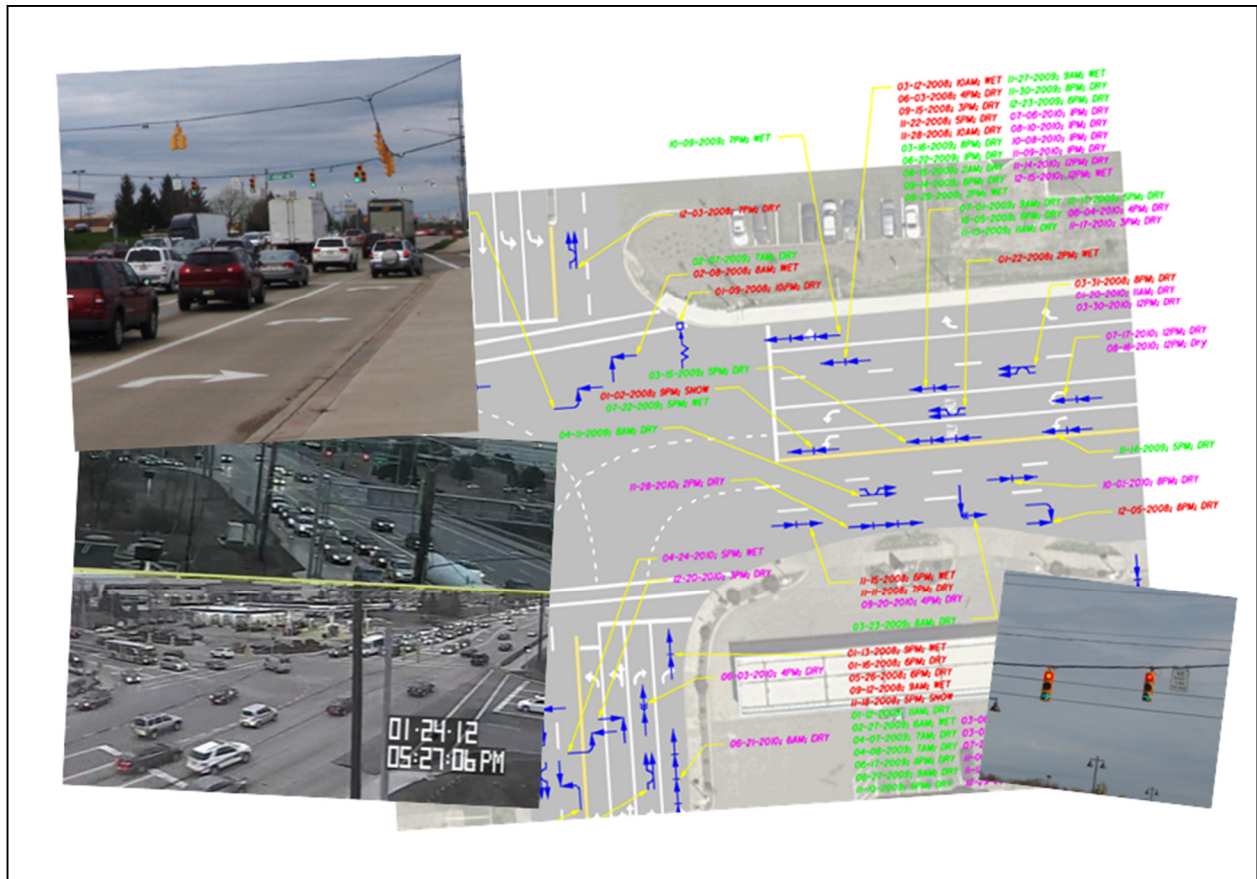


Formal Study, CUY-82 (3.00-3.60) 2010 Safety Analyst Rank #25 and #41 Non-Freeway Locations



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TABLE OF CONTENTS

	Page
Executive Summary	1
i. Purpose.....	1
ii. Background.....	2
iii. Brief Overview of Possible Causes	3
Crash Data	4
Traffic Analysis	8
Recommendations	11
Photos	13
Appendix	17

EXECUTIVE SUMMARY

Purpose and Need

The State Route 82 (Royalton Road) corridor from the northbound entrance ramp of Interstate Route 71 to 400 feet east of Ordner Drive was selected for a formal traffic study due to the high occurrences of crashes. The area encompassed by the study had 289 crashes occur between mile post 2.70 and mile post 3.70 from 2008 to 2010. The corridor is comprised of 6 signalized intersections and no unsignalized intersections. The most critical intersection included in the study is the Howe Road and SR 82 intersection which was analyzed due a high frequency of crashes occurring in and around the intersection.



Figure 1. Plan view of State Route 82 formal study area.

In response to the high crash frequency, the intersection of Howe Road and S.R. 82 was ranked number 25 on ODOT's Highway Safety Program (HSP) Non-Freeway (NF) list in 2010. The segment of SR 82 over IR 71 also ranked 41 on the HSP NF list. However, the 37 of these crashes were mislogged as occurring on the overpass but in reality, the crashes occurred at the two signalized intersections servicing IR 71. The purpose of this study is to consider several potential countermeasures of varying magnitudes to address the increasing traffic congestion and safety concerns along the corridor. The report offers several recommendations including: short-term, medium-term and long-term recommendations.

Background

State Route 82 is a six lane urban principal arterial that runs in an East-West direction, with a posted speed limit of 35 MPH. The study includes signals on SR 82 at the following locations:

1. IR 71 Northbound Entrance/Exit Ramp
2. IR 71 Southbound Entrance/Exit Ramps
3. Howe Road
4. Southpark Center East Mall Entrance
5. Falling Water Road
6. Placid Cove West Mall Entrance

The major intersection evaluated in this study is the signalized intersection of SR 82 and Howe Road. This intersection is at the root of congestion and resulting crashes. A potential factor contributing to the increased congestion is the addition of a commercial shopping area, north of the SR 82 and Howe Road intersection. Consequently, the newly developed shopping area has increased the average daily traffic while simultaneously limiting the mobility due to the addition of the northern access drive. Further aggravating the congestion problem is the close proximity of the southbound exit ramp of IR 71 and Southpark Mall. The IR 71 southbound ramp is located less than 900 feet west of the intersection while Southpark Mall has access points east and south of the intersection within 1,000 feet.

Original plans called for development north of the mall but were halted due to zoning issues. The land was initially zoned as residential. Development of the land was delayed until a court case with the city of Strongsville changed the zoning from residential to commercial, stating best land use. A traffic impact study was performed in 2007. The study concluded that adding a right turn lane on westbound SR 82 and adding an additional phase to the existing signal at Howe could be done without impacting the traffic operations at the intersection. Lane configuration at the Howe Rd. approach was also changed to accommodate the additional movements. No improvements were made to the eastbound approach.

The SR 82 and Howe Road intersection is a four legged intersection with SR 82 running west to east, Howe Road at the south approach, and the shopping area access drive at the north approach. Left lanes are provided on all four approaches. Specifically, the east approach of SR 82 and the northern shopping area exit have two dedicated left turn lanes, while the Howe Road approach and west approach of SR 82 have one dedicated left turn. The Howe Road approach also has a shared-use lane which provides the opportunity for a left turn or through movement. The 2010 annual average daily traffic (AADT) for SR 82 at Howe Road is approximately 29,000 vehicles per day with 4% heavy vehicles. (ODOT Traffic Survey Report 2010.)



Figure 2. Plan view of Howe Rd. and State Route 82, showing existing lane use.

Brief Overview of Possible Causes

- 1) Access to the interstate highway system and highly developed commercial shopping center has resulted in large traffic volumes and high congestion
- 2) Traffic improvements made in conjunction with the development north of Howe Rd. do not appear to have mitigated congestion in the corridor.
- 3) Preferential lane use further reduces the capacity of the S.R. 82 eastbound approaches and Howe Rd. northbound. Over-utilization of the curb lane occurs on both lanes because only one departing leg for S.R. 82 at Howe road services both I.R. 71 northbound and I.R. 71 southbound on the west approach to Howe Rd., the S.R. 82 eastbound curb lane also is over-utilized with traffic headed south onto Howe Rd.
- 4) Existing Signal Control is not functioning to its full potential at the I.R. 71 S interchange.
- 5) The multitude of access drives to the two gas stations located at the south approach of the Howe Rd. intersections may be causing some of the angle crashes at that intersection.

CRASH DATA

Crash Data Analysis

A crash query was run using the CAM Tool provided by ODOT District 12 between the log points of 2.7 and 3.7 along S.R. 82. The initial query yielded 315 crashes from 2008 to 2010. Analysis of the crash data showed there were 26 mislogged crashes. Elimination of these crashes resulted in 289 crashes. Seventy-six crashes (26.3%) occurred in 2008, 116 crashes (40.1%) occurred in 2009, and 97 crashes (33.6%) occurred in 2010. During the three year period, there were no fatal crashes. However, 67 crashes (23.2%) resulted in injuries and 222 crashes (76.8%) involved property damage. Along the study area, 49.5% of all crashes were non-intersection related while 43.6% of all crashes were at an intersection or related to an intersection.

Further analysis of the crash data revealed crash trends pertaining to month of the year, day of the week and time of day. From the data, the average amount of crashes per month between January and October is 21 (7.4%). However, November and December have a significant increase in crashes at 34 (11.8%) and 41 (14.2%), respectively. The increase in crashes during November and December is to be expected given that this is a commercial area, and it's during this time that traffic increases due to holiday shopping. Providing further evidence to correlate the amount of crashes with the traffic due to commercial business, is the high amount of crash occurrences on Fridays and Saturdays at 52 (18.0%) and 44 (15.2%), respectively. The time period with the highest frequency of crashes was between the hours of 4:00 PM and 7:00 PM. During this time period, a total of 98 (34.0%) occurred.

S.R. 82 and Howe Road

Of the 289 total crashes in the area, 113 (39.0%) occurred at log points 3.2-3.3, corresponding with the intersection of S.R. 82 and Howe Rd. For this intersection area, rear end crashes were the most frequent type, consisting of a total of 74 crashes (65.5%). Of all the rear end occurrences, 35.7% were at log points 3.2-3.3, corresponding with the intersection of S.R. 82 and Howe Rd. Furthermore, 58.0% of the rear ends occurred within the immediate area surrounding the intersection of S.R. 82 and Howe Rd.

TOTAL CRASHES (CUI-0082R - 2.7 to 3.7)	289
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CRASH_MONTH_NBR	Number	%
1	25	8.7%
2	13	4.5%
3	24	8.3%
4	18	6.2%
5	18	6.2%
6	27	9.3%
7	23	8.0%
8	22	7.6%
9	25	8.7%
10	19	6.6%
11	34	11.8%
12	41	14.2%
Grand Total	289	100.0%

DAY_OF_WEEK	Number	%
FRIDAY	52	18.0%
SUNDAY	25	8.7%
WEDNESDAY	44	15.2%
SATURDAY	44	15.2%
MONDAY	39	13.5%
TUESDAY	41	14.2%
THURSDAY	44	15.2%
Grand Total	289	100.0%

HOUR_OF_DAY	Number	%
02	1	0.3%
04	1	0.3%
06	10	3.5%
07	12	4.2%
08	10	3.5%
09	8	2.8%
10	7	2.4%
11	11	3.8%
12	18	6.2%
13	13	4.5%
14	25	8.7%
15	21	7.3%
16	32	11.1%
17	34	11.8%
18	32	11.1%
19	14	4.8%
20	19	6.6%
21	14	4.8%
22	5	1.7%
23	2	0.7%
Grand Total	289	100.0%

TRAFFIC_CRASH_YEAR	Number	%
2008	76	26.3%
2009	116	40.1%
2010	97	33.6%
Grand Total	289	100.0%

CRASH_SEVERITY	Number	%
INJURY CRASH	67	23.2%
PROPERTY DAMAGE CRASH	222	76.8%
Grand Total	289	100.0%

LOCATION	Number	%
NON-INTERSECTION	143	49.5%
INTERSECTION	77	26.6%
INTERSECTION RELATED	49	17.0%
DRIVEWAY ACCESS	19	6.6%
RAILROAD CROSSING	1	0.3%
Grand Total	289	100.0%

ROAD_CONDITION	Number	%
ROAD - DRY	220	76.1%
ROAD - WET	54	18.7%
ROAD - SNOW	12	4.2%
ROAD - ICE	2	0.7%
ROAD CONDITION NOT STATED	1	0.3%
Grand Total	289	100.0%

TYPE_OF_CRASH	Number	%
REAR END	207	71.6%
SIDESWIPE - PASSING	33	11.4%
ANGLE	30	10.4%
LEFT TURN	11	3.8%
BACKING	3	1.0%
HEAD ON	2	0.7%
SIDESWIPE - MEETING	1	0.3%
ANIMAL	1	0.3%
FIXED OBJECT	1	0.3%
Grand Total	289	100.0%

NUMBER_OF_VEHICLES	Number	%
1	1	0.3%
2	252	87.2%
3	30	10.4%
4	3	1.0%
5	2	0.7%
6	1	0.3%
Grand Total	289	100.0%

Table 1. Crash summary tables

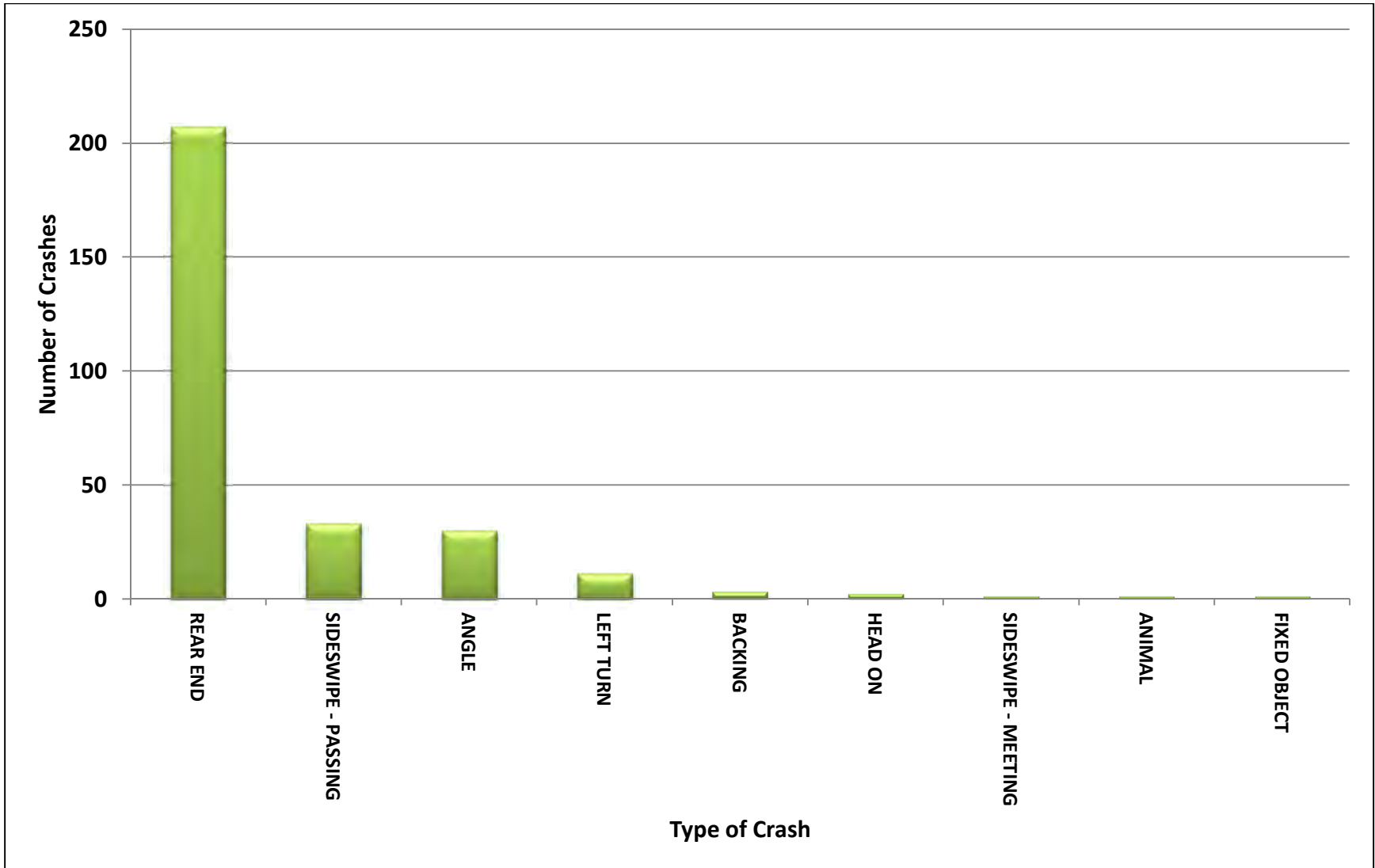


Figure 3. Frequency of Crashes by Type of Crash

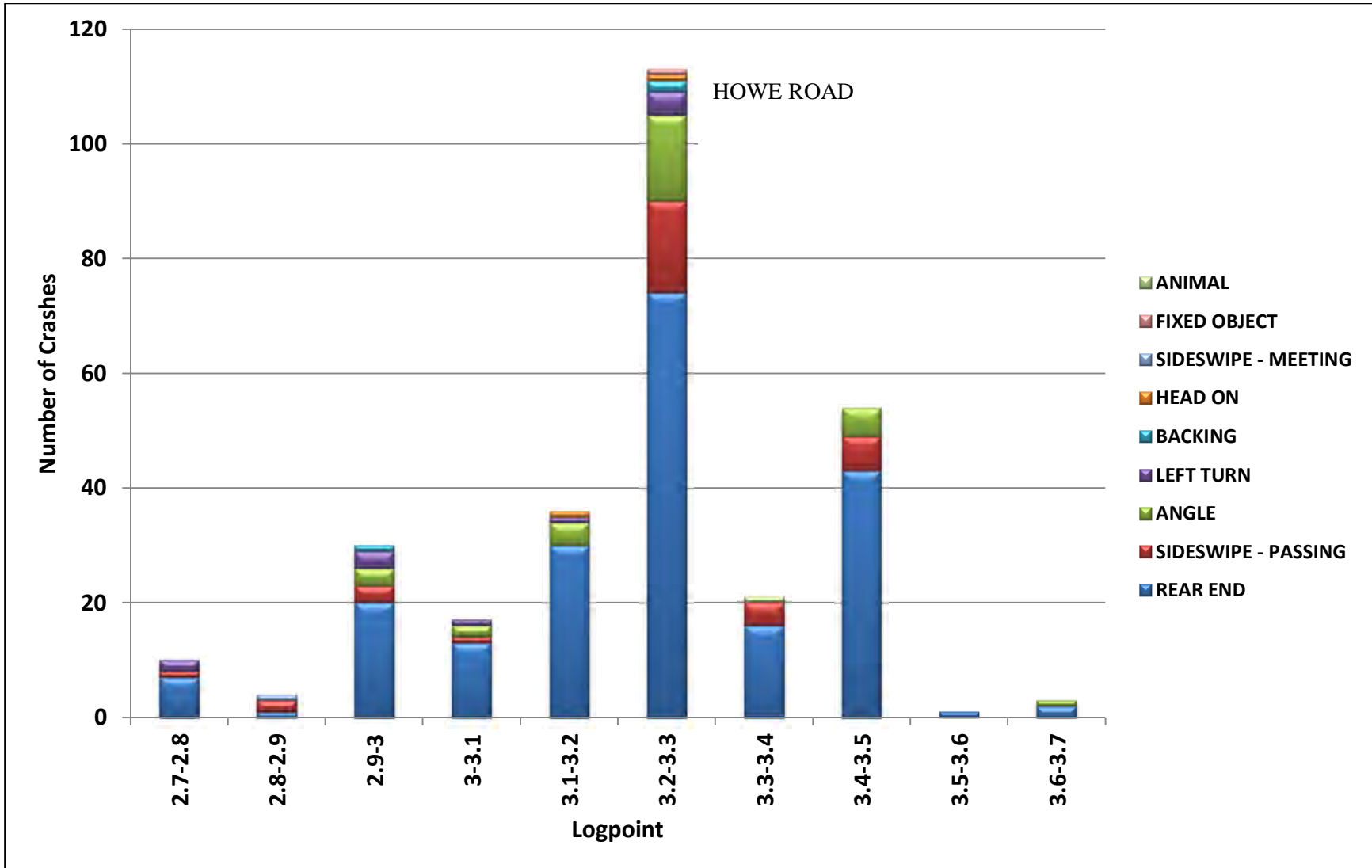


Figure 4. A Location Frequency Chart by Type of Crash.

TRAFFIC ANALYSIS

The lane configurations for the S.R. 82 corridor are shown in the Condition Diagrams. The intersection capacity was analyzed using the Synchro 8 traffic software, which follows the procedures presented in the 2000 Highway Capacity Manual (HCM). Each intersection is characterized by a level of service (LOS) which describes the traffic flow conditions at a particular intersection. LOS ranges from A to F, **A** being near ideal traffic conditions and **F** having high congestions and excessive delays. Signalized intersections are also characterized by control delay. Control delay describes the amount of time delay that would not occur in an unsignalized condition. This includes acceleration/deceleration and additional time spent waiting at the traffic signal. Due to the small number of conflicting pedestrian movements throughout the corridor, pedestrian signal timings were not considered in the traffic model. Capacity analysis was performed on the intersections of Howe Road and IR 71S interchange. The results of the Traffic Analysis can be found in the Appendix.

S.R. 82 at Howe Road

The intersection was analyzed under 2012 existing conditions. Traffic counts were obtained from video surveillance on Tuesday January 24th 2012 provided by the Ohio Department of Transportation. From these counts, AM and PM Peak volumes were used in the Synchro model. Existing signal plans could not be obtained, so signal timings were observed from the field. Preferential lane use in the eastbound curb lane of SR 82 was observed during both peak hours. Traffic turning onto Howe, IR 71S, and IR 71N all must use the right lane. This results in high queues developing from the IR 71S traffic signal through Howe Rd. Preferential lane use was also observed in the curb lane on Howe Road north displaying a similar condition. Capacity analysis was performed using the observed signal timings and traffic counts. The results of the capacity analysis are shown in Table 2.

Approach	AM Peak LOS (Delay in sec/veh)	PM Peak LOS (Delay in sec/veh)
	Observed Timing	Observed Timing
East bound	D (54.6)	D (53.4)
West bound	D (45.4)	D (43.9)
North bound	F (294.7)	D (41.3)
South bound	D (41.3)	D (45.3)
Intersection	F (126.1)	D (46.1)

Table 2. Howe Rd. & S.R. 82 Capacity Analysis

The level of service at this intersection was found to be a LOS of F during the AM Peak and a LOS of D during the PM Peak. The approach of Howe has a LOS of F at the AM Peak. This results from the poor lane utilization for eastbound S.R. 82 in the curb lane. Queues on Howe Road extend south past the mall entrance during the AM peak congestion period.

S.R. 82 at I.R. 71S interchange

The intersection was analyzed using traffic counts obtained from the ODOT Office of Technical Services Traffic Monitoring Section. Seasonal correction factors were applied to these traffic counts to get more accurate traffic volumes. Existing signal plans could not be obtained so signal timings were observed from the field. Capacity analysis was performed using the observed signal timings. The results of the capacity analysis are shown in Table 3.

Approach	AM Peak LOS (Delay in sec/veh)	PM Peak LOS (Delay in sec/veh)
	Observed Timing	Observed Timing
East bound through	F (90.5)	B (11.1)
East bound ramp	A (5.3)	A (0.8)
West bound left	E (72.4)	F (184.4)
West bound through	B (19.9)	D (44.1)
North bound right	E (60.2)	E (61.1)
Southwest ramp	C (23.8)	E (57.0)
Intersection	E (59.9)	D (40.7)

Table 3. I.R. 71 S. Entrance / EB Exit & Royalton Rd. & I.R. 71 S. WB Exit Capacity Analysis

Existing signal operations at the intersection appear to be performing at a substandard level. Pavement loop detectors appear to be non-functioning and consequently the signal timings are on max recall for all phases (either intentionally or unintentionally). This is causing unneeded delays to SR 82 through traffic waiting for the IR 71S exit ramps regardless of traffic volumes on the ramps.

Access Management

Access management along this corridor appears to be adequate for the majority of locations along this segment. Most access points are under signalized control. The few drives that are unsignalized do not appear to have a crash history associated with them. However, the two gas stations located at the south approach of the S.R. 82 and Howe Rd. intersection contain several access points for S.R. 82 traffic. Left turn accessibility from westbound S.R. 82 may result in potentially dangerous movements considering the number of lanes on S.R. 82 and the large volume of traffic on the route. During field review, concerns regarding fuel tankers accessing the BP Station from Howe Rd. were alleviated when a fuel delivery truck was observed accessing the BP station from Howe Rd. rather than S.R. 82.

Possible Causes

- 1) Crashes are mostly the result of congestion. Access to the interstate highway system and highly developed commercial shopping center has resulted in large traffic volumes and high congestion
- 2) Traffic improvements made in conjunction with the development north of Howe Rd. do not appear to have mitigated congestion in the corridor. Storage length of the left turn to the new shopping center appears to be inadequate and queues from this lane are extending to the eastbound through lanes in the evening peak and many hours of the day during weekends
- 3) Preferential lane use further reduces the capacity of the S.R. 82 eastbound approaches and Howe Rd. northbound. Over-utilization of the curb occurs on both lanes because only one departing leg for S.R. 82 at Howe road services both I.R. 71 northbound and I.R. 71 southbound on the west approach to Howe Rd., the S.R. 82 eastbound curb lane also is over-utilized with traffic headed south onto Howe Rd.
- 4) Existing signal control is not functioning to its full potential. Actuated approaches at the I.R. 71 S interchange should be returning used green to the S.R. 82 through movements
- 5) The multitude of access drives to the two gas stations located at the south approach of the Howe Rd. intersections may be causing some of the angle crashes at that intersection. Providing access to these gas stations for vehicles turning left from westbound S.R. 82 allows for a potential dangerous movement across several lanes of heavy traffic. Queues may also develop while the vehicle is waiting for a gap to turn safely.

SUMMARY OF RECOMMENDATIONS

Recommended Countermeasures

The following recommendations are presented for consideration to improve the traffic flow and reduce crashes in this corridor:

Short Term

1. Eliminate Display of Red ball for Howe Road northbound right turn overlap. This signal indication violates driver expectation and is not permitted by the Ohio Manual of Uniform Traffic Control Devices (OMUTCD) as it further conflicts with the No Right Turn on Red Sign (R10-11b) posted next to the signal head. See Photos 19 and 20 of the Appendix.
2. Repair loop detectors at I.R. 71S ramp to S.R. 82 west (Ramp F), I.R. 71S ramp to S.R. 82 east (Ramp C), and the S.R. 82 westbound left turn lane to I.R. 71S. Return signal operation to its Actuated/Coordinated settings and return the unused time to S.R. 82 through movements.
3. Review and make repairs to pedestrian crossings all I.R. 71 ramp crossings. Appear to be non-functioning. Consider providing a walk indication during the S.R. 82 through movements. Look into pedestrian signal lights possibly being burnt out.
4. Turn the pedestrian signal head located at the northeast corner of the Howe Rd. intersection so it is facing west in the direction of the crosswalk. See Photo 3 of the Appendix.
5. Place No Pedestrian Crossing Symbol Sign (R9-3) and USE CROSSWALK Plaque (9-3bp) at the Northeast and Southeast corners of the Howe Rd. intersections.
6. Re-position the dotted line from Howe Road northbound right turn lane to S.R. 82 so it turns into the curb lane, not the inside lane as it is currently. A similar condition existing at the south approach of the South Park Center Road east entrance and should also be re-stripped.
7. Provide a dotted line for the Howe Rd. through movement to the shopping center north of the intersection to reduce potential conflict with westbound vehicles turning right on red.
8. Review pre-empt signal operation throughout the corridor. Pre-empt lights appear to be non-functional based on field observation. Further examine the startup phase after pre-empt is activated to avoid any potential delays for mainline traffic.
9. Conduct further traffic analysis to determine how to obtain better lane use on S.R. 82 eastbound using existing pavement.
10. Consider re-lamping with LED for longer life. LED lights tend to having longer life spans than traditional bulbs and will require less maintenance.
11. Conduct a signal progression study for the corridor once items 1&2 are completed. Submit request to ODOT to perform under safety GEC. Develop more sophisticated timing plans for peak and off peak operation, including a holiday plan. Study several time intervals including weekends.

Medium Term

1. New main controller and signals for corridor with up to date timing optimization. Possible Adaptive/Traffic Response Controller.
2. Consider providing additional storage length at westbound approach of Howe Road intersection for the left turn into Shopping center. Increased storage length will help avoid queue extending into eastbound through lanes.
3. Consider prohibiting left turn movements into both gas stations. Left turns will be prohibited by eliminating the two access drives closest to the intersection and making the subsequent drives

right in/right out by placing a concrete divider that discourages left turn movements. Fuel tanker deliveries would then be routed to the Howe Rd. access points.

4. Conduct Origin-Destination study of eastbound S.R. 82 & northbound Howe Rd. to make better estimate of where traffic flowing after moving through the intersection. Either conduct field observations using latest technology or request Northeast Ohio Areawide Coordinating Agency (NOACA) to model the segment.
5. Consider Replacing Head with back plates
6. Consider upgrading overhead signals from span wires to mast arms.
7. Add battery backup system to provide power to signal during power outages.

Long Term

1. Consider widening S.R. 82 eastbound from South Park Mall drive to separate I-71 northbound lane from Howe/I.R. SB to provide better lane use, shorter queues, and better signal operation

A double lane left turn into the Shopping Center North of Howe Road was considered as a possible short term countermeasure. However, after referencing the Location and Design Manual Vol. 1 Figure 401-11E, it was determined that an extended throat width of 31 feet is required. Given the Double Lane Left on the opposite approach, the throat widths for the 2 movements crossed. A Lead/Lag left turn condition could be considered.

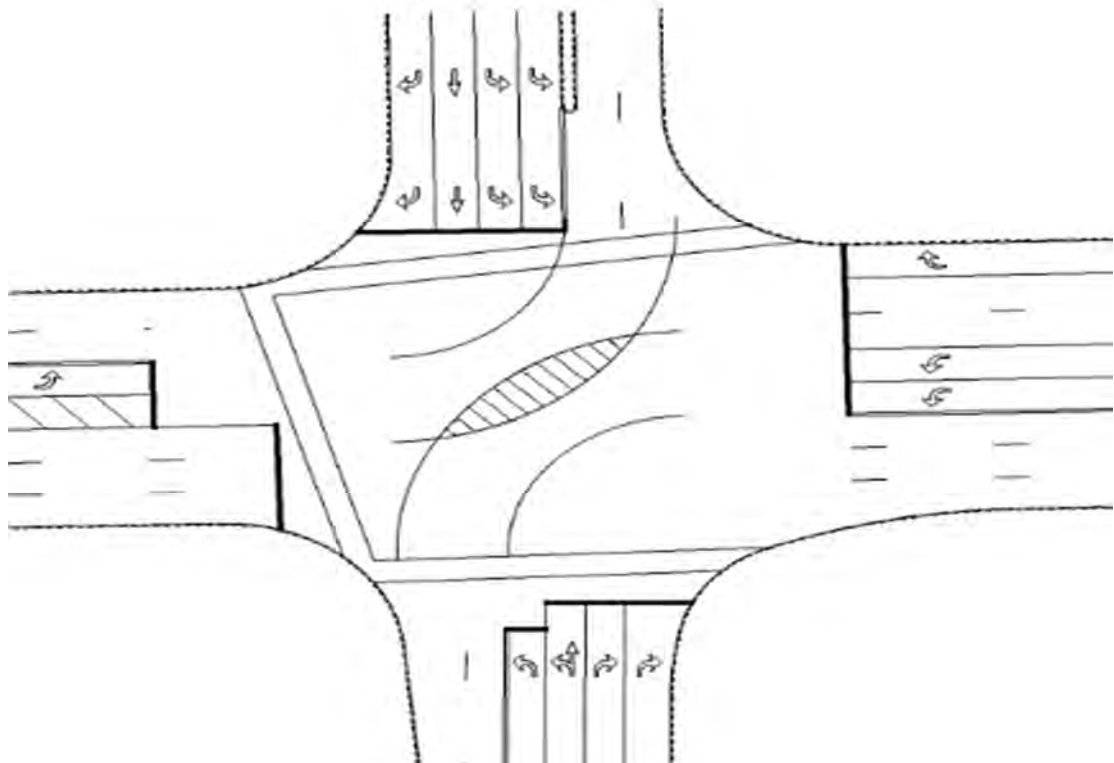


Figure 5. Double Lane Left Turn into Shopping Center North of Howe Rd.

Appendix A

Traffic Volumes

CARS													
Interval Starts	Southbound			Westbound			Northbound			Eastbound			Total
	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	
6:00 AM	1	0	2	29	83	0	18	1	170	6	163	2	475
6:15 AM	6	0	0	35	133	1	25	1	231	1	149	6	588
6:30 AM	4	0	4	85	176	0	35	4	216	5	205	3	737
6:45 AM	8	0	2	57	130	1	26	7	252	3	242	2	730
6AM to 7AM	19	0	8	206	522	2	104	13	869	15	759	13	2530
7:00 AM	2	0	6	59	127	1	36	1	272	3	197	9	713
7:15 AM	5	2	6	78	205	0	33	5	165	8	239	1	747
7:30 AM	9	0	2	122	304	1	47	4	201	10	210	7	917
7:45 AM	4	1	0	121	233	0	38	4	191	1	206	13	812
7AM to 8AM	20	3	14	380	869	2	154	14	829	22	852	30	3189
TRUCKS													
Interval Starts	Southbound			Westbound			Northbound			Eastbound			Total
	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	
6:00 AM	0	0	2	1	3	0	0	0	2	0	10	3	21
6:15 AM	0	0	2	0	6	1	0	0	0	0	8	0	17
6:30 AM	1	0	0	3	11	0	2	0	0	0	5	3	25
6:45 AM	0	0	0	2	9	0	1	1	1	1	8	2	25
6AM to 7AM	1	0	4	6	29	1	3	1	3	1	31	8	88
7:00 AM	1	0	2	1	7	0	3	0	2	1	12	3	32
7:15 AM	1	0	0	2	4	1	1	1	0	0	13	0	23
7:30 AM	0	0	0	2	15	0	0	0	5	0	12	2	36
7:45 AM	1	0	0	5	10	0	1	0	1	0	10	3	31
7AM to 8AM	3	0	2	10	36	1	5	1	8	1	47	8	122
PERCENTAGE HEAVY VEHICLES													
P _{HV} (7-8AM)	13.04	0.00	12.50	2.56	3.98	33.33	3.14	6.67	0.96	4.35	5.23	21.05	3.68
PEAK HOUR FACTOR													
PHF	0.58	0.38	0.50	0.77	0.71	0.38	0.80	0.63	0.76	0.52	0.89	0.59	0.87

Table 5. 6AM to 8AM – S.R. 82 & Howe Rd

CARS													
Interval Starts	Southbound			Westbound			Northbound			Eastbound			Total
	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	
4:00 PM	37	19	43	212	301	53	28	24	140	36	269	8	1170
4:15 PM	40	29	35	180	354	53	28	19	102	25	339	23	1227
4:30 PM	50	27	34	200	282	57	30	15	152	35	289	14	1185
4:45 PM	40	21	28	225	372	58	26	21	131	32	301	23	1278
4PM to 5PM	167	96	140	817	1309	221	112	79	525	128	1198	68	4860
5:00 PM	48	33	35	202	336	76	29	21	181	40	306	15	1322
5:15 PM	44	21	38	236	377	55	29	13	167	45	317	22	1364
5:30 PM	44	29	34	190	347	68	36	19	159	24	275	9	1234
5:45 PM	48	21	35	198	343	62	31	14	131	40	233	20	1176
5PM to 6PM	184	104	142	826	1403	261	125	67	638	149	1131	66	5096
TRUCKS													
Interval Starts	Southbound			Westbound			Northbound			Eastbound			Total
	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	
4:00 PM	0	0	0	0	13	0	1	1	0	0	15	0	30
4:15 PM	0	0	0	1	3	0	1	0	1	0	9	0	15
4:30 PM	0	0	0	1	5	0	0	0	0	0	7	0	13
4:45 PM	0	0	0	0	12	0	1	0	0	0	5	0	18
4PM to 5PM	0	0	0	2	33	0	3	1	1	0	36	0	76
5:00 PM	0	0	0	1	6	1	0	0	0	0	2	0	10
5:15 PM	1	0	2	0	5	2	1	0	1	0	5	0	17
5:30 PM	0	0	0	0	7	0	0	0	0	0	6	0	13
5:45 PM	0	0	1	1	5	0	0	0	1	1	3	0	12
5PM to 6PM	1	0	3	2	23	3	1	0	2	1	16	0	52
PERCENTAGE HEAVY VEHICLES													
P _{HV} (5-6PM)	0.54	0.00	2.07	0.24	1.61	1.14	0.79	0.00	0.31	0.67	1.39	0.00	1.01
PEAK HOUR FACTOR													
PHF	0.94	0.79	0.91	0.87	0.93	0.85	0.85	0.80	0.88	0.82	0.89	0.75	0.93

Table 6. 4PM to 6PM – S.R. 82 & Howe Rd.

Appendix B
Photos



Photo 1. 200 feet from S.R. 82 and Howe Rd., looking west



Photo 2. 600 feet from S.R. 82 and Howe Rd., looking west



Photo 3. 1000 feet from S.R. 82 and Howe Rd., looking west



Photo 4. S.R. 82 and Howe Rd. northeast corner



Photo 5. S.R. 82 and Howe Rd. northwest corner



Photo 6. S.R. 82 and Howe Rd. southeast corner



Photo 7. S.R. 82 and Howe Rd. southwest corner



Photo 8. S.R. 82 and Howe Rd., looking north



Photo 9. S.R. 82 and Howe Rd., looking south from Costco Drive



Photo 10. S.R. 82 and Howe Rd. rotated pedestrian head



Photo 11. S.R. 82 and Howe Rd. north side, looking east



Photo 12. S.R. 82 and Howe Rd. north side, looking east



Photo 13. S.R. 82 and Howe Rd. north side, looking west



Photo 14. S.R. 82 and Howe Rd. north side, looking west



Photo 15. S.R. 82 and Howe Rd. south side, looking east



Photo 16. S.R. 82 and Howe Rd. south side, looking east



Photo 17. S.R. 82 and Howe Rd. south side, looking west



Photo 18. S.R. 82 and I-71S, looking south from ramp



Photo 19. S.R. 82 and I-71S, looking southwest from ramp



Photo 20. S.R. 82 and I-71S north side, looking east



Photo 21. S.R. 82 and I-71S north side, looking west



Photo 22. S.R. 82 and I-71S north side, looking west



Photo 23. S.R. 82 and I-71S Signal Head from ramp



Photo 24. S.R. 82 and I-71S south side, looking east



Photo 25. Overhead signs between Howe Rd. and I-71S, looking west



Photo 26. Red Ball and Green Arrow on Howe Rd., looking north



Photo 27. Red Ball and Green Arrow on Howe Rd.

Appendix C

Capacity Analysis

Timings

1: Howe Rd./Shopping Center & Royalton Rd.

4/6/2012

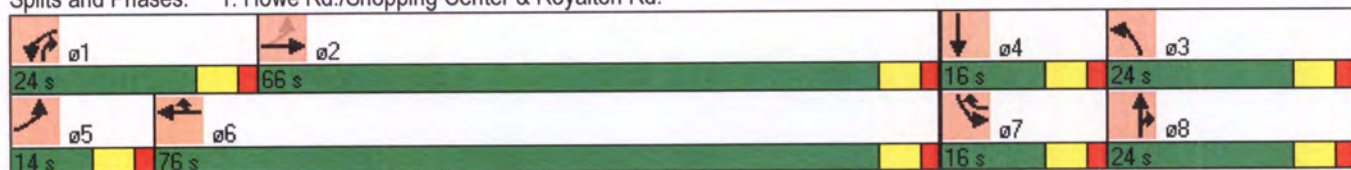


Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Configurations										
Volume (vph)	22	852	380	869	2	154	14	829	20	3
Turn Type	pm+pt	NA	Prot	NA	pt+ov	Prot	NA	pt+ov	Prot	NA
Protected Phases	5	2	1	6	6 7	3	8	8 1	7	4
Permitted Phases	2									
Detector Phase	5	2	1	6	6 7	3	8	8 1	7	4
Switch Phase										
Minimum Initial (s)	8.0	60.0	18.0	70.0		18.0	18.0		10.0	10.0
Minimum Split (s)	14.0	66.0	24.0	76.0		24.0	24.0		16.0	16.0
Total Split (s)	14.0	66.0	24.0	76.0		24.0	24.0		16.0	16.0
Total Split (%)	10.8%	50.8%	18.5%	58.5%		18.5%	18.5%		12.3%	12.3%
Yellow Time (s)	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0		2.0	2.0		2.0	2.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0		0.0	0.0		0.0	0.0
Total Lost Time (s)	6.0	6.0	6.0	6.0		6.0	6.0		6.0	6.0
Lead/Lag	Lead	Lag	Lead	Lag		Lag	Lag		Lead	Lead
Lead-Lag Optimize?										
Recall Mode	Max	Max	Max	C-Max		Max	Max		Max	Max
Act Effct Green (s)	68.0	60.0	18.0	70.0	86.0	18.0	18.0	42.0	10.0	10.0
Actuated g/C Ratio	0.52	0.46	0.14	0.54	0.66	0.14	0.14	0.32	0.08	0.08
v/c Ratio	0.18	0.97	1.04	0.65	0.01	0.46	0.47	1.68	0.14	0.14
Control Delay	11.4	56.4	107.6	22.8	7.0	58.7	58.9	341.0	57.6	25.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	11.4	56.4	107.6	22.8	7.0	58.7	58.9	341.0	57.6	25.9
LOS	B	E	F	C	A	E	E	F	E	C
Approach Delay		54.6		47.1			294.7			41.3
Approach LOS		D		D			F			D

Intersection Summary

Cycle Length: 130
 Actuated Cycle Length: 130
 Offset: 0 (0%), Referenced to phase 6:WBT, Start of Yellow, Master Intersection
 Natural Cycle: 150
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 1.68
 Intersection Signal Delay: 126.8
 Intersection Capacity Utilization 102.3%
 Analysis Period (min) 15
 Intersection LOS: F
 ICU Level of Service G

Splits and Phases: 1: Howe Rd./Shopping Center & Royalton Rd.



Timings

6: I-71 S Entrance/ EB Exit & Royalton Rd. & I-71 S WB Exit

4/6/2012

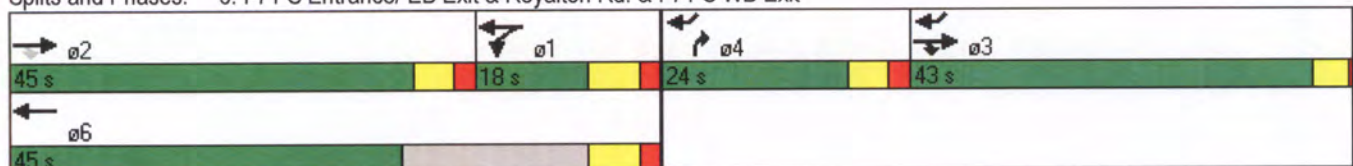


Lane Group	EBT	EBR	WBL	WBT	NBR2	SWR	ø2	ø6
Lane Configurations	↑↑↑	↑	↓	↑↑↑	↑↑	↑↑↑		
Volume (vph)	1565	136	96	474	224	681		
Turn Type	NA	custom	Prot	NA	custom	custom		
Protected Phases	3 2	3	1	6 1	4	4 3	2	6
Permitted Phases		2						
Detector Phase	3 2	3	1	6 1	4	4 3		
Switch Phase								
Minimum Initial (s)		36.0	11.0		18.0		38.0	38.0
Minimum Split (s)		43.0	18.0		24.0		45.0	45.0
Total Split (s)		43.0	18.0		24.0		45.0	45.0
Total Split (%)		33.1%	13.8%		18.5%		35%	35%
Yellow Time (s)		3.5	5.0		4.0		4.0	5.0
All-Red Time (s)		0.5	2.0		2.0		2.0	2.0
Lost Time Adjust (s)		0.0	0.0		0.0			
Total Lost Time (s)		4.0	7.0		6.0			
Lead/Lag		Lag	Lag		Lead		Lead	
Lead-Lag Optimize?		Yes	Yes		Yes		Yes	
Recall Mode		Max	Max		Max		Max	Max
Act Effct Green (s)	84.0	84.0	11.0	56.0	18.0	61.0		
Actuated g/C Ratio	0.65	0.65	0.08	0.43	0.14	0.47		
v/c Ratio	1.12	0.14	0.69	0.24	0.60	0.42		
Control Delay	90.5	5.3	74.1	16.3	60.2	23.8		
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0		
Total Delay	90.5	5.3	74.1	16.3	60.2	23.8		
LOS	F	A	E	B	E	C		
Approach Delay	83.7			26.1				
Approach LOS	F			C				

Intersection Summary

Cycle Length: 130	
Actuated Cycle Length: 130	
Offset: 60 (46%), Referenced to phase 1:WBTL, Start of Yellow	
Natural Cycle: 150	
Control Type: Pretimed	
Maximum v/c Ratio: 1.12	
Intersection Signal Delay: 59.4	Intersection LOS: E
Intersection Capacity Utilization Err%	ICU Level of Service H
Analysis Period (min) 15	

Splits and Phases: 6: I-71 S Entrance/ EB Exit & Royalton Rd. & I-71 S WB Exit



Timings

11: 82 EB Exit/ I-71 N Exit & Roylton Rd. & I-71 N Exit from WB 82

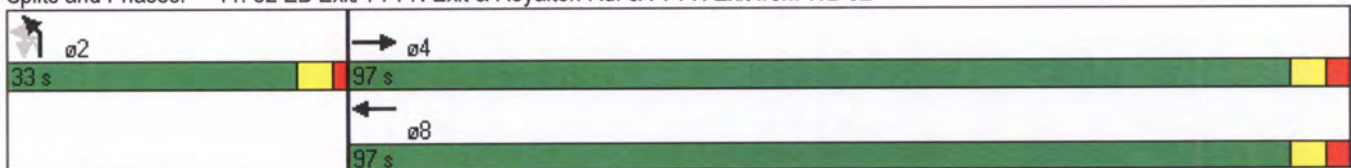
4/6/2012



Lane Group	EBT	EBR	WBT	NBL2	NBL
Lane Configurations	↑↑	↑	↑↑↑	↔	↔
Volume (vph)	466	1323	303	267	0
Turn Type	NA	Free	NA	Perm	NA
Protected Phases	4		8		2
Permitted Phases		Free		2	
Detector Phase	4		8	2	2
Switch Phase					
Minimum Initial (s)	91.0		91.0	14.0	14.0
Minimum Split (s)	97.0		97.0	19.0	19.0
Total Split (s)	97.0		97.0	33.0	33.0
Total Split (%)	74.6%		74.6%	25.4%	25.4%
Yellow Time (s)	3.5		3.5	3.5	3.5
All-Red Time (s)	2.5		2.5	1.5	1.5
Lost Time Adjust (s)	0.0		0.0	0.0	0.0
Total Lost Time (s)	6.0		6.0	5.0	5.0
Lead/Lag					
Lead-Lag Optimize?					
Recall Mode	None		C-Max	None	None
Act Effct Green (s)	98.4	130.0	98.4	20.6	20.6
Actuated g/C Ratio	0.76	1.00	0.76	0.16	0.16
v/c Ratio	0.19	0.86	0.33	0.74	0.61
Control Delay	3.9	8.6	5.8	68.7	45.8
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	3.9	8.6	5.8	68.7	45.8
LOS	A	A	A	E	D
Approach Delay	7.3		5.8		57.7
Approach LOS	A		A		E

Intersection Summary	
Cycle Length:	130
Actuated Cycle Length:	130
Offset:	94 (72%), Referenced to phase 8:WBT, Start of Yellow
Natural Cycle:	120
Control Type:	Actuated-Coordinated
Maximum v/c Ratio:	0.86
Intersection Signal Delay:	12.3
Intersection LOS:	B
Intersection Capacity Utilization:	96.7%
ICU Level of Service:	F
Analysis Period (min):	15

Splits and Phases: 11: 82 EB Exit/ I-71 N Exit & Roylton Rd. & I-71 N Exit from WB 82



Timings

1: Howe Rd./Shopping Center & Royalton Rd.

4/6/2012



Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Configurations	↘	↗↗↗	↘↘	↗↗	↗	↘	↗	↗↗	↘↘	↗↗
Volume (vph)	149	1131	826	1403	261	125	67	638	184	104
Turn Type	pm+pt	NA	Prot	NA	pt+ov	Prot	NA	pt+ov	Prot	NA
Protected Phases	5	2	1	6	6 7	3	8	8 1	7	4
Permitted Phases	2									
Detector Phase	5	2	1	6	6 7	3	8	8 1	7	4
Switch Phase										
Minimum Initial (s)	8.0	47.0	36.0	75.0		18.0	18.0		10.0	10.0
Minimum Split (s)	14.0	53.0	42.0	81.0		24.0	24.0		16.0	16.0
Total Split (s)	14.0	53.0	42.0	81.0		24.0	24.0		21.0	21.0
Total Split (%)	10.0%	37.9%	30.0%	57.9%		17.1%	17.1%		15.0%	15.0%
Yellow Time (s)	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0		2.0	2.0		2.0	2.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0		0.0	0.0		0.0	0.0
Total Lost Time (s)	6.0	6.0	6.0	6.0		6.0	6.0		6.0	6.0
Lead/Lag	Lead	Lag	Lead	Lag		Lag	Lag		Lead	Lead
Lead-Lag Optimize?										
Recall Mode	Max	Max	Max	C-Max		Max	Max		Max	Max
Act Effct Green (s)	55.0	47.0	36.0	75.0	96.0	18.0	18.0	60.0	15.0	15.0
Actuated g/C Ratio	0.39	0.34	0.26	0.54	0.69	0.13	0.13	0.43	0.11	0.11
v/c Ratio	1.19	0.79	1.05	0.80	0.26	0.52	0.52	0.60	0.52	0.59
Control Delay	161.1	41.2	80.2	32.7	1.2	66.2	66.0	33.4	64.6	32.2
Queue Delay	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	161.1	41.2	80.2	33.2	1.2	66.2	66.0	33.4	64.6	32.2
LOS	F	D	F	C	A	E	E	C	E	C
Approach Delay		55.4		45.8			41.3			45.3
Approach LOS		E		D			D			D

Intersection Summary

Cycle Length: 140
 Actuated Cycle Length: 140
 Offset: 0 (0%), Referenced to phase 6:WBT, Start of Yellow, Master Intersection
 Natural Cycle: 135
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 1.19
 Intersection Signal Delay: 47.6
 Intersection LOS: D
 Intersection Capacity Utilization 114.1%
 ICU Level of Service H
 Analysis Period (min) 15

Splits and Phases: 1: Howe Rd./Shopping Center & Royalton Rd.



Timings

6: I-71 Entrance/ EB Exit & Royalton Rd. & I-71 S WB Exit

4/6/2012

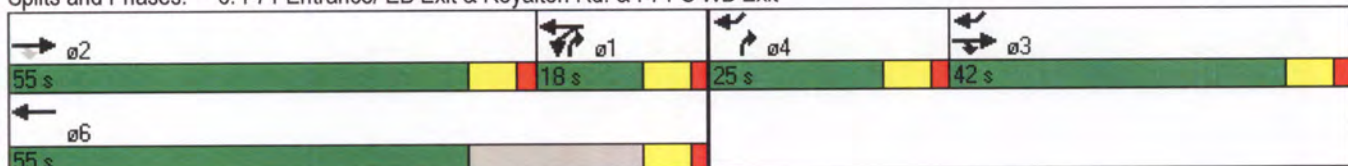


Lane Group	EBT	EBR	WBL	WBT	NBR2	SWR	ø2	ø4	ø6
Lane Configurations	↑↑↑	↑	↑	↑↑	↑↑	↑↑↑			
Volume (vph)	1723	230	162	1270	603	1509			
Turn Type	NA	custom	Prot	NA	custom	custom			
Protected Phases	3 2	3	1	6 1	1 4	4 3	2	4	6
Permitted Phases		2							
Detector Phase	3 2	3	1	6 1	1 4	4 3			
Switch Phase									
Minimum Initial (s)		35.0	11.0				48.0	18.0	41.0
Minimum Split (s)		42.0	18.0				55.0	25.0	55.0
Total Split (s)		42.0	18.0				55.0	25.0	55.0
Total Split (%)		30.0%	12.9%				39%	18%	39%
Yellow Time (s)		5.0	5.0				5.0	5.0	5.0
All-Red Time (s)		2.0	2.0				2.0	2.0	2.0
Lost Time Adjust (s)		0.0	0.0						
Total Lost Time (s)		7.0	7.0						
Lead/Lag		Lag	Lag				Lead	Lead	
Lead-Lag Optimize?		Yes	Yes				Yes	Yes	
Recall Mode		Max	Max				Max	Max	Max
Act Effct Green (s)	90.0	90.0	11.0	66.0	36.0	60.0			
Actuated g/C Ratio	0.64	0.64	0.08	0.47	0.26	0.43			
v/c Ratio	0.57	0.21	1.17	0.83	0.84	0.98			
Control Delay	13.5	2.1	184.3	44.0	61.1	57.0			
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0			
Total Delay	13.5	2.1	184.3	44.0	61.1	57.0			
LOS	B	A	F	D	E	E			
Approach Delay	12.2			58.8					
Approach LOS	B			E					

Intersection Summary

Cycle Length: 140	
Actuated Cycle Length: 140	
Offset: 86 (61%), Referenced to phase 1:WBTL, Start of Green	
Natural Cycle: 140	
Control Type: Pretimed	
Maximum v/c Ratio: 1.17	
Intersection Signal Delay: 41.5	Intersection LOS: D
Intersection Capacity Utilization Err%	ICU Level of Service H
Analysis Period (min) 15	

Splits and Phases: 6: I-71 Entrance/ EB Exit & Royalton Rd. & I-71 S WB Exit



Timings

11: 82 E Exit/ I-71 N Exit & Royalton Rd. & I-71 N Exit From WB 82

4/6/2012

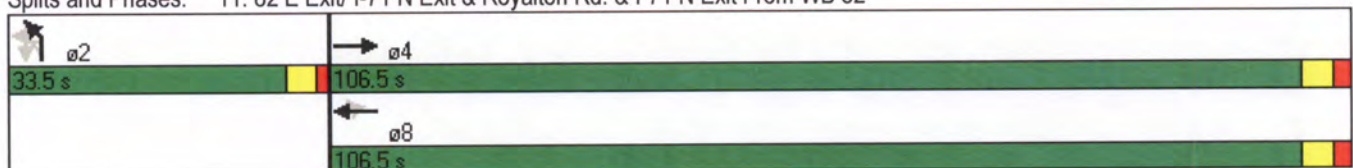


Lane Group	EBT	EBR	WBT	WBR	NBL2	NBL
Lane Configurations	↑↑	↑	↑↑	↑	↘	↘
Volume (vph)	1293	1033	981	378	289	0
Turn Type	NA	Free	NA	Perm	Perm	NA
Protected Phases	4		8			2
Permitted Phases		Free		8	2	
Detector Phase	4		8	8	2	2
Switch Phase						
Minimum Initial (s)	101.0		101.0	101.0	23.0	23.0
Minimum Split (s)	106.5		106.5	106.5	27.5	27.5
Total Split (s)	106.5		106.5	106.5	33.5	33.5
Total Split (%)	76.1%		76.1%	76.1%	23.9%	23.9%
Yellow Time (s)	3.5		3.5	3.5	3.0	3.0
All-Red Time (s)	2.0		2.0	2.0	1.5	1.5
Lost Time Adjust (s)	0.0		0.0	0.0	0.0	0.0
Total Lost Time (s)	5.5		5.5	5.5	4.5	4.5
Lead/Lag						
Lead-Lag Optimize?						
Recall Mode	None		C-Max	C-Max	None	None
Act Effct Green (s)	105.4	140.0	105.4	105.4	24.6	24.6
Actuated g/C Ratio	0.75	1.00	0.75	0.75	0.18	0.18
v/c Ratio	0.53	0.67	0.40	0.32	0.68	0.61
Control Delay	8.3	5.8	6.8	1.2	65.9	49.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	8.3	5.8	6.8	1.2	65.9	49.9
LOS	A	A	A	A	E	D
Approach Delay	7.2		5.2			58.1
Approach LOS	A		A			E

Intersection Summary

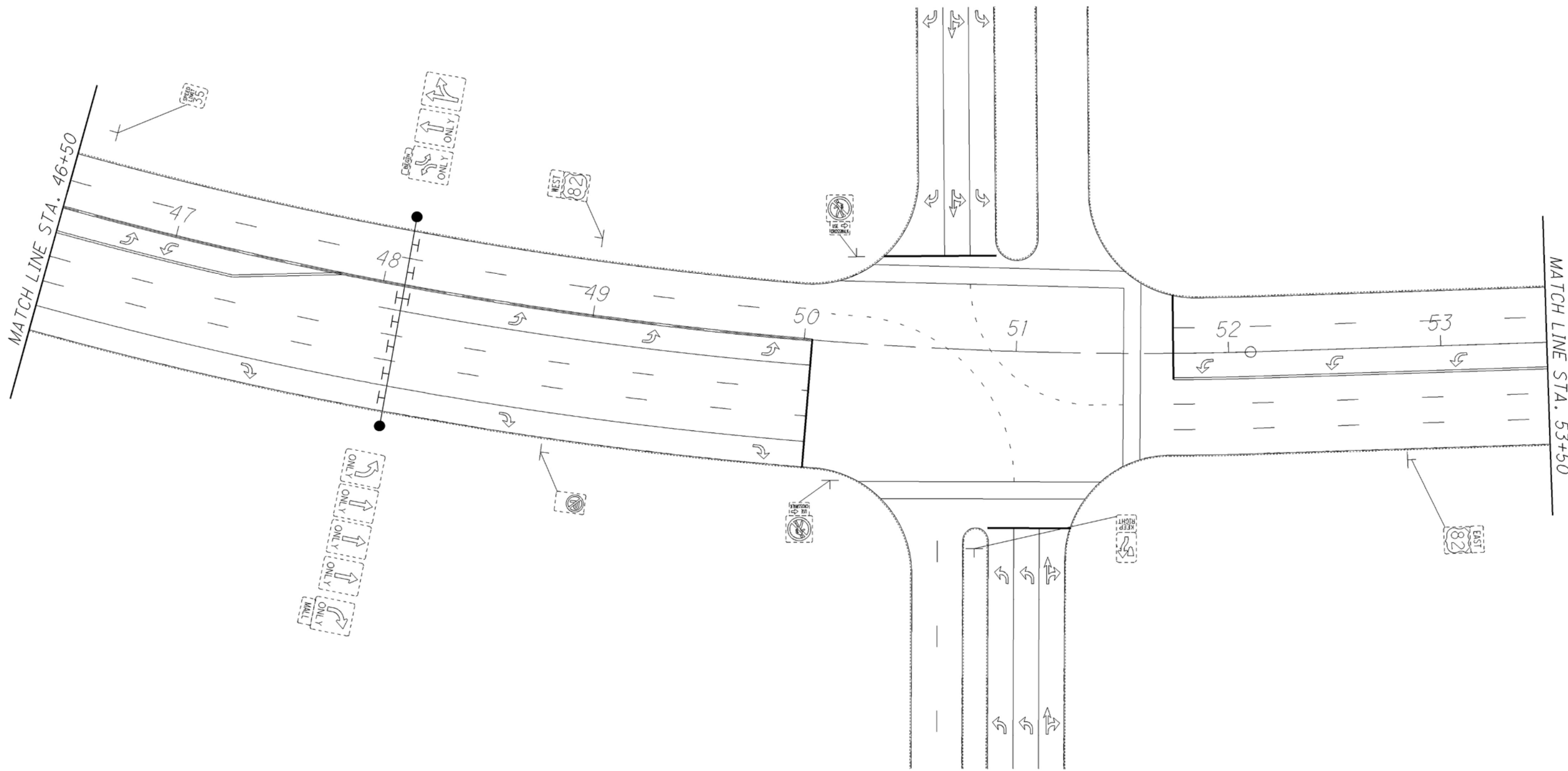
Cycle Length: 140
 Actuated Cycle Length: 140
 Offset: 76 (54%), Referenced to phase 8:WBT, Start of Green
 Natural Cycle: 135
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 0.68
 Intersection Signal Delay: 11.3
 Intersection Capacity Utilization 111.7%
 Analysis Period (min) 15
 Intersection LOS: B
 ICU Level of Service H

Splits and Phases: 11: 82 E Exit/ I-71 N Exit & Royalton Rd. & I-71 N Exit From WB 82



Appendix D

Existing Condition Diagrams

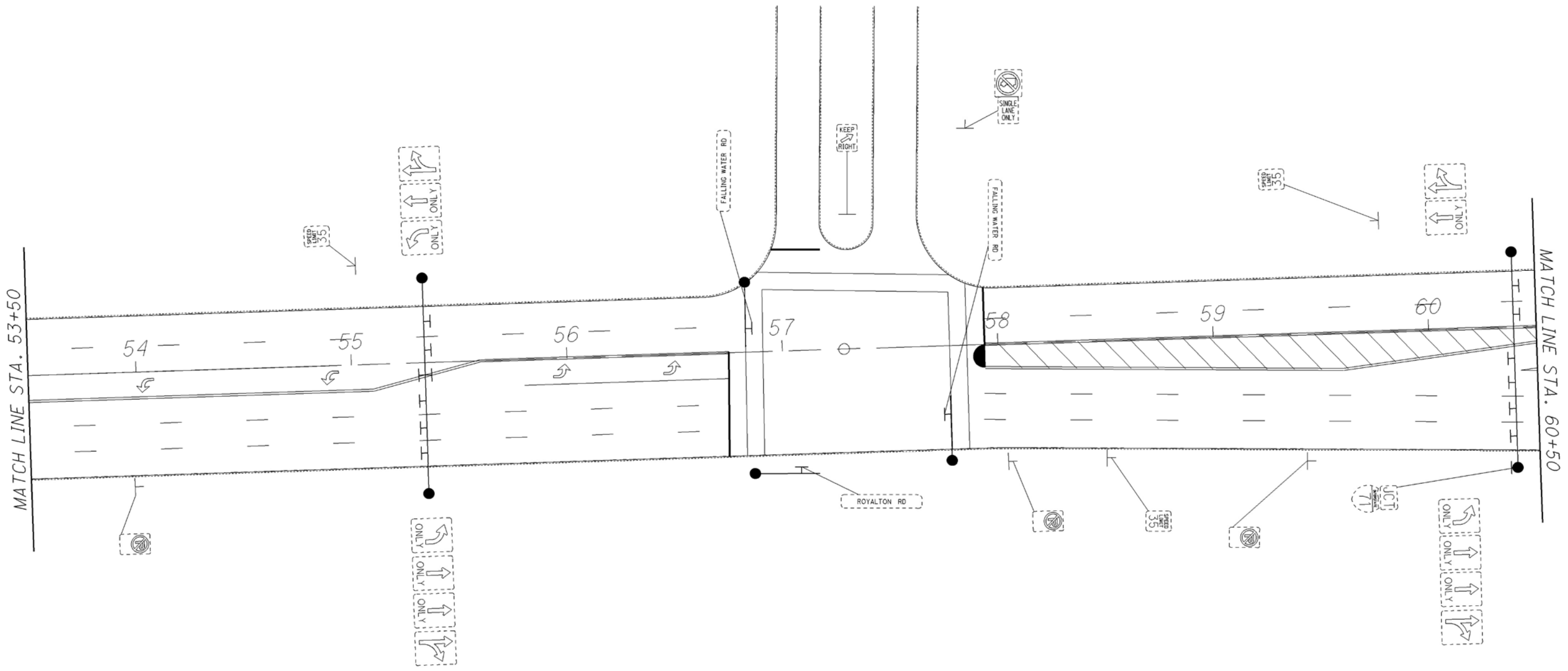


S.R. 82 FORMAL STUDY
STRONGSVILLE OHIO

CONDITION DIAGRAM 1

ROYALTON RD (S.R. 82)

STA 46+50 TO STA 53+50

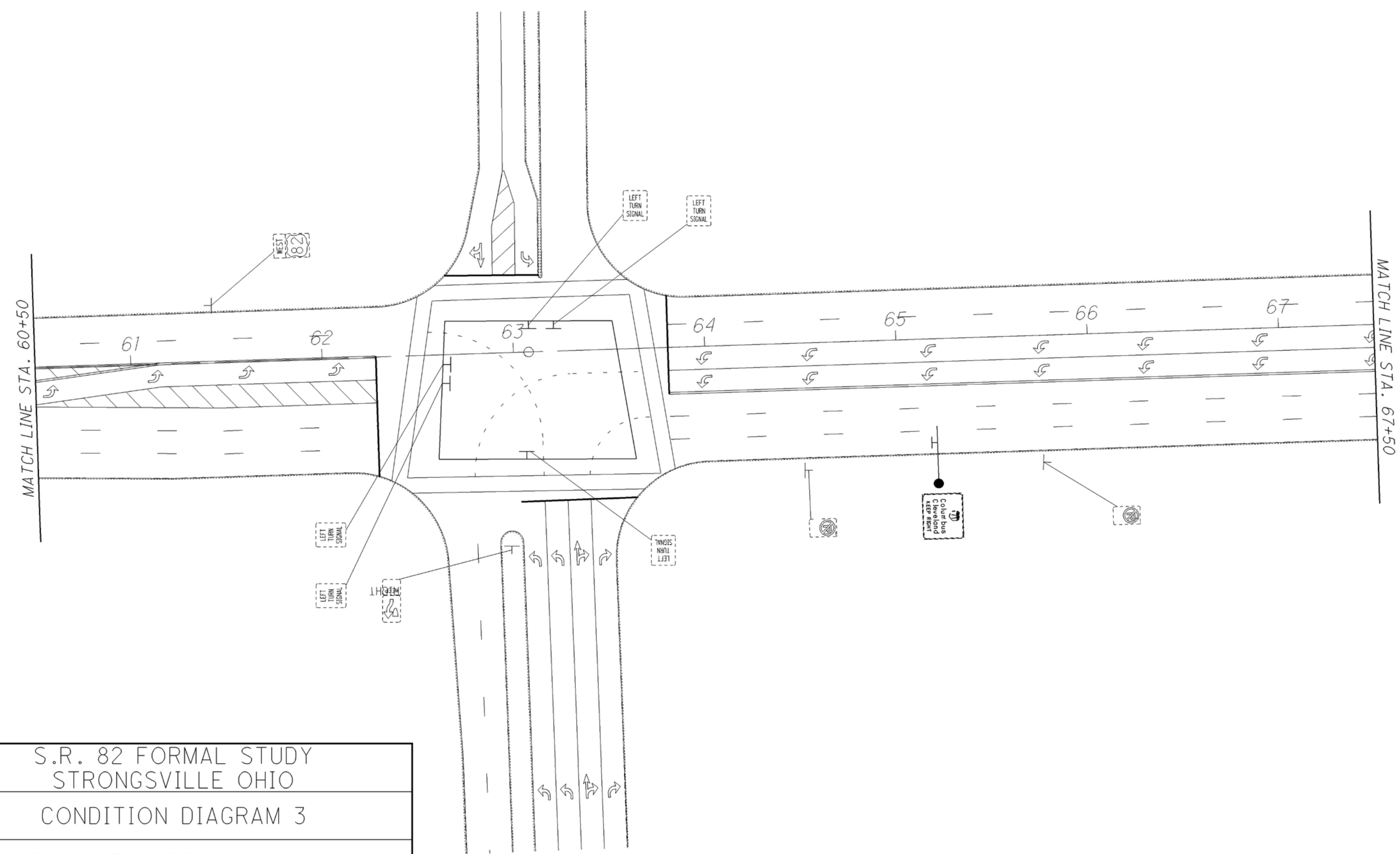


S.R. 82 FORMAL STUDY
STRONGSVILLE OHIO

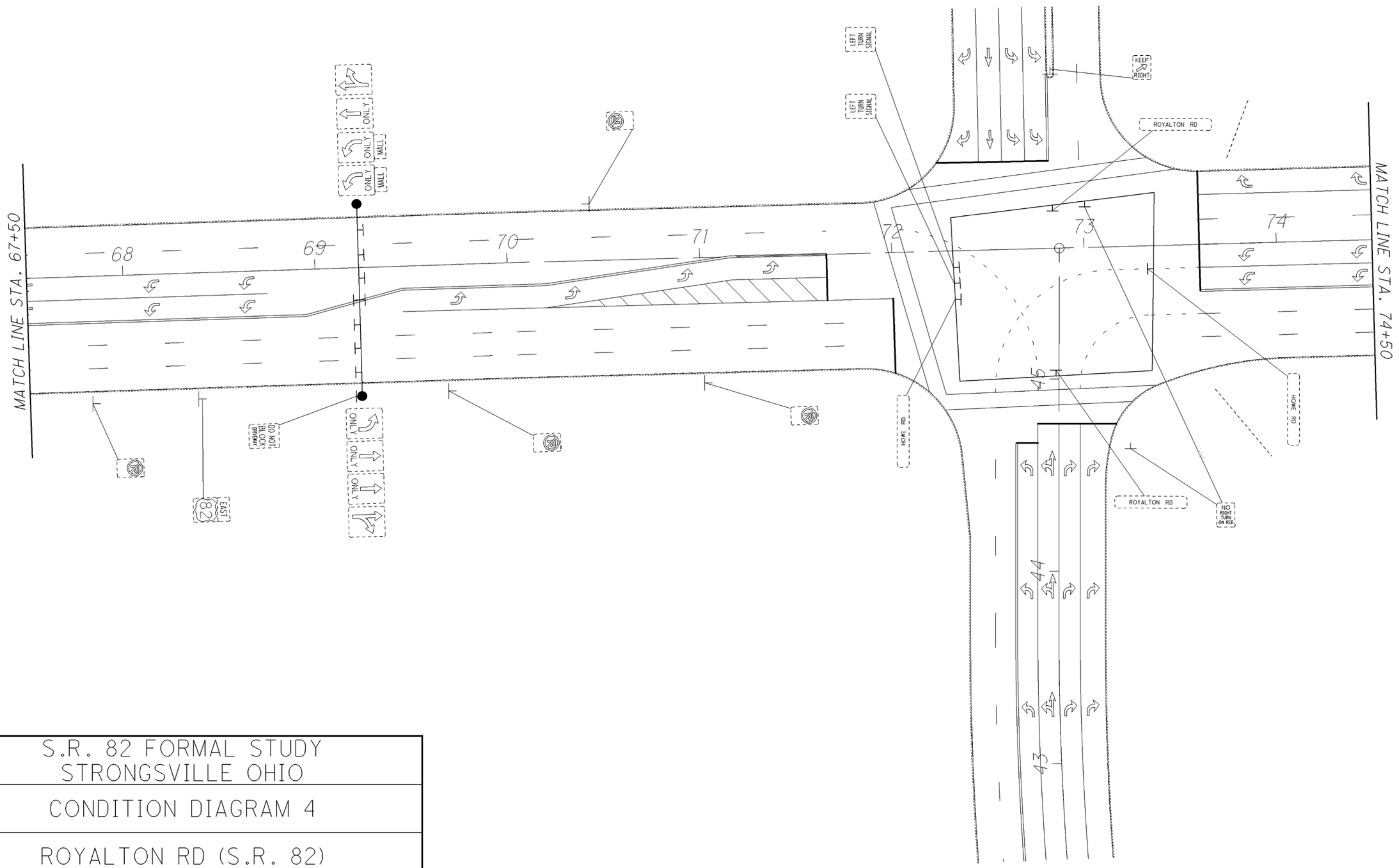
CONDITION DIAGRAM 2

ROYALTON RD (S.R. 82)

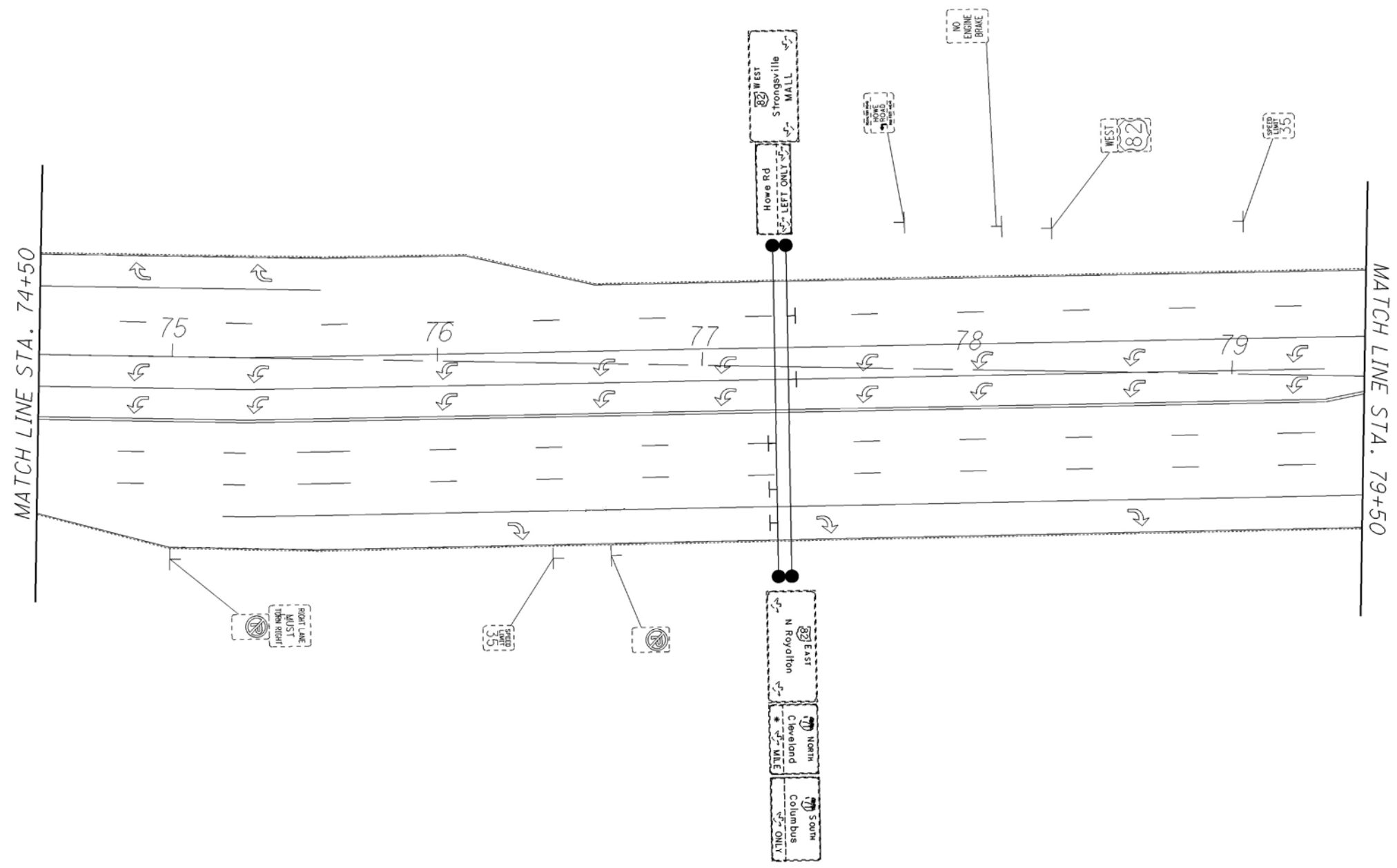
STA 53+50 TO STA 60+50



S.R. 82 FORMAL STUDY STRONGSVILLE OHIO
CONDITION DIAGRAM 3
ROYALTON RD (S.R. 82)
STA 60+50 TO STA 67+50



S.R. 82 FORMAL STUDY
STRONGSVILLE OHIO
CONDITION DIAGRAM 4
ROYALTON RD (S.R. 82)
STA 67+50 TO STA 74+50



S.R. 82 FORMAL STUDY
 STRONGSVILLE OHIO

CONDITION DIAGRAM 5

ROYALTON RD (S.R. 82)

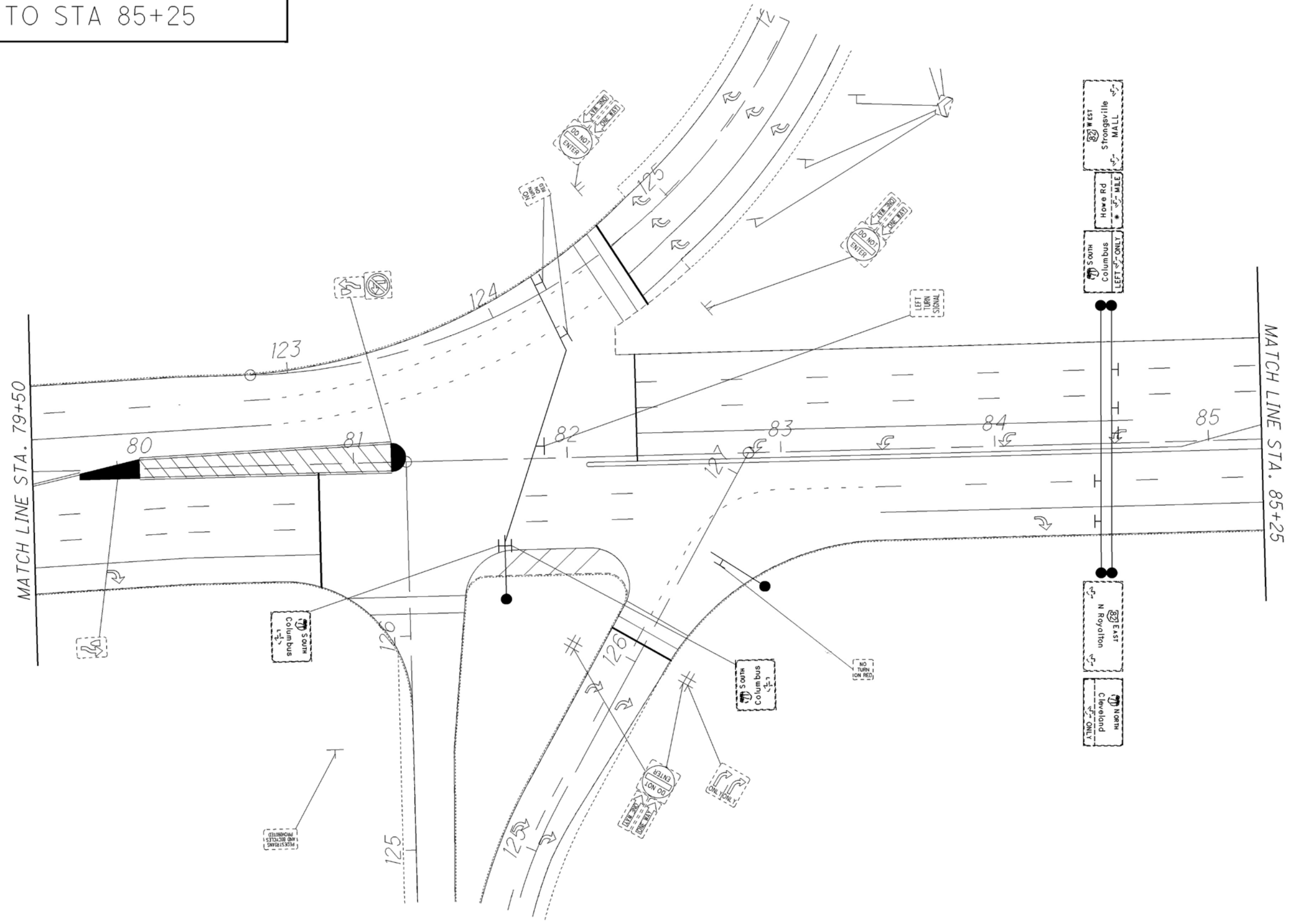
STA 74+50 TO STA 79+50

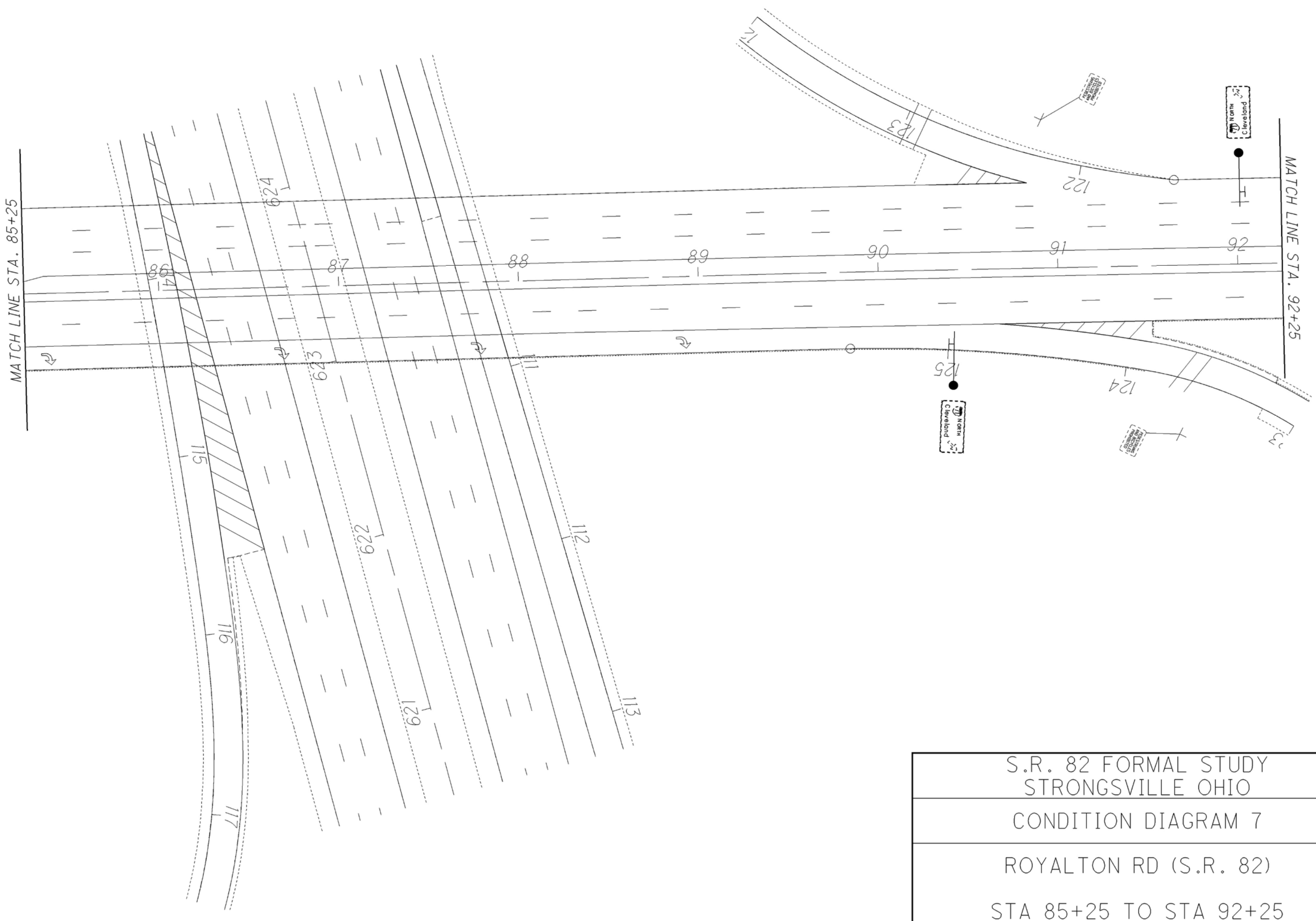
S.R. 82 FORMAL STUDY
STRONGSVILLE OHIO

CONDITION DIAGRAM 6

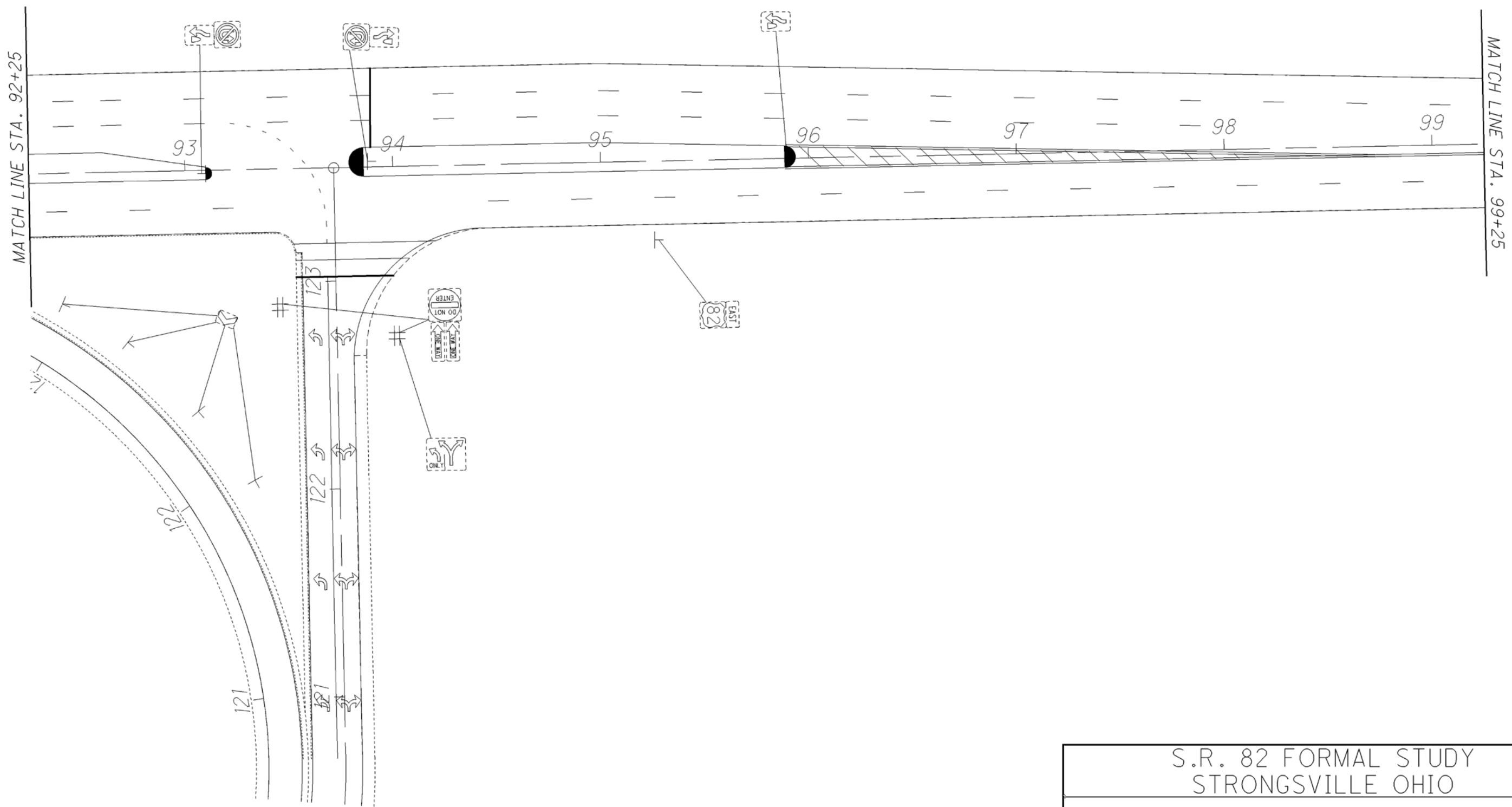
ROYALTON RD (S.R. 82)

STA 79+50 TO STA 85+25





S.R. 82 FORMAL STUDY STRONGSVILLE OHIO
CONDITION DIAGRAM 7
ROYALTON RD (S.R. 82) STA 85+25 TO STA 92+25

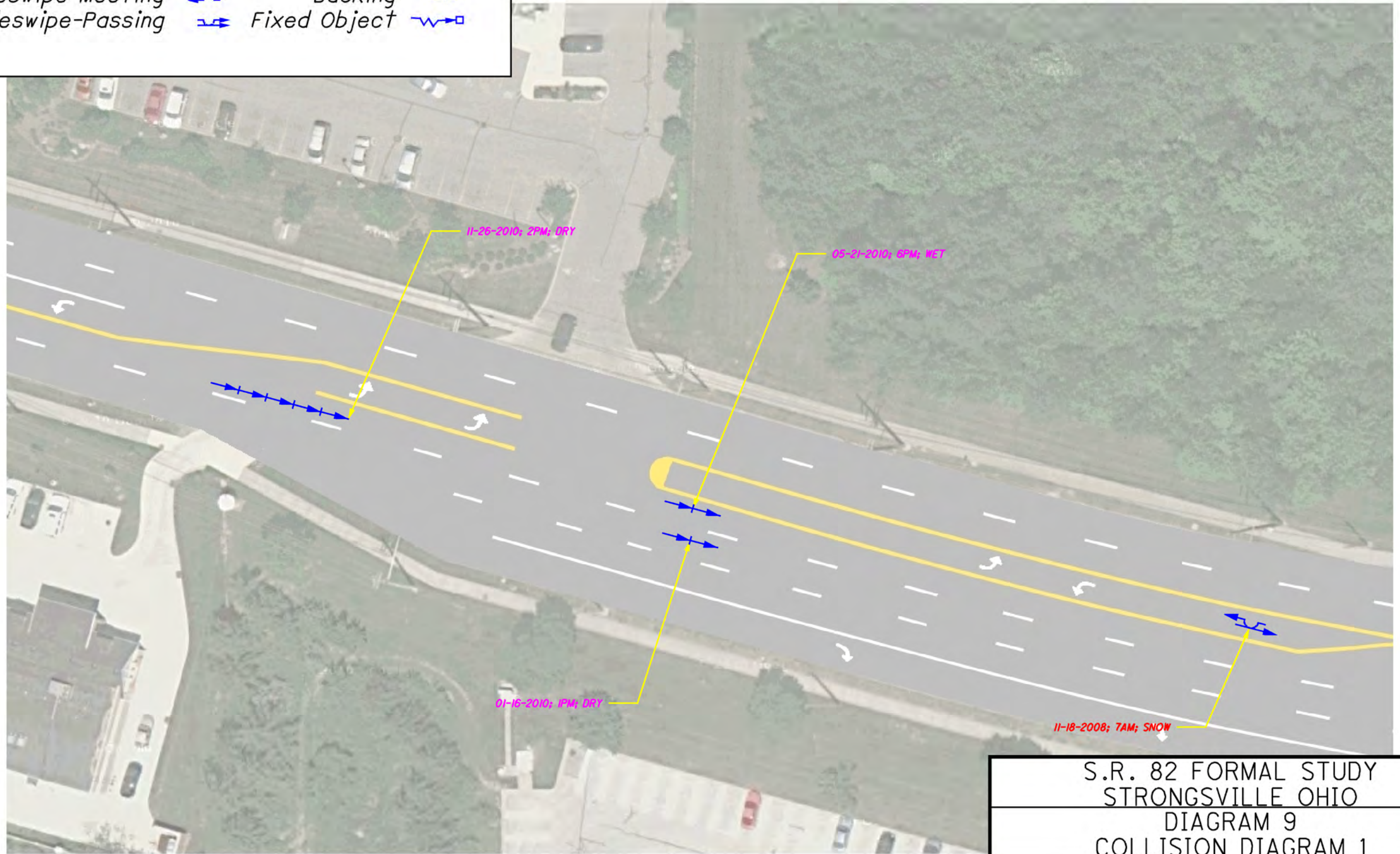


S.R. 82 FORMAL STUDY STRONGSVILLE OHIO
CONDITION DIAGRAM 8
ROYALTON RD (S.R. 82) STA 92+25 TO STA 99+25

Appendix E

Collision Diagrams

LEGEND			
Rear End		Angle	
Head-on		Left Turn	
Sideswipe-Meeting		Backing	
Sideswipe-Passing		Fixed Object	

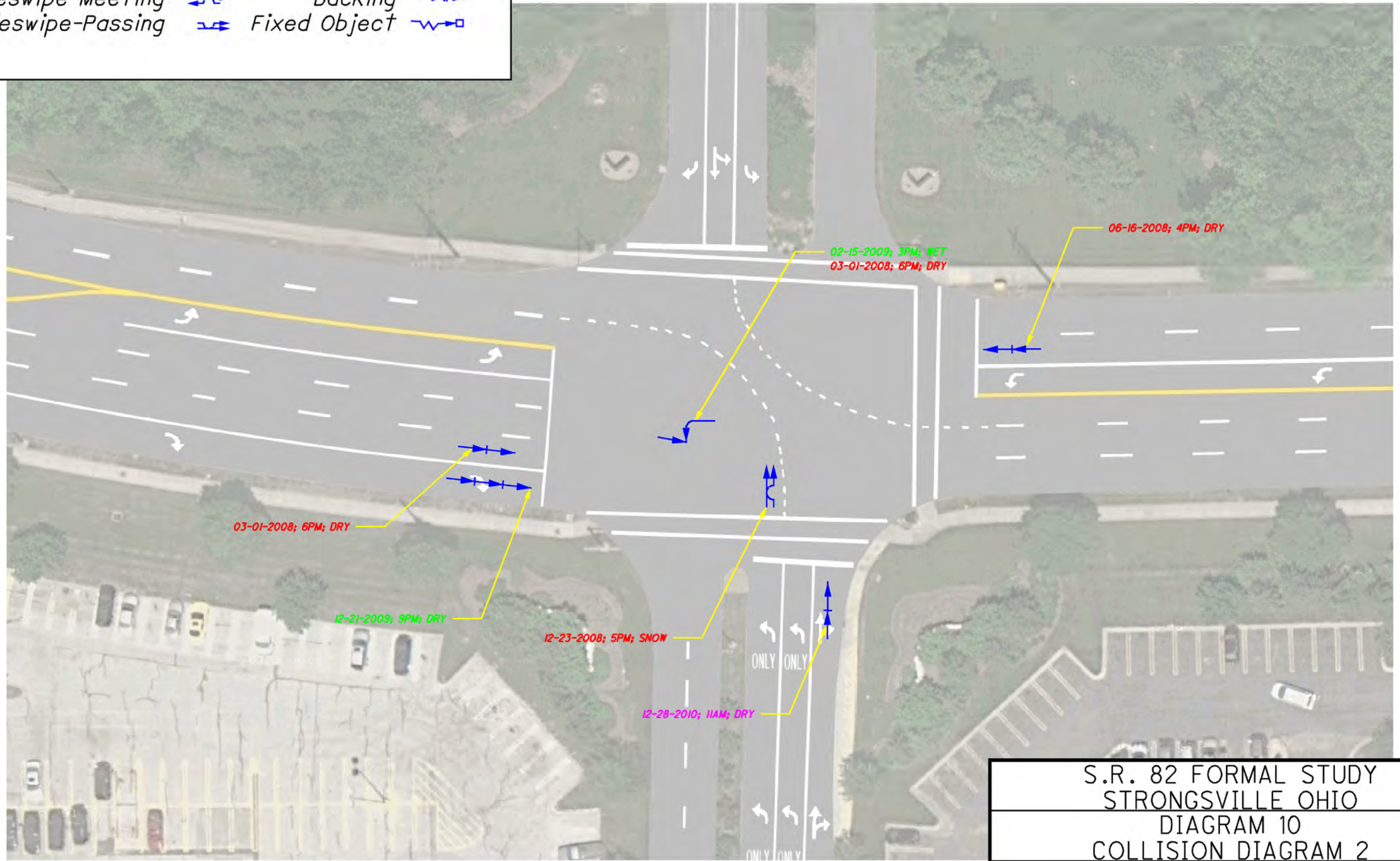


20 ft
10 M

S.R. 82 FORMAL STUDY
STRONGSVILLE OHIO
DIAGRAM 9
COLLISION DIAGRAM 1
ROYALTON RD. (S.R. 82)
WEST OF SOUTHPARK CENTER
WEST ENTRANCE

LEGEND

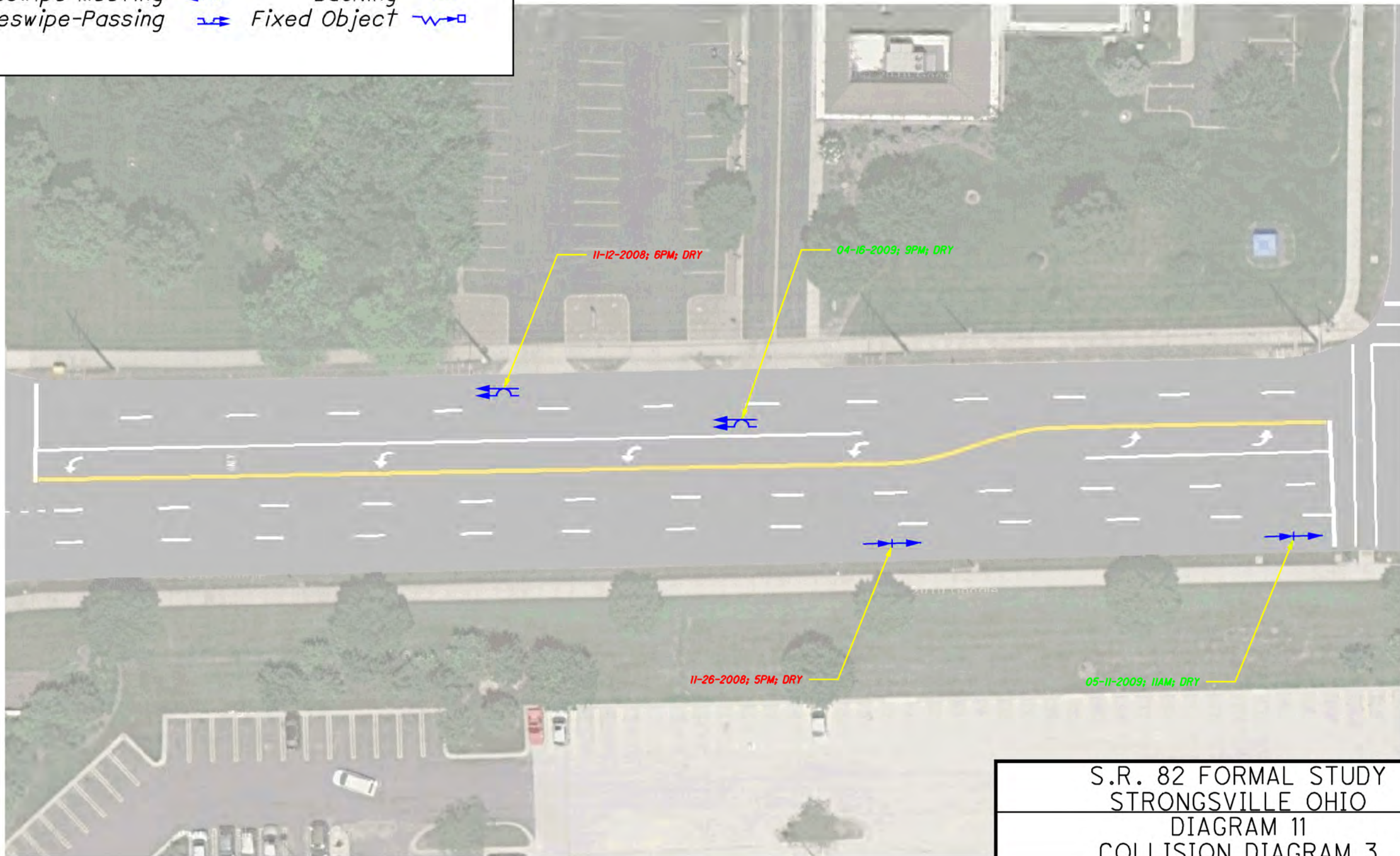
Rear End		Angle	
Head-on		Left Turn	
Sideswipe-Meeting		Backing	
Sideswipe-Passing		Fixed Object	



20 ft
10 M

S.R. 82 FORMAL STUDY
 STRONGSVILLE OHIO
 DIAGRAM 10
 COLLISION DIAGRAM 2
 ROYALTON RD. (S.R. 82)
 &
 SOUTHPARK CENTER (WEST)

LEGEND			
Rear End		Angle	
Head-on		Left Turn	
Sideswipe-Meeting		Backing	
Sideswipe-Passing		Fixed Object	

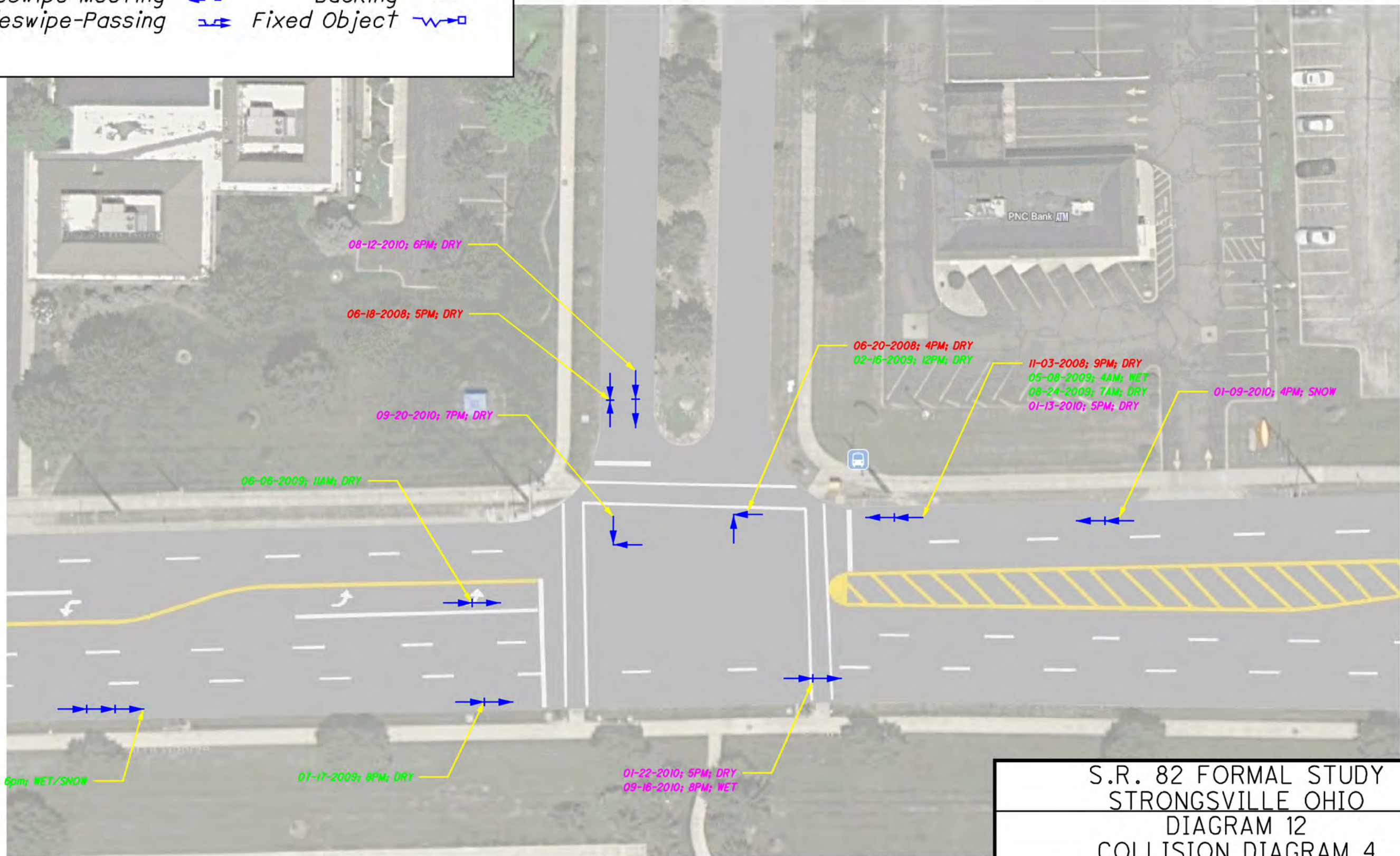


20 ft
10 M

S.R. 82 FORMAL STUDY STRONGSVILLE OHIO
DIAGRAM 11 COLLISION DIAGRAM 3
ROYALTON RD. (S.R. 82) EAST OF FALLING WATER RD.

LEGEND

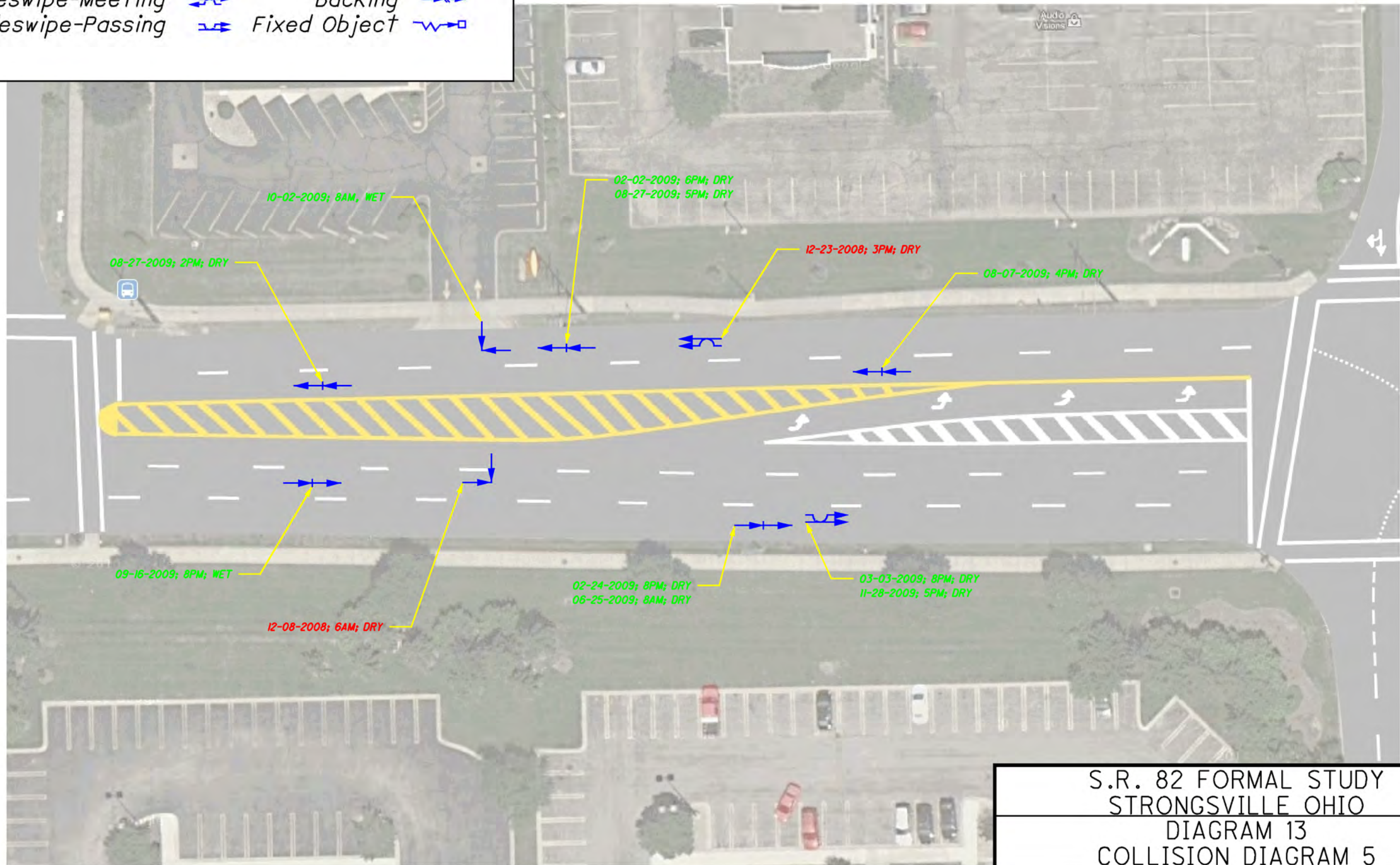
Rear End		Angle	
Head-on		Left Turn	
Sideswipe-Meeting		Backing	
Sideswipe-Passing		Fixed Object	



20 ft
10 M

S.R. 82 FORMAL STUDY
 STRONGSVILLE OHIO
 DIAGRAM 12
 COLLISION DIAGRAM 4
 ROYALTON RD. (S.R. 82)
 &
 FALLING WATER RD.

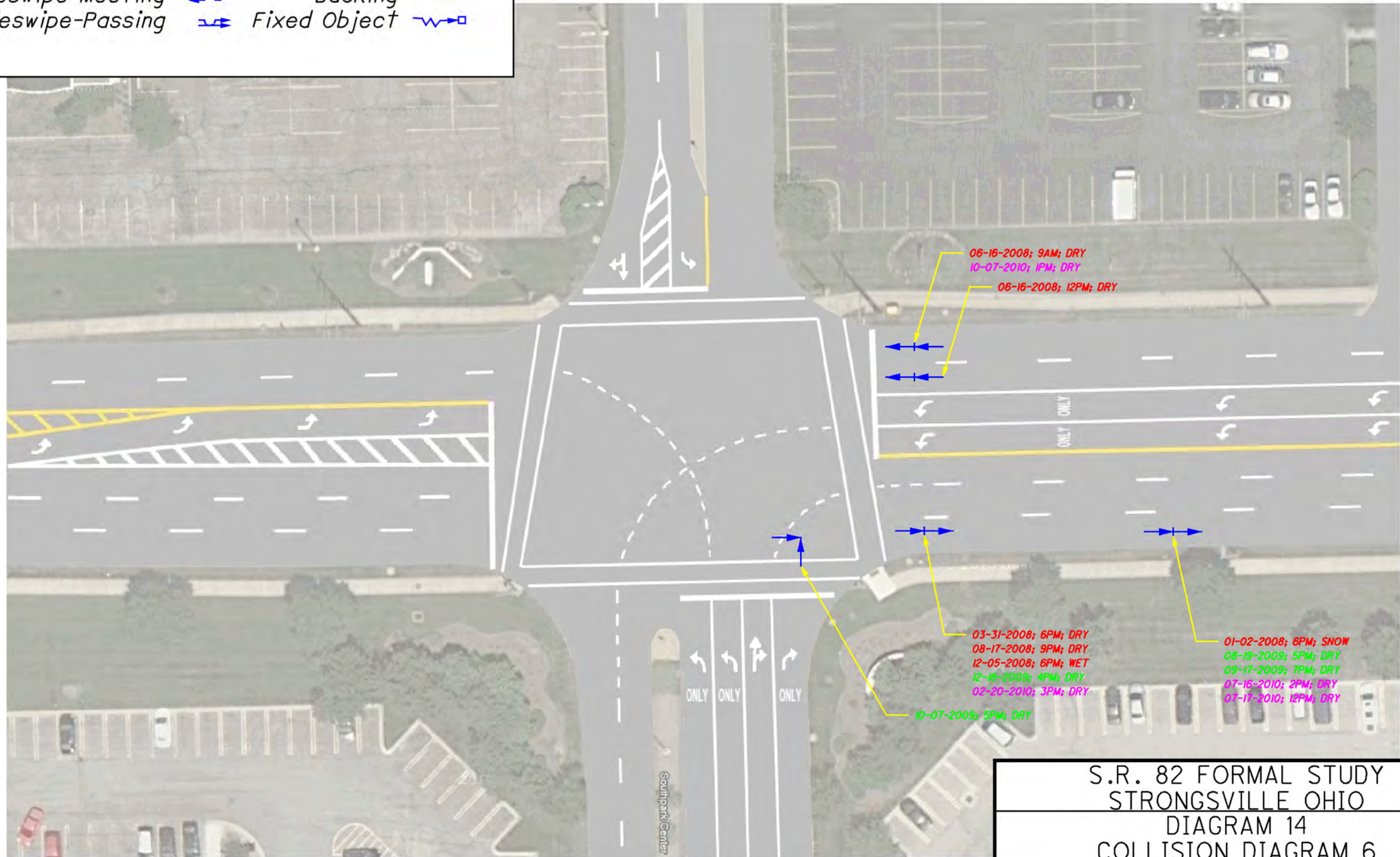
LEGEND			
Rear End		Angle	
Head-on		Left Turn	
Sideswipe-Meeting		Backing	
Sideswipe-Passing		Fixed Object	



20 ft
10 M

S.R. 82 FORMAL STUDY
STRONGSVILLE OHIO
DIAGRAM 13
COLLISION DIAGRAM 5
ROYALTON RD. (S.R. 82)
WEST OF SOUTHPARK CENTER
EAST ENTRANCE

LEGEND			
Rear End		Angle	
Head-on		Left Turn	
Sideswipe-Meeting		Backing	
Sideswipe-Passing		Fixed Object	











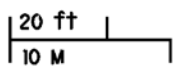
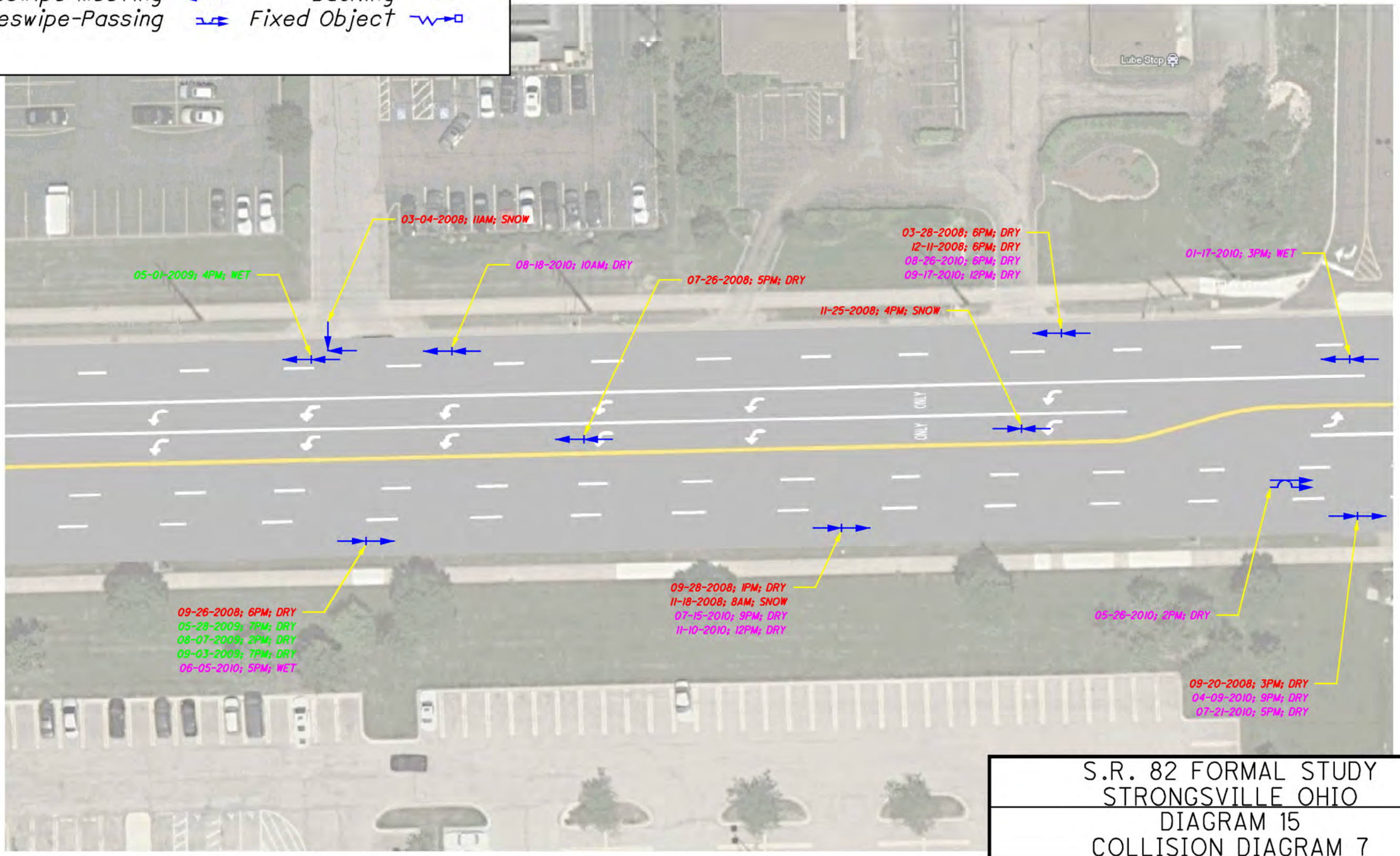
20 ft
10 M

S.R. 82 FORMAL STUDY
STRONGSVILLE OHIO
DIAGRAM 14
COLLISION DIAGRAM 6
ROYALTON RD. (S.R. 82)
&
SOUTHPARK CENTER EAST

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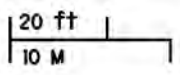
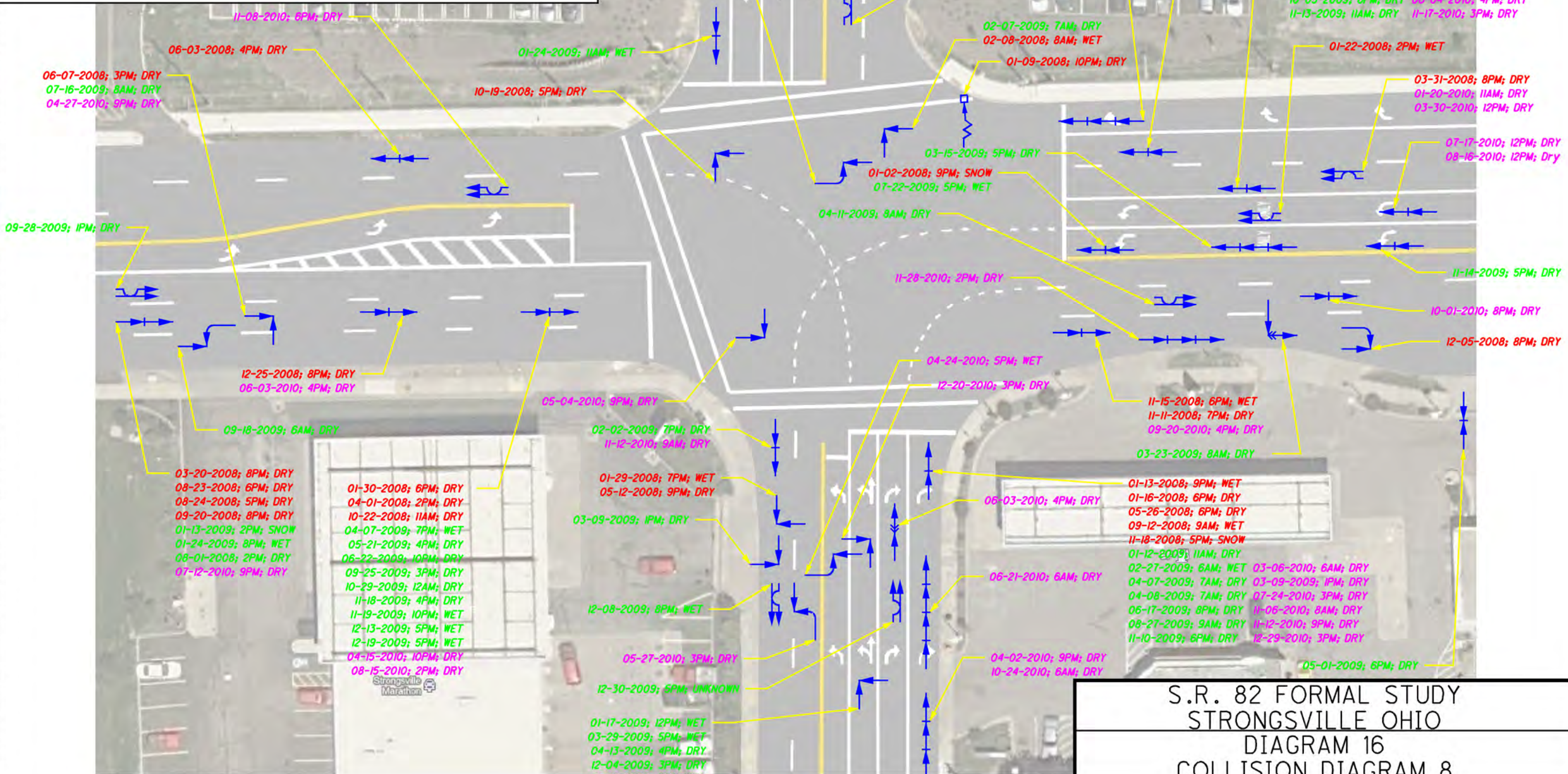
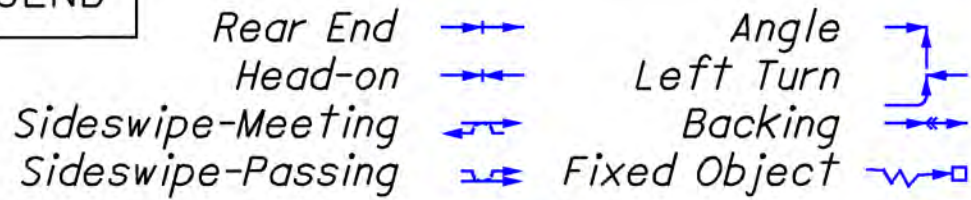
LEGEND

- Rear End 
- Head-on 
- Sideswipe-Meeting 
- Sideswipe-Passing 
- Angle 
- Left Turn 
- Backing 
- Fixed Object 



S.R. 82 FORMAL STUDY
 STRONGSVILLE OHIO
 DIAGRAM 15
 COLLISION DIAGRAM 7
 ROYALTON RD. (S.R. 82)
 EAST OF HOWE RD.

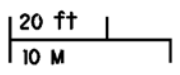
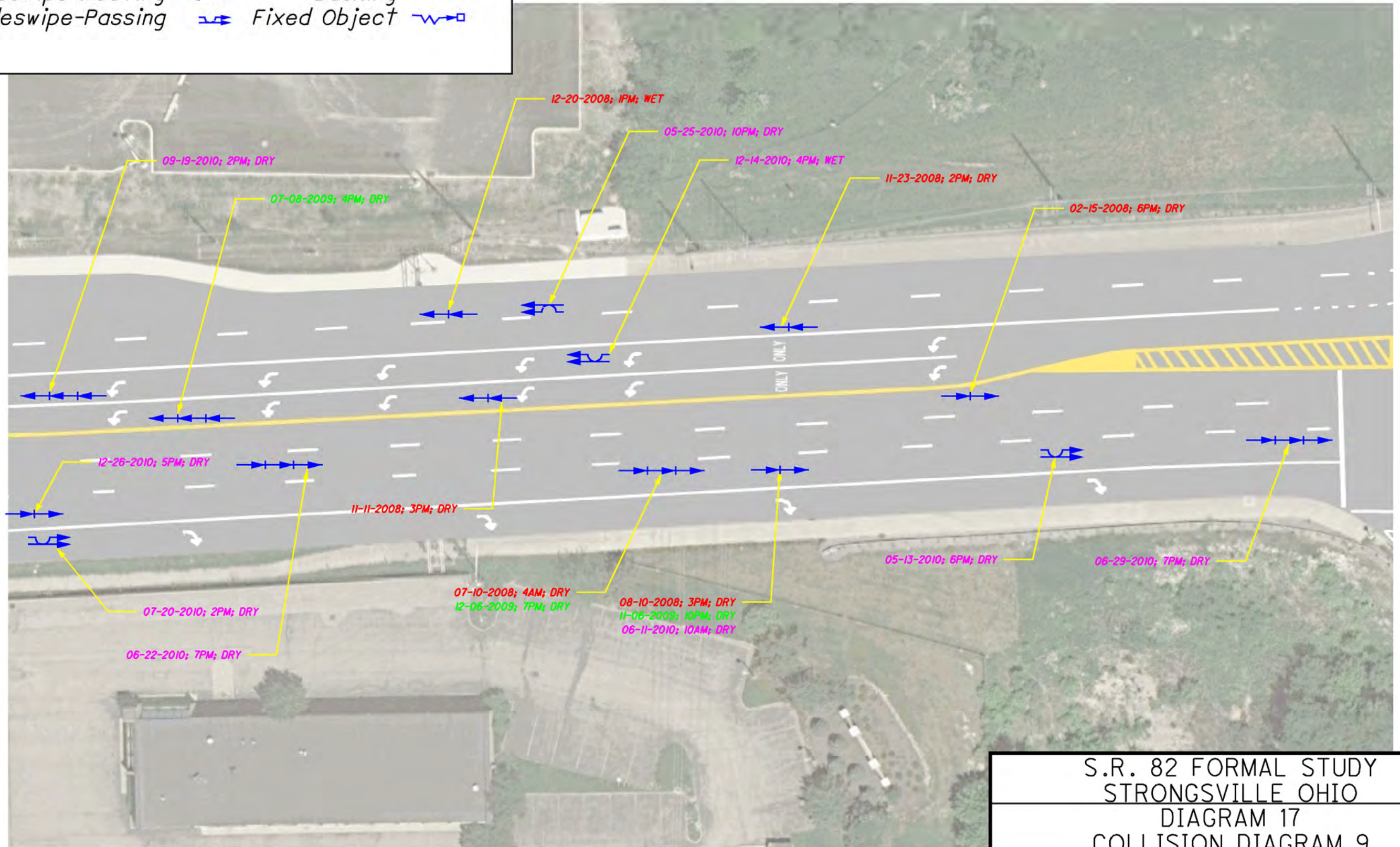
LEGEND



S.R. 82 FORMAL STUDY
 STRONGSVILLE OHIO
 DIAGRAM 16
 COLLISION DIAGRAM 8
 ROYALTON RD. (S.R. 82)
 &
 HOWE RD.

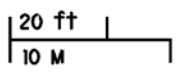
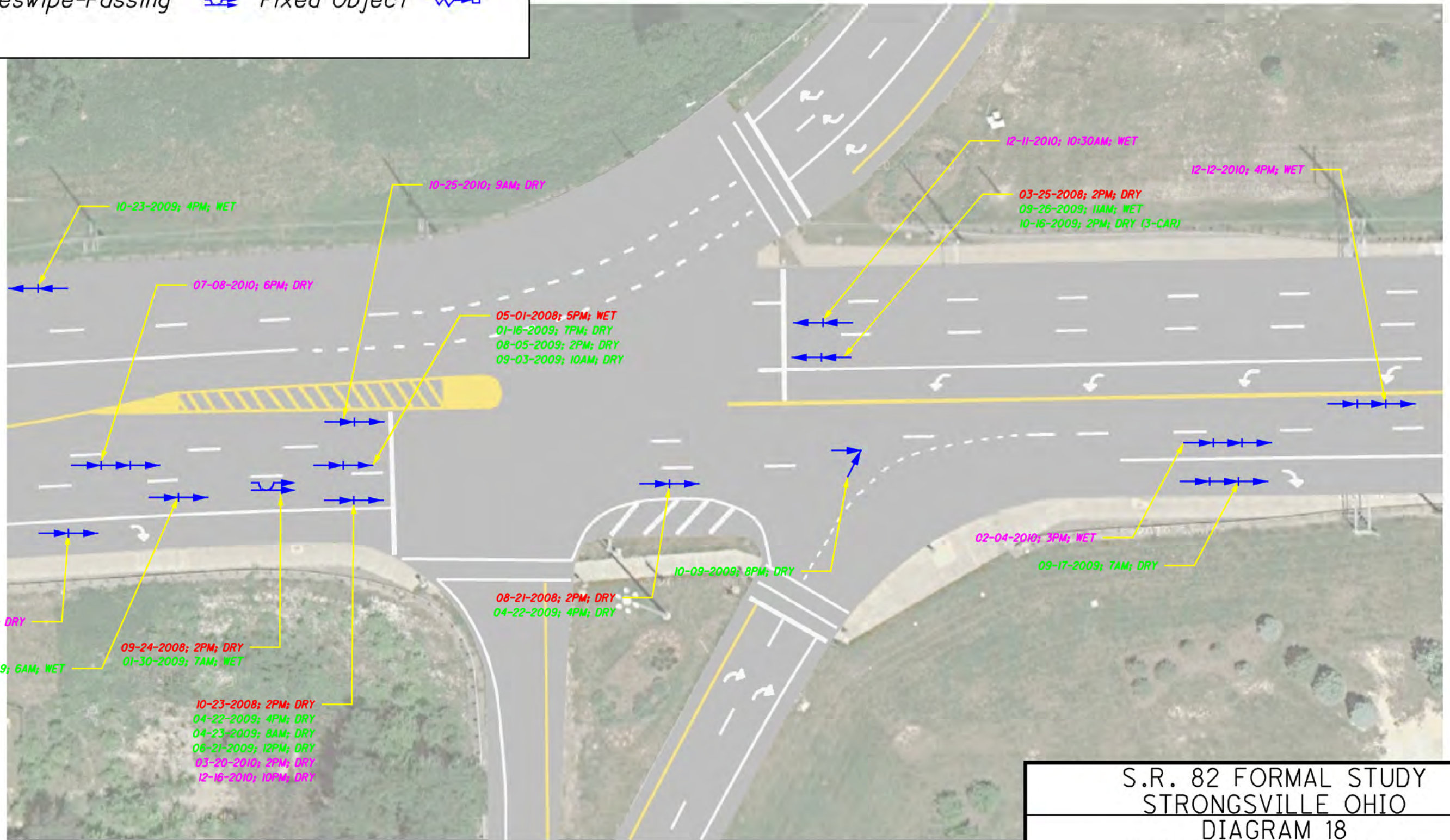
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LEGEND			
Rear End		Angle	
Head-on		Left Turn	
Sideswipe-Meeting		Backing	
Sideswipe-Passing		Fixed Object	



S.R. 82 FORMAL STUDY
 STRONGSVILLE OHIO
 DIAGRAM 17
 COLLISION DIAGRAM 9
 ROYALTON RD. (S.R. 82)
 EAST OF I.R. 71 SOUTH RAMPS

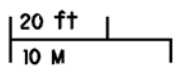
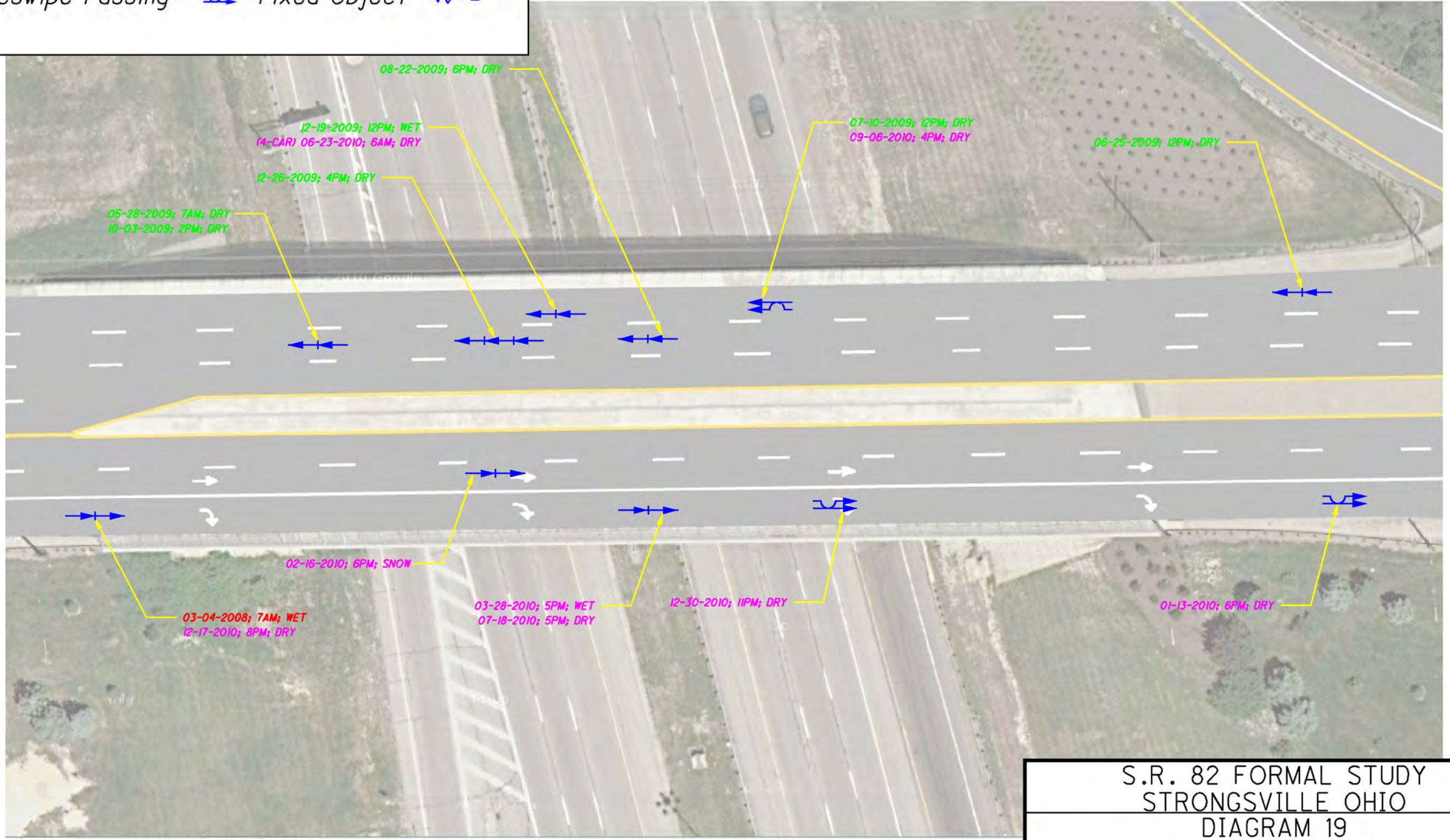
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S.R. 82 FORMAL STUDY
STRONGSVILLE OHIO
DIAGRAM 18
COLLISION DIAGRAM 10
ROYALTON RD. (S.R. 82)
&
I.R. 71 SOUTH RAMPS

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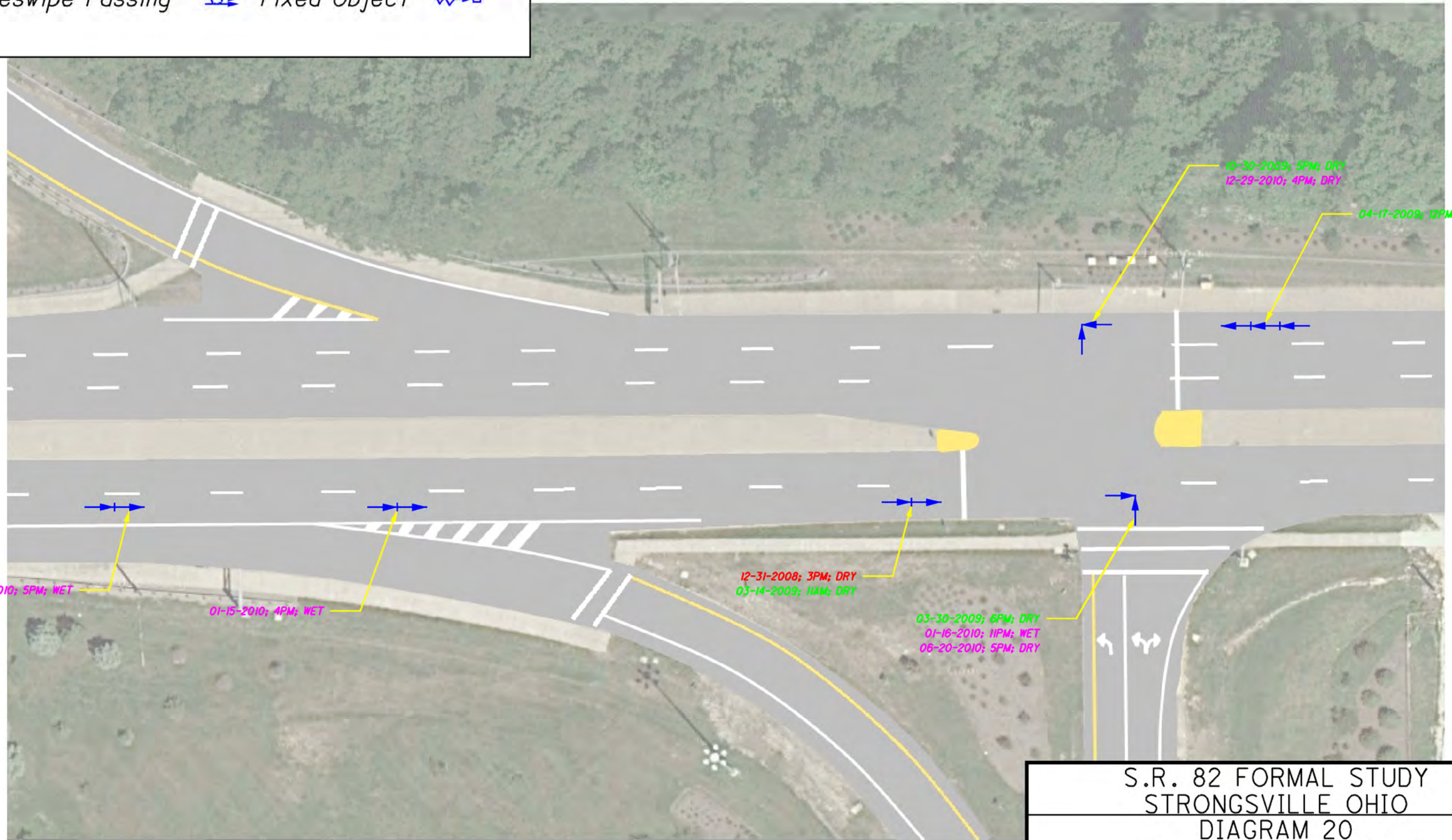
LEGEND			
Rear End		Angle	
Head-on		Left Turn	
Sideswipe-Meeting		Backing	
Sideswipe-Passing		Fixed Object	



S.R. 82 FORMAL STUDY STRONGSVILLE OHIO
DIAGRAM 19 COLLISION DIAGRAM 11
ROYALTON RD. (S.R. 82)
I.R. 71 OVERPASS

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LEGEND			
Rear End		Angle	
Head-on		Left Turn	
Sideswipe-Meeting		Backing	
Sideswipe-Passing		Fixed Object	



11-05-2010; 3PM; WET

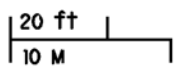
01-15-2010; 4PM; WET

12-31-2008; 3PM; DRY
03-14-2009; 11AM; DRY

03-30-2009; 6PM; DRY
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10-30-2009; 5PM; DRY
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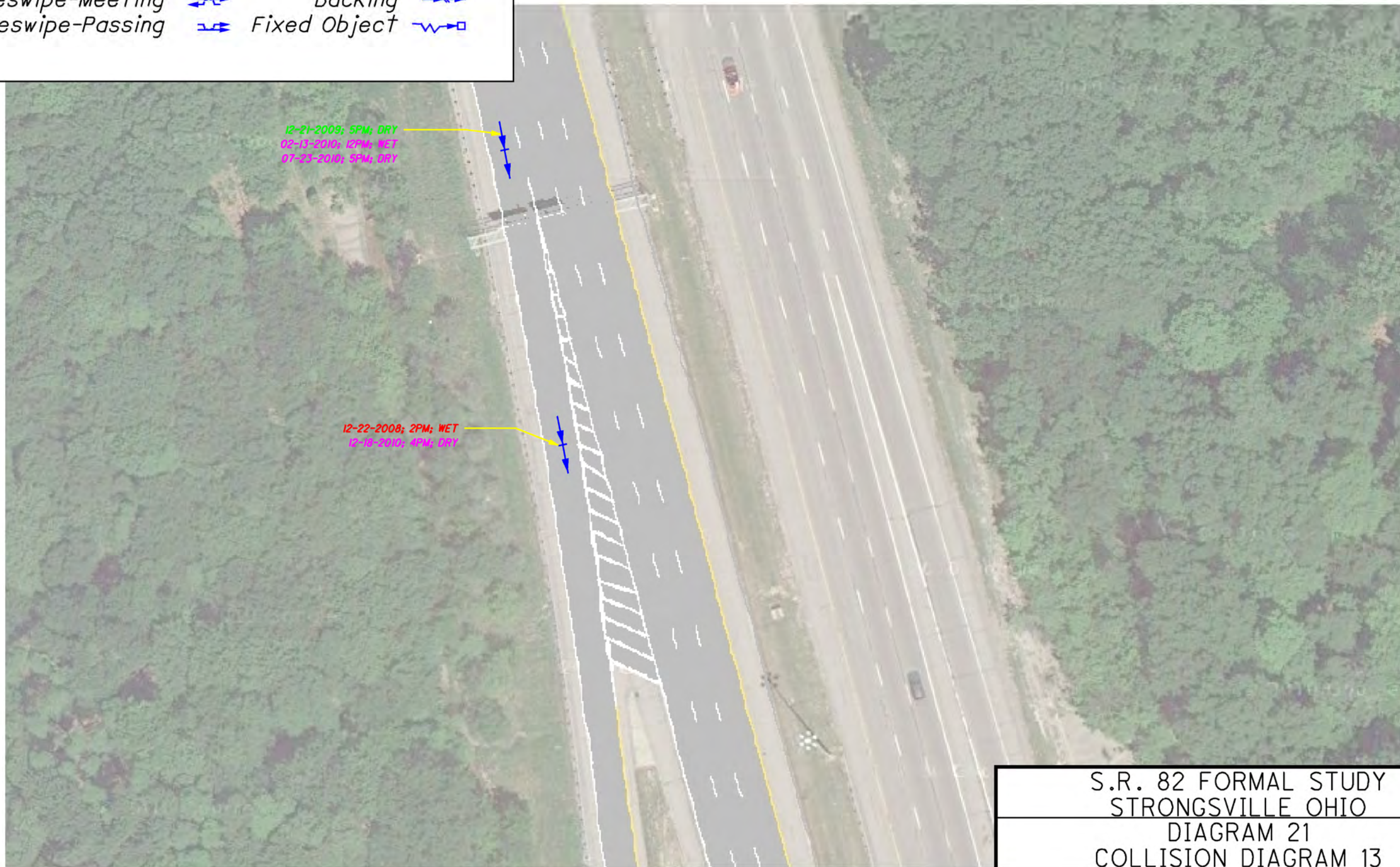
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S.R. 82 FORMAL STUDY STRONGSVILLE OHIO
DIAGRAM 20 COLLISION DIAGRAM 12
ROYALTON RD. (S.R. 82)
I.R. 71 NORTH RAMPS

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LEGEND			
Rear End		Angle	
Head-on		Left Turn	
Sideswipe-Meeting		Backing	
Sideswipe-Passing		Fixed Object	











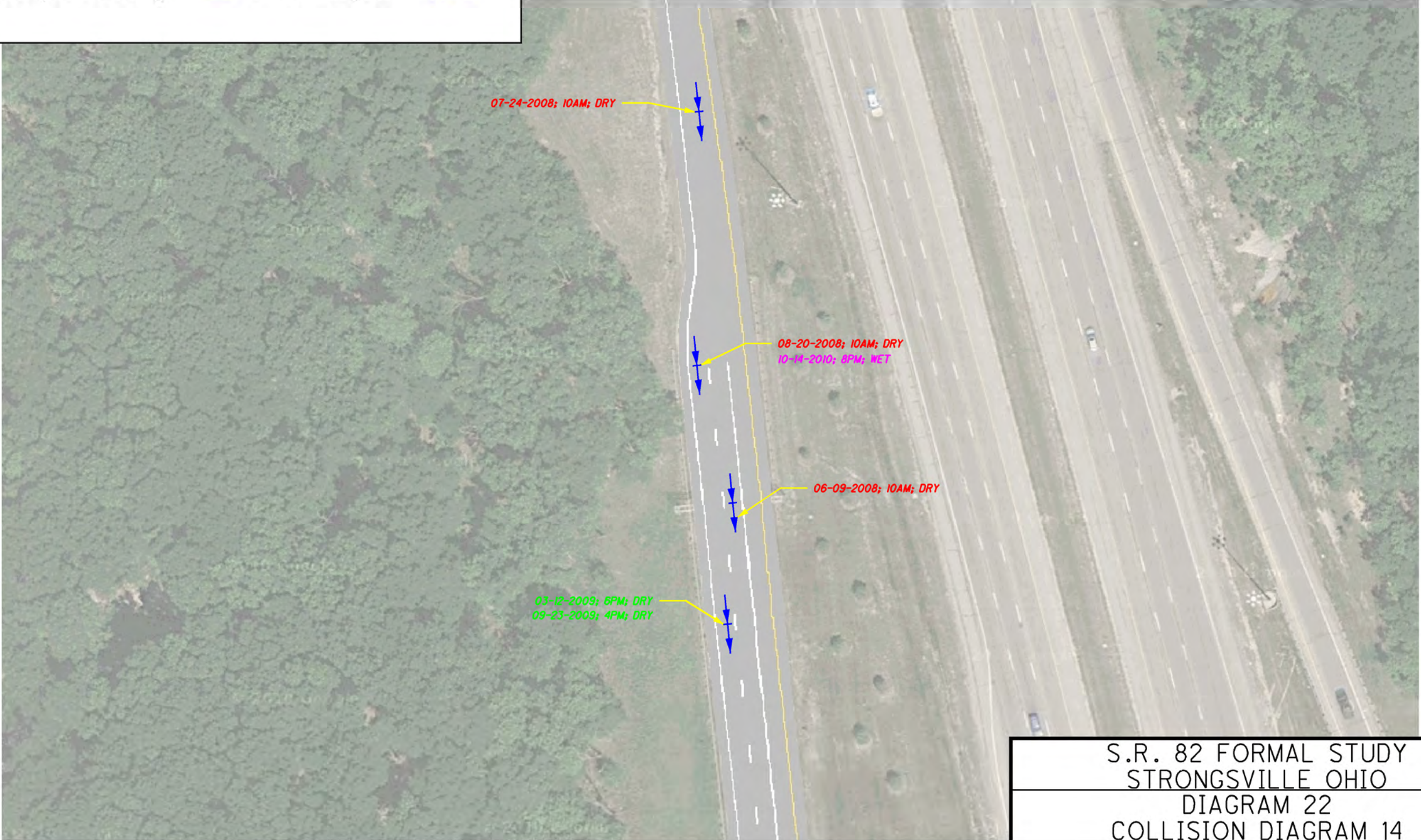
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10 M

S.R. 82 FORMAL STUDY
 STRONGSVILLE OHIO
 DIAGRAM 21
 COLLISION DIAGRAM 13
 I.R. 71 S
 &
 I.R. 71S EXIT RAMP TO S.R. 82 WEST

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LEGEND

- Rear End 
- Head-on 
- Sideswipe-Meeting 
- Sideswipe-Passing 
- Angle 
- Left Turn 
- Backing 
- Fixed Object 

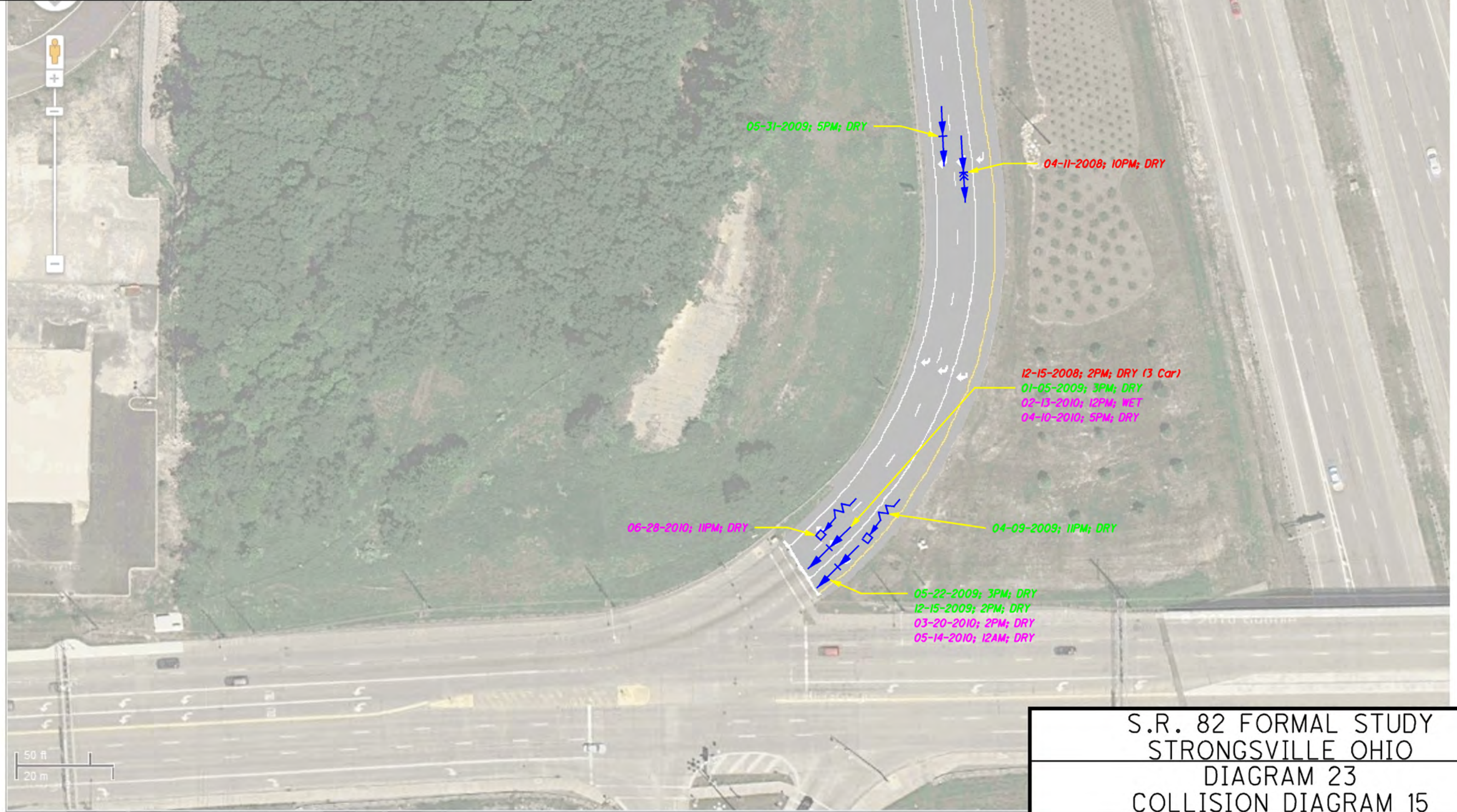


20 ft
10 M

S.R. 82 FORMAL STUDY
 STRONGSVILLE OHIO
 DIAGRAM 22
 COLLISION DIAGRAM 14
 I.R. 71S EXIT RAMP TO S.R. 82 WEST

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LEGEND			
Rear End		Angle	
Head-on		Left Turn	
Sideswipe-Meeting		Backing	
Sideswipe-Passing		Fixed Object	



S.R. 82 FORMAL STUDY
 STRONGSVILLE OHIO
 DIAGRAM 23
 COLLISION DIAGRAM 15
 ROYALTON RD. (S.R. 82)
 &
 I.R. 71S EXIT RAMP TO S.R 82 WEST

20 ft
10 M

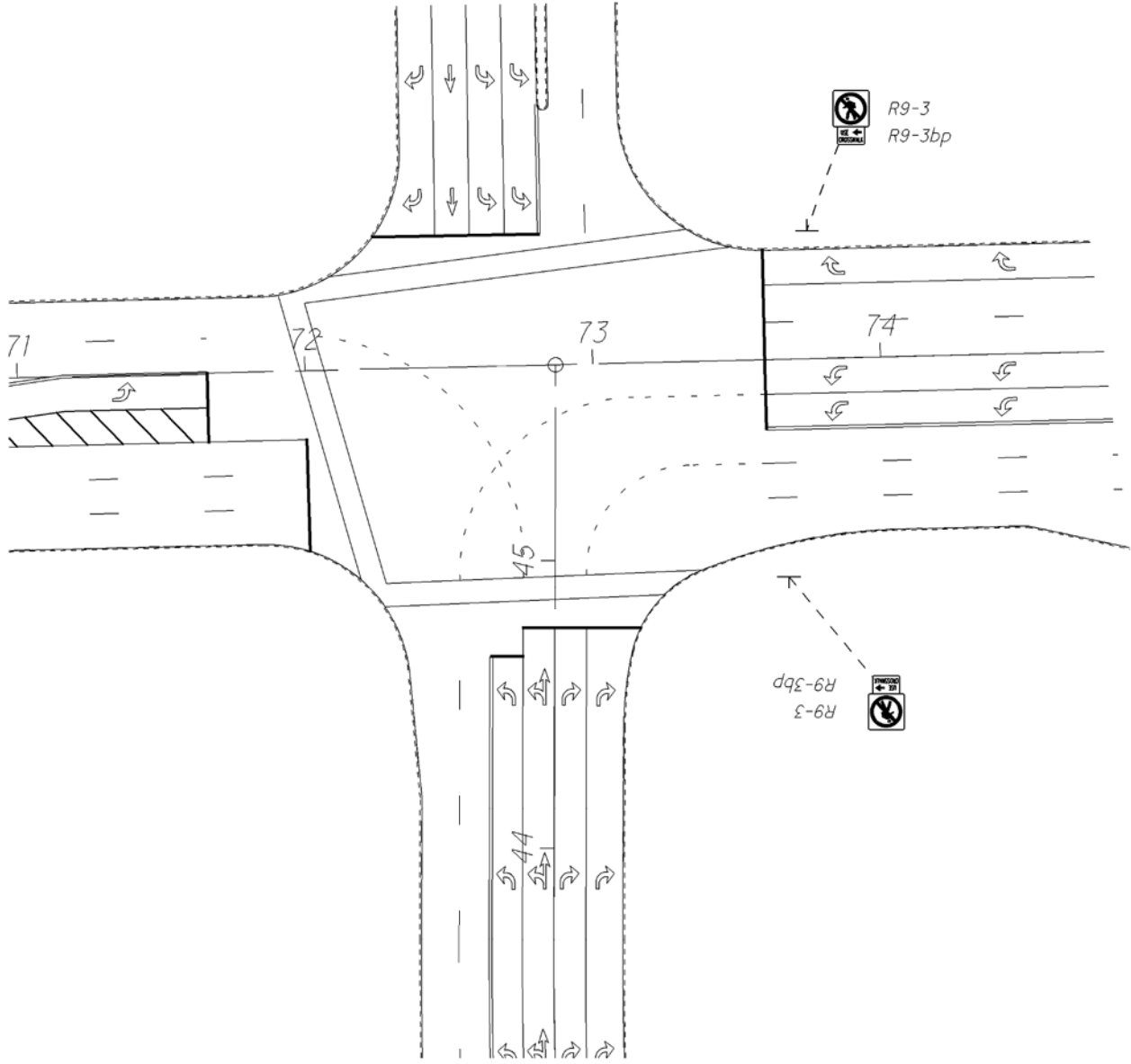
Appendix F

Recommended Countermeasures Diagrams



**PROPOSED NO-PED CROSSING SIGN
S.R. 82 & HOWE**

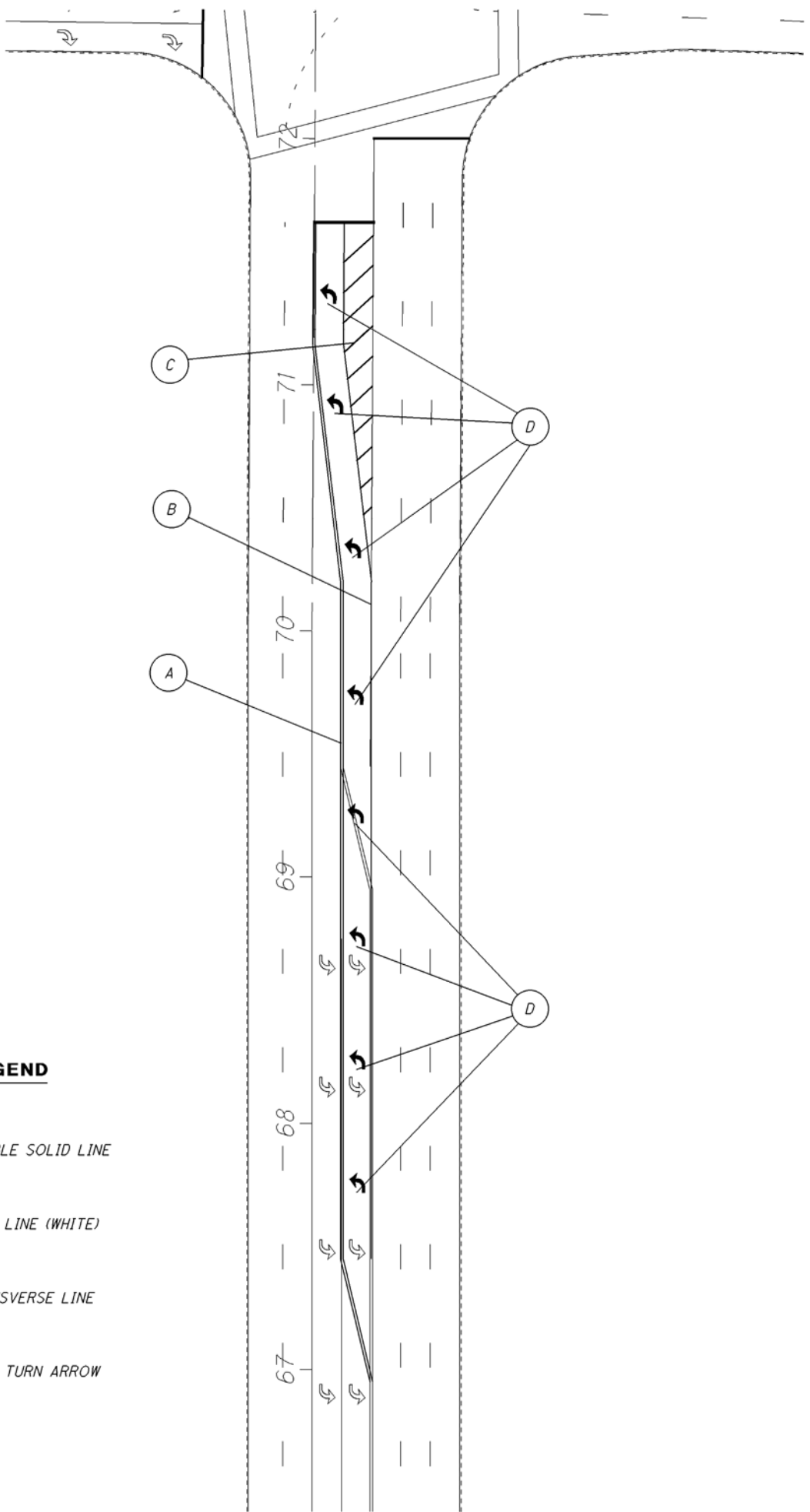
S.R. 82 FORMAL





**SR 82 & HOWE RD. WEST APPROACH
EXTENDED LEFT TURN LANE**

S.R 82 FORMAL



LEGEND

- (A) DOUBLE SOLID LINE
- (B) EDGE LINE (WHITE)
- (C) TRANSVERSE LINE
- (D) LEFT TURN ARROW