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Creative People, Practical Solutions.

Radar Vehicle Detection Within Four Quadrant Gate Crossings

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Problem Statement

- Increased exposure at grade crossings due to train frequencies and traffic volumes.
- Short throat storage at adjacent signalized intersections may lead to queuing on the track.
- Highway and rail vehicle collisions are costly in terms of damage and delay but ultimately in loss of life.

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Current Solutions

- Closure / Consolidation
- Active Warning Devices
- Traffic Signal Preemption
- **Four Quadrant Gates**
- Grade Separation

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Potential Solution

- Use vehicle detection to determine if a crossing is clear
  - Provides dynamic control of the exit gate
- Less delay between entry and exit gate descent
- Extends the exit gate delay only in the direction of a 'trapped' vehicle.

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Radar Installation

1) Introduction
2) Literature Review
3) Methodology
4) Results
5) Conclusions
6) Acknowledgments

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Federal Highway Administration Grants

U.S. Department of Transportation
Federal Highway Administration

- Two grants totaling $1,263,800 to NC Department of Transportation
  - 7 Sites, 3 Currently
- Two phases of ITRE study:
  - Passive Portion
  - Active Portion

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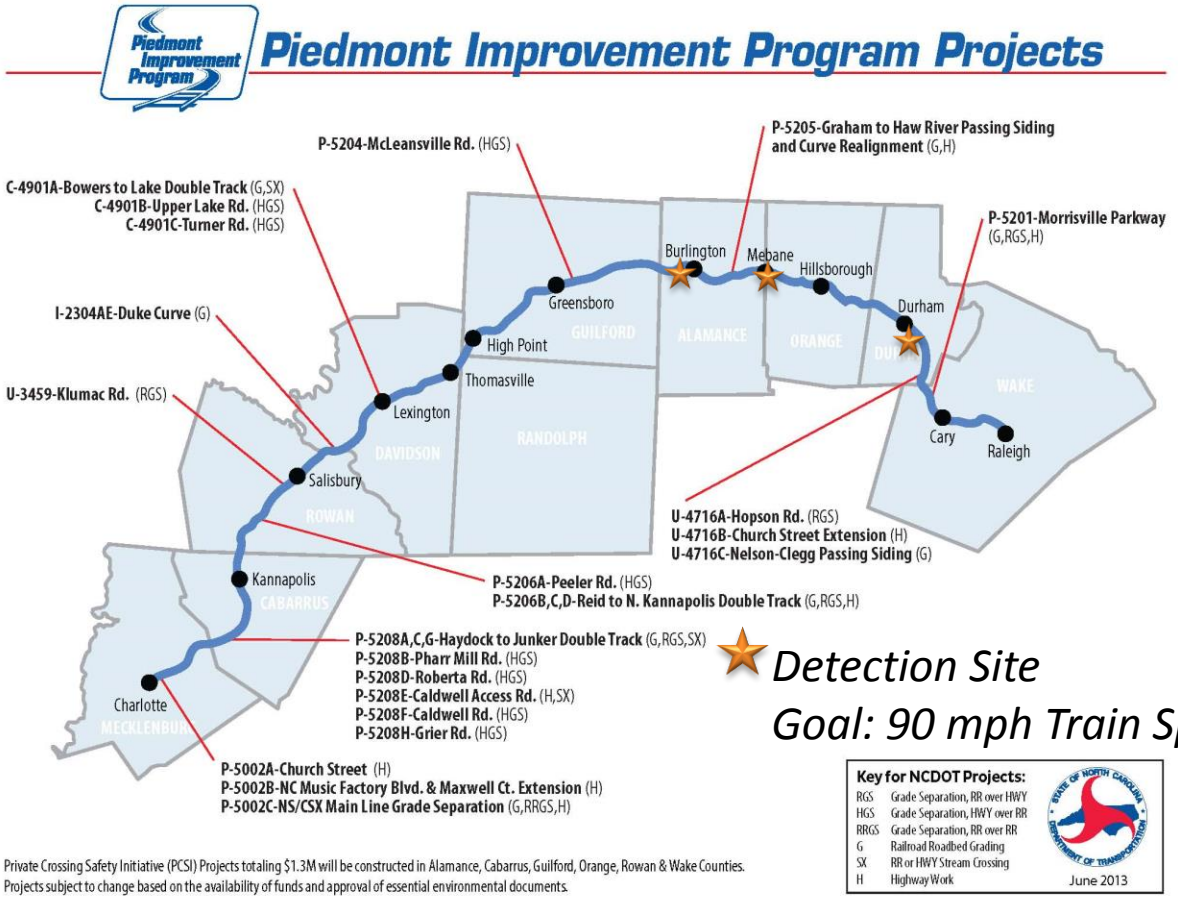
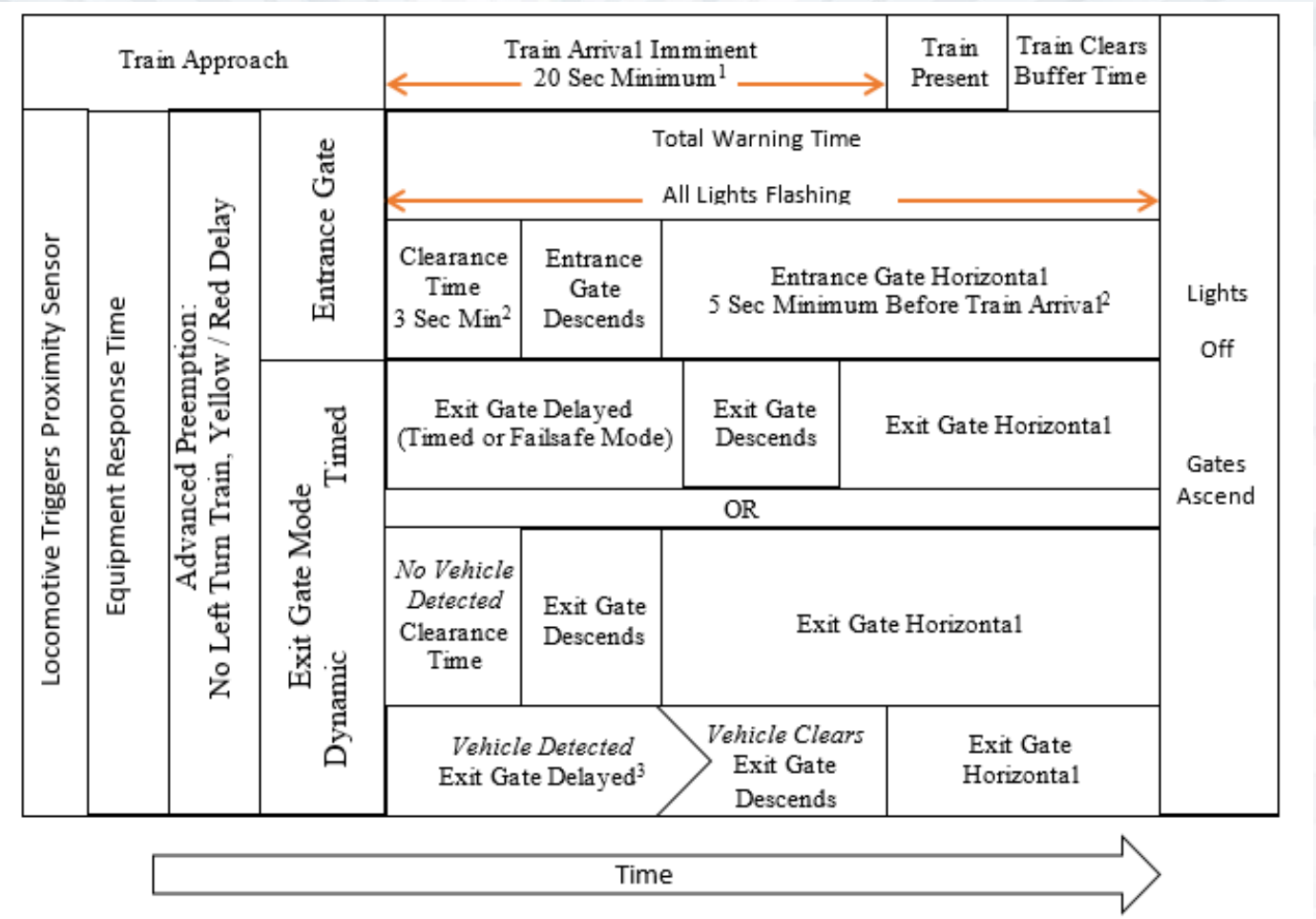
North Carolina Projects



Exit Gate Operating Modes (EGOM)

Hellman, Adrian, and Tashi Ngamdung. 2009. *Illinois high-speed rail four-quadrant gate reliability assessment.* U.S. Department of Transportation, Federal Railroad Administration, DOT/FRA/ORD-09/19



Modified from Hellman and Ngamdung

Sensor Types

	Inductive Loops	Radar
Typical Uses	Actuated Intersections	Freeway Volume Detection
Railroad Applications	Illinois HSR Connecticut NEC	Illinois Evaluation North Carolina
Installation Location	Embedded in Roadway	**Mounted Overhead**
Cost	May Cause Delay During Installation / Maintenance	Higher Purchase Cost
Life Cycle	4 to 6 years	**10 years**
Redundant Coverage	No	**Yes**
Illinois Evaluation*	No Missed Detections	No Missed Detections

* Hilleary, Thomas, and Tarek Omar. 2012. *A Radar Vehicle Detection System for Four-Quadrant Gate Warning Systems and Blocked Crossing Detection.* Washington, DC: Federal Railroad Administration, DOR/FRA/ORD-12/24.

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Dual Matrix Radar Detection

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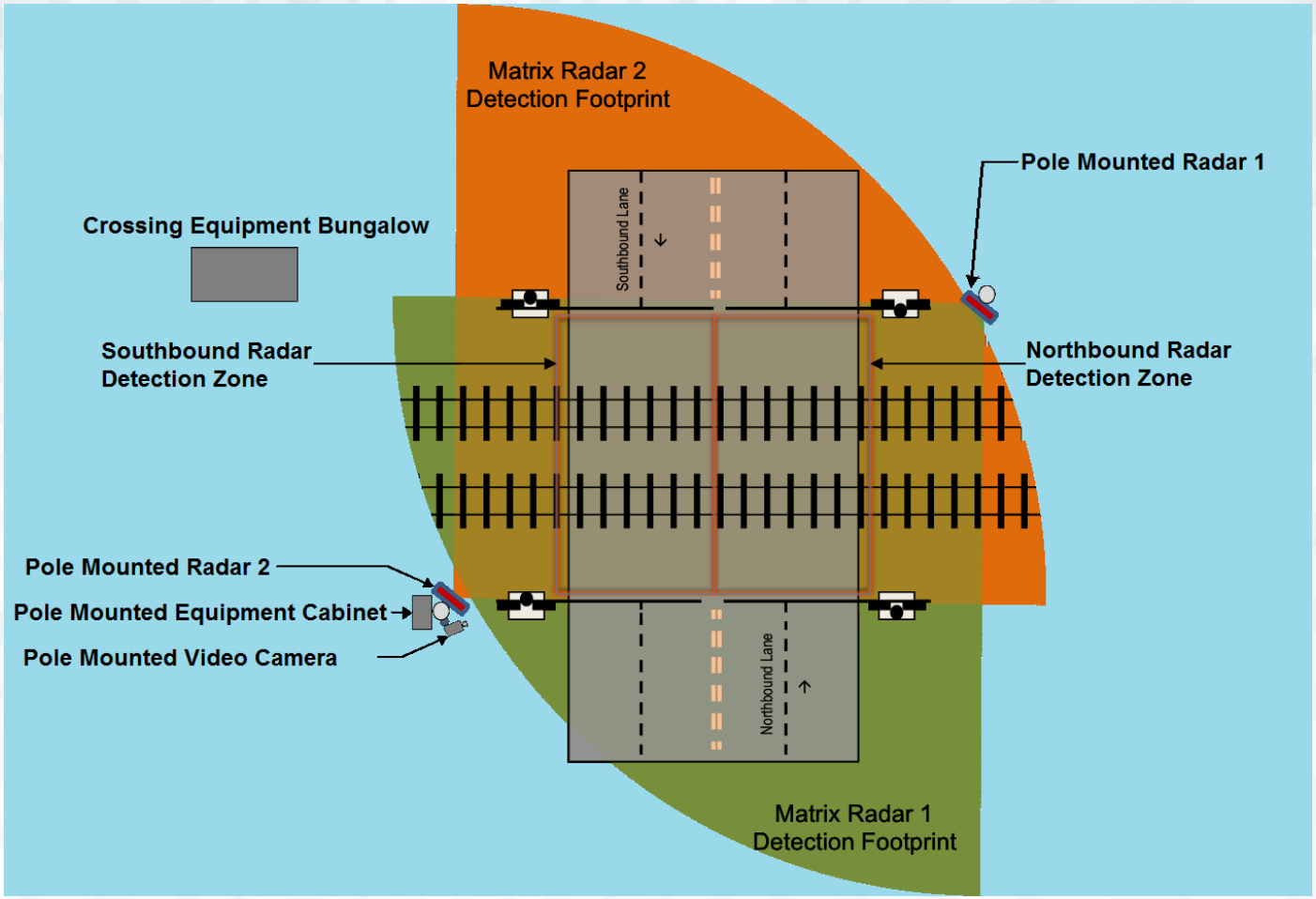
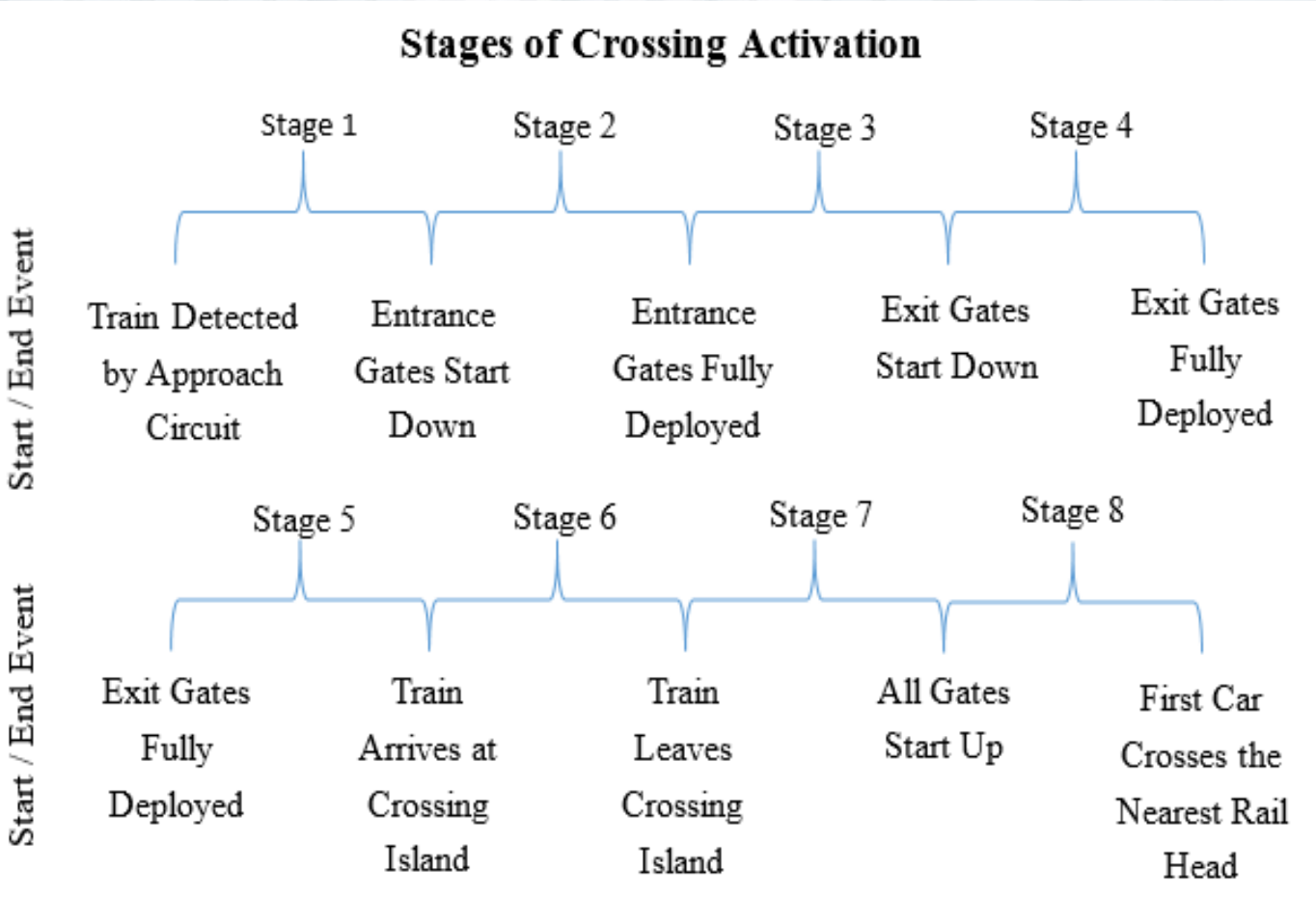


Camera Image

Delayed Exit Gate

Gate Operations & Radar Detection Counts



Activation: From Train Detection on Approach to First Car Crossing Rail

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Detection Classification and Anomalies

- Successful Detection
- Missed Detection
- Critical Failure
- False Detection
  - Phantom Detection
  - Rain or Snow Detection
  - Adjacent Lane Detection

Mebane: 5th Street

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Four Quadrant Gate Crossings

City	Mebane, NC
Crossing Number	735 472 D
Road Name	5th Street
Local Land Use	Commercial
Warning Devices	4QG, 2 Cantilevers, 12 Flashing Pairs, Preemption
Number of Tracks	1 Main
Number of Daily Trains / Speed	16 @ 60 mph
Number of Highway Lanes / Speed	3 NB, 2 SB @ 35 mph
ADT (year)	12,290 (2010)
Collisions (year)	7 (10, 10, 05, 87, 81, 80, 78)

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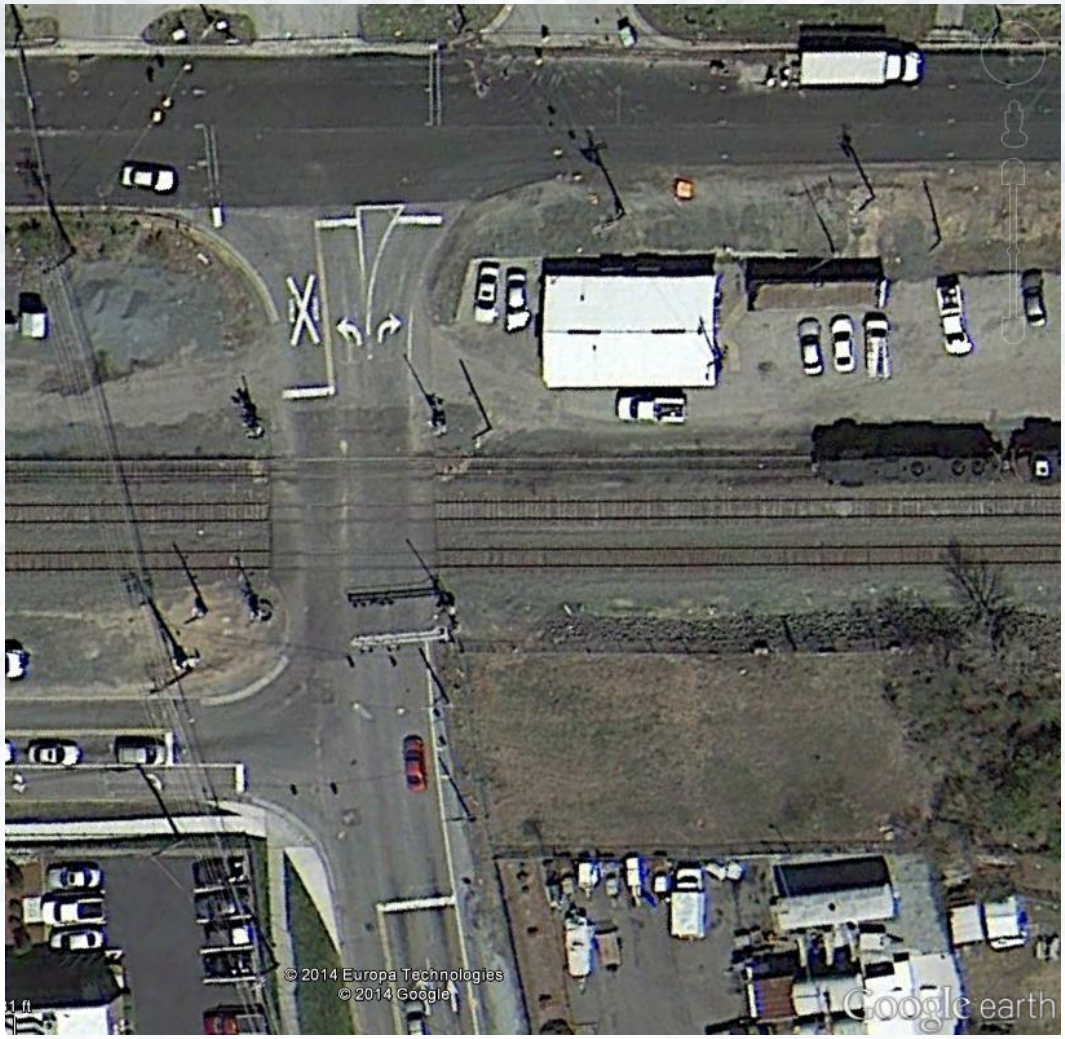
Durham: Ellis Road



City	Durham, NC
Crossing Number	735 236 Y
Road Name	Ellis Road
Local Land Use	Industrial: Heavy Vehicles
Warning Devices	4QG, 1 Cantilever, 7 Flashing Pairs, Preemption
Number of Tracks	1 Main, 1 Siding, 1 Yard
Number of Daily Trains / Speed	16 @ 60 mph
Number of Highway Lanes / Speed	2 NB, 1 SB @ 35 mph
ADT (year)	5,866 (2010)
Collisions (year)	12 (10, 09, 08, 06, 02, 01, 98, 87, 79, 79, 79, 75)

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Elon: Williamson Avenue

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Radar Vehicle Detection Within Four Quadrant Gate Crossings

City	Elon, NC
Crossing Number	722 995 V
Road Name	Williamson Avenue
Local Land Use	University: Pedestrians
Warning Devices	4QG, 2 Cantilevers, 12 Flashing Pairs, Preemption
Number of Tracks	1 Main
Number of Daily Trains / Speed	16 @ 60 mph
Number of Highway Lanes / Speed	1 NB, 2 SB @ 20 mph
ADT (year)	6,805 (2010)
Collisions (year)	1 (84)

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Vehicle Detection

Car / Truck	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5-8	Activations	Violating Vehicles *
Durham	75 / 3	41 / 4	1 / 0	1 / 0	None	294	43 / 4 16%
Elon	125 / 0	41 / 0	None	None	None	311	41 / 0 13%
Mebane	107 / 2	66 / 4	None	None	None	147	66 / 4 48%
Total	**307 / 5**	**148 / 8**	**1 / 0**	**1 / 0**	**None**	**752**	**150 / 8 21%**

*Violating Vehicles cross after the start down of the entrance gate
Percentage is the number of activations with a violating vehicle

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Detection Classification and Anomalies

	Successful Detection	Missed Detection	False Detection	Phantom Detection	Rain or Snow Detection	Adjacent Lane Detection	Critical Failure
Durham	125	0	3[1]	0	0	0	0
Elon	166	0	1	0	1	1	0
Mebane	179	0	3[2]	0	0	2	0
Total	**470**	**0**	**7**	**0**	**1**	**3**	**0**
% of Total	98.5%	0.0%	1.5%	0.0%	0.2%	0.6%	0.0%

False detection issue resolved by adjusting:

1 Radar mounting angle

2 Radar sensitivity

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Conclusions

- 10 Seconds between entrance gate down and exit gate start down
- 15 Seconds between gates fully deployed and train arrival
- Radar detection system is very reliable
  - No Missed Detections
  - 98.5% Successful detections
  - False detection issues were resolved

Conclusions

- 1 in 5 Activations have a violating vehicle
- 1 in 3 Vehicles that arrive during an activation violate the active warning devices
- Currently collecting active data for comparison

Acknowledgments

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THANK YOU!

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