Observation and Analysis of Motorist Behaviors: Highway-Railway Grade Crossing at SR 3014 (Morrisville-Carpenter Road)

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RESEARCH & DEVELOPMENT

Observation and Analysis of Motorist Behaviors

Highway-Railway Grade Crossing at SR 3014 (Morrisville-Carpenter Road)

Morrisville, Wake County, North Carolina (Crossing 734753J)

Phase II: Data Collection Protocol and Summary

August 7, 2024

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16. Abstract

The purpose of this project was to gather video data and analyze it to quantify the occurrence of motorists' behaviors and actions. This effort included the installation of video cameras for continuous monitoring and recording motorists' actions to identify, capture, and catalog errant movements within the crossing and highway intersection. The research builds upon experience gained with artificial intelligence developed under NCDOT R&D Project 2017-50 "*Pedestrian Incident Detection Monitoring using Artificial Intelligence*" to automatically identify videos with potential relevance for this project.

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INTRODUCTION

The purpose of this project was to gather video data and analyze it to quantify the occurrence of motorists' behaviors and actions. This effort included the installation of video cameras for continuous monitoring and recording motorists' actions to identify, capture, and catalog errant movements within the crossing and highway intersection. The research builds upon experience gained with artificial intelligence developed under NCDOT R&D Project 2017-50 "*Pedestrian Incident Detection Monitoring using Artificial Intelligence*" to automatically identify videos with potential relevance for this project.

METHODOLOGY

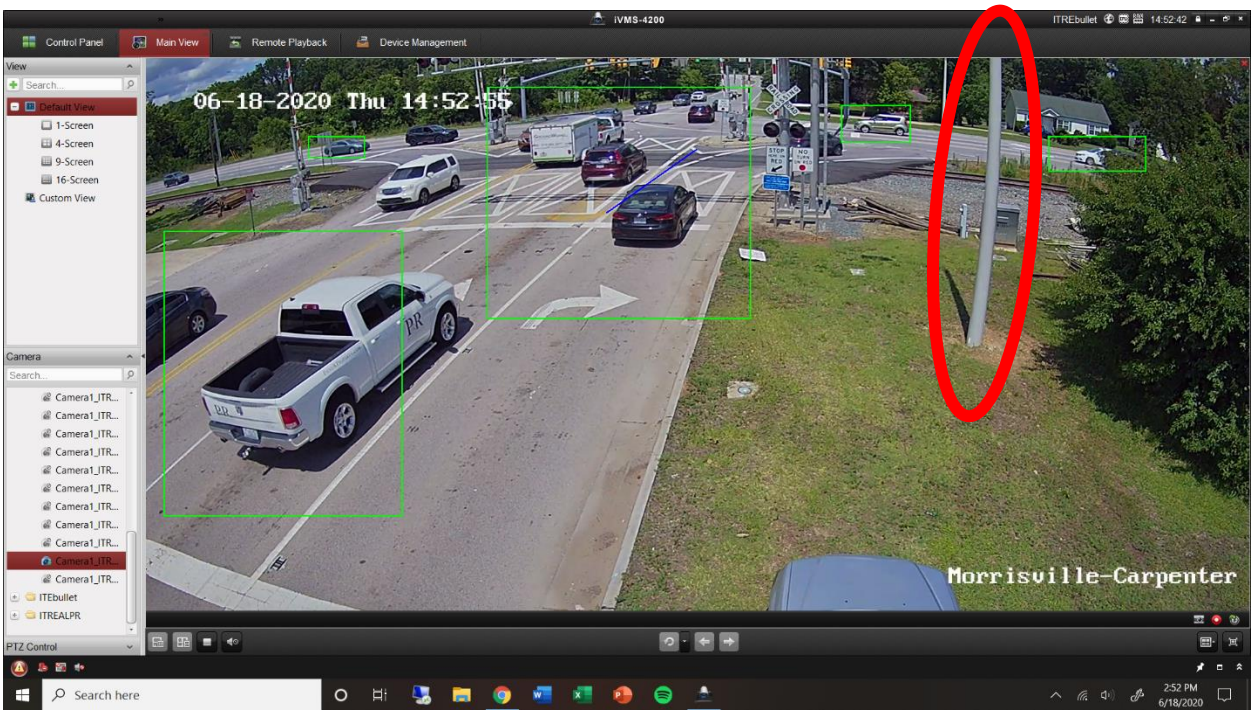
Equipment Installation

A camera was mounted approximately 20 feet above the ground on a light pole adjacent to the southern corner of Morrisville Carpenter Road and Chapel Hill Road/NC-54 to achieve an advantageous perspective over the observed intersection. The camera could be accessed via wireless cellular modem to remotely observe a live view and confirm proper operation. However, recordings were only downloaded manually while directly connected to the camera via Ethernet because of the size of the videos and proximity of the location to the project team. The camera and modem were both powered by three 22-amp-hour lead-acid batteries in parallel that were charged by a 20-watt solar panel in the initial install. The 20-watt solar panel was replaced with a larger 100-watt panel before the nearby plants regained leaves which might block sunlight to the panel. This was to prevent the batteries from draining below the necessary voltage to properly operate the equipment. The batteries, modem, solar controller, and wiring are shown in the images below.

Initial Camera Installation

Camera Installation w/ Larger Solar Panel

Batteries, Wiring, and Modem Setup

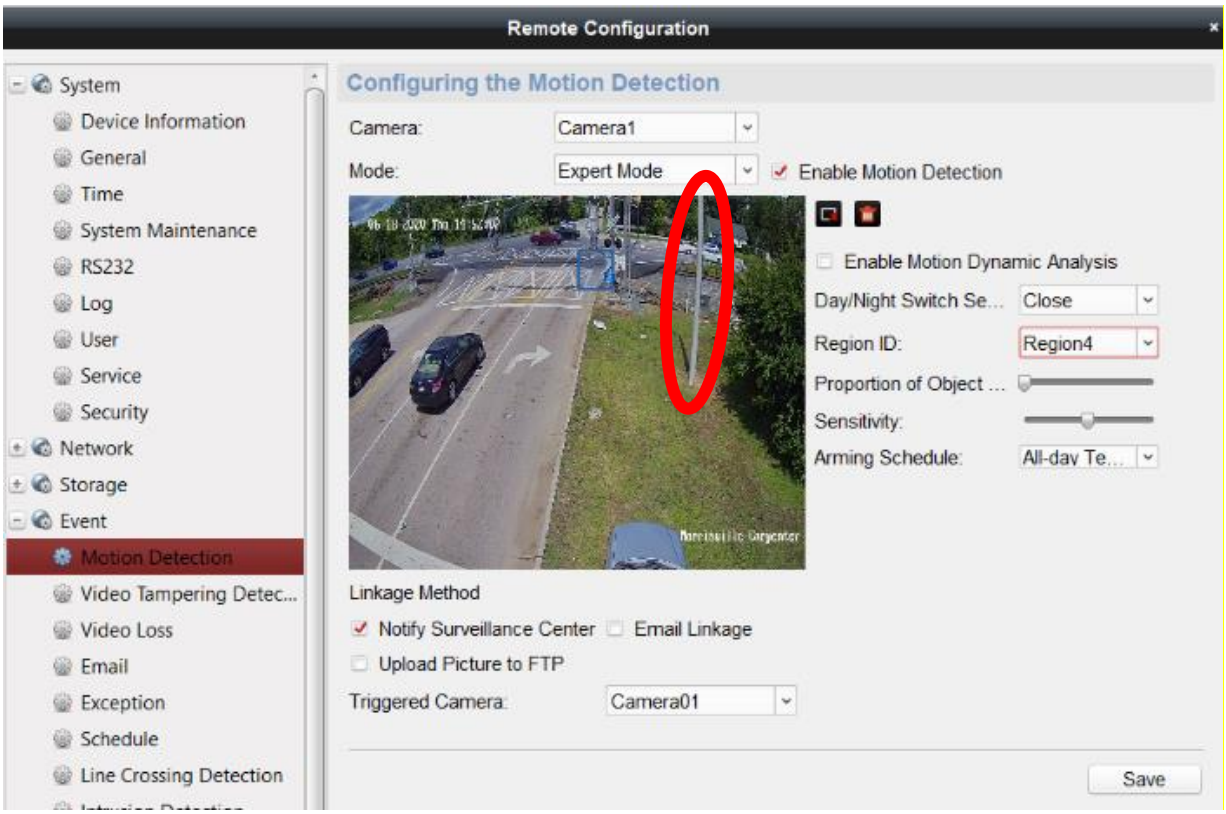


Example of Artificial Intelligence to Automatically Identify Vehicles (from Phase I, Phase II camera location circled in red)

Phase II Camera View

Identifying Undesirable Vehicle Maneuvers

The camera used an automatic day-night switch with built-in infrared so videos could be recorded at all times of day. A motion detection zone was drawn to cover the northeast-bound right turn lane to capture recordings of vehicles moving around the median island, which was the primary movement of interest to the NCDOT.



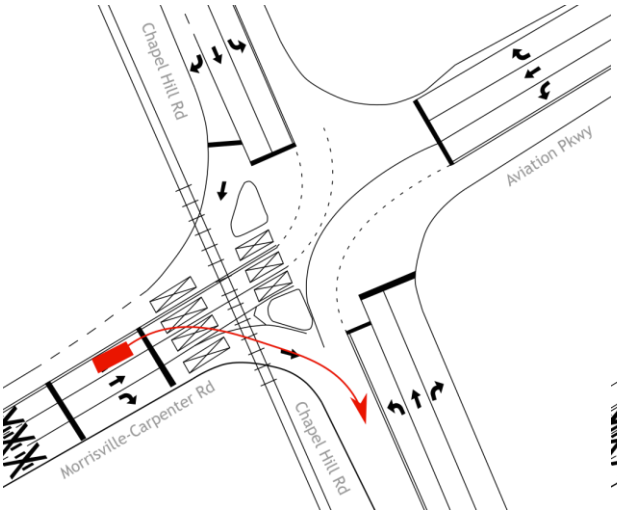
Example of Motion Detection Zones to Trigger Recordings (from Phase I, Phase II camera location circled in red; detection zone in blue)

Virtual loops were drawn to help reduce the amount of video to parse through, but these still captured false positives when vehicles were making normal maneuvers through the northeast-bound right turn lane. The recordings were manually reduced to remove all normal maneuvers and identify the undesirable movements. The recordings that included unusual behavior were flagged in a spreadsheet and copies of these recordings were saved in folders grouped by general behavior. These include vehicles which stopped in the middle of the intersection for no apparent reason, vehicles turning from the wrong lane, and, of most interest to the NCDOT, vehicles going around the median island instead of turning before the median island when traveling southwest on Aviation Parkway and turning left onto NC-54.

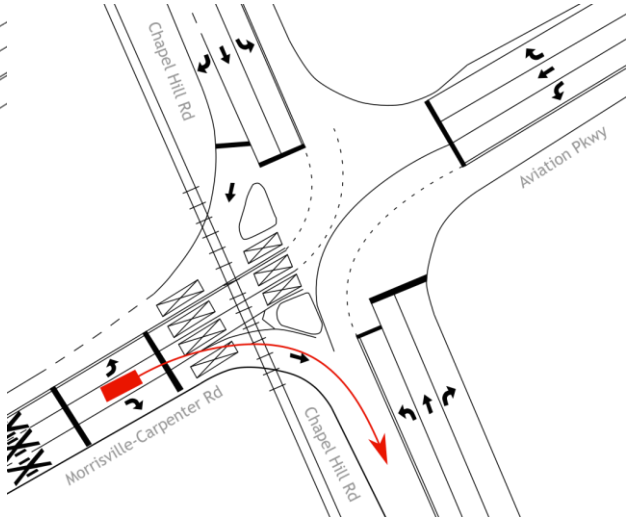
Analysis Methodology

Researchers identified five different maneuver categories while processing the 26,000 videos: turns involving a wrong lane, stopped vehicles on the rail island, barrier related erratic maneuvers, police officer events, and construction events. From January 5th to February 28th 2023, researchers reviewed videos using the VCL Player, observing different driving behaviors. In conjunction with each event, the date and timestamp were recorded. Further, the analyst recorded particular aspects about the nature of the event, including the location of the vehicle, if the event involved a commercial truck, if a visible police officer enforced the traffic infraction, if there it was raining during the event, and if the event resulted in a vehicle making a right on red. Further, events were classified as occurring during either night or day.

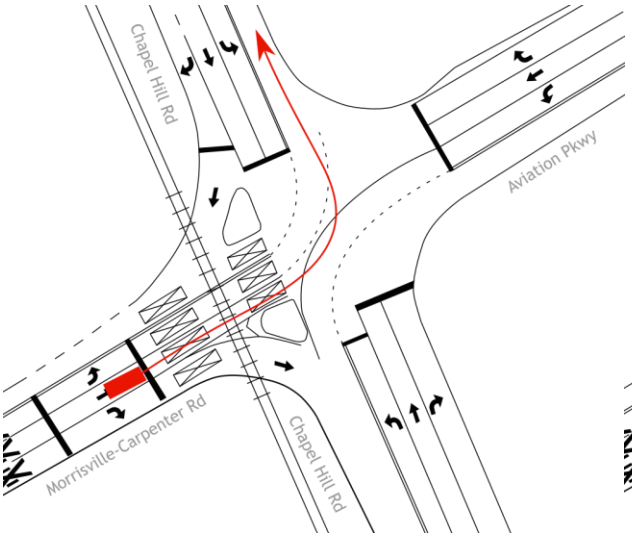
As aforementioned, events were placed into one of five categories, beginning with making a turn from the incorrect lane when approaching the Morrisville-Carpenter and Chapel Hill Road intersection. This event was specifically monitored in relation to vehicles approaching the intersection east-bound on Morrisville-Carpenter Road. The event was further sub-categorized into the following: vehicle makes right turn from middle lane, vehicle makes right turn from left lane, vehicle makes left turn from middle lane, vehicle goes straight from right lane, and vehicle goes straight from left lane.



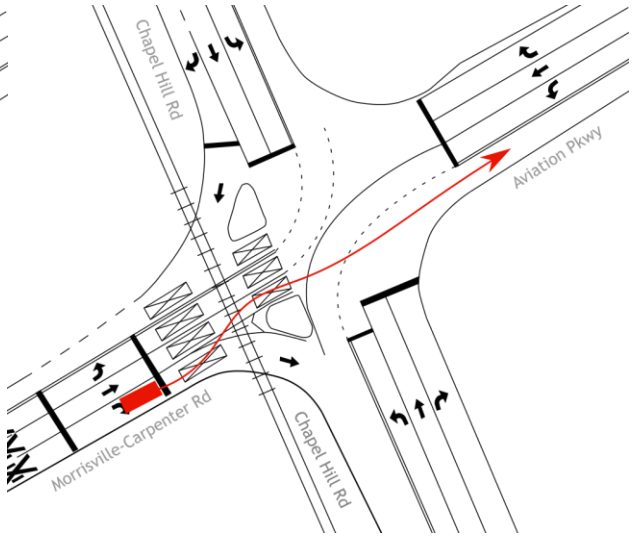
Right Turn from Left Lane



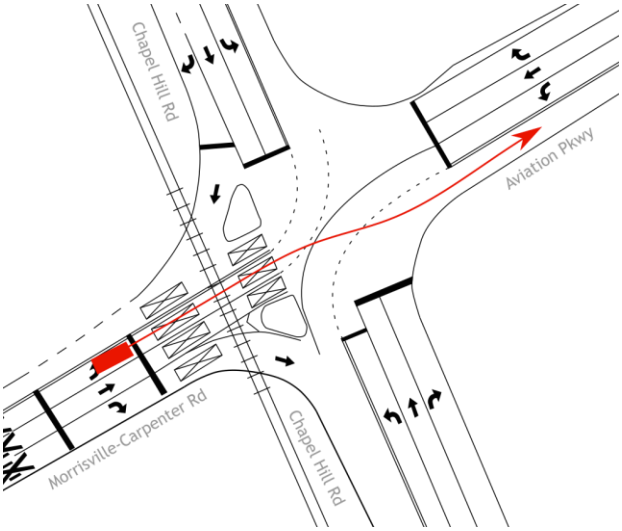
Right Turn from Middle Lane



Left Turn from Middle Lane

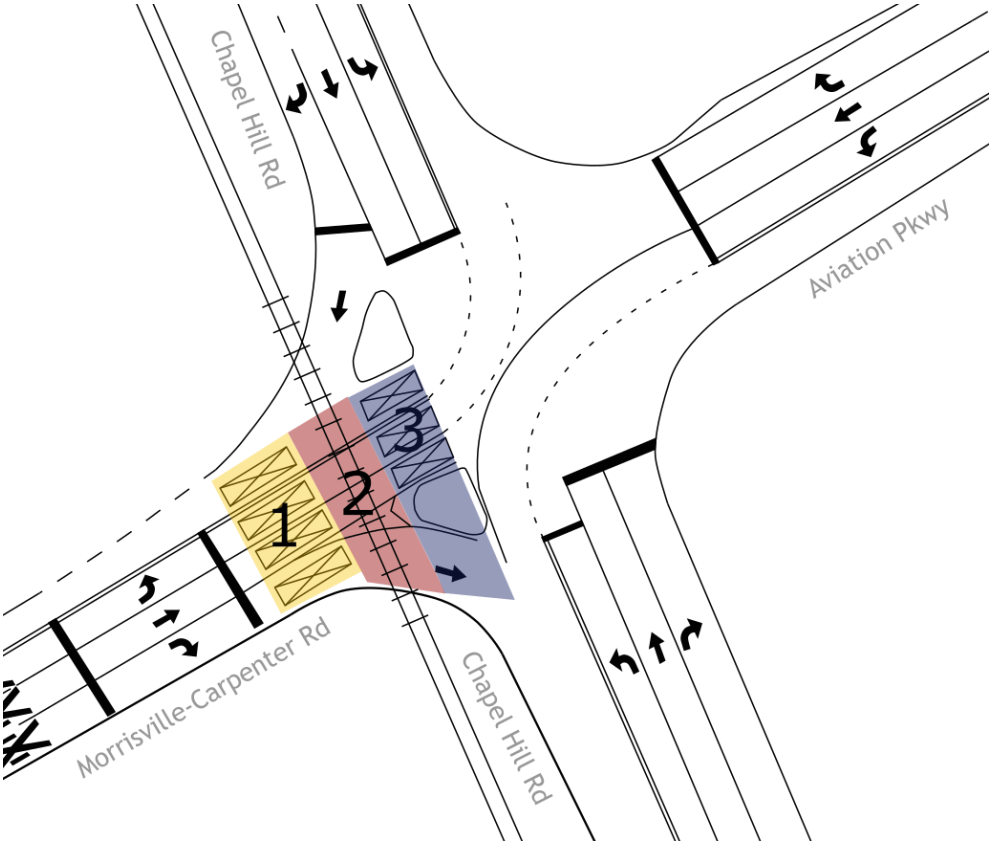


Straight from Right Lane



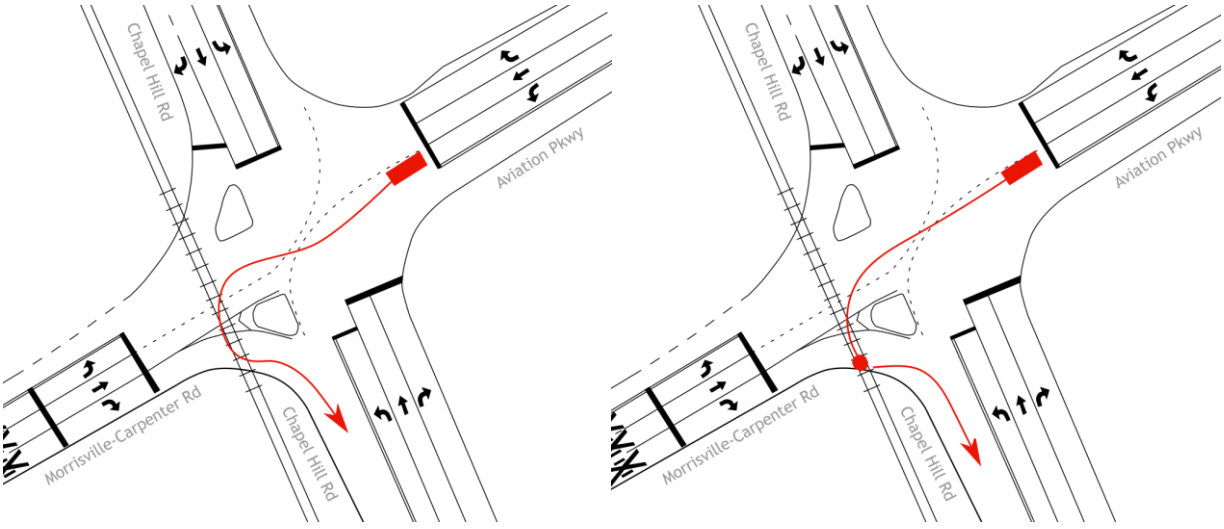
Straight from Left Lane

Vehicles that stopped at the intersection in close proximity to the railroad were classified as vehicle stops on the rail island. This event was limited to vehicles approaching the intersection east-bound on Morrisville-Carpenter Road. The analyst took note of which lane the vehicle(s) was in and the proximity of the vehicle to the railroad tracks. This proximity was further categorized into four zones: Zone 1, Zone 2, Zone 3, and Zone 3+. Zone 1 represented the encroachment of the first set of 'Do Not Block the Box' markings. Zone 2 represented the vehicle stopping on the railroad. Zone 3 represented the encroachment of the second set of 'Do Not Block the Box' markings. Zone 3+ represented the vehicle stopping in the intersection.

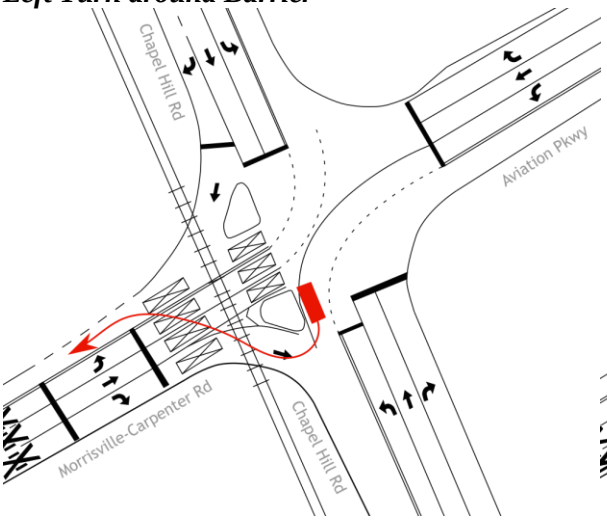


Rail Island Zones Depiction

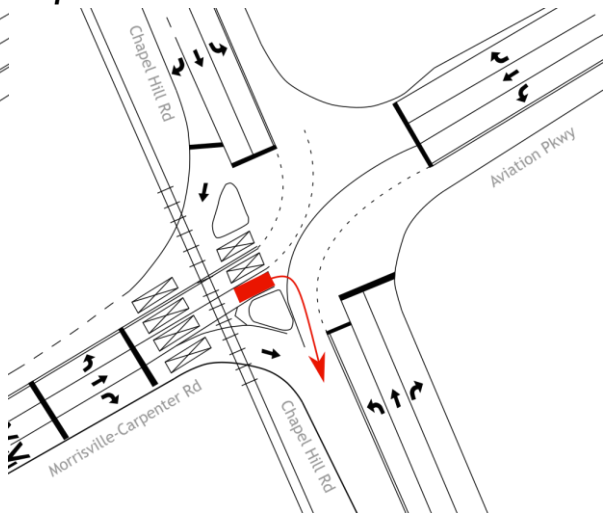
Events which related to vehicles making erratic maneuvers around the barrier were recorded into the following categories: a vehicle makes a turn on the wrong side of barrier, a vehicle makes a left turn around the barrier, a vehicle makes a U-turn around the barrier, a vehicle makes a right turn around the barrier, a vehicle turns left through the wrong lane around the barrier, a vehicle moves around the barrier in the right lane onto the tracks, and a vehicle makes an illegal left turn around the barrier. These maneuvers were recorded from vehicles approaching the intersection from all directions.



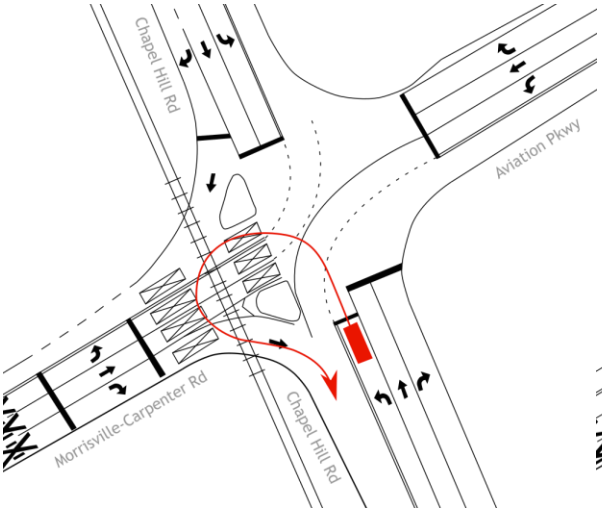
Left Turn around Barrier



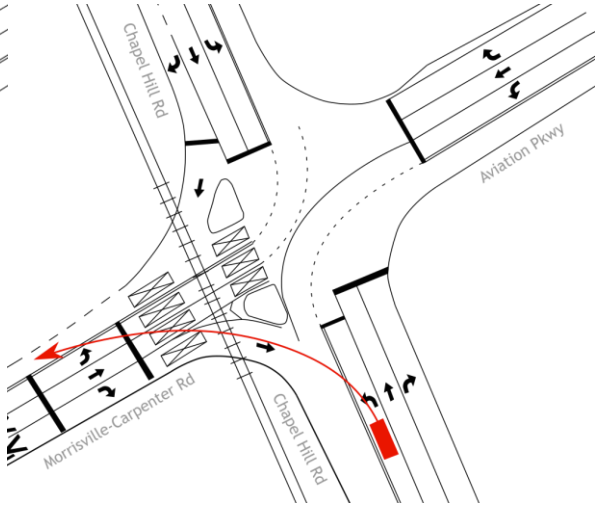
Left Turn around Barrier onto Tracks



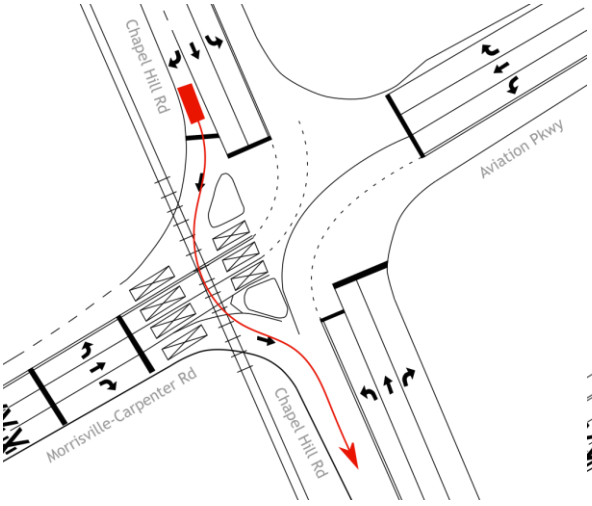
Right Turn around Barrier



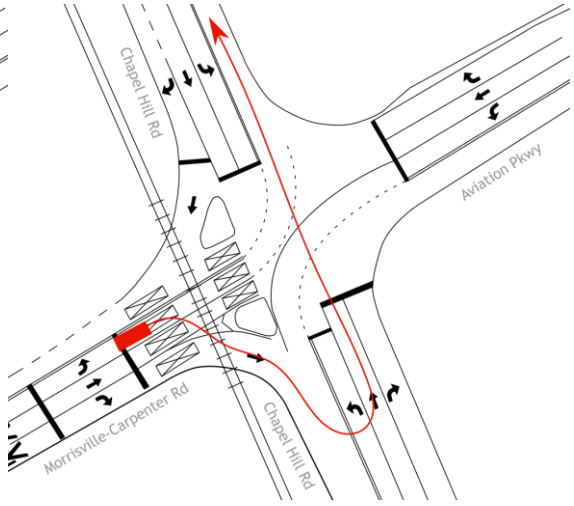
U-Turn around Barrier



Left through Wrong Lane



Through from Right Turn Lane



U-Turn after Right Turn

General Maneuvers
Some maneuvers did not fit in the other categories and were therefore designated as "General" events. These events included: failing to stop for red light in left-turn or through lanes, reversing vehicle in opposite direction of travel away from intersection to change lanes, and a vehicle driving under the rail crossing gate arms.

AADT Estimation Methodology
Daily volumes at the intersection of Chapel Hill Road and Aviation Parkway were estimated by extrapolating from each intersection leg's 2019 annual average daily traffic (AADT) by using continuous counters from across North Carolina. Table 1, below, describes the approaches of the intersection.

Table 1: AADT Base Values

Name	Approach	Functional Classification	2019 AADT
Aviation Parkway	East	Minor Arterial	14000
Morrisville Carpenter Rd	West	Minor Arterial	17000
Chapel Hill Rd	North	Other Principal Arterial	15500
Chapel Hill Rd	South	Other Principal Arterial	21000

AADT data was obtained from the NCDOT Annual Average Daily Traffic mapping application, continuous count data from the Traffic Count Database System (TCDS), and roadway functional classifications from the NCDOT Functional Class ArcGIS map image layer.

Separate models were constructed for the minor arterial and other principal arterial approaches. Nine minor arterial and sixteen other principal arterial continuous counters were sampled, although there were frequent days when the sample sizes were lower due to missed counts (70.7% of days had the full sample size for other principal arterials, and 84.0% of days had the full sample size for minor arterials.) At these continuous counters, daily volumes between January 1, 2019 and December 31, 2023 were divided by the average of the daily volumes from 2019:

$$V_{ik,\,scaled} = \frac{V_{ik}}{\frac{1}{n}\sum_{j=1}^{n} V_{jk}}$$

Where:

V_{ik}: Daily volume for day $i \in$ {Days of data between 1/1/2019 and 12/31/2023} at continuous counting station k
V_{jk}: Daily volume for day $j \in$ {Days of data between 1/1/2019 and 12/31/2019} at continuous counting station k
n: Number of days of 2019 data actually present in dataset

The mean of these $V_{i,\,scaled}$ ratios over all continuous counting stations within a given roadway functional classification was then used to create a scaling factor for each day:

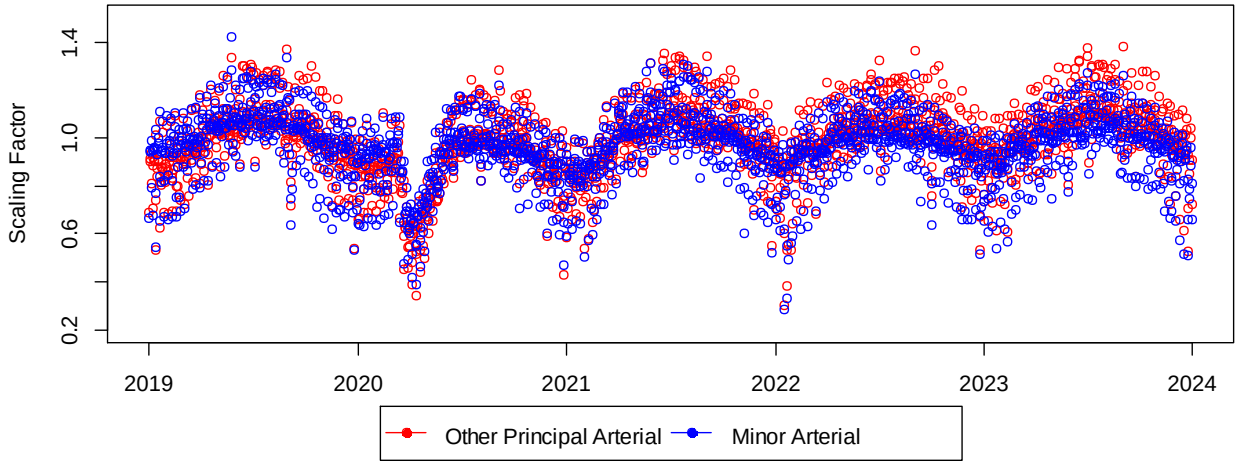
$$SF_i = \frac{1}{s}\sum_{k=1}^{s} V_{ik,\,scaled}$$

Where

SF_i:	Scaling factor for day $i \in$ {Days of data between 1/1/2019 and 12/31/2023}
k:	Index of continuous counting station
s:	Total number of continuous counting stations with data available that day

These scaling factors are shown in the Figure 1 below.

Figure 1: AADT Scaling Factors by Date and Functional Classification



The daily traffic at Chapel Hill Road and Aviation Parkway was estimated using the following equation:

$$V_{i,\,intersection} = \frac{1}{2}\sum_{a=1}^{4} (AADT\_2019)_a * SF_i$$

Where

$V_{i,\,intersection}$:	Estimated daily volume at intersection for day $i \in$ {Days of data between 1/1/2019 and 12/31/2023}
a:	Index for intersection approach, $a \in \{1, 2, 3, 4\}$
$AADT\_2019$:	NCDOT-reported 2019 AADT for intersection approach

And all other terms are as defined previously. The factor of 0.5 corrects for double-counting; each vehicle must enter and exit the intersection, so it is counted twice.

RESULTS

The Phase I analysis period covered April 1st, 2020 through September 11th, 2020. This span is divided into "Before" and "After" periods based on the installation of "Don't Block the Box" pavement markings and signage around mid-day April 28th, 2020. This timeframe consists of 163 days (~27 ½ days in "Before" period, ~135 ½ days in "After" period) equating to about 23 weeks total (~4 weeks in "Before" period, ~19 weeks in "After" period). A total of 3,289 erratic events were captured (188 events in "Before" period, 3,101 events in "After" period) from the 48,588 motion-detection-triggered videos (2,539 videos in "Before" period, 46,049 videos in the "After" period). This information is shown in Table 1 below.

The Phase II analysis period covered January 5th to February 28th, 2023. This span was collected after the end of the COVID-19 pandemic to determine the long-term effects of the new markings and changes in traffic behavior from the Phase I collection that occurred during the beginning of the COVID-19 pandemic. This timeframe consists of 55 days equating to approximately 8 weeks total. A total of 6,045 erratic events were captured from the 26,044 motion-detection-triggered videos. This information is shown in Table 2 below.

Table 2: Data Set Information

Period	Days	Weeks	Erratic Events	Videos Reviewed	Estimated AADT
Before New Pavement Markings (Phase I, 2020)	27.5	3.9	188	2,539	20,616
After New Pavement Markings (Phase I, 2020)	135.5	19.4	3,101	46,049	32,569
Phase I Cumulative Totals (Phase I, 2020)	163	23.3	3,289	48,588	30,577
Long Term After (Phase II, 2023)	**55**	**7.9**	**6,045**	**26,044**	**30,184**

The motion detection settings used were configured to only trigger a recording a few seconds before and after movement was detected in the right turn lane on the northbound leg of Morrisville Carpenter Road. This was to focus on capturing the maneuvers around the rail barrier. This method of data collection could allow other events to be ignored by the camera and thus in the final results.

Results for All Maneuver Categories

Table 3: All Maneuvers in Before Period (Phase I, 2020)

Before New Pavement Markings (Phase I, 2020)											
Maneuver	Total Frequencies					Weather			Time		
	Total	% Total Erratic	% Total Videos	Per Week	Per 10k Vehicles	Dry	Rain	% Rain	Day	Night	% Night
Barrier Maneuver	6	3%	0.2%	1.5	0.10	6	0	0%	2	4	67%
Construction Event	4	2%	0.2%	1.0	0.07	4	0	0%	4	0	0%
General	1	1%	0.04%	0.3	0.02	1	0	0%	1	0	0%
Turns from Wrong Lane	85	45%	3%	21.7	1.47	85	0	0%	68	17	20%
Vehicle Stops on Rail Island	92	49%	4%	23.4	1.59	91	1	1%	77	15	16%

Table 4: All Maneuvers in After Period (Phase I, 2020)

	After New Pavement Markings (Phase I, 2020)										
Maneuver	Total Frequencies					Weather			Time		
	Total	% Total Erratic	% Total Videos	Per Week	Per 10k Vehicles	Dry	Rain	% Rain	Day	Night	% Night
Barrier Maneuver	24	1%	0.1%	1.2	0.05	24	0	0%	14	10	42%
Construction Event	16	1%	0.03%	0.8	0.04	16	0	0%	16	0	0%
General	2	0.1%	0.004%	0.1	0.004	2	0	0%	2	0	0%
Police Officer Event	10	0.4%	0.02%	0.5	0.02	10	0	0%	4	6	60%
Turns from Wrong Lane	406	15%	1%	21	0.91	398	8	2%	297	109	27%
Vehicle Stops on Rail Island	2,303	83%	5%	119	5.16	2,190	113	5%	1,629	630	27%
ROR w/o Queue	170	6%	0.4%	8.8	0.38	161	9	5%	119	51	30%
ROR w/ Queue	170	6%	0.4%	8.8	0.38	162	8	5%	126	44	26%

*Right-on-red only collected during after period

Table 5: Totals for All Maneuvers (Total Phase I, 2020)

Total (Phase I, 2020)											
Maneuver	Total Frequencies					Weather			Time		
	Total	% Total Erratic	% Total Videos	Per Week	Per 10k Vehicles	Dry	Rain	% Rain	Day	Night	% Night
Barrier Maneuver	30	1%	0.06%	1.3	0.06	30	0	0%	16	14	47%
Construction Event	20	1%	0.04%	0.9	0.04	20	0	0%	20	0	0%
General	3	0.1%	0.01%	0.1	0.01	3	0	0%	3	0	0%
Police Officer Event	10	0.3%	0.02%	0.4	0.02	10	0	0%	4	6	60%
Turns from Wrong Lane	491	15%	1%	21.1	0.98	483	8	2%	365	126	26%
Vehicle Stops on Rail Island	2,395	73%	5%	102.8	4.78	2,281	114	5%	1,706	645	27%
ROR w/o Queue*	170	5%	0.3%	7.3	0.34	161	9	5%	119	51	30%
ROR w/ Queue*	170	5%	0.3%	7.3	0.34	162	8	5%	126	44	26%

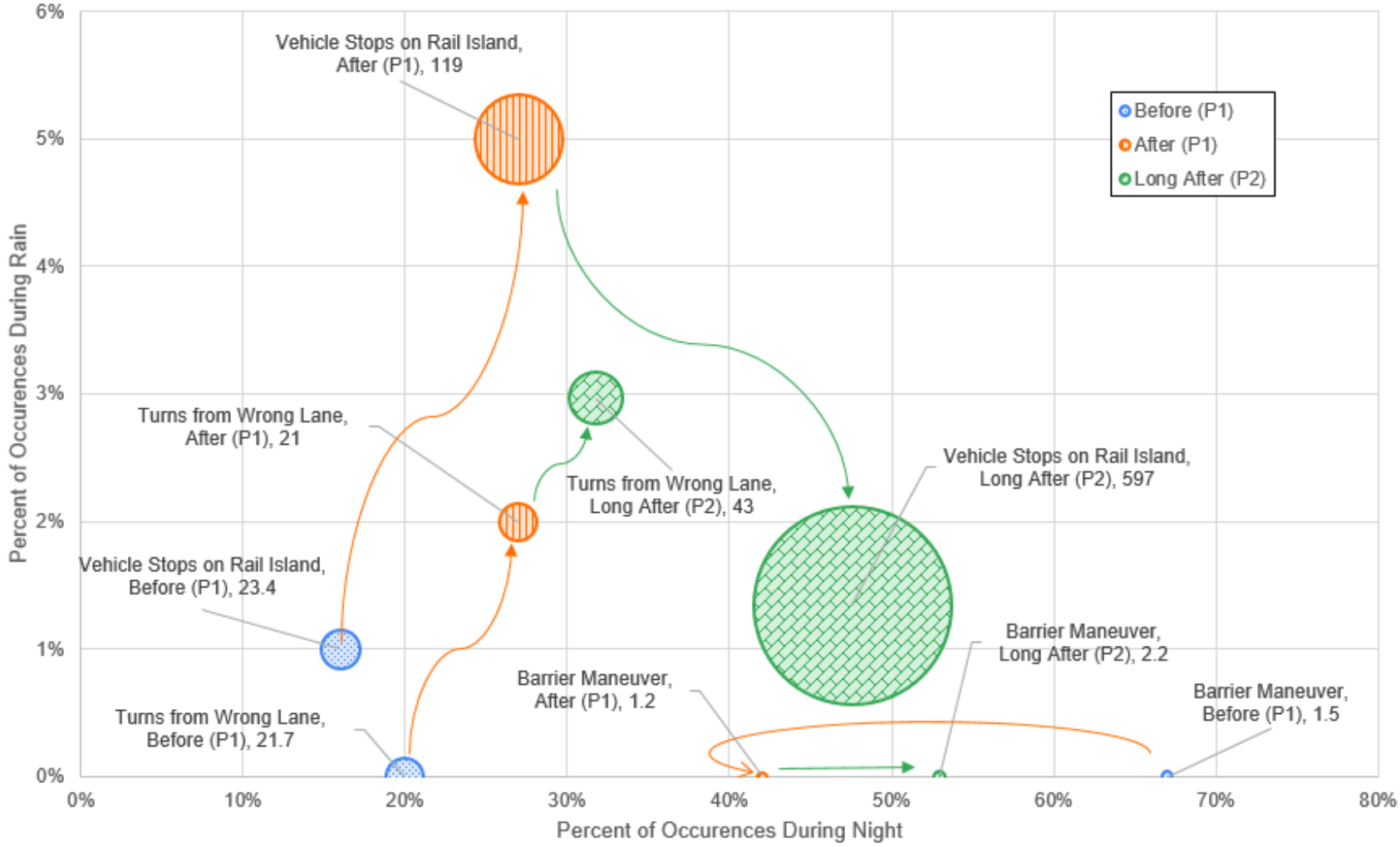
*Right-on-red only collected during after period

Table 6: Totals for All Maneuvers Long Term After Period (Phase II, 2023)

Totals for All Maneuvers Long Term After (Phase II, 2023)											
Maneuver	Total Frequencies					Weather			Time		
	Total	% Total Erratic	% Total Videos	Per Week	Per 10k Vehicles	Dry	Rain	% Rain	Day	Night	% Night
Barrier Maneuver	17	0.3%	0.1%	2.2	0.10	17	0	0%	8	9	53%
Construction Event	6	0.1%	0.02%	0.8	0.04	6	0	0%	6	0	0%
General	42	0.7%	0.2%	5.3	0.25	42	0	0%	18	24	57%
Police Officer Event	2	0.03%	0.01%	0.3	0.01	2	0	0%	2	0	0%
Turns from Wrong Lane	337	5.6%	1%	43	2.03	327	10	3%	230	107	32%
Vehicle Stops on Rail Island	4,694	78%	18%	597	28.28	4631	63	1%	2,461	2,233	48%
ROR w/o Queue**	1,270	21%	5%	162	7.65	1257	13	1%	649	621	49%
ROR w/ Queue**	116	2%	0.4%	15	0.70	111	5	4%	72	44	38%

**Right-on-red may have occurred along with other erratic behaviors

Figure 2: Percent Erratic Maneuvers
(Barrier Maneuvers, Turns from Wrong Lane, & Vehicle Stops on Rail Island) Occurring During Rain vs. Night Occurrences Weighted According to Average Per Week Frequency*



*Based on Table 2, Table 3 and Table 5

Barrier Maneuvers

All barrier-related maneuvers occurred in the absence of rain.

Table 7: Barrier Maneuvers in Before Period (Phase I, 2020)

Before New Pavement Markings (Phase I, 2020)				
Maneuver	Total Frequencies		Time	
	Total	% Barrier Movements	Day	Night
Car makes illegal left turn around barrier	1	17%	1	0
Car makes left turn barely missing tracks around barrier	2	33%	0	2
Car makes right turn around barrier	1	17%	0	1
Car makes turn on wrong side of barrier	0	0%	0	0
Car makes U turn around barrier	1	17%	1	0
Car moves through in right lane on tracks around barrier	0	0%	0	0
Car turns left through wrong lane around barrier	1	17%	0	1

Table 8: Barrier Maneuvers in After Period (Phase I, 2020)

After New Pavement Markings (Phase I, 2020)				
Maneuver	Total Frequencies		Time	
	Total	% Barrier Movements	Day	Night
Car makes illegal left turn around barrier	2	8%	0	2
Car makes left turn barely missing tracks around barrier	1	4%	0	1
Car makes right turn around barrier	4	17%	3	1
Car makes turn on wrong side of barrier	1	4%	1	0
Car makes U turn around barrier	7	29%	5	2
Car moves through in right lane on tracks around barrier	5	21%	4	1
Car turns left through wrong lane around barrier	4	17%	1	3

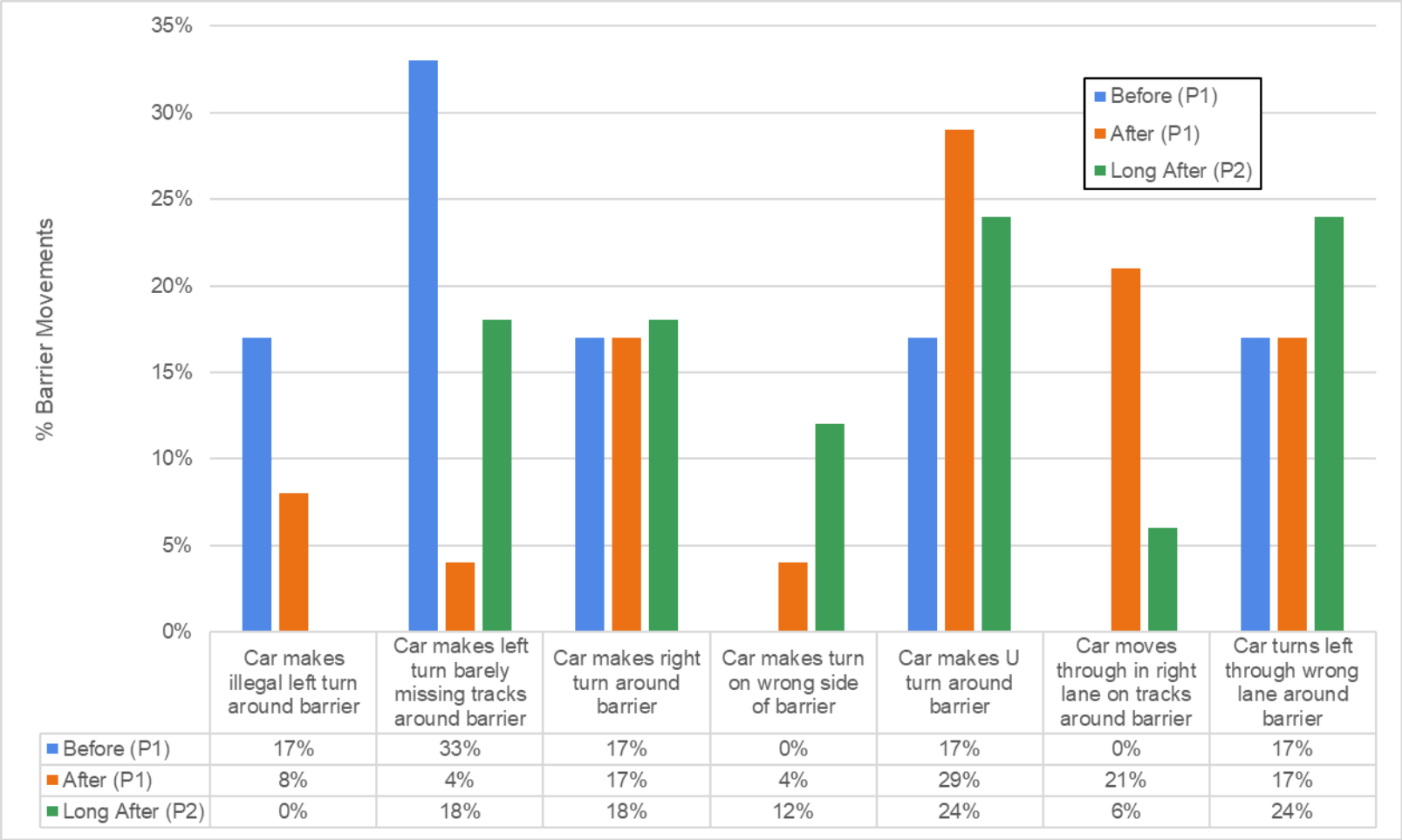
Table 9: All Barrier Maneuvers (Phase I, 2020)

All Barrier Maneuvers (Phase I, 2020)				
Maneuver	Total Frequencies		Time	
	Total	% Barrier Movements	Day	Night
Car makes illegal left turn around barrier	3	10%	1	2
Car makes left turn barely missing tracks around barrier	3	10%	0	3
Car makes right turn around barrier	5	17%	3	2
Car makes turn on wrong side of barrier	1	3%	1	0
Car makes U turn around barrier	8	27%	6	2
Car moves through in right lane on tracks around barrier	5	17%	4	1
Car turns left through wrong lane around barrier	5	17%	1	4

Table 10: All Barrier Maneuvers Long Term After Period (2023)

All Barrier Maneuvers Long Term After (Phase II, 2023)				
Maneuver	Total Frequencies		Time	
	Total	% Barrier Movements	Day	Night
Car makes illegal left turn around barrier	0	0%	0	0
Car makes left turn barely missing tracks around barrier	3	18%	0	3
Car makes right turn around barrier	3	18%	3	0
Car makes turn on wrong side of barrier	2	12%	1	1
Car makes U turn around barrier	4	24%	2	2
Car moves through in right lane on tracks around barrier	1	6%	0	1
Car turns left through wrong lane around barrier	4	24%	2	2

Figure 3: All Barrier Maneuvers by Period



	Car makes illegal left turn around barrier	Car makes left turn barely missing tracks around barrier	Car makes right turn around barrier	Car makes turn on wrong side of barrier	Car makes U turn around barrier	Car moves through in right lane on tracks around barrier	Car turns left through wrong lane around barrier
Before (P1)	17%	33%	17%	0%	17%	0%	17%
After (P1)	8%	4%	17%	4%	29%	21%	17%
Long After (P2)	0%	18%	18%	12%	24%	6%	24%

Rail Island Maneuvers

Table 11: Rail Island Maneuvers in Before Period (Phase I, 2020)

Before New Pavement Markings (Phase I, 2020)											
Maneuver	Total Frequencies					Weather			Time		
	Total	% RR Vehicles	% Total Videos	Per Week	Per 10k Vehicles	Dry	Rain	% Rain	Day	Night	% Night
Zone 1	54	44%	2%	13.8	0.9	53	1	2%	47	7	13%
Zone 2	31	25%	1%	7.9	0.5	31	0	0%	23	8	26%
Zone 3	37	30%	1%	9.4	0.6	37	0	0%	31	6	16%
Zone 3+	0	0%	0%	0	0	0	0	0%	0	0	0%

Table 12: Rail Island Maneuvers in After Period (Phase I, 2020)

After New Pavement Markings (Phase I, 2020)											
Maneuver	Total Frequencies					Weather			Time		
	Total	% RR Vehicles	% Total Videos	Per Week	Per 10k Vehicles	Dry	Rain	% Rain	Day	Night	% Night
Zone 1	1,229	41%	3%	63.5	2.8	1,168	61	5%	940	289	24%
Zone 2	558	19%	1%	28.8	1.3	531	27	5%	405	153	27%
Zone 3	1,199	40%	3%	61.9	2.7	1,150	49	4%	882	317	26%
Zone 3+	28	1%	0%	1.4	0.1	26	2	7%	22	6	21%

Table 13: All Rail Island Maneuvers (Phase I, 2020)

All Rail Island Maneuvers (Phase I, 2020)											
Maneuver	Total Frequencies					Weather			Time		
	Total	% RR Vehicles	% Total Videos	Per Week	Per 10k Vehicles	Dry	Rain	% Rain	Day	Night	% Night
Zone 1	1,283	41%	3%	66.3	2.6	1,221	62	5%	987	296	23%
Zone 2	589	19%	1%	30.4	1.2	562	27	5%	428	161	27%
Zone 3	1,236	39%	3%	63.8	2.5	1,187	49	4%	913	323	26%
Zone 3+	28	1%	0.1%	1.4	0.1	26	2	7%	22	6	21%

Table 14: All Rail Island Maneuvers (Phase II, 2023)

All Rail Island Maneuvers Long Term After (Phase II, 2023)											
Maneuver	Total Frequencies					Weather			Time		
	Total	% RR Vehicles	% Total Videos	Per Week	Per 10k Vehicles	Dry	Rain	% Rain	Day	Night	% Night
Zone 1	2,561	55%	10%	325.9	15.4	2,528	33	1%	1,380	1181	46%
Zone 2	667	14%	3%	84.9	4.0	658	9	1%	343	324	49%
Zone 3	1,402	30%	5%	178.4	8.4	1,364	38	3%	716	686	49%
Zone 3+	306	7%	1%	38.9	1.8	302	4	1%	153	153	50%

CONCLUSIONS

These conclusions focus on barrier movements and especially the barrier movement where a vehicle makes a left around the barrier almost onto the tracks. This was the primary maneuver that the data collection methodology of this and the previous phase of research was designed to quantify. Some of the barrier movements could be due to misunderstanding the layout of the intersection. However, it still appears that some movements were made intentionally to avoid stopping at a red light as in Phase I. This potential incentive for barrier movements might be mirrored by the increase in frequency of right-on-red turns. One example would be when a vehicle makes a left turn through the wrong lane around a barrier, it was typically because the driver appeared to be attempting to avoid oncoming traffic and not wait for a designated green left turn light. Vehicles that are making barrier maneuvers will typically yield to other vehicles in or around the intersection that are driving legally.

Most events saw significant increases in the percentage of occurrences at night in Phase II. This could be due to seasonal change in the length of daylight in each day, as the collection period of Phase II was all during the winter (January-February) compared to late spring and summer period that Phase I was collected in (April-September). There was also an increase from the "before" to the "after" period in Phase I, so it could also be evidence of the changes in pavement markings and enforcement as a deterrent from events occurring during the day when there is a greater perceived risk of repercussions or difficulty following pavement markings during low-visibility.

The barrier movements initially went form 1.5 per week to 1.2 per week between the "before" and "after" periods during Phase I, however, due to the low number of total events it was difficult to make strong conclusions on the impact that the new pavement markings had on barrier movements. In Phase II, the barrier movements increased in frequency to 2.2 per week. Generally, most of the barrier maneuvers occurred when there was not a lot of traffic/congestion at the intersection. As mentioned earlier, drivers could have misunderstood the layout of the intersection and without other vehicles ahead of them to follow due to lower volume at that time of day/night, got confused and made erratic maneuvers around the barrier, especially the late-night occurrences when the intersection has fewer vehicles. Drivers may also have felt more comfortable making the erratic barrier maneuvers during times of lower traffic volumes due to a perceived increase in ability to avoid conflicting traffic by using the larger gaps, again, especially the late-night occurrences when the intersection is empty.

The frequency of vehicles stopping on or around the rails increased through Phase I and into Phase 2 even when taking into account the changes in estimated traffic volumes due to the Covid-19 pandemic in 2020 during Phase I. However, the ratios of each zone that the vehicles were observed stopping in shifted from Phase I to Phase II in that the percentage of vehicles stopping on the tracks in Zone 2 (directly on the tracks and most at risk of rail collision) decreased and shifted into the other Zones 1, 3, and 3+. In Phase I, Zone 1 made up approximately the same percentage as Zone 3 and Zone 3+ cumulatively, but in Phase II, Zone 1 made up a more discernable majority of the vehicle events versus Zone 3 and Zone 3+ cumulatively. Both of these trends demonstrate a potential shift in driver behavior towards studied erratic maneuvers with lower perceived risk involved.

Barrier maneuvers that involved vehicles that almost turned onto the tracks initially decreased after the pavement markings were placed on the roadway, but then increased in the "long after" period higher than in the "before". There was one vehicle that almost turned onto the tracks in the approximately 20 weeks of the "after" period during Phase I and then three vehicles almost turned onto the tracks in the approximately 8 weeks of the "long after" period during Phase II. Therefore, in the scope of this phase of the project, the frequency of the "vehicle almost turned onto the tracks" event increased by a factor of about 7.5, while it had decreased by a factor of 2.5 from the "before" to "after" period during Phase I. When this maneuver occurred without the pavement markings, the vehicle was very close to turning onto the track, whereas when it occurred with the pavement markings, in both "after" and "long after" periods, the vehicle veered away from the tracks much sooner (all instances occurred at night as well).