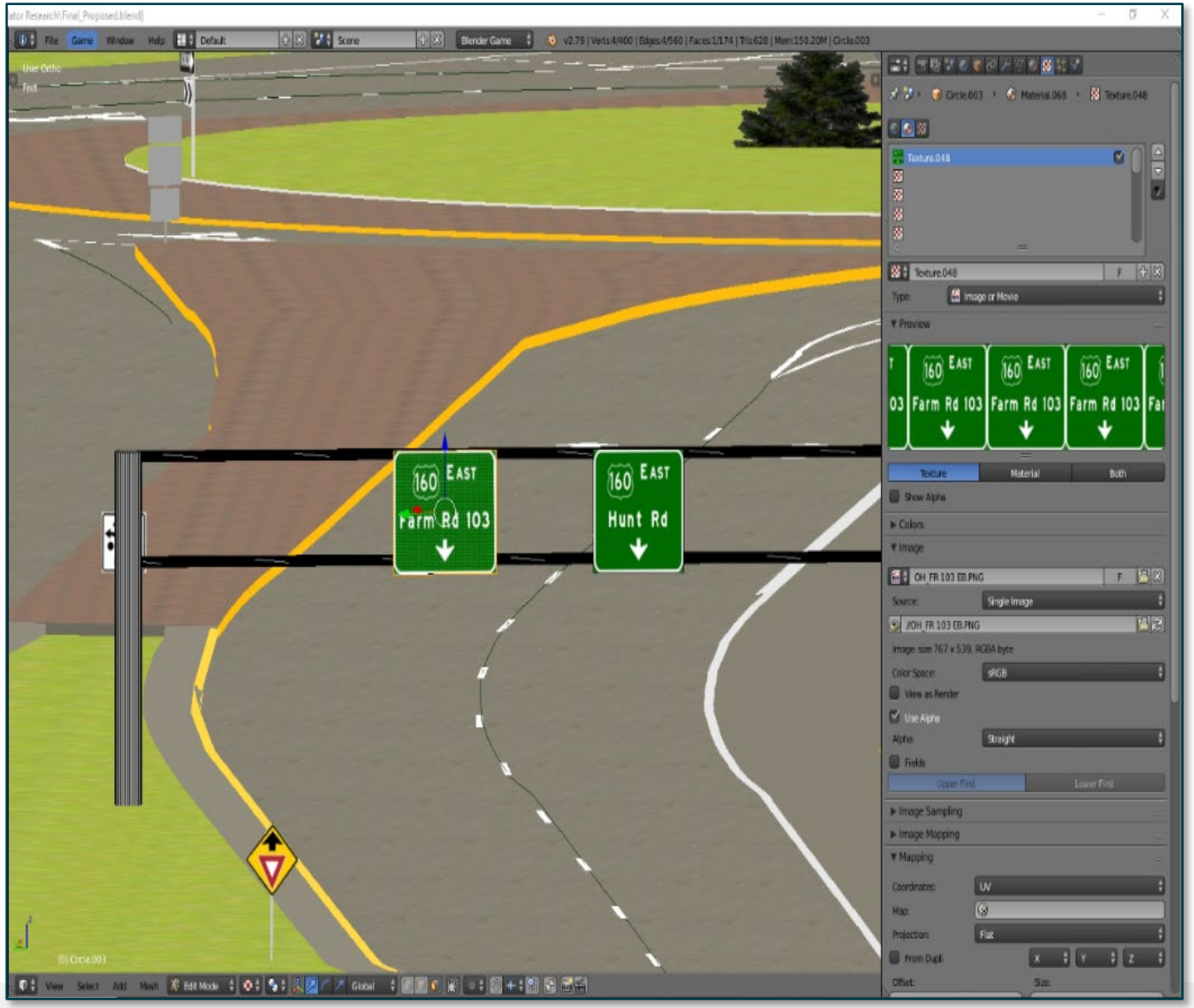
Sample Output Data

Time	Speed	Steer Amount	Location X1	Location Y1	Brake Amount
0	0.170310247	1.120689655	-1413.541016	2621.114258	0
0.507254848	1.199995929	-0.32820197	-1413.230713	2621.114258	0
2.024208062	5.307040791	-4.746921182	-1408.606934	2621.111328	0
2.543753324	6.877418721	-6.732142857	-1405.472534	2621.102783	0
3.043375103	8.74285366	-13.61637931	-1401.602173	2621.081055	0
3.568028754	10.79473636	-11.4070197	-1396.573364	2620.997803	0
4.079385325	13.18469268	-11.4070197	-1390.42395	2620.812744	0
4.590659773	15.63062102	-3.530172414	-1383.007568	2620.479492	0
5.105876828	18.01957427	-3.274014778	-1374.346069	2620.027832	0
5.613764931	20.31771785	-3.017857143	-1364.802612	2619.50708	0
6.129914867	22.74917082	-2.05726601	-1353.715332	2618.876465	0
6.627312874	25.04539632	-0.584359606	-1341.806885	2618.177002	0

Recorded Component	Unit	Description
Time	Seconds (s)	Time is recorded in either one second or one half second intervals beginning when the volunteer starts moving
Speed	Miles per hour (MPH)	The computer collects position data and pairs it with the simulation run-time to calculate current speed
Steer Amount	Degrees from 0	A neutral steering wheel is at zero. A left turn will return a negative value and a magnitude correlating to the rotation of the wheel from the zero position. A right turn will return a positive value.
Location X	Feet (ft)	The current position of the car with relation to the x-axis.
Location Y	Feet (ft)	The current position of the car with relation to the y-axis.
Brake Amount	Percentage	A measure of the position of the brake pedal. A value of zero means the pedal is not depressed, while a value of 100 means the pedal is completely depressed.

SIMULATOR RESEARCH & ANALYSIS

Simulation Development



SIMULATOR RESEARCH & ANALYSIS

Research Methods

1

REALISTIC SIMULATION DEVELOPMENT

Existing & Proposed Roadway Simulations

2

OBTAIN DIVERSE SAMPLE GROUP

Age | Gender | Driving Experience

3

DRIVING HISTORY ANALYSIS

Annual Miles Driven | Crash History | Traffic Violations

4

PARTICIPANT TESTING

Test Track | Existing Roadway | Proposed Roadway

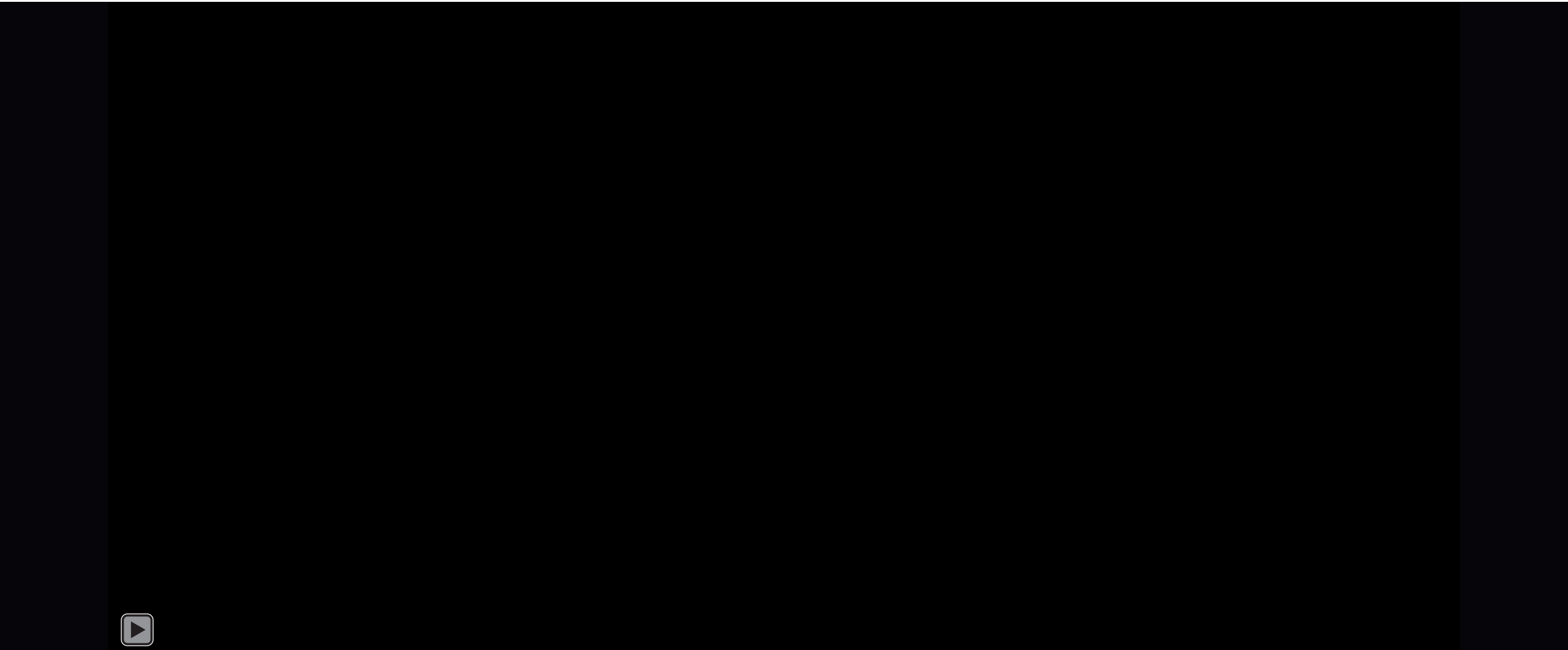
5

DATA ANALYSIS

Speed | Lane Departures | Intersection Approach

VISUALIZING & EVALUATING DESIGNS

Route 160 Simulation



SIMULATOR RESEARCH & ANALYSIS

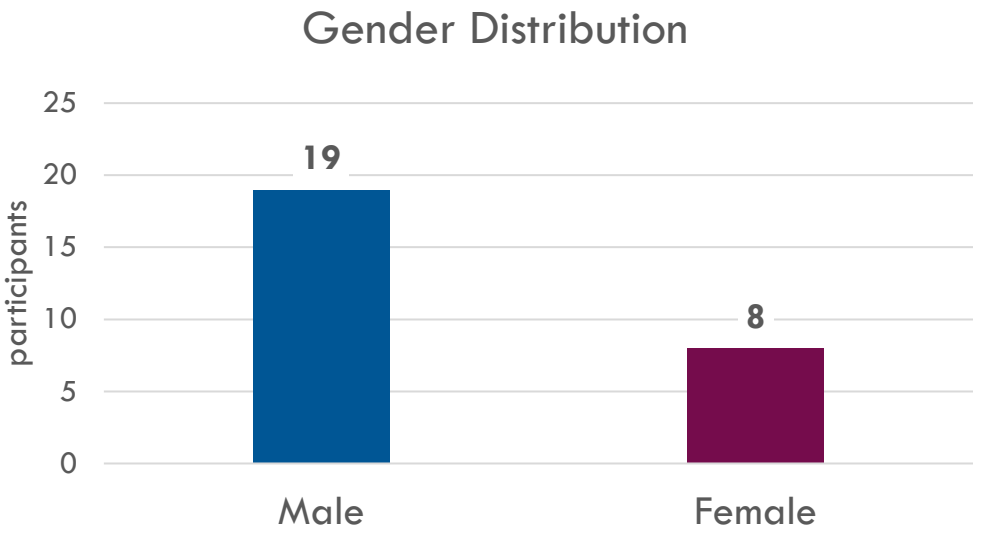
Diverse Sample Population

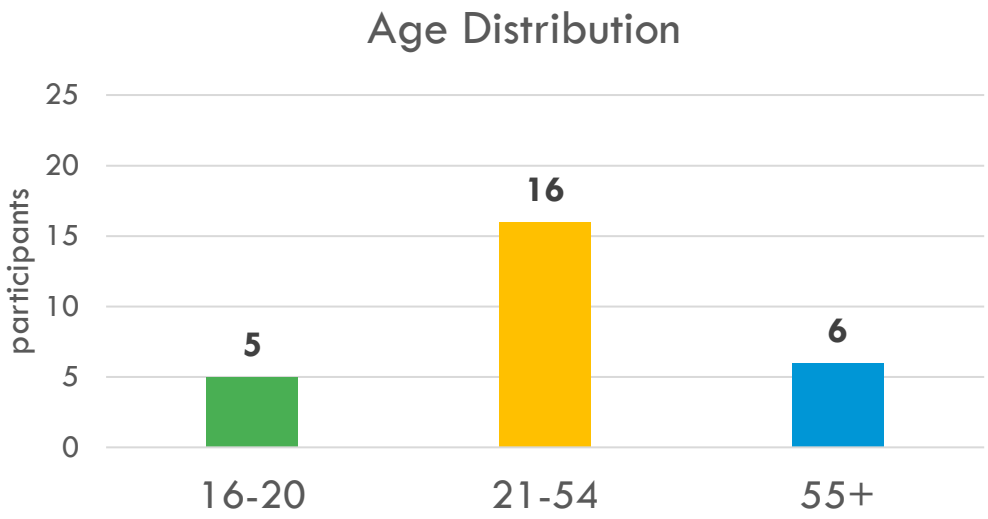
27 **Total Participants**

Obtained 20 Usable Data Sets
Ranging from Ages 16 to 67

Participant Requirements:

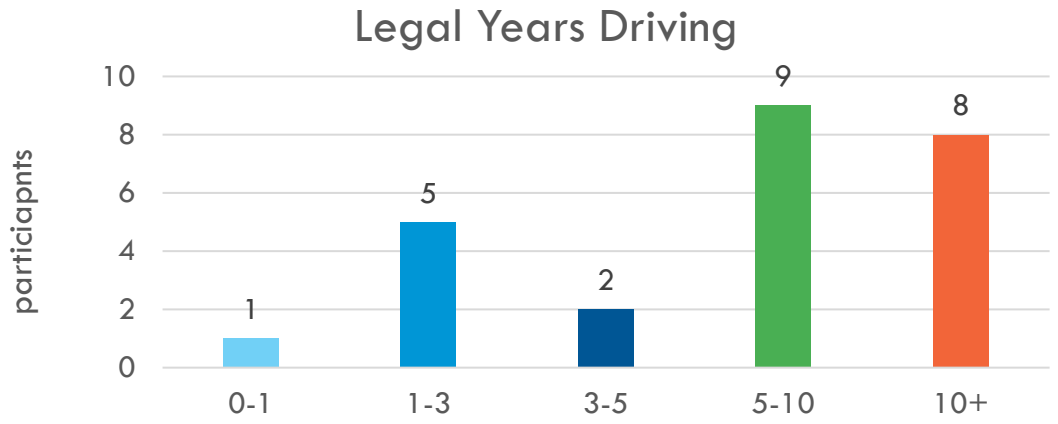
- ✓ Hold a valid Driver's License
- ✓ No medical condition inhibiting driving ability
- ✓ No medical condition triggered by virtual screen/flashing motions

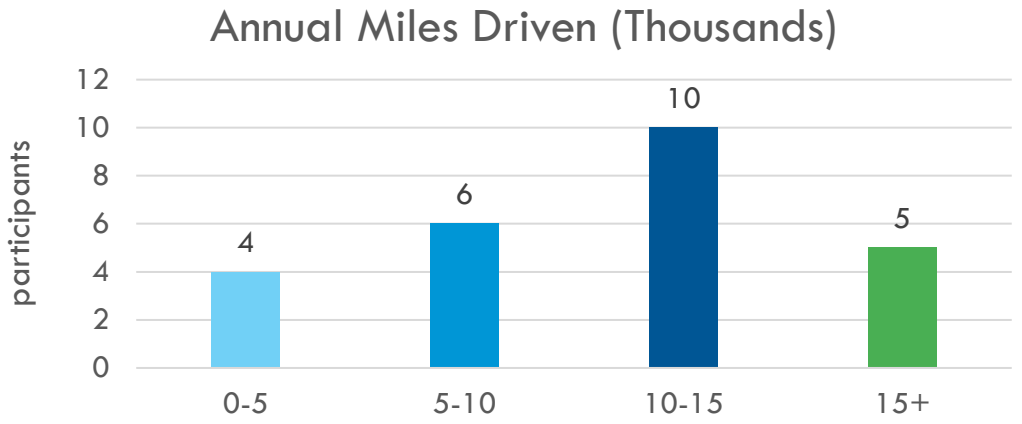


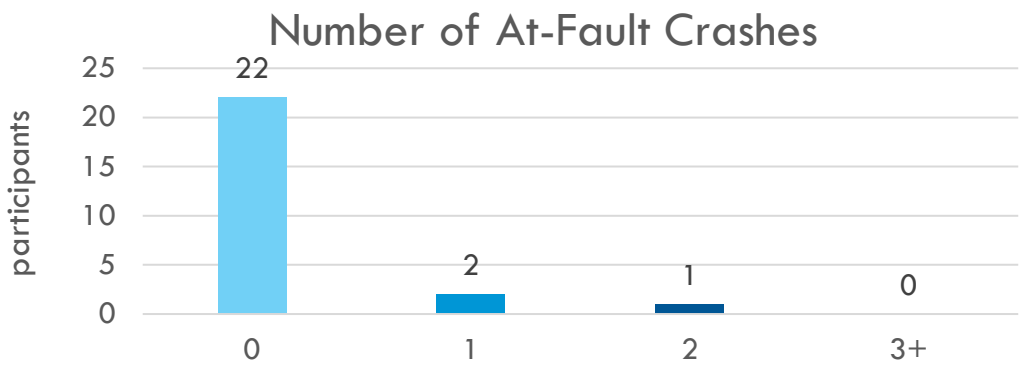


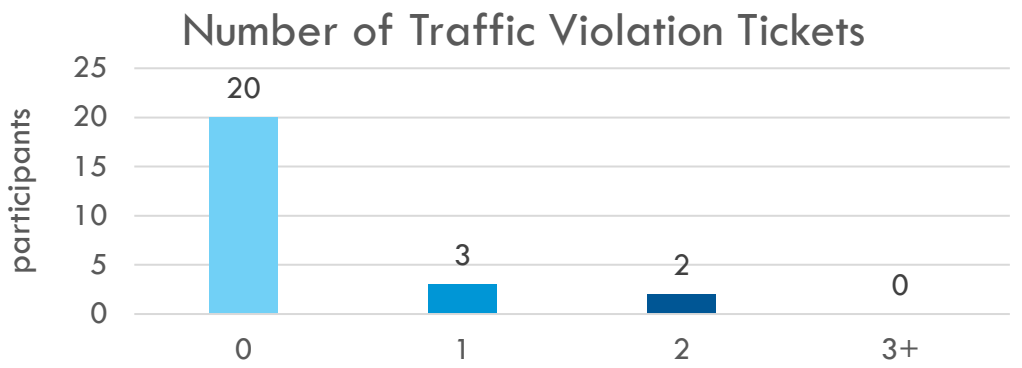
SIMULATOR RESEARCH & ANALYSIS

Driving History Analysis









SIMULATOR RESEARCH & ANALYSIS

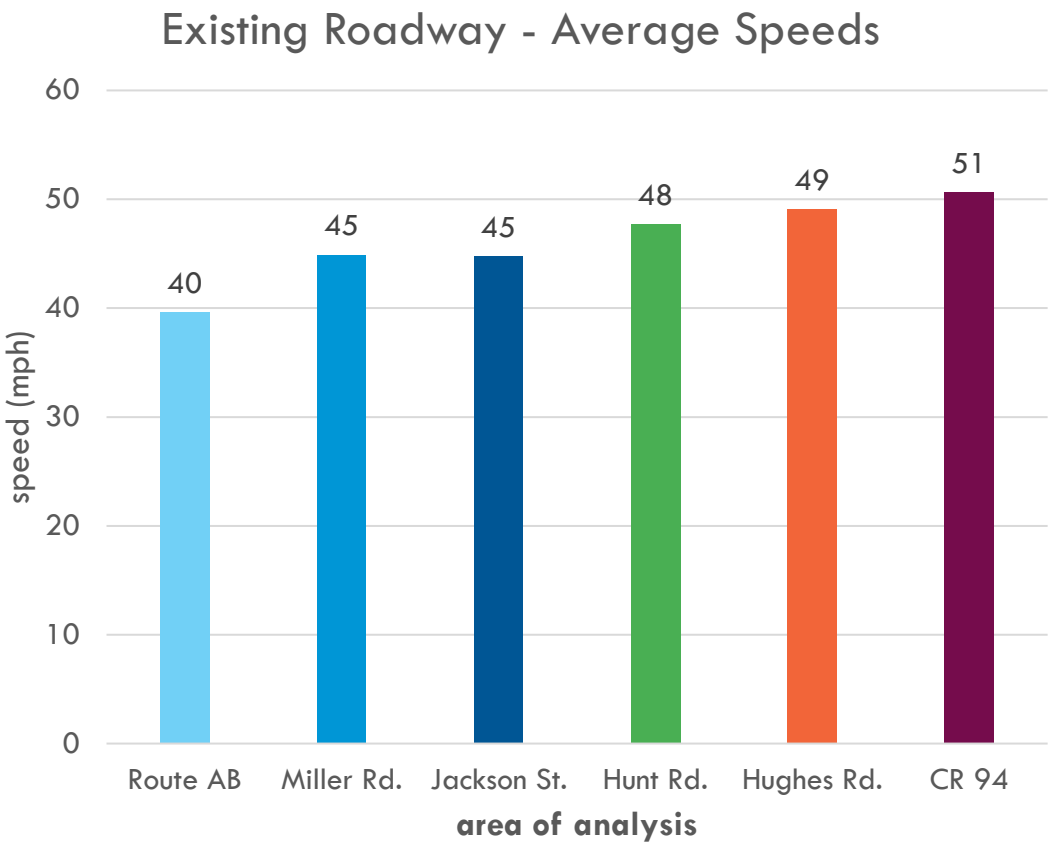
Existing Route 160 Driving Simulation

EASTBOUND TRAVEL DIRECTION

BASELINE DRIVING BEHAVIORS

AVERAGE SEGMENT SPEEDS

- 43.1 MPH (45 MPH Zone)
- 49.1 MPH (60 MPH Zone)



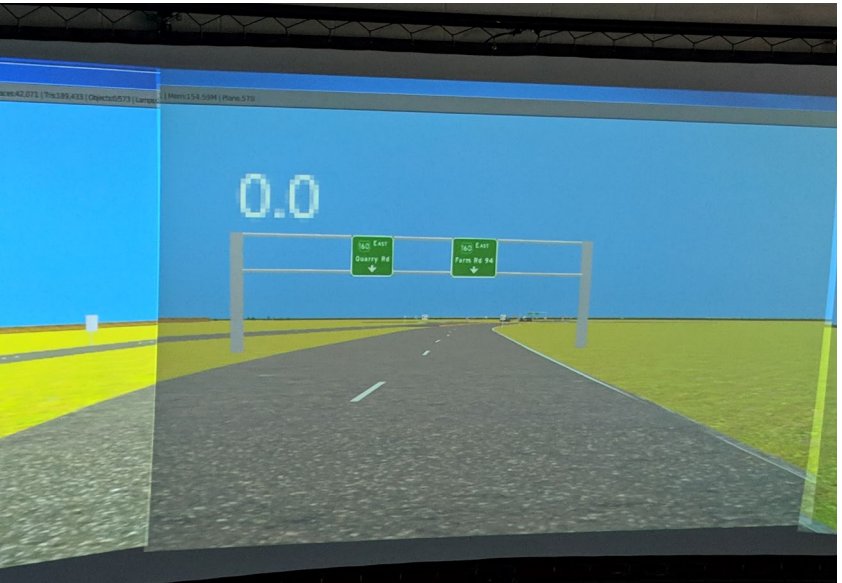
SIMULATOR RESEARCH & ANALYSIS

Proposed 160 Driving Simulation

EASTBOUND TRAVEL DIRECTION

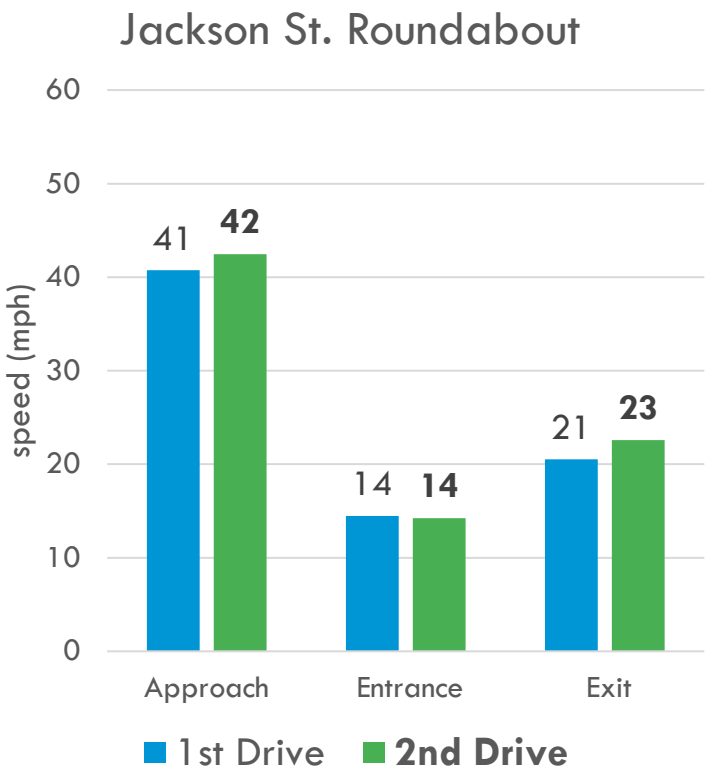
2 **Proposed Simulations Driven**

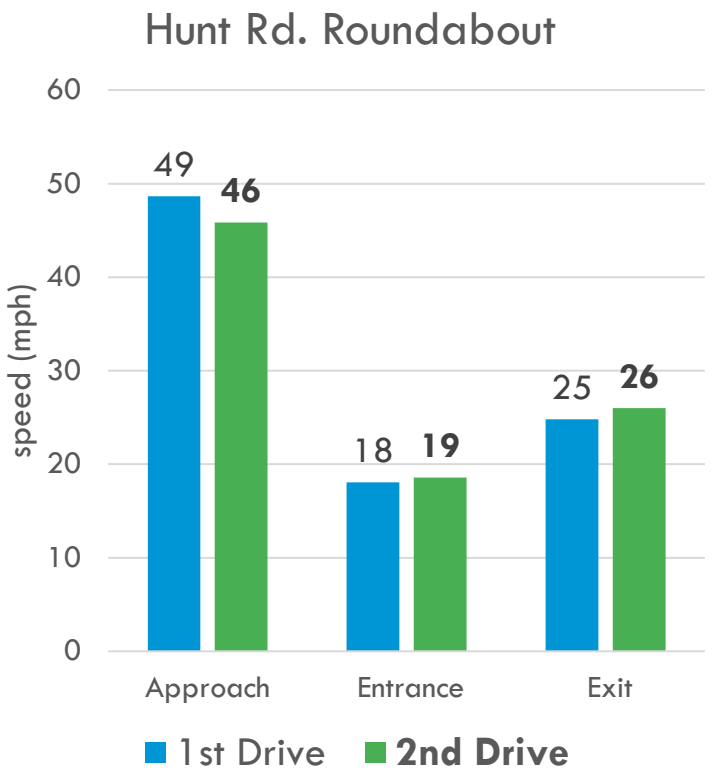
To Evaluate Familiarity

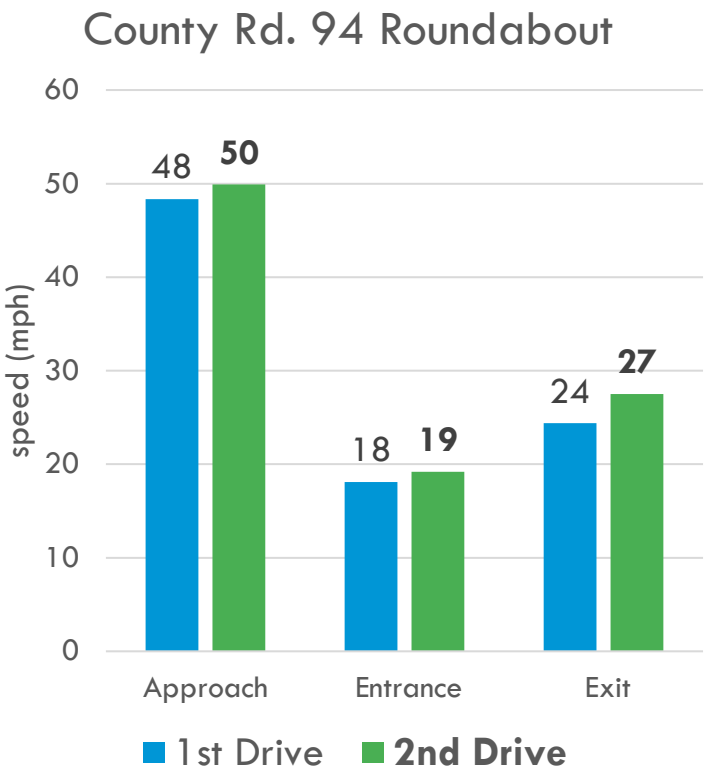


SIMULATOR RESEARCH & ANALYSIS

Proposed 160 Roundabouts







SIMULATOR RESEARCH & ANALYSIS

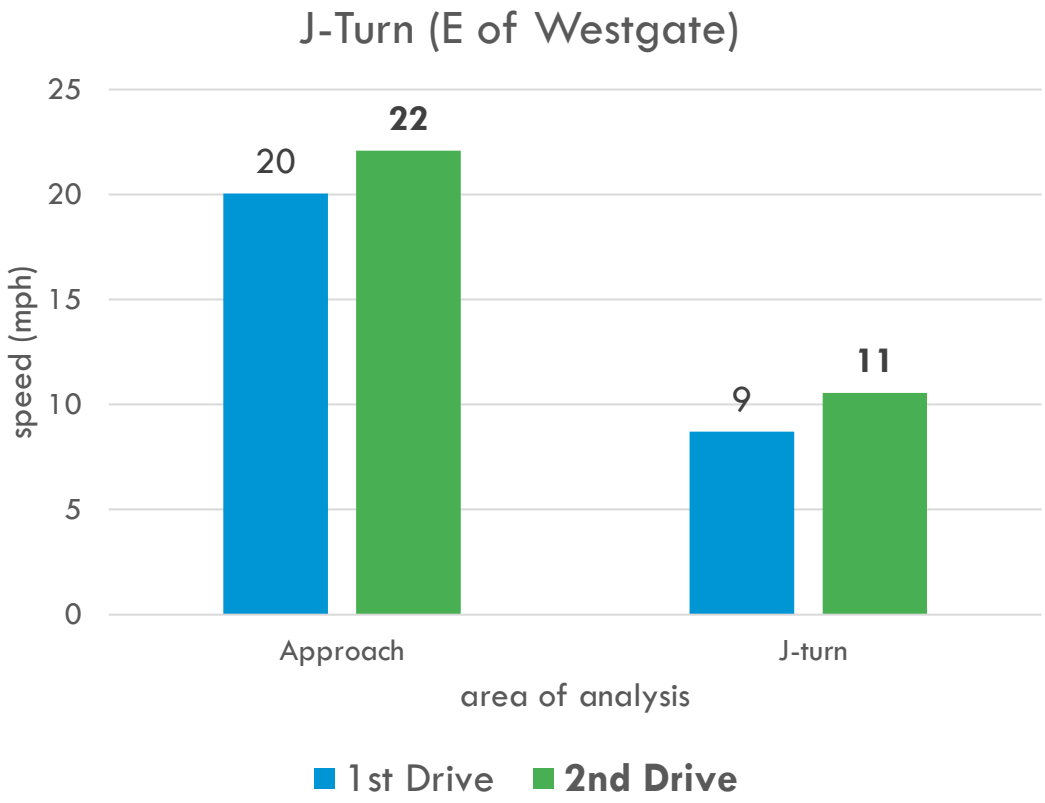
Proposed 160 J-Turn Intersections

1 **J-Turn Intersection Analyzed**

US 160/Westgate Ave. Intersection

RESEARCH OBSERVATION

Few Drivers Yielded (stopped), but most could if Traffic was Present



SIMULATOR RESEARCH & ANALYSIS

Simulation Braking Analysis

ANALYSIS FOCUS: ROUNDABOUT APPROACHES

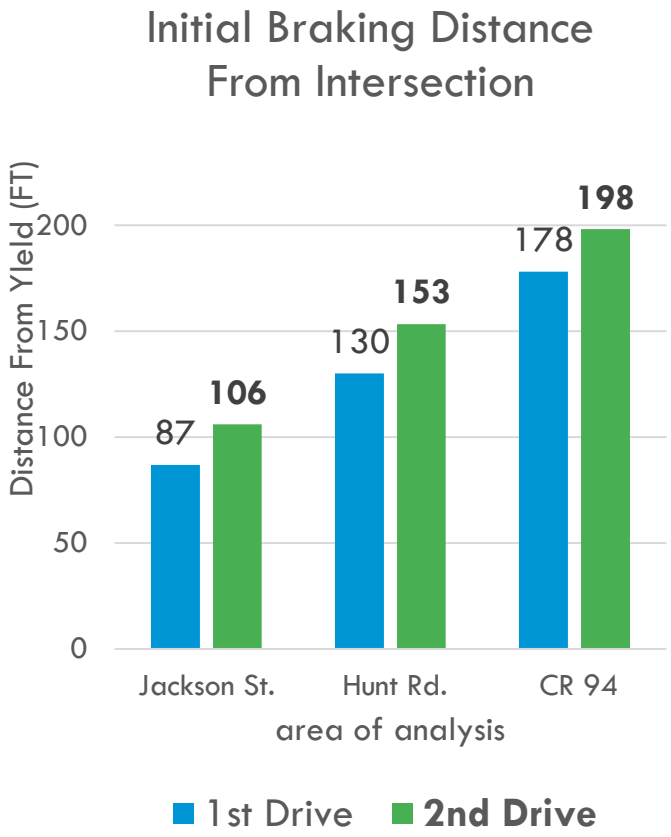
Measured From Roundabout W2-6 Warning to Yield Triangles

16% **Breaking Distance Increase**

(21') in 2nd Drive

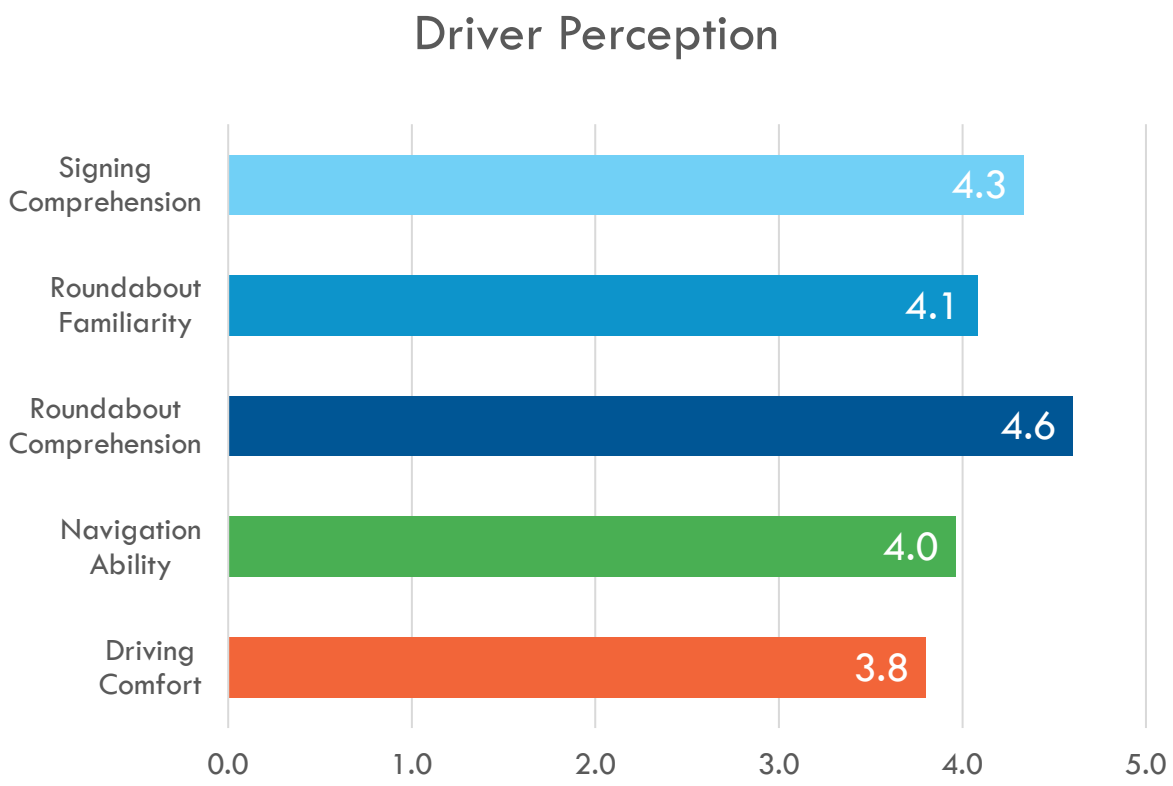
Required Stopping Distance[1]			
Speed (MPH)	Perception Reaction Distance (Feet)	Braking Deceleration Distance (Feet)	Stopping Distance (Feet)
25 MPH	55	30	85
45 MPH	99	97	196

[1]National Association of City Transportation Officials (NACTO)



SIMULATOR RESEARCH & ANALYSIS

Post-Simulation Feedback



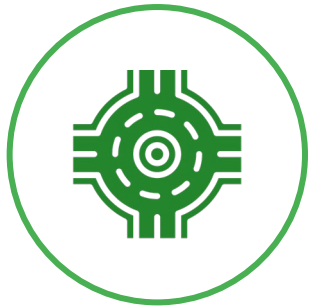
"Increase [size of] roundabout signs and provide [yellow] flashing lights to grab attention."

"The rapid transition from 60 to 20 MPH for the roundabout felt drastic, especially because it felt like they were only separated by a mile."

"It would be helpful to have a warning sign about the roundabout a little sooner."

SIMULATOR RESEARCH & ANALYSIS

Driving Simulator Study Conclusions



ROUNDABOUTS REDUCE SEVERITY

Right-Angle Crash Potential & Lower Speeds result in Increased Safety

DATA ANALYSIS & FEEDBACK

Convey the **Roadway Functions** as designed & is **Effective in Reducing the Speed** at Major Intersections

RESEARCH OBSERVATIONS

Show Initial Roadway Conversion will require **Acclimation Period** & will likely Operate at lower Initial Efficiency

SIMULATOR RESEARCH & ANALYSIS

Recommended Enhancements

4 Key Recommendations

Simplify Overhead Signing

Increase Warning Sign Presence

Using Horizontal Type 3 Object Markers (OM-3) under the W2-6 Sign

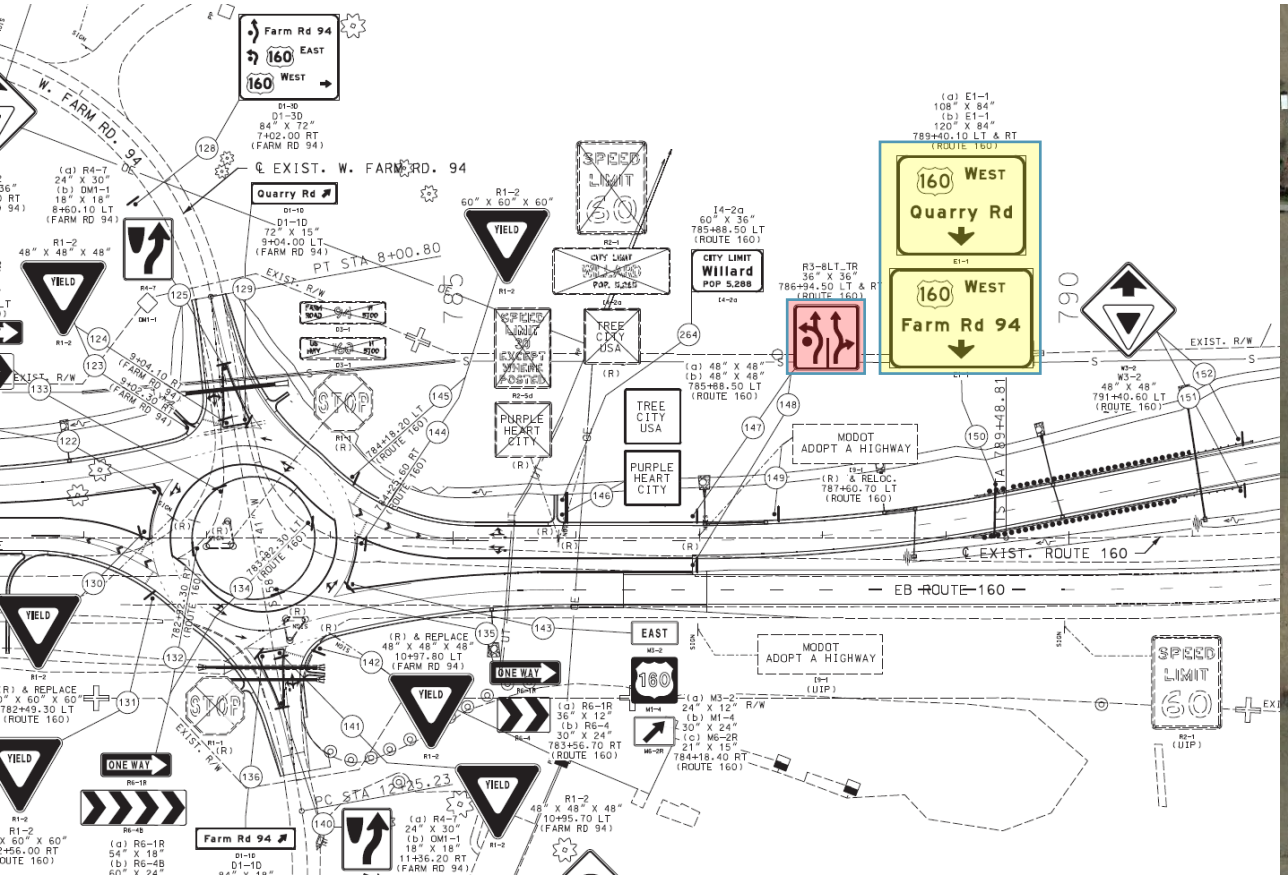
Install LED Flashers in W2-6

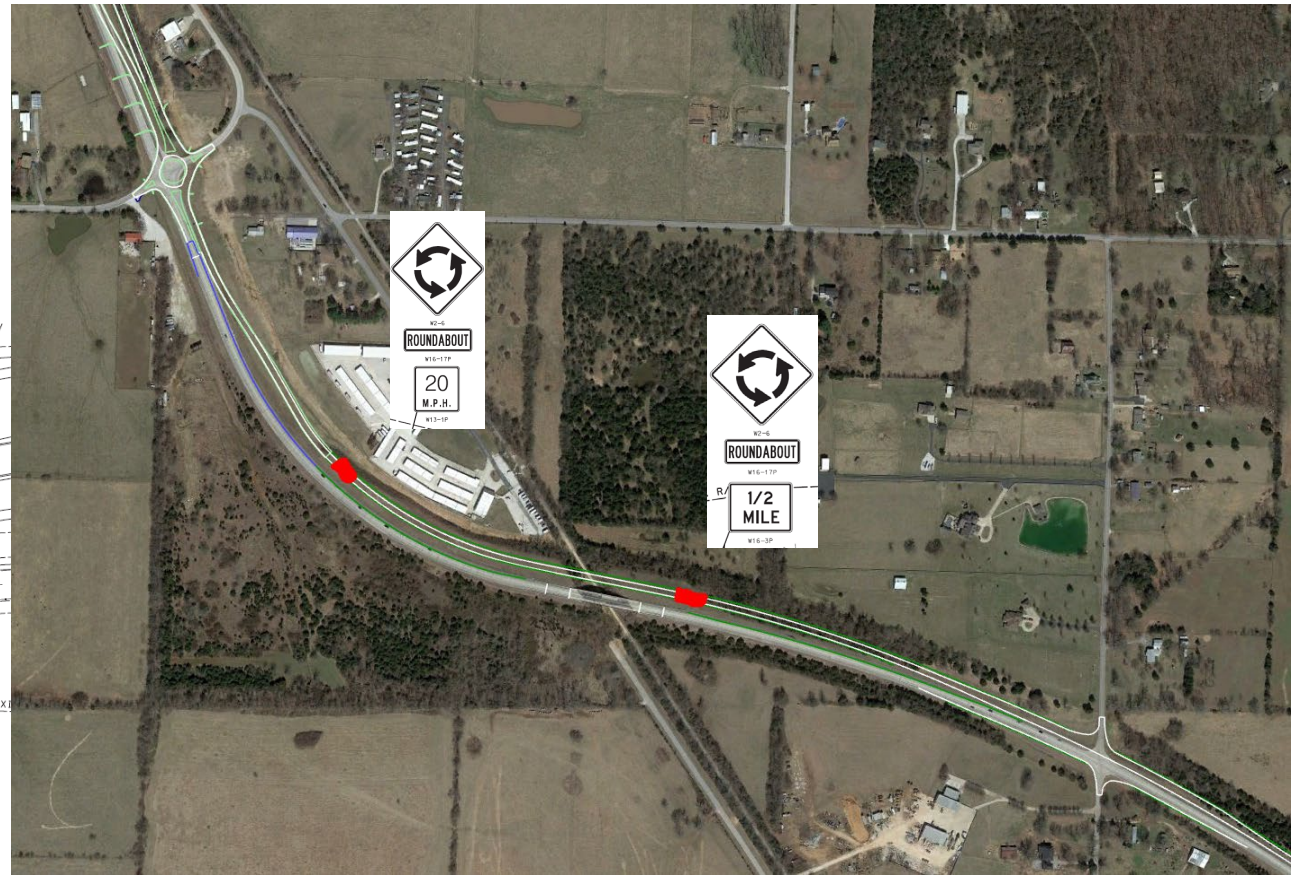
Transverse Rumble Strips

At Roundabout approaches located in 60 MPH zone

SIMULATOR RESEARCH & ANALYSIS

Incorporated Design Elements





VALUABLE DESIGN-RESEARCH COLLABORATION

Study Summary

- Speed control assumptions
- Braking location on approach
- Increased advanced warnings

VALUABLE DESIGN-RESEARCH COLLABORATION

Questions?

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ROUTE 160 WIDENING

Improvement Plan Statistics

2 Signalized Intersections

2 J-Turn/RCUT Locations

3 Roundabouts

2 Pedestrian Underpasses

1 Continuous Green Tee Intersection

6 Total Project Miles