

# **Examining the Traffic Safety Effects of Urban Rail Transit:**

**A Review of the National Transit Database and a Before-After Analysis of the  
Orlando SunRail and Charlotte Lynx Systems**

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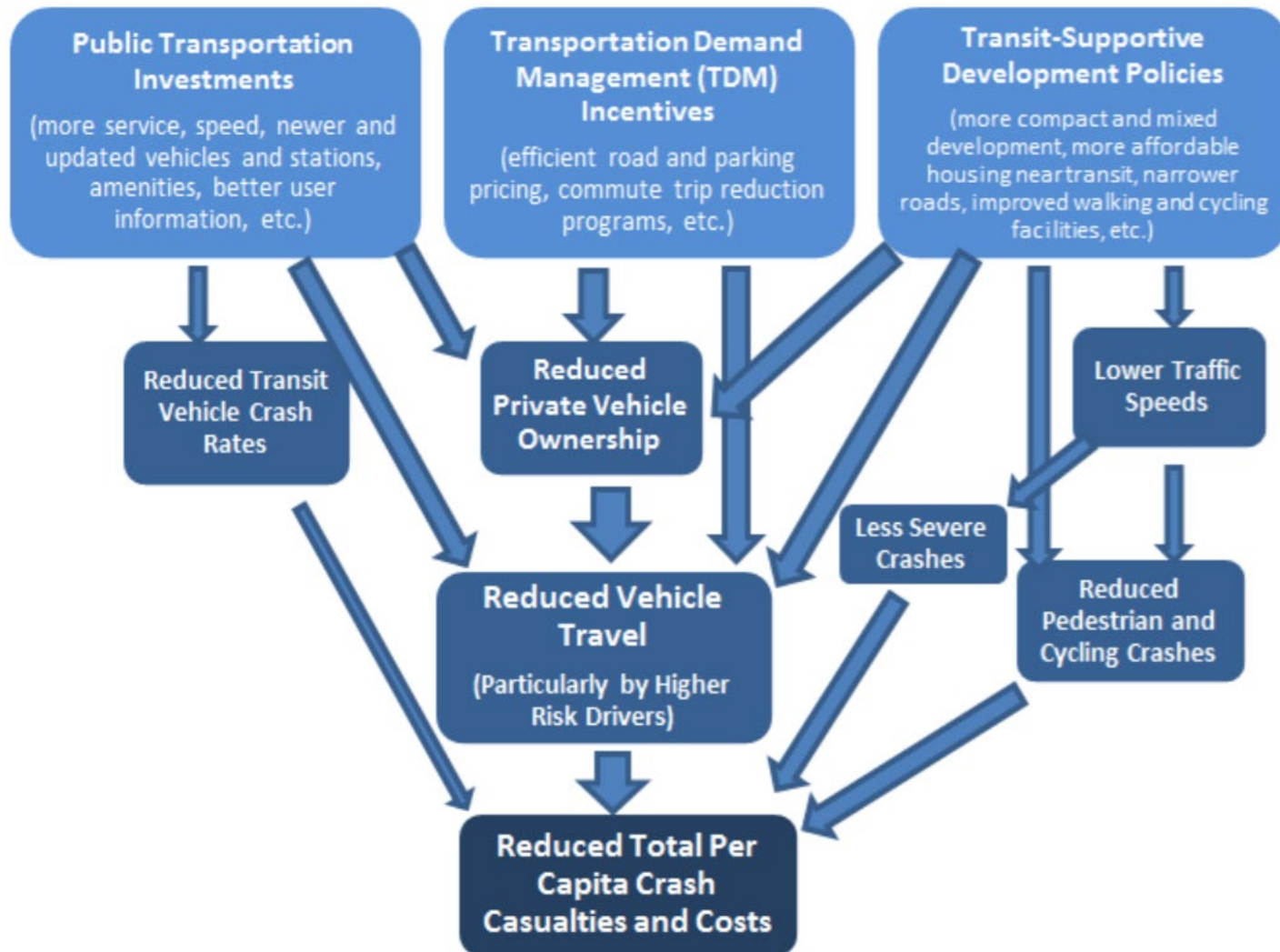
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# Conventional Wisdom:



# Fatality Rates Per Billion Miles Traveled

Mode	Fatalities	Miles Traveled (Billions)*	Fatality Rate
Passenger Car	37,133	3,212.4	9.4
Bus	90	19.3	4.7
Light Rail	51	2.8	18.2
Heavy Rail	88	17.7	5.0

\* Transit ridership measured as passenger miles traveled

- **Issues:**

- Research only details fatalities involving rail vehicles and passengers.
- No examination to date examining how the introduction of these services affect system safety—i.e., changes in crash frequency and severity associated with changes to stations and intersections.
- Safety of passenger service on freight rail lines entirely excluded.

# What are the Safety Effects of Adding At-Grade Service on Existing Freight Tracks?

## Passenger Rail: Orlando SunRail



## Light Rail: Charlotte Lynx

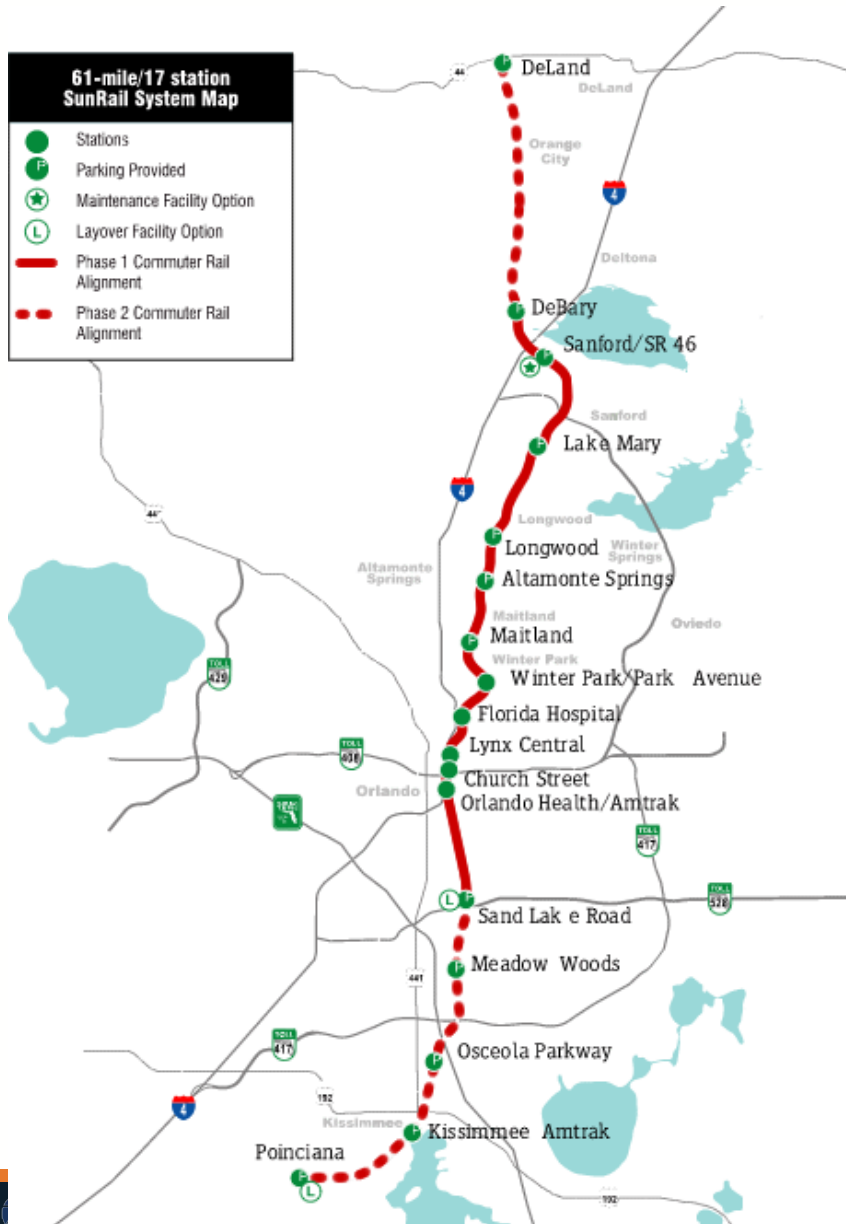


- Before-after Study
  - Crashes within 0.1 and 0.25 miles from stations
  - Crashes within 250 ft. from at-grade crossings
- Audit of high-crash locations using satellite imagery

Passenger Rail

**ORLANDO SUNRAIL**

# Orlando SunRail



- Phase 1:
  - Opened May, 2014
  - 12 stations
  - 35 miles
  - 94 at-grade crossings
- Data:
  - Before: 2009-2011
  - Construction: 2012-2014
  - Omitted Period: 2014-2015
  - After: 2015-2017





# Crashes Within 0.1 Miles from SunRail Station

SunRail Station	Total			KSI Crashes*		
	Before	After	Pct. Change*	Before	After	Pct. Change*
Altamonte Springs	9	32	255.56%	0	0	0%
Church Street	25	57	128.00%	0	1	100%
DeBary	0	4	400.00%	0	2	200%
AdventHealth	2	14	600.00%	0	2	200%
Lake Mary	2	4	100.00%	0	0	0%
Longwood	7	22	214.29%	0	0	0%
Lynx Central	28	38	35.71%	1	0	1%
Maitland	1	0	-100.00%	0	0	0%
Orlando Health	3	1	-66.67%	0	0	0%
Sand Lake Road	1	4	300.00%	0	0	0%
Sanford	0	0	0.00%	0	0	0%
Winter Park	6	20	233.33%	0	0	0%
<b>Total</b>	<b>84</b>	<b>196</b>	<b>133.33%</b>	<b>1</b>	<b>5</b>	<b>400%</b>
	Wilcoxon z=2.592; p(z)=0.0095					

\*Note: where there are 0 values, pct. Change is 100% of the crash count

## Crashes Within 0.25 Miles from SunRail Station

SunRail Station	Total Crashes			KSI Crashes*		
	Before	After	Pct. Change	Before	After	Pct. Change
Altamonte Springs	52	75	44.23%	3	2	-33.33%
Church Street	252	436	73.02%	5	11	120.00%
DeBary	1	11	1000.00%	0	4	400%
AdventHealth	67	126	88.06%	0	7	700%
Lake Mary	24	79	229.17%	3	0	-300%
Longwood	15	64	326.67%	1	0	-100%
Lynx Central	171	261	52.63%	10	11	10.00%
Maitland	37	85	129.73%	5	0	-500%
Orlando Health	21	30	42.86%	1	1	0.00%
Sand Lake Road	97	127	30.93%	4	7	75.00%
Sanford	9	14	55.56%	0	1	100%
Winter Park	33	88	166.67%	0	4	400%
<b>Total</b>	<b>779</b>	<b>1396</b>	<b>79.20%</b>	<b>32</b>	<b>48</b>	<b>50.00%</b>
	Wilcoxon z=3.061; p(z)=0.002					

\*Note: where there are 0 values, pct. change is 100% of the crash count



# Crash Types Near SunRail Stations

	0.1 Miles			0.25 Miles		
	Before	After	Pct. Change	Before	After	Pct. Change
<b>Pedestrian</b>	1	4	300.00%	32	36	11.11%
<b>Bicyclist</b>	1	0	-100.00%	20	12	-66.67%
<b>Rail-Vehicle</b>	0	1	100.00%	0	4	400.00%
<b>Parked Car</b>	6	7	16.67%	30	46	34.78%
<b>Multiple Vehicle</b>						
- <b>Rear-End</b>	25	76	204.00%	234	478	51.05%
- <b>Head-on</b>	3	3	0.00%	19	38	50.00%
- <b>Angle</b>	21	37	76.19%	219	348	37.07%
- <b>Sideswipe</b>	6	31	416.67%	80	231	65.37%
- <b>Other Multiple Vehicle</b>	11	16	45.45%	68	89	23.60%
<b>Fixed Object</b>	6	17	183.33%	48	89	46.07%
<b>Other/Unknown</b>	4	4	0.00%	29	25	-16.00%
<b>Total</b>	84	196	133.33%	779	1,396	44.20%

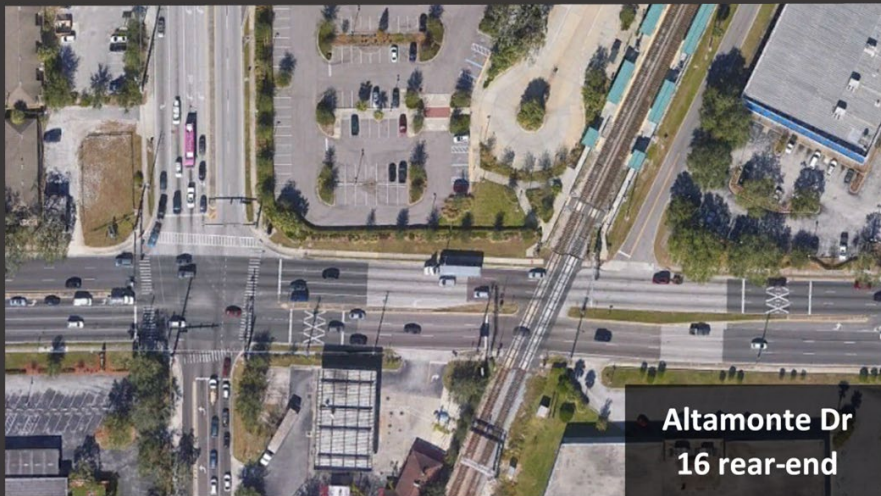
## Crashes within 250 ft of a SunRail Grade Crossing

Crash Severity	Before	After	Pct. Change
Fatal injury	1	5	400.00%
Incapacitating injury	4	11	175.00%
Non-incapacitating injury	32	51	59.38%
Possible injury	64	145	126.56%
PDO	90	393	336.67%
Unknown	7	14	100.00%
KSI Crashes	5	16	220.00%
Total Crashes	198	619	212.63%

# Crash Types within 250' of a SunRail Grade Crossing

	Before	After	t	p
<b>Pedestrian</b>	2	7	1.518	0.066
<b>Bicyclist</b>	2	11	2.229	0.014
<b>Rail-Vehicle</b>	2	17	2.698	0.004
<b>Parked Car</b>	6	16	2.575	0.006
<b>Multiple Vehicle</b>				
- <b>Rear-End</b>	81	220	4.580	0.000
- <b>Head-on</b>	9	8	-0.257	0.399
- <b>Angle</b>	34	135	5.329	0.000
- <b>Sideswipe</b>	14	64	4.676	0.000
- <b>Other Multiple Vehicle</b>	18	47	2.702	0.004
<b>Fixed Object</b>	17	73	3.624	0.000
<b>Other/Unknown</b>	13	21	1.238	0.109
<b>Total</b>	198	619	6.762	0.000

# Locations of Read-end Collisions

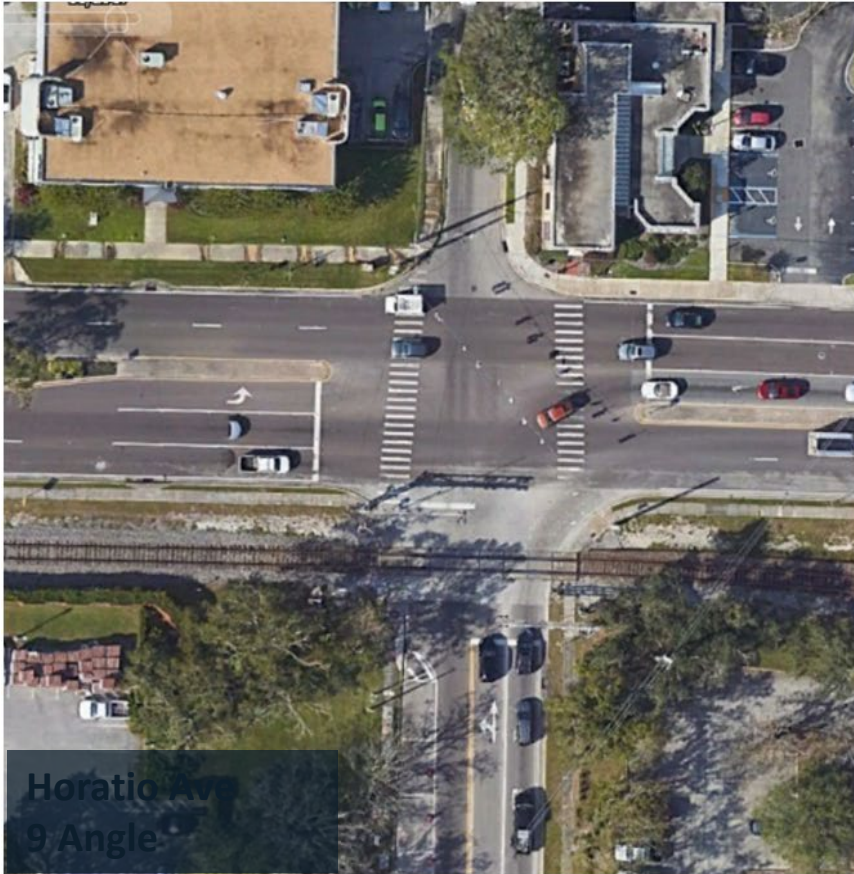


## MUTCD 8C.09: Traffic Control Signals at or Near Highway-Rail Grade Crossings

- 04. If a highway-rail grade crossing is equipped with a flashing-light signal system and is located within **200 feet** of an intersection or midblock location controlled by a traffic control signal, the traffic control signal should be provided with preemption in accordance with Section 4D.27.
- 05. Coordination with the flashing-light signal system, queue detection, or other alternatives should be considered for traffic control signals located farther than **200 feet** from the highway-rail grade crossing. Factors to be considered should include traffic volumes, highway vehicle mix, highway vehicle and train approach speeds, frequency of trains, and queue lengths.



## Locations of Angle Collisions



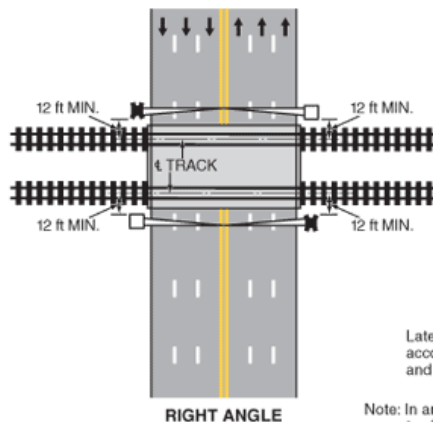
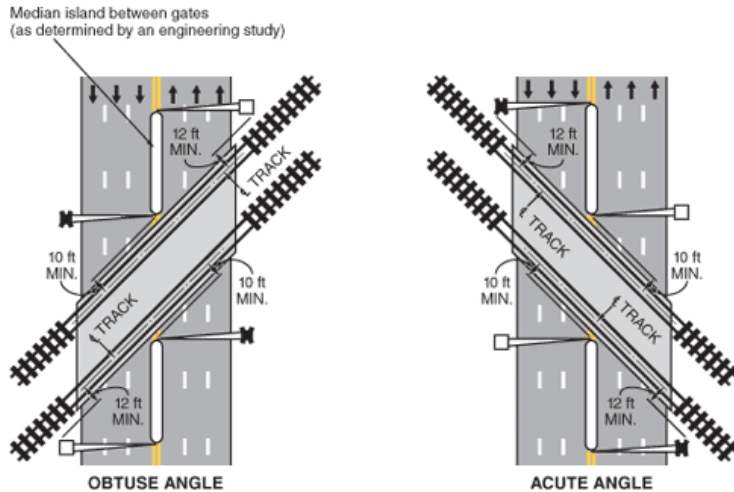
## Locations of Rail-Vehicle Collisions





# Four-Quadrant Gates and Quiet Zones

Figure 8C-2. Example of Location Plan for Flashing-Light Signals and Four-Quadrant Gates



Lateral clearances shall be in accordance with Figure 8C-1 and Chapter 8C.

Note: In an effort to simplify the figure to show typical location plans for flashing-light signals and four-quadrant gates, not all traffic control devices are shown on this figure.

## Legend

- Direction of travel
- ⌘ Entrance gate
- Exit gate

- 49 CFR Part 222: The following engineering types of ASMs may be included in a proposal for approval by FRA for creation of a **quiet zone**: (1) Temporary Closure of a Public Highway-Rail Grade Crossing, (2) Four-Quadrant Gate System, (3) Gates With Medians or Channelization Devices, and (4) One-Way Street With Gate(s).
- MUTCD 8C.06.01 Four-Quadrant Gate systems may be installed to improve safety at grade crossings based on an engineering study when less restrictive measures, such as automatic gates and median islands, are not effective.

Light Rail

**CHARLOTTE LYNX**



## Charlotte Lynx

- Blue Line
  - Opened November, 2007
  - 15 stations
  - 9.6 miles
  - 16 at-grade crossings
  
- Data:
  - Before: 2004
  - Construction: 2005-2007
  - Omitted Period: 2008
  - After: 2009-2011
  - Issue: limited before data



## Data Issues...

- Data recording methods changed between before and after periods.
- “Great Recession” led to 24% national reduction in fatalities between 2004 and 2011.
- The data report a 21% countywide reduction in crashes between 2004 and 2009-2011

# Comparison Lynx vs. SunRail

	SunRail	Lynx	Lynx vs. SunRail
Stations	12	15	
Crashes 0.1 mile from Station	196	228	
Avg. Crashes 0.1 mile from Station	16	15	-6.94%
Grade Crossings	94	16	
Total Crashes near Crossings	619	196	
Average Crashes per Crossing	7	12	86.03%

# Crashes within 0.1 Mile of a Lynx Station

Lynx Station	Total Crashes*			KSI Crashes*		
	Before (1 year)	After (1 yr avg)	Pct. Change	Before (1 year)	After (1 yr avg)	Pct. Change
3rd St/Convention Center	29	14	-52%	0	0.3	30%
7th St	35	29	-17%	0	0	0%
Archdale	43	32	-26%	0	0	0%
Arrowood	11	7	-36%	0	0	0%
Bland St	19	9	-53%	0	0	0%
Carson	10	6	-40%	0	0	0%
Charlotte Transportation Center	40	27	-33%	0	0	0%
East/West	35	36	3%	0	0	0%
I-485/South Blvd	7	4	-43%	0	0	0%
New Bern	18	8	-56%	0	0.3	30%
Scaleybark	11	9	-18%	0	0.3	30%
Sharon Road West	25	11	-56%	0	0	0%
Stonewall	31	15	-52%	0	0	0%
Tyvola	16	20	25%	0	1	100%
Woodlawn	1	1	0%	0	0	0%
<b>Total</b>	<b>331</b>	<b>228</b>	<b>-0.31%</b>	<b>0</b>	<b>1.9</b>	<b>190%</b>
	Wilcoxon z=-2.929; p(z)=0.003			Wilcoxon z=-2.929; p(z)=0.003		

# Crashes within 0.25 Mile of a Lynx Station

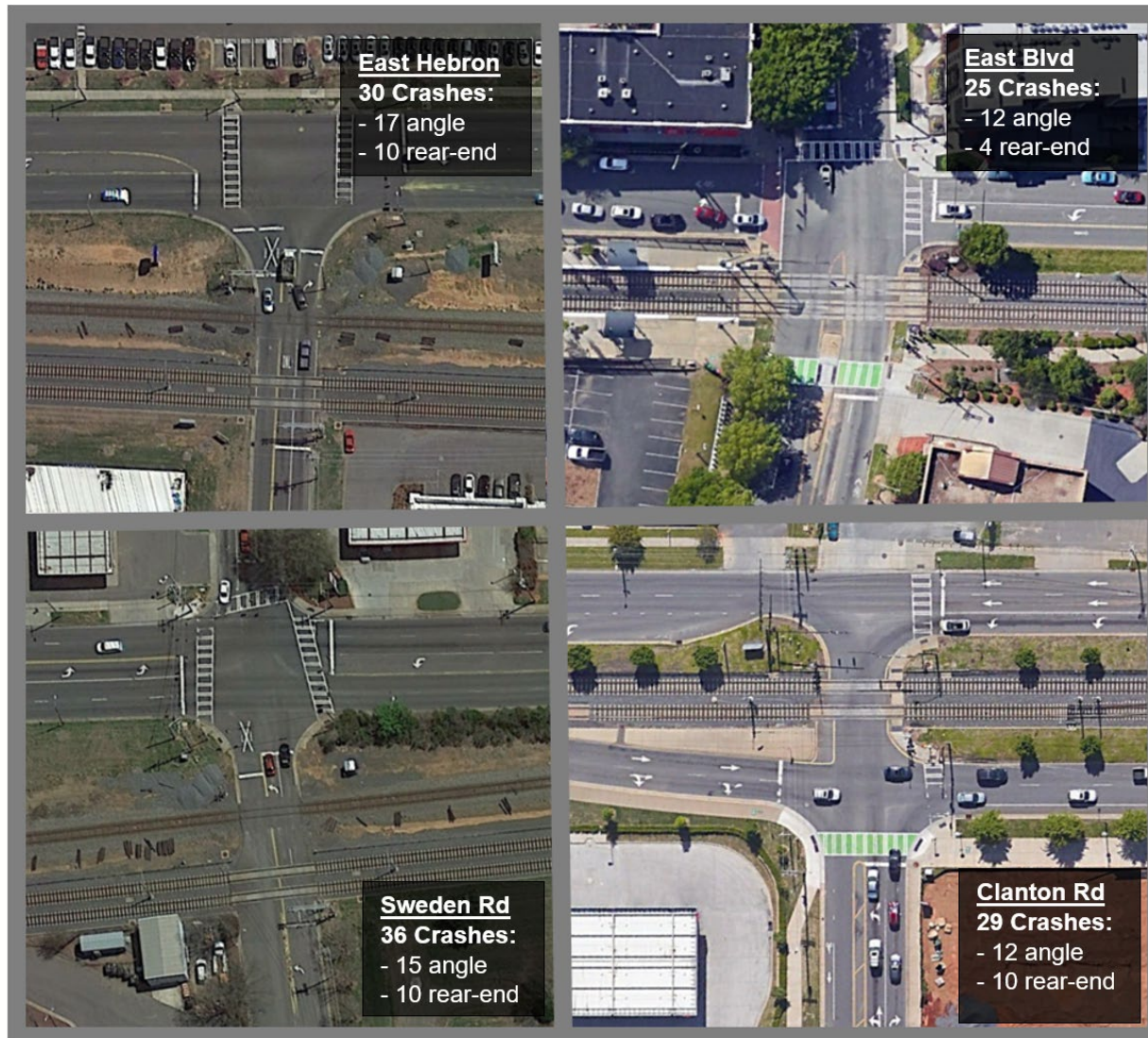
Lynx Station	Total Crashes*			KSI Crashes*		
	Before (1 year)	After (1 year avg)	Pct. Change	Before (1 year)	After (1 year avg)	Pct. Change
3rd St/Convention Center	128	83	-35%	0	0.7	70%
7th St	183	93	-49%	1	0	-100%
Archdale	71	53	-25%	0	0.3	30%
Arrowood	57	41	-28%	0	0	0%
Bland St	57	49	-14%	1	0	-1%
Carson	49	47	-4%	0	0	0%
Charlotte Transportation Center	130	97	-25%	1	0.3	-70%
East/West	117	85	-27%	0	0.3	300%
I-485/South Blvd	26	20	-23%	0	0.3	300%
New Bern	37	25	-32%	0	0	0%
Scaleybark	57	32	-44%	0	0.3	30%
Sharon Road West	61	18	-70%	0	0	0%
Stonewall	78	53	-32%	1	0	-1%
Tyvola	139	93	-33%	1	1.3	30%
Woodlawn	117	65	-44%	0	0	0%
<b>Total</b>	<b>1,307</b>	<b>855</b>	<b>-35%</b>	<b>5</b>	<b>3.5</b>	<b>-30%</b>
	Wilcoxon z=-3.08; p(z)=0.0007			Wilcoxon z=-0.058; p(z)=0.9535		



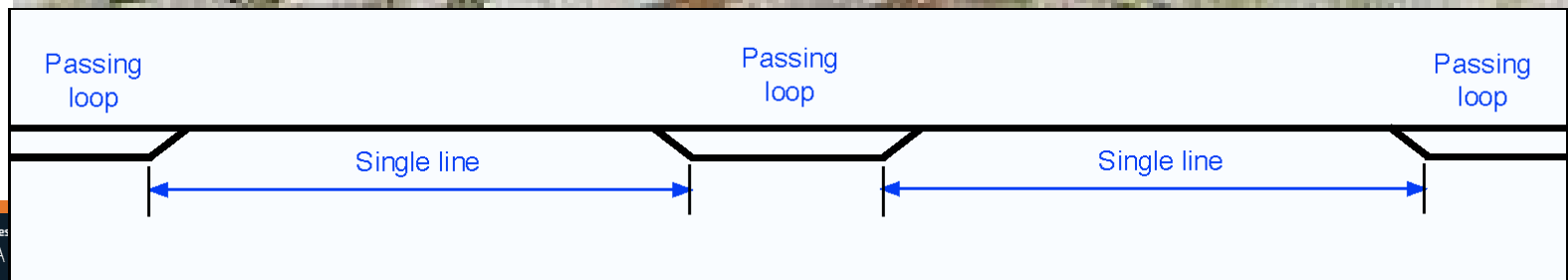
# Crashes within 250' of intersection

	Total		KSI	
Type	Before (one-year)	After (one year avg)	Before (one year)	After (one-year avg)
Pedestrian	na	1	na	0
Bicyclist	na	1	na	0
Rail-vehicle	na	0	na	0
Parked car	na	0	na	0
Multiple Vehicle	na	0	na	0
- Rear-end	na	22	na	0
- Head-on	na	1	na	0
- Angle	na	20	na	0
- Sideswipe	na	7	na	0
- Other multiple vehicle	na	2	na	0
Fixed object	na	2	na	0
Other/unknown	na	9	na	0.3
Total	78	65	0	0.3

# High-Crash Intersections



# Consideration: Passing Loop vs. Double-track



# Major Conclusions:

- Findings do not support the conclusion that light rail or passenger rail necessarily lead to improved safety.
  - **Orlando SunRail:** significant increases in total and KSI crashes observed near stations and at intersections.
  - **Charlotte Lynx:** despite data issues, findings were, at best, mixed. Safety performance similar to or worse than SunRail, though before-after data report only small increases in KSI crashes observed within 0.1 mile of stations; and at select intersections.

# Safety Considerations:



- More than collisions involving rail vehicles:
  - Most pronounced effect on **multiple-vehicle** crashes near crossings.
  - Angle and rear-end collisions particularly common.
- Pedestrian safety important, but the safety effects are not as pronounced as multiple-vehicle collisions.

# Policy and Research Needs

- Greater attention to effects along at-grade crossings:
  - Revision to MUTCD policy on traffic signal and rail pre-emption.
  - Research on the safety effects of double-tracking near signalized intersections
  - Examination of appropriate signal phasing: protected-only left turn phasing and extended red clearance intervals likely needed.

